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1. Accepted: Abstract by International Food Conference 2021 (25-8-2021)

-Correspondence

-Acceptance Letter

-Guideline IFC



Paini Sri Widyawati <paini@ukwms.ac.id>

Abstract Acceptance

International Food Conference 2021 <ifc@ukwms.ac.id>
To: paini@ukwms.ac.id

Wed, Aug 25, 2021 at 8:00 AM


Dear Participant,

First of all, congratulations! Your abstract is accepted! Through this email, we would like to attach some important information for the next step. We also attach the guidelines books below and hopefully these can help you. Thank you and once again, congratulations!

Best regards,
IFC Committee

2 attachments

 **Guidelines IFC 2021.pdf**
4411K

 **Acceptance Letter IFC 2021_Paini Sri Widyawati (RDP-87).pdf**
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INTERNATIONAL FOOD CONFERENCE 2021
AGRICULTURAL TECHNOLOGY FACULTY

WIDYA MANDALA SURABAYA CATHOLIC UNIVERSITY

Jl. Dinoyo 42 – 44 Surabaya 60265



Surabaya, August 22th 2021

No. : 37/FTP-IFC/8/2021

Subject : 3rd Circular Abstract Acceptance

Paini Sri Widyawati

Widya Mandala Surabaya Catholic University

Dear Paini Sri Widyawati,

On behalf of the INTERNATIONAL FOOD CONFERENCE (IFC) 2021 Organizing Committee, we are pleased to inform you that your abstract entitled **Potency of Pluchea (Pluchea indica Less) Leaves to Increase Functional Value of Wet Noodles** with **RDP-85** has been selected for the **POSTER** presentation at the IFC 2021, which will be held on November 3rd, 2021, as an online conference. Congratulations!

Please prepare your full paper with an appropriate template according to the type of publication you choose. Templates are available on link below:

- <https://www.myfoodresearch.com/author-guidelines.html> (Food Research Journal)
- <https://wasd.org.uk/publications/journals/author/> (International Journal of Food, Nutrition, and Public Health)
- <https://www.e3s-conferences.org/for-authors> (E3S Proceeding, one column format)

If you choose to not publish your paper on those options, you don't have to submit your full paper.

We're kindly remind that there will be additional charge for your publication.

No.	Publication	Additional charge
1.	Food Research (Q3 Scopus-Indexed Journal)	USD 350
2.	International Journal of Food, Nutrition, and Public Health (Proquest-Indexed Journal)	USD 25
3.	E3S (Scopus-Indexed Proceeding)	IDR 1.800.000/ USD 125

Please reconfirm your type publication by August 31th 2021 via email.

Please submit the full paper online through website <http://ocs.wima.ac.id/index.php/IFC2021/home> by September 10th 2021 through your account (see attached IFC Guidelines page 25). Should there be any other information needed, feel free to reach out to us.

We are looking forward to meeting you at the conference.

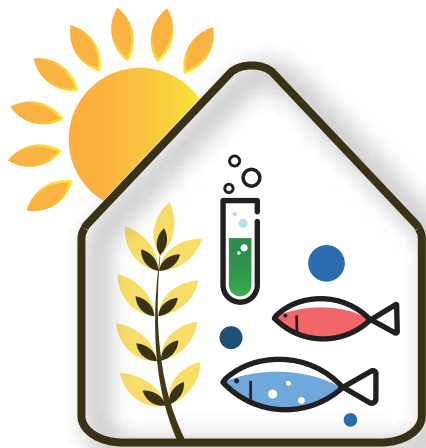
Best regards,



Anita Maya Sutedja, PhD
 Chair Person of Organizing Committee



Dr. Ignatius Srianata
 Dean of Agriculture Technology
 Widya Mandala Surabaya Catholic University
 Surabaya, Indonesia



IFC 2021

**International
Food Conference**

Website User Guide

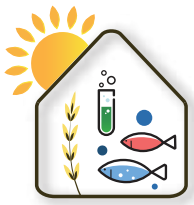


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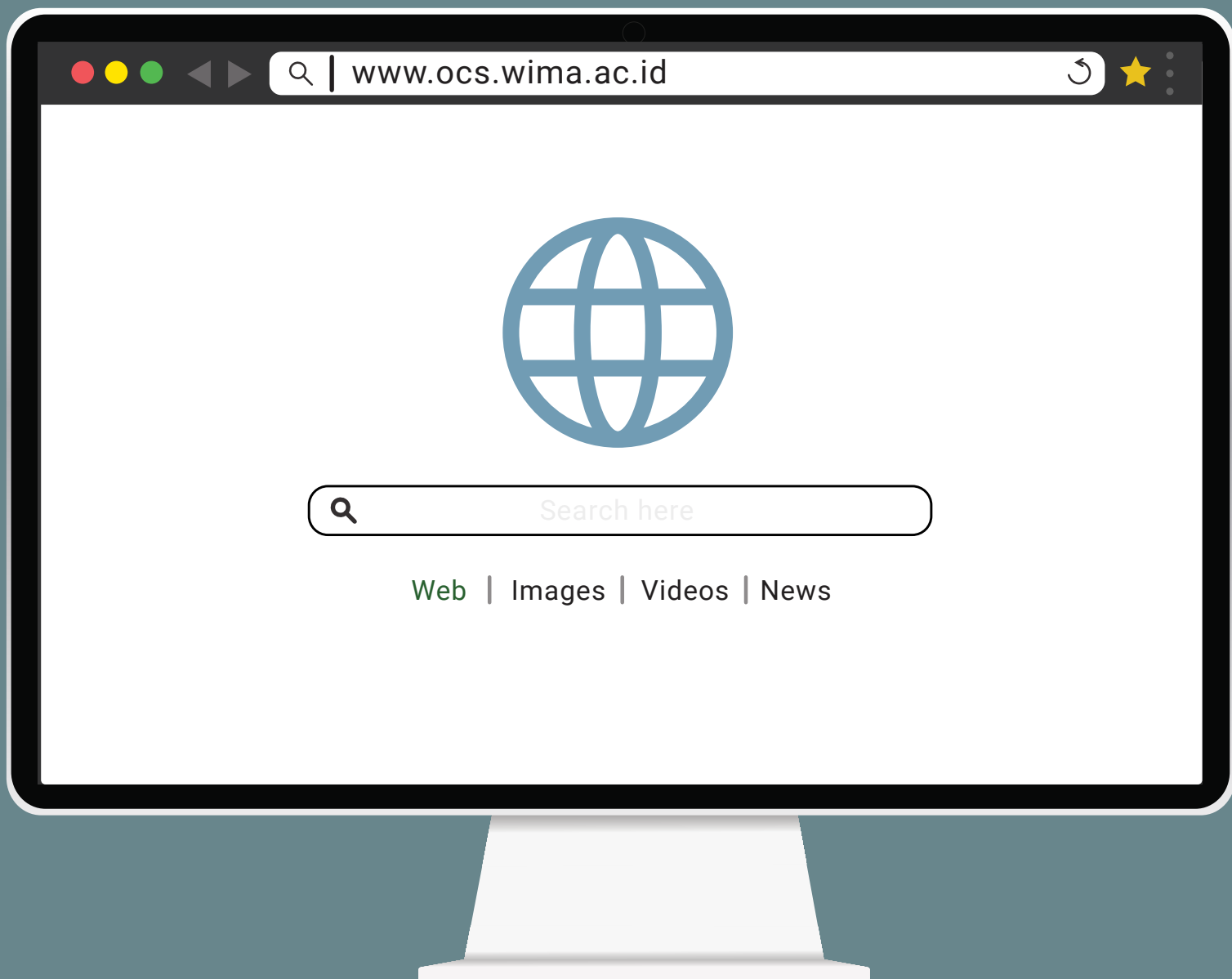




Creating New Account

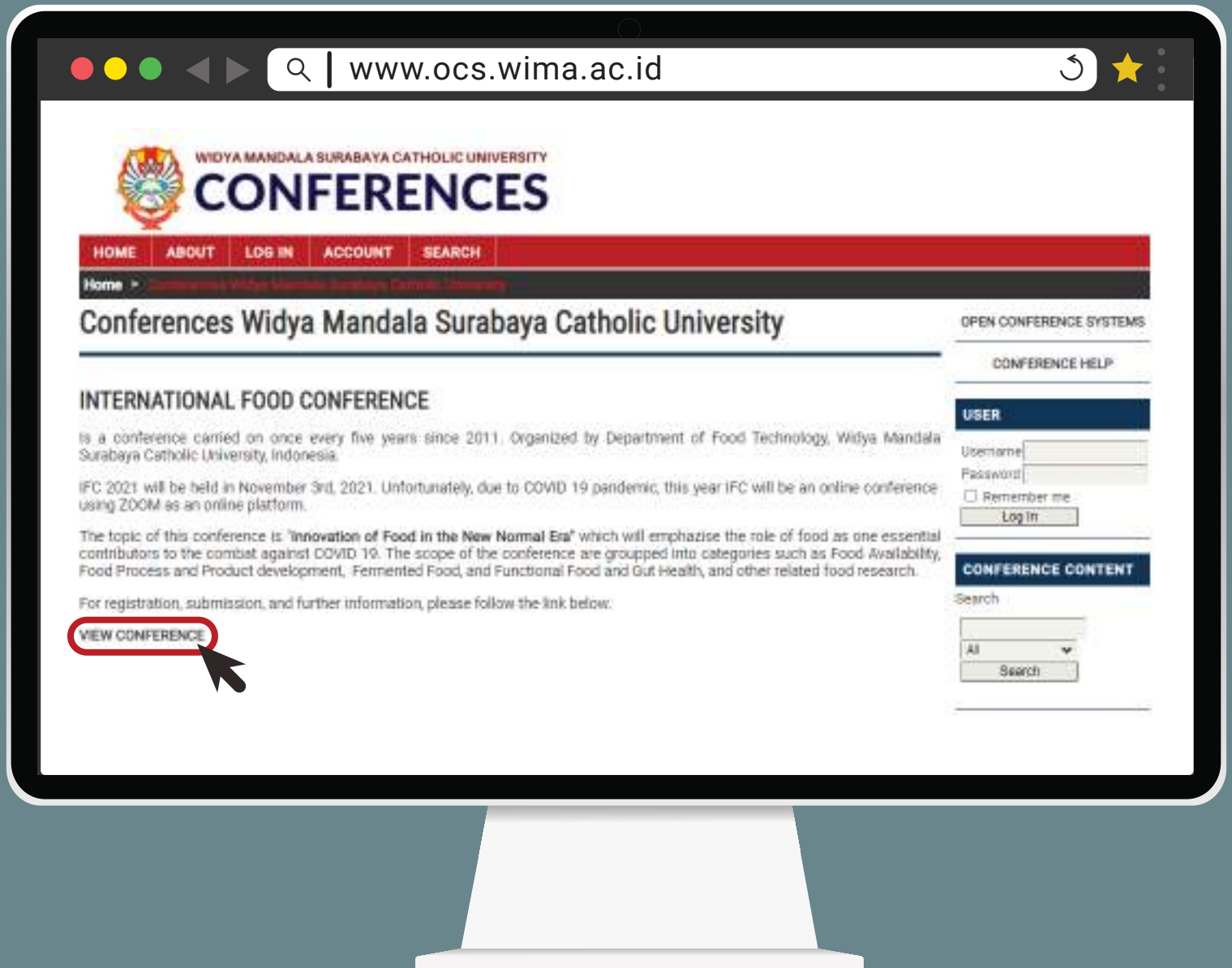
1

Search our website **www.ocs.wima.ac.id**
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We suggested using mozilla firefox browser
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Then select "view conference"
for entering IFC website



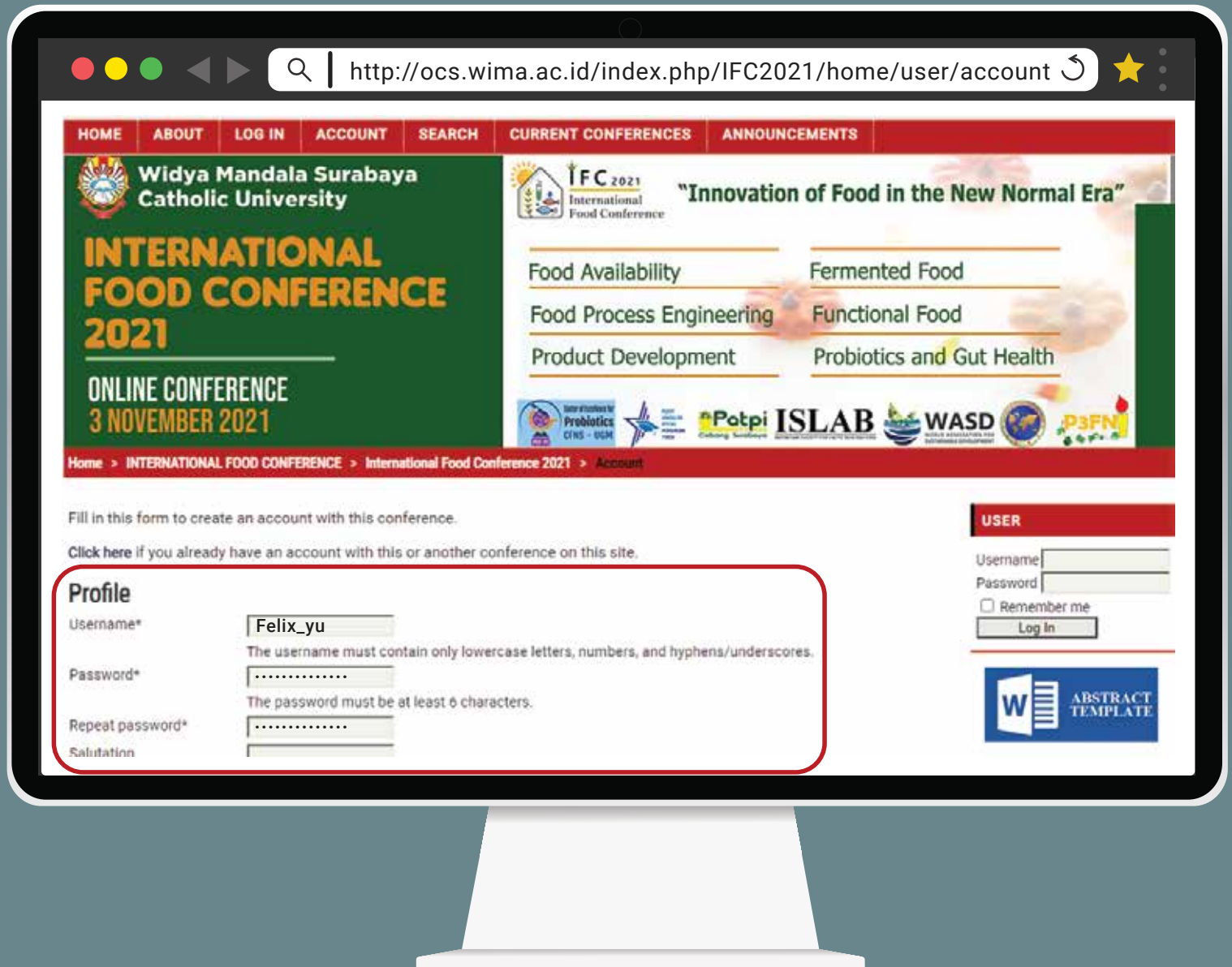
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then select "Account Menu" for creating an account

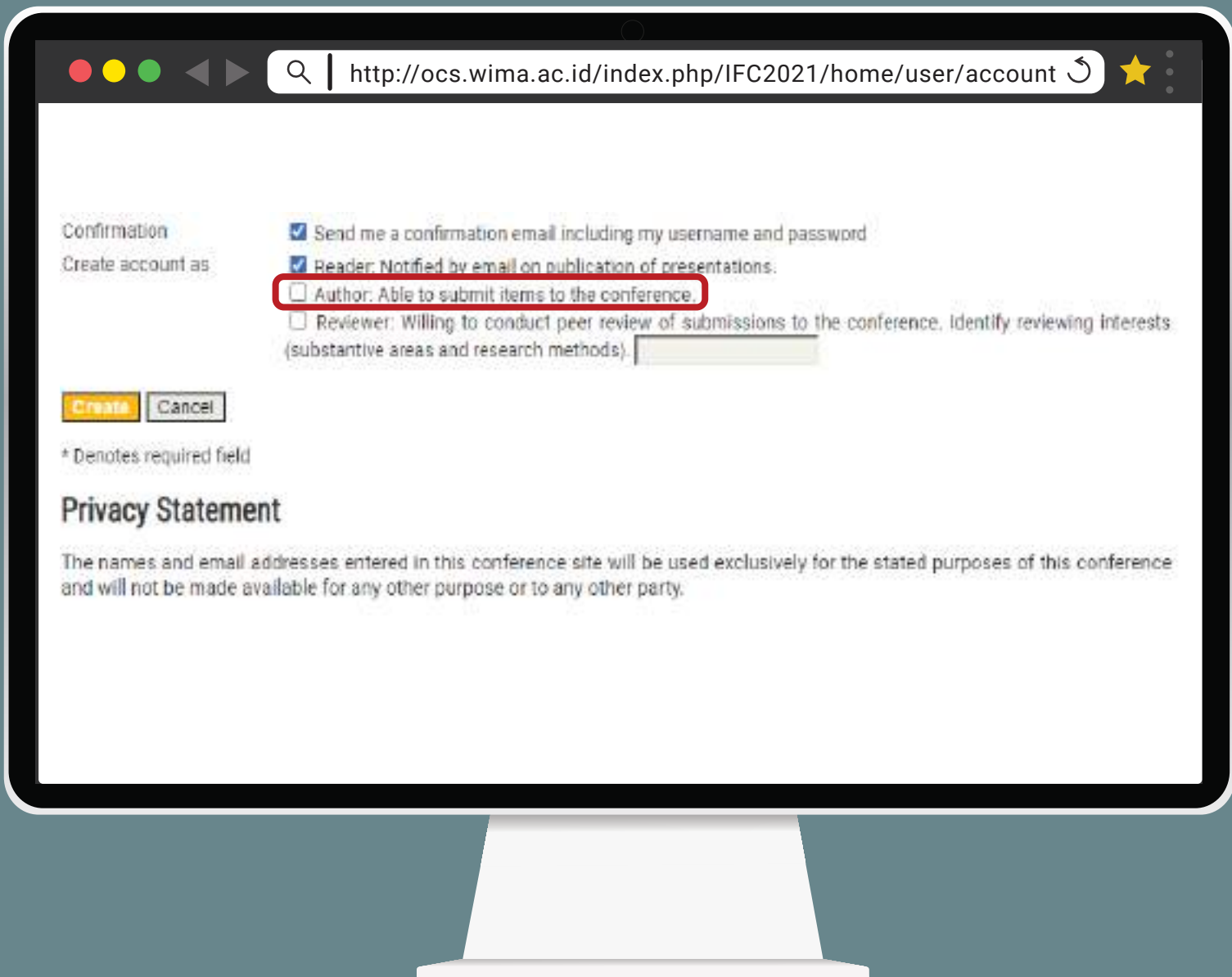


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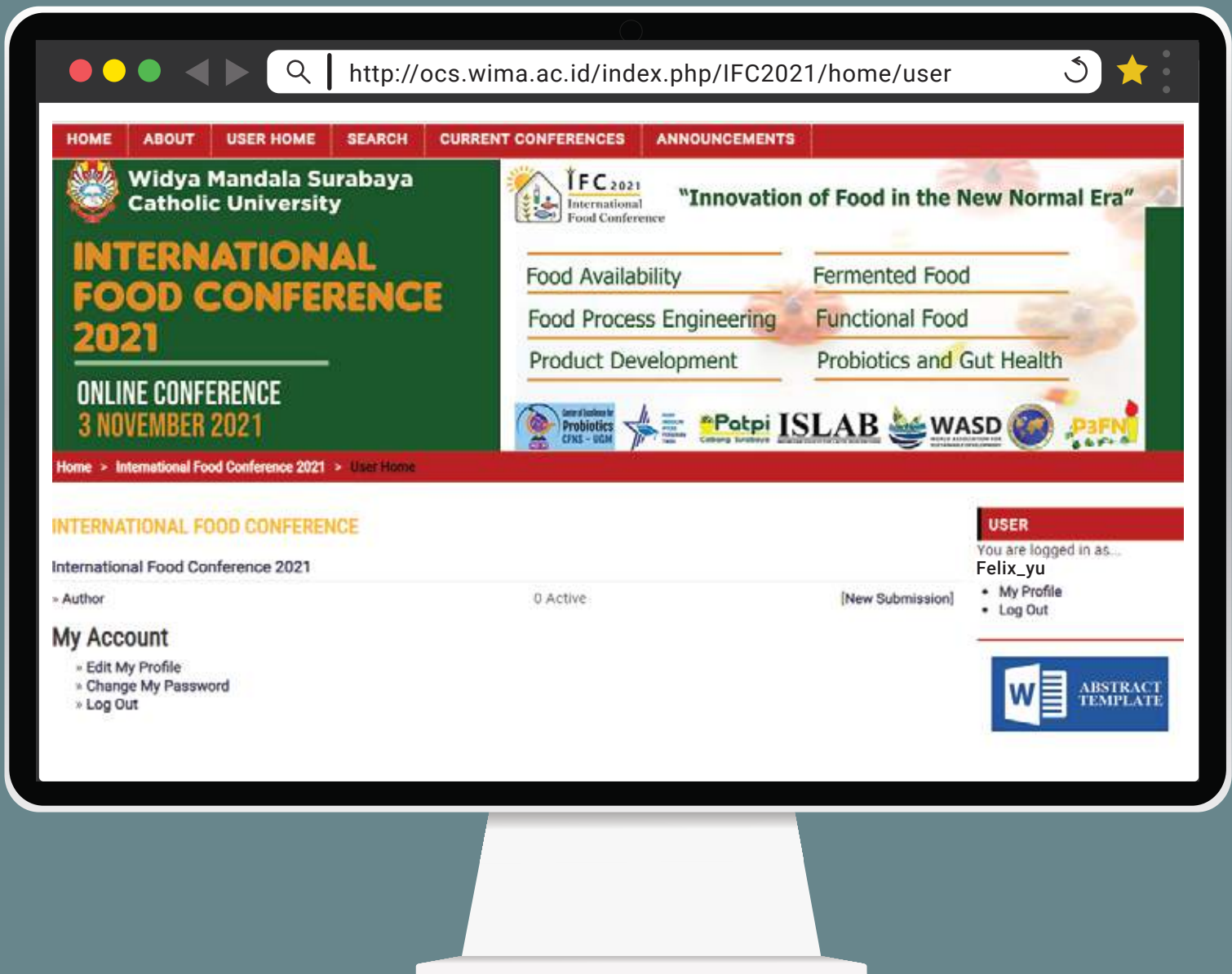


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You can use your account to submit your paper or carry out the registration process



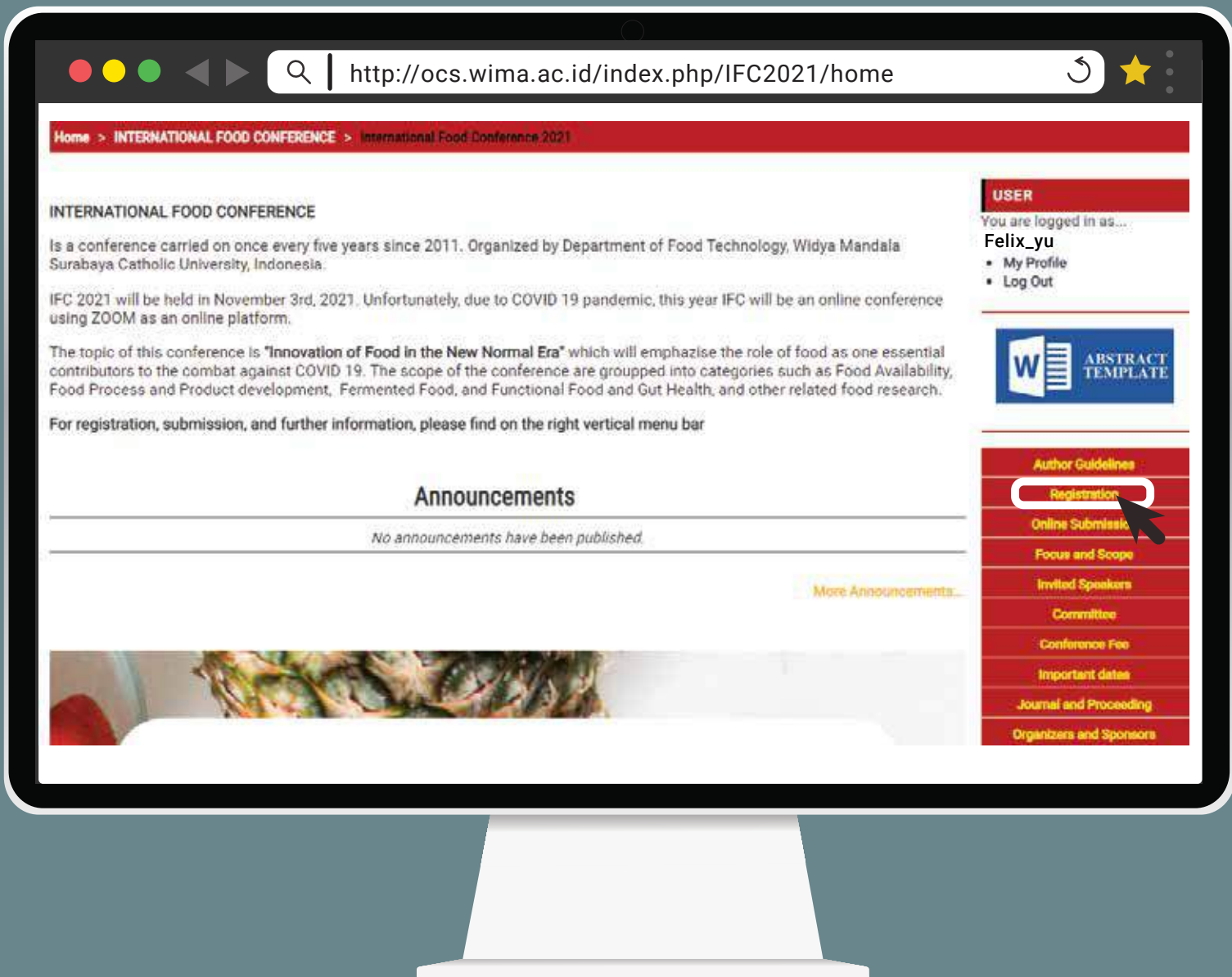
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Registration Procedure

1

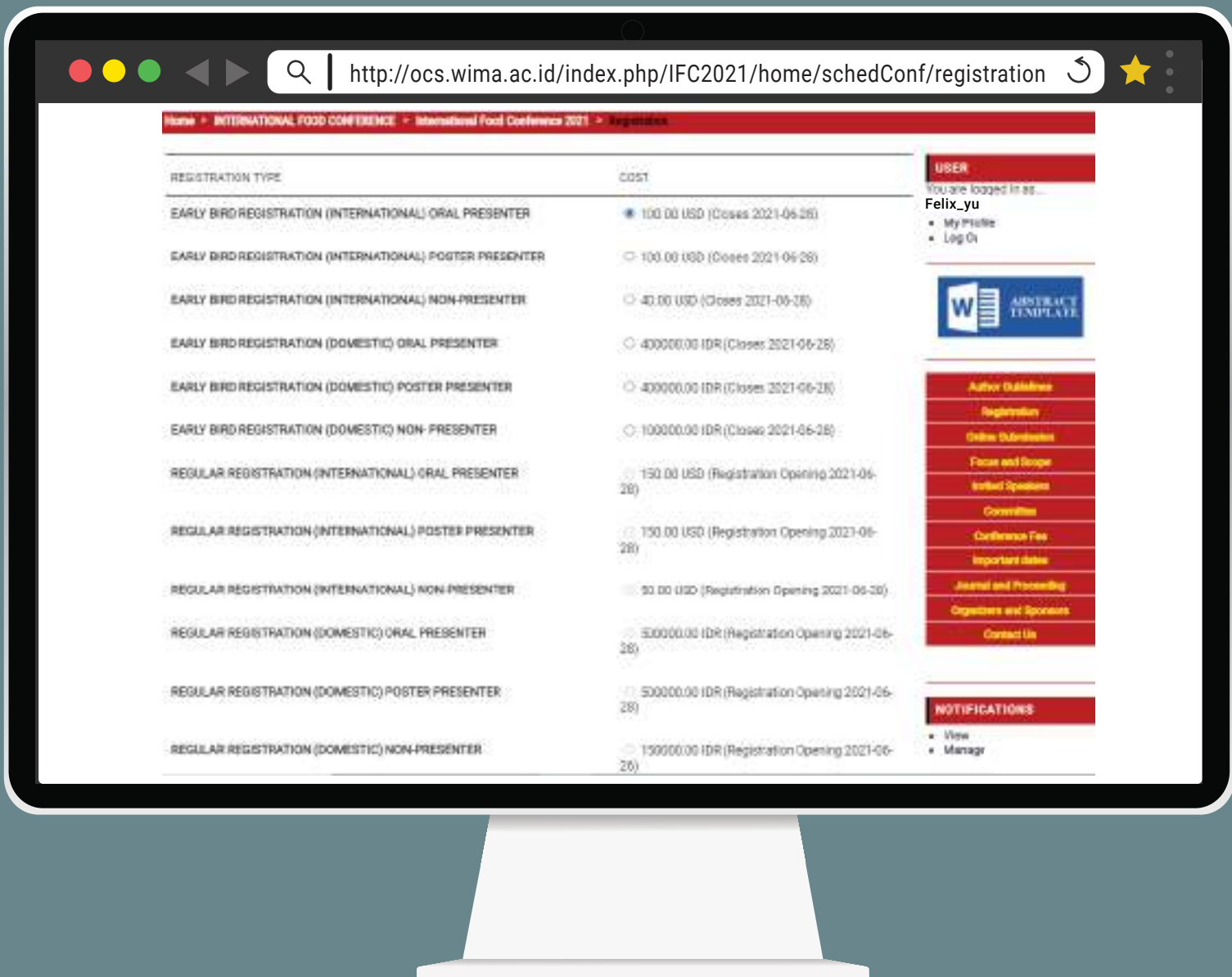
Go to Home page and find “Registration Menu” in the right corner of the website



We suggest you to login first, before you do the registration process

2

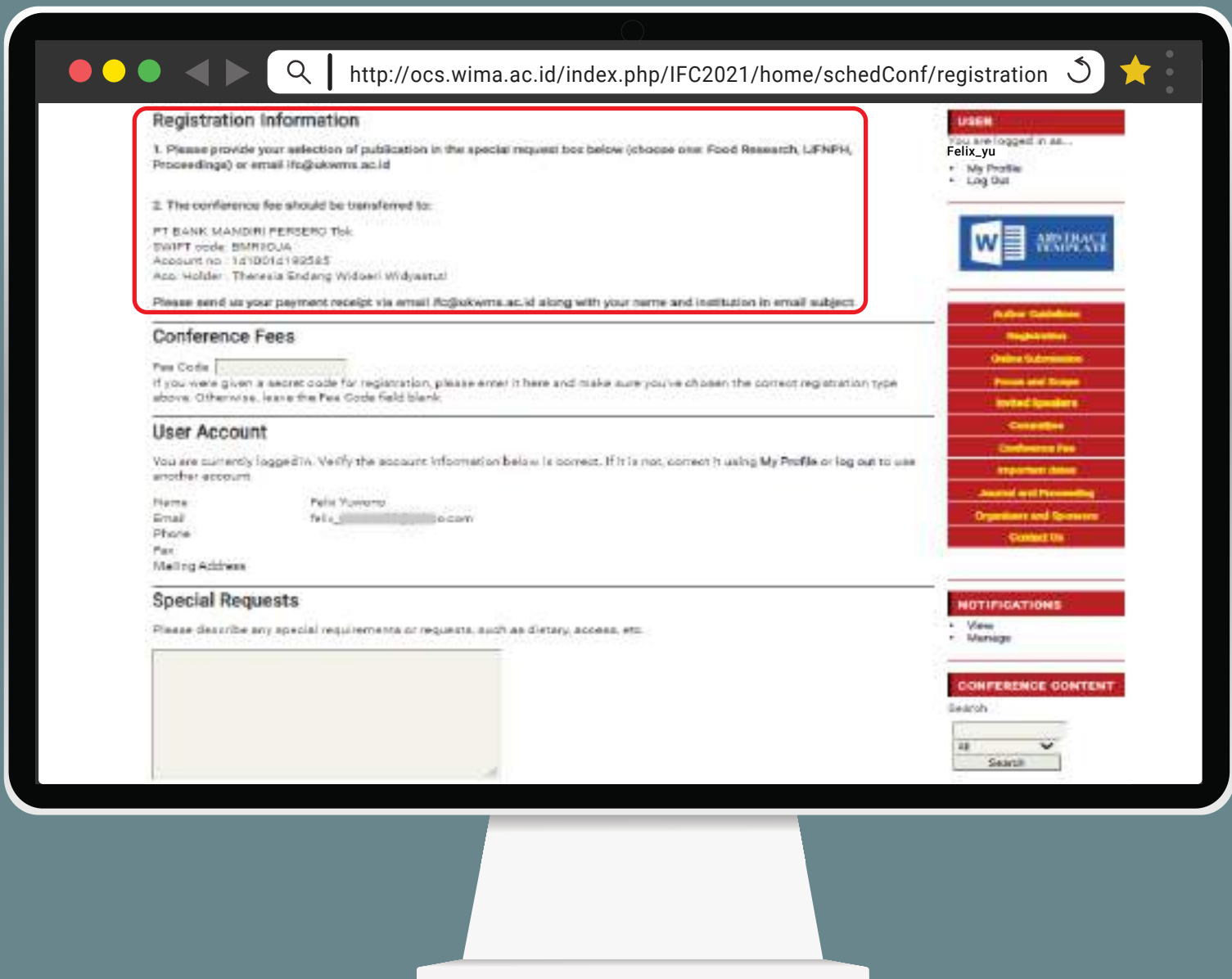
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3

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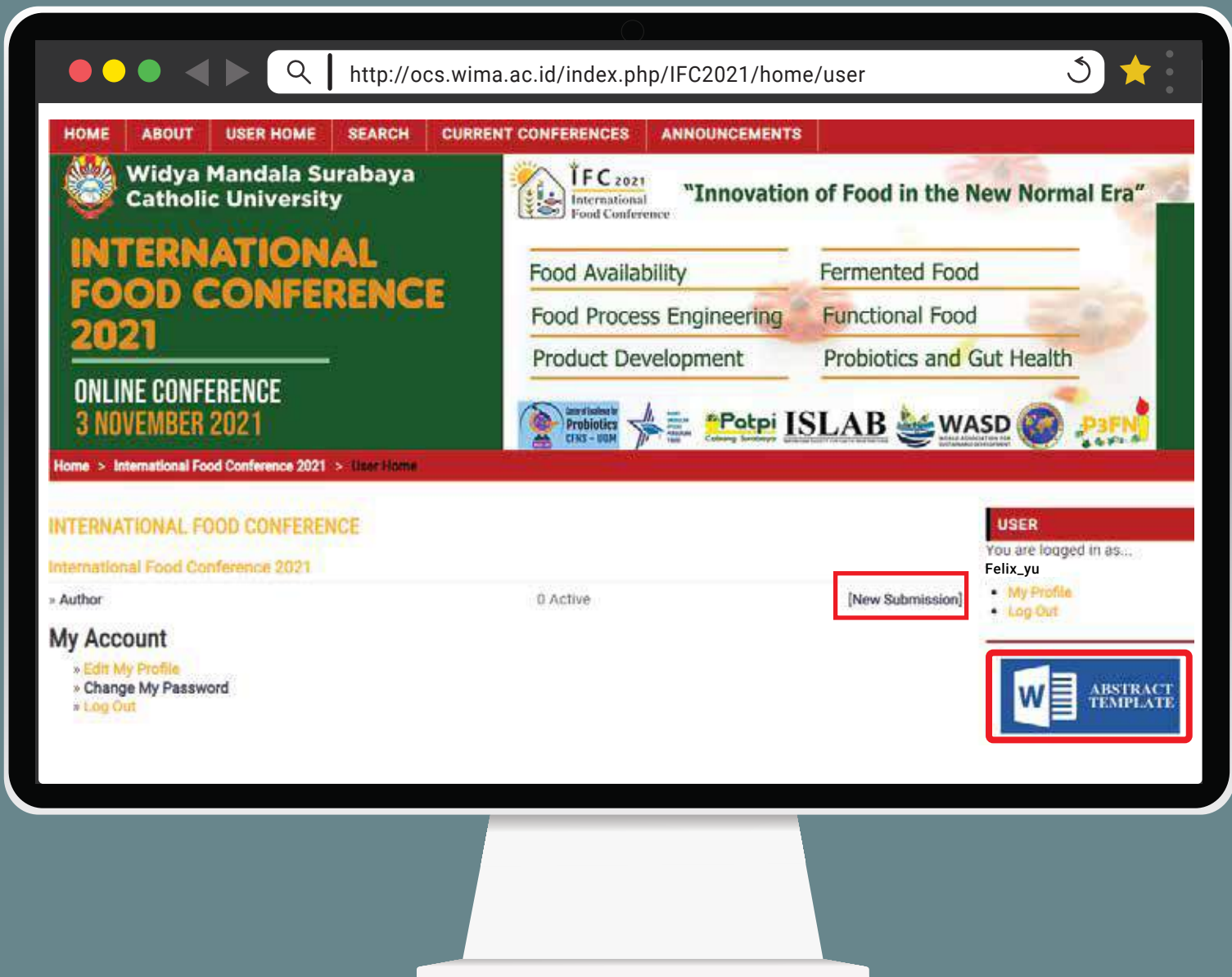
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Submit Your Paper

1

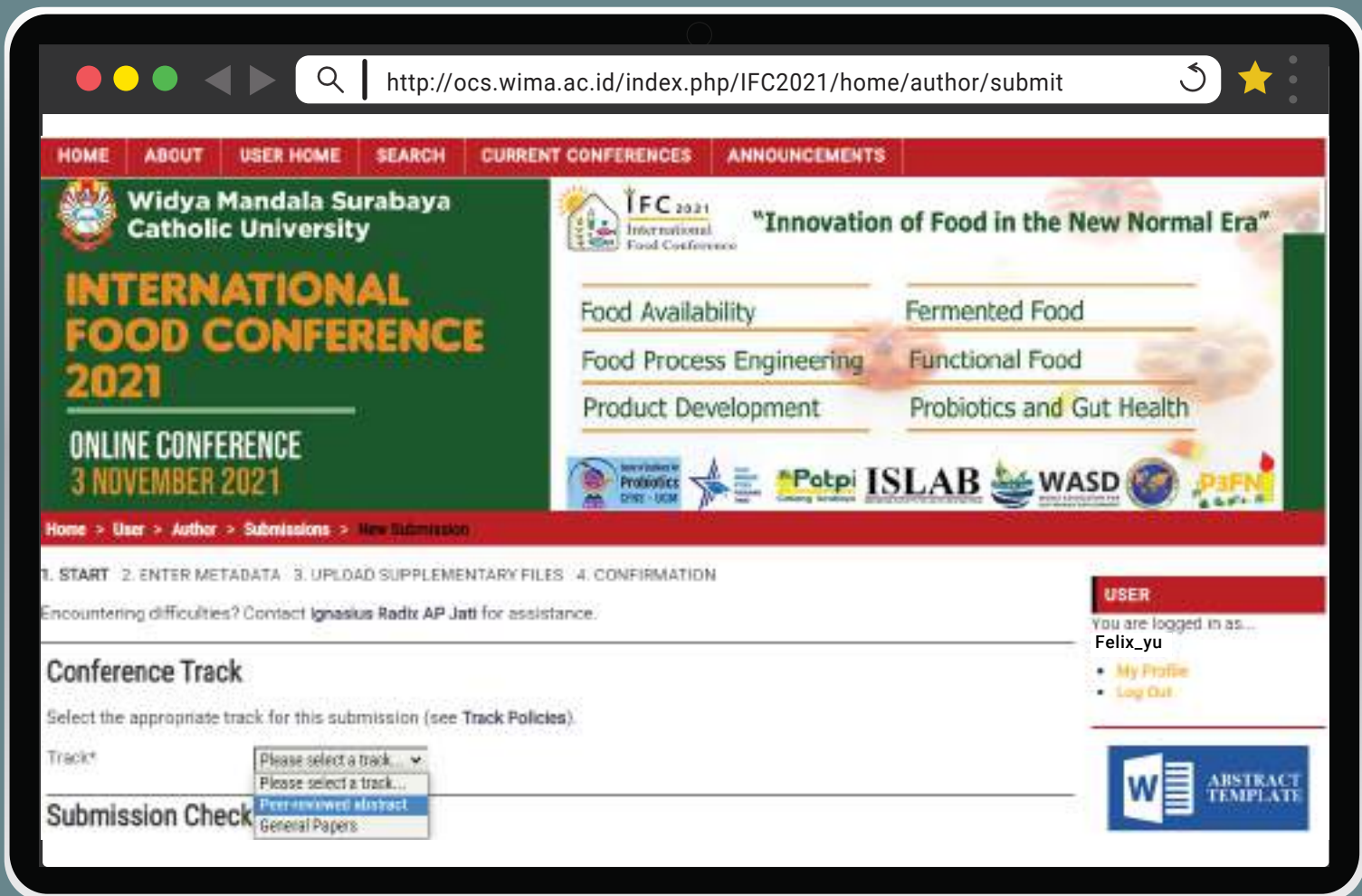
Login to your account,
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before you send your abstract

2

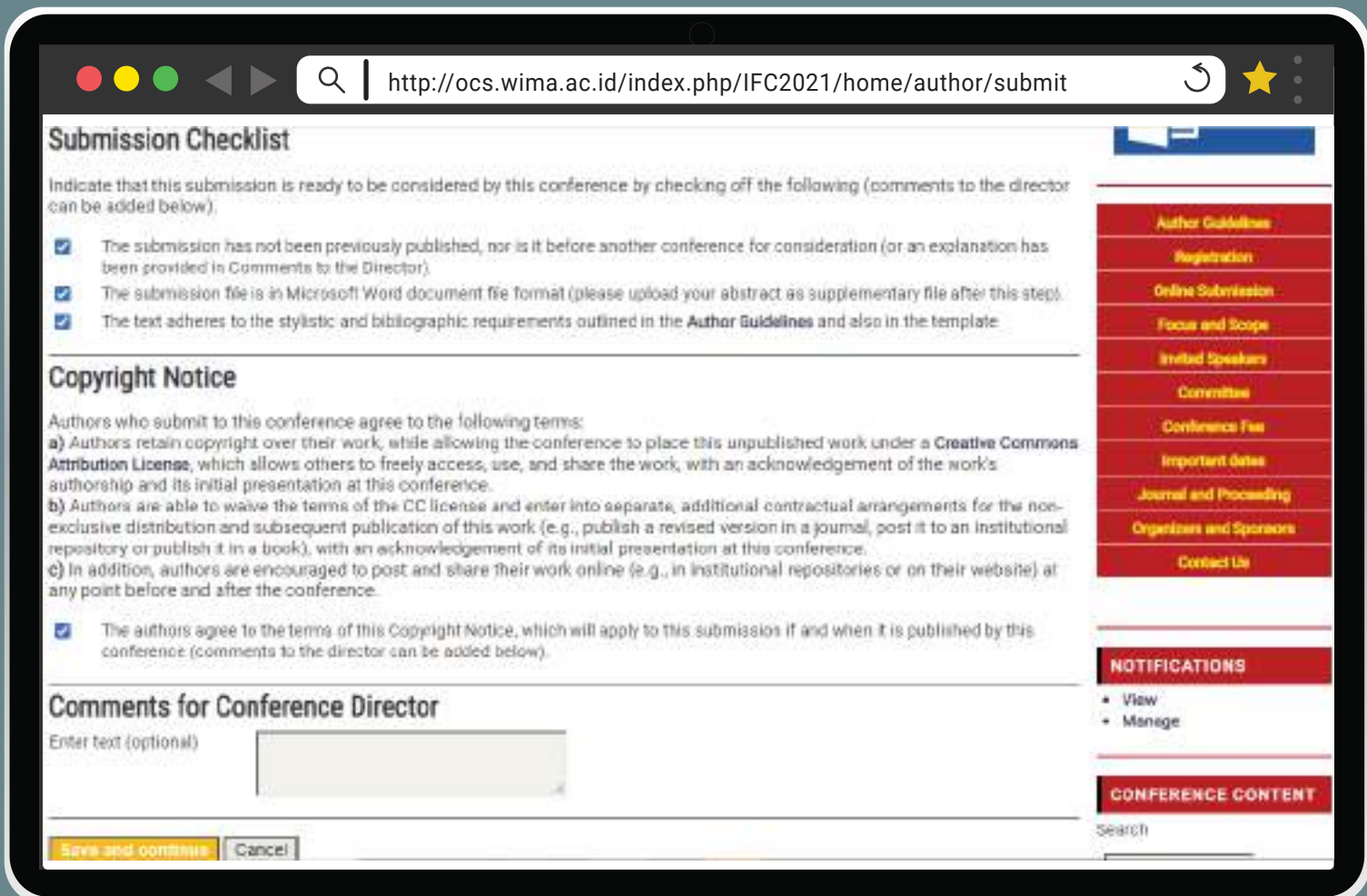
For Track option you can choose
“Peer-reviewed abstract” for abstract submission
“General Papers” for full paper



The process begins by submitting your abstract first.
Then if your abstract gets approval,
it can be continued by sending your full paper

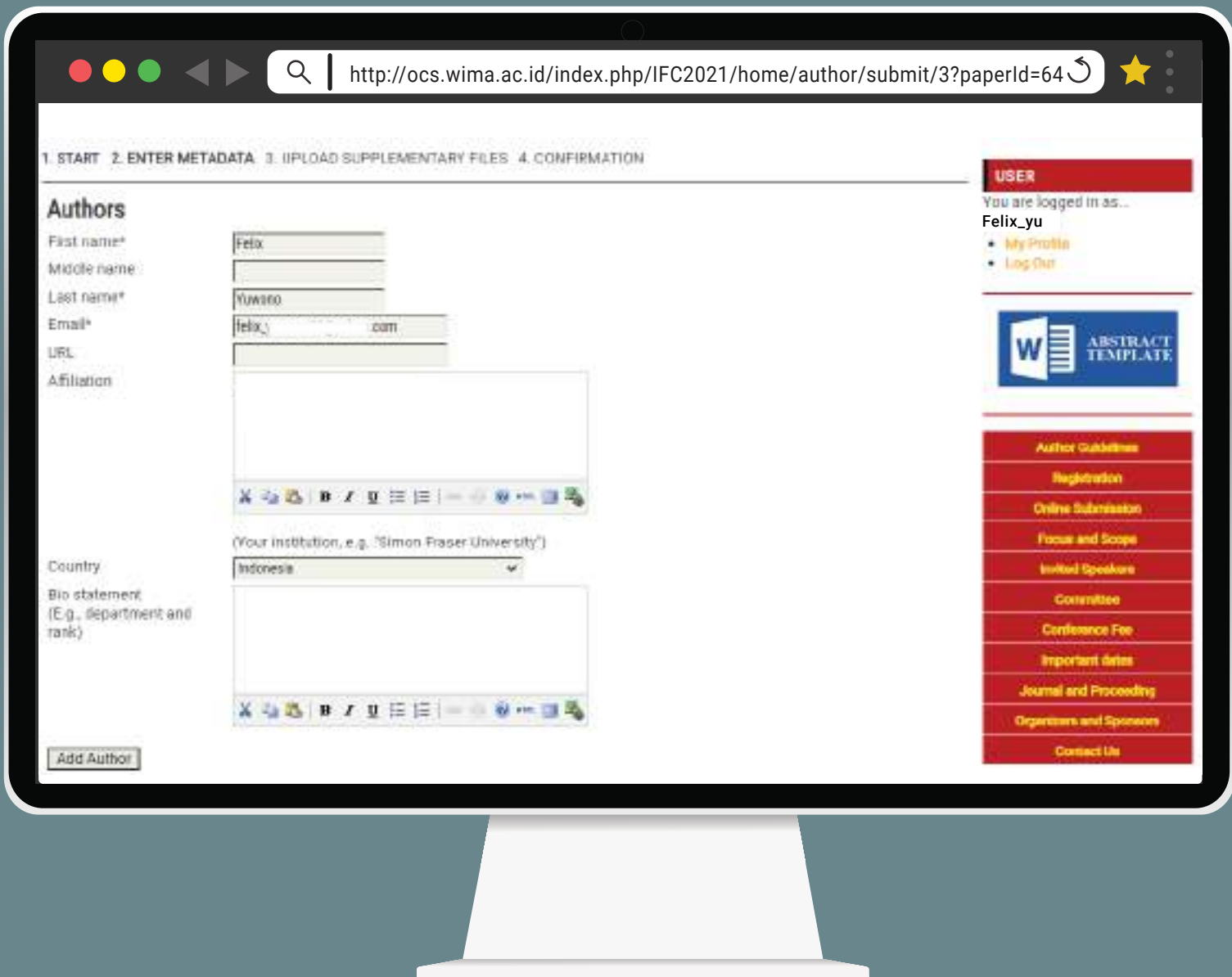
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Check all the checklists before continuing to the next step



4

Fill out all the forms in the metadata section



The screenshot shows a web browser window with the URL <http://ocs.wima.ac.id/index.php/IFC2021/home/author/submit/3?paperId=64>. The page has a navigation bar with four steps: 1. START, 2. ENTER METADATA, 3. UPLOAD SUPPLEMENTARY FILES, and 4. CONFIRMATION. The main content area is titled "Authors" and contains two identical form sections. Each form section includes fields for: Fast name* (filled with "Felix"), Middle name (empty), Last name* (filled with "Yuwono"), Email* (filled with "felix_...@...com"), URL (empty), Affiliation (empty), Country (filled with "Indonesia"), and Bio statement (E.g., department and rank) (empty). Each form also has a rich text editor toolbar. At the bottom left of the form area is an "Add Author" button. On the right side of the page, there is a "USER" section indicating the user is logged in as "Felix_yu" with links for "My Profile" and "Log Out". Below this is a blue "ABSTRACT TEMPLATE" button and a vertical red sidebar menu with the following items: Author Guidelines, Registration, Online Submission, Focus and Scope, Invited Speakers, Committee, Conference Fee, Important dates, Journal and Proceeding, Organizers and Sponsors, and Contact Us.

You can add more author by clicking “Add Author” and don’t forget to choose who will be the **principal contact for editorial correspondence**

5

Upload your supplementary files to the website. After that you will be directed to the next webpage to confirm your files



To submit an abstract file in the form of a word file. You can be submitted to the supplementary files section

6

After all your supplementary files and meta data forms are complete, please select "Save and Continue"

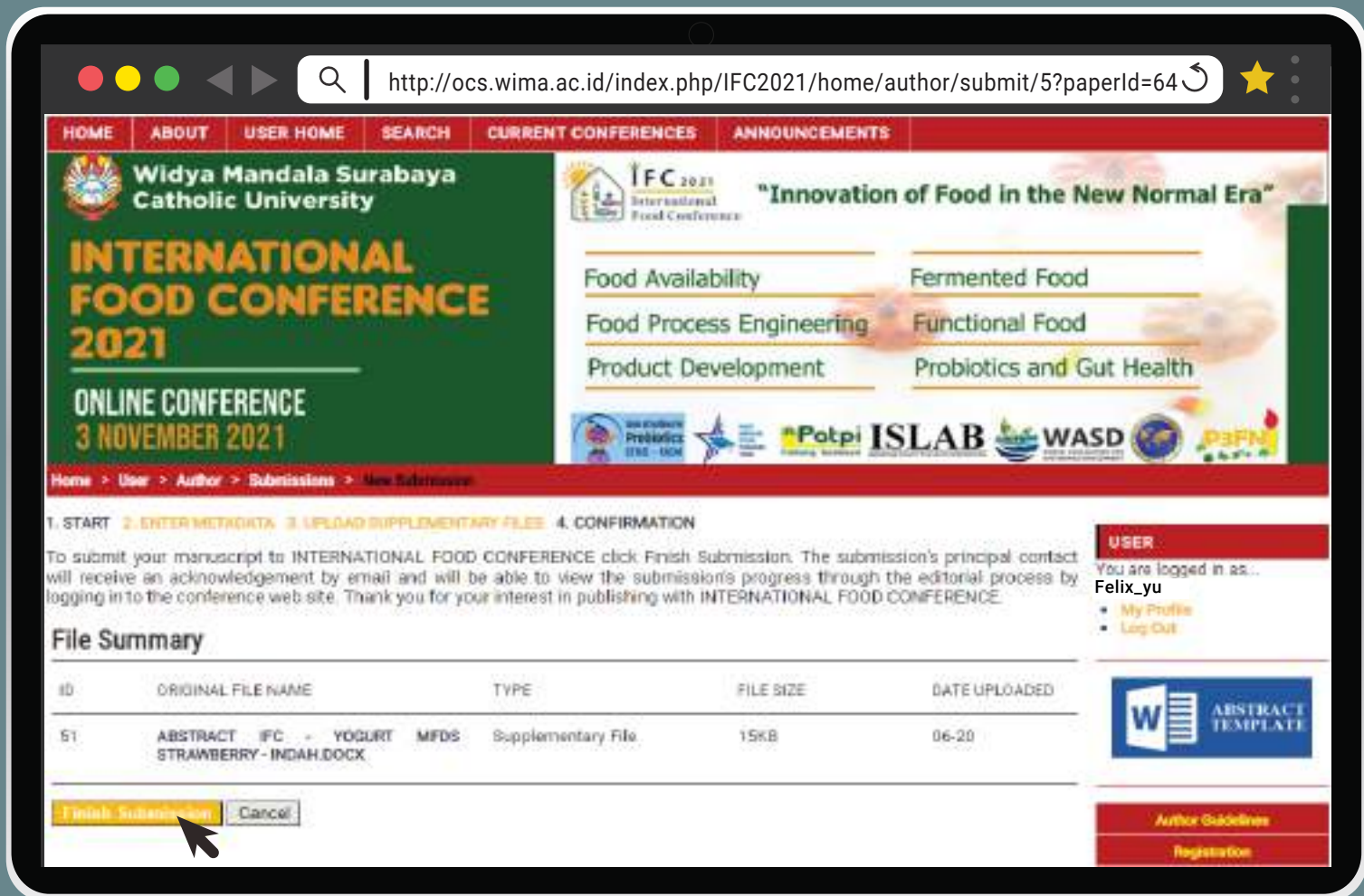
The screenshot shows a web browser window displaying the submission page for the International Food Conference 2021. The browser's address bar shows the URL: <http://ocs.wima.ac.id/index.php/IFC2021/home/author/submit/4?paperId=64>. The page features a navigation menu with links for HOME, ABOUT, USER HOME, SEARCH, CURRENT CONFERENCES, and ANNOUNCEMENTS. The main content area includes the Widya Mandala Surabaya Catholic University logo and the conference title "INTERNATIONAL FOOD CONFERENCE 2021 ONLINE CONFERENCE 3 NOVEMBER 2021". A list of topics is displayed: Food Availability, Food Process Engineering, Product Development, Fermented Food, Functional Food, and Probitics and Gut Health. Logos for various institutions like Potpi, ISLAB, WASD, and D3FN are also visible. The submission progress bar indicates the current step is "4. CONFIRMATION". A text box explains that this step allows for the addition of supplementary files. Below this, a table lists the uploaded file:

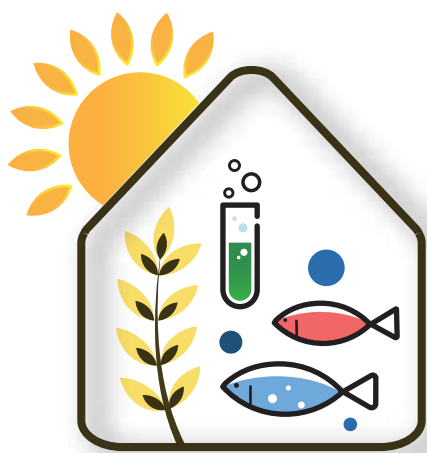
ID	TITLE	ORIGINAL FILE NAME	DATE UPLOADED	ACTION
41	Untitled	Abstract IFC - yogurt MFDS strawberry - Indah.docx	06-20	EDIT DELETE

Below the table, there is a section for "Upload supplementary file" with a "Choose File" button (showing "No file chosen") and an "Upload" button. At the bottom left, there are "Save and continue" and "Cancel" buttons. On the right side, a "USER" section shows the user is logged in as "Felix_yu" with links for "My Profile" and "Log Out". There is also a link for "ABSTRACT TEMPLATE" and "Author Guidelines Registration" at the bottom right.

7

Confirm your submission, and choose “Finish Submission”





IFC 2021

**International
Food Conference**



Paini Sri Widyawati <paini@ukwms.ac.id>

Abstract Acceptance

International Food Conference 2021 <ifc@ukwms.ac.id>

Thu, Aug 26, 2021 at 8:00 AM

To: paini@ukwms.ac.id

Dear Participant,

We're very sorry for the inconvenience. The guidelines sent before weren't the latest version therefore we would like to resend the latest guidelines version. Once again we're truly sorry about this inconvenience

Thank you for your understanding, best regards

IFC Committee

[Quoted text hidden]

 **Guidelines IFC 2021 .pdf**
6132K

2. Submitted: Full paper to International Food Conference 2021 (22-9-2021)

-Correspondence

-Document



Paini Sri Widyawati <paini@ukwms.ac.id>

[REMINDER IFC 2021]

International Food Conference 2021 <ifc@ukwms.ac.id>
To: paini@ukwms.ac.id

Wed, Sep 22, 2021 at 4:29 PM

Dear Participants,
Kindly remind for the participants to complete the submission process. Things you have to do to complete the submission process are:

- Send the payment proof of registration fee
- Upload your full paper file (word document) to our official website or send it via email

Due date 30th September 2021
Please reply to this email as soon as possible for all the datas above.

Warm Regards,

IFC Organizing Committee
Widya Mandala Surabaya Catholic University

Whatsapp: +6281313187071
Website: <http://ocs.wima.ac.id>

1 **Potency of *Pluchea indica* Less Leaves to Increase Functional Value of Wet Noodles**

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4 *University, Jalan Dinoyo 42-44, Surabaya, 60265, Indonesia*

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7
8 Author No.1: ORCID

9 Author No. 2: ORCID

10 Author No. 3: ORCID

11 Author No. 4: ORCID

12 Author No. 5: ORCID

13
14 **Abstract**

15 Wet noodles are lack of nutritional components that are beneficial for health, thus it is necessary to add
16 other food ingredients that can increase the functional value of wet noodles. One of the food ingredients
17 that can be added in wet noodles formulation is *Pluchea indica* Less leaves, which have been known as
18 sources of antioxidants and used by the community as a traditional medicine to treat various health
19 problems. The use of *Pluchea indica* Less leaves in making wet noodles is expected to increase the
20 functional value of wet noodles. This research aimed to determine the potency of *Pluchea indica* Less
21 leaves in affecting the phytochemical compounds content and functional properties of wet noodles. The
22 use of *Pluchea indica* Less leaves showed to have a potency to increase the phytochemical compounds
23 contents of wet noodles, such as alkaloids, flavonoids, phenolics, saponins, tannins, and cardiac
24 glycosides, which play an important role in the health of human body and maintaining the quality of wet

25 noodles, including antioxidant, anti-warmed over flavor, anti-inflammatory, antidiabetic, and
26 antimicrobial activities. Accordingly, the increase in phytochemical compounds in wet noodles can also
27 affect the functional properties of wet noodles.

28 **Keywords:** *Pluchea indica* Less, wet noodles, functional value

29

30 **1. Introduction**

31 Noodles as one of the wheat flour-based product are quiet popular among various levels of society in
32 Indonesia. Noodles can be classified into five forms based on processing stage and water content of the
33 noodles product, including raw noodles, wet noodles, dry noodles, fried noodles, and instant noodles.
34 Wet noodles are noodles product that has water content of about 52% and is produced through the
35 cooking stage of raw noodles before being marketed (Koswara, 2009). According to Estiasih et al. (2017),
36 the high moisture content of wet noodles causes the shelf life of wet noodles to only reach 40 hours at
37 room temperature storage.

38 Increased awareness and interest in functional food supports the development of various food
39 products with high functional value (Abbas, 2020). The functional value of a food product depends on the
40 nutrients contained in the food ingredients that make up the food product. Raw materials in the
41 manufacture of noodles generally include wheat flour, eggs, water, and other additives so that noodles
42 are known to be low in nutritional content that is beneficial to health (Suyanti, 2008). Therefore, various
43 efforts have been made to overcome the shortcomings of these wet noodles products. Increasing the
44 functional value of wet noodles can be done by adding other food ingredients that contain bioactive
45 compounds in the manufacture of wet noodles, one of which is the addition of *Pluchea* leaves.

46 *Pluchea* (*Pluchea indica* Less) is a herbaceous plant that contains phytochemical compounds, including
47 alkaloids, saponins, tannins, phenol hydroquinone, flavonoids, cardiac glycosides, and sterols so that they
48 are potential sources of natural antioxidants (Widyawati et al., 2015). In addition, *Pluchea* leaves also have

49 antimicrobial activity that has the potency to prevent food damage (Ardiansyah et al., 2003). The use of
50 Pluchea leaves in the manufacture of wet noodles is expected to produce wet noodles that are able to
51 provide antioxidant effects that are good for health, and have an impact on increasing the shelf life of the
52 wet noodles product.

53 Currently, the use of Pluchea leaves is only limited as fresh vegetables and drinks, but there have been
54 many studies on the use of Pluchea leaves in the food sector that continue to be developed, including
55 making tempeh with Pluchea leaf extract (Magatra, 2013), Pluchea-black tea salted eggs (Adventi et al.,
56 2015), effervescent powder based on Pluchea leaf extract (Hudha and Widyaningsih, 2015), Pluchea bun
57 products (Chiang, 2018), Pluchea soy milk (Widyawati et al., 2019), Pluchea-green tea jelly drink (Wijaya,
58 2019), and Pluchea wet noodles (Wibisono, 2021). The use of Pluchea leaves in the manufacture of wet
59 noodles needs to be studied further as an effort to develop functional food products that are beneficial
60 to the health of the consumer's body.

61

62 **2. Materials and Methods**

63 Materials of this research were data from several appropriate literatures regarding the utilization of
64 Pluchea (*Pluchea indica* Less) leaves in making wet noodles and the potency of Pluchea leaves in wet
65 noodles by comparing the content of phytochemical compounds (represented by total flavonoid content
66 (TFC) value) and antioxidant activity (represented by iron ion reducing power (RP) value) of Pluchea wet
67 noodles with other similar products from several studies. This study used literature and comparative study
68 method by collecting data that show the potency of *Pluchea indica* Less leaves in wet noodles.

69

70 **3. Results and Discussion**

71 Several factors such as individual education, household standards and level of knowledge about food
72 products with health claims, as well as perceptions of some existing functional food product attributes

73 affect the development of public interest in functional food products (Stojanovic et al., 2013; Sari, 2014).
74 Marsono (2008) also stated that increasing awareness of the importance of food in preventing or curing
75 disease, consumer demands for foods with more properties (containing functional ingredients),
76 experiences with alternative medicines, and studies on the prevalence of certain diseases that are
77 influenced by diet have also become the basis for the rapid development of functional food products in
78 various countries.

79 Functional food is defined as a food product that is able to provide benefits to the health of the body,
80 one of which is through the presence of bioactive components contained in a functional food product
81 (Suter, 2013; Abbas, 2020). According to Abbas (2020), there are five categories of functional food, namely
82 foodstuffs with a reduction or increase in the basic nutritional content, products that naturally do not
83 have certain nutrients and are then added to them, milk-based products fermented with probiotics,
84 products that are specially formulated to fulfill certain needs, and foodstuffs containing herbal ingredients
85 to help overcome various health problems.

86 Herbal plants as a source of functional food, namely a source of natural antioxidants that can be used
87 in the food sector to improve the functional properties of processed food products, one of which is the
88 use of herbal plants to increase the content of bioactive components in wheat flour-based products such
89 as noodles. According to Fadzil et al. (2020), noodles are known to be low in nutritional components that
90 are beneficial to health, while noodles with functional properties such as high antioxidants are in high
91 demand at this time.

92 *3.1 Utilization of Pluchea Leaves in Making Wet Noodles*

93 The main ingredients in making noodles are generally wheat flour, eggs, water, and other
94 additives as needed so that noodles products only contain carbohydrates, proteins, fats, and minerals.
95 The content of carbohydrates, several minerals, and energy in noodles are very high, but the content of
96 protein, fat, and vitamins in noodles products are low (Suyanti, 2008). Several studies have been carried

97 out in an effort to improve the functional properties of noodles products, one of which is by using the
98 leaves of plants that have been known as traditional medicines to be added to the manufacture of
99 noodles, such as making herbal noodles with kenikir (*Cosmos caudatus* Kunth.) leaf extract (Norlaili et al.,
100 2014), manufacture of herbal noodles with leaves of the maja plant (*Aegle marmelos*) (Shamim et al.,
101 2016), manufacture of sidondo (*Vitex negundo* Linn.) noodles (Syahirah and Rabeta, 2018), addition of
102 Moringa (*Moringa oleifera*) leaf extract to wet noodles (Khasanah and Astuti, 2019), making herbal
103 noodles with pegagan (*Centella asiatica*) extract (Fadzil et al., 2020), and using Pluchea (*Pluchea indica*
104 Less) leaf powder steeped water in making Pluchea wet noodles (Wibisono, 2021).

105 The content and activity of phytochemical compounds in Pluchea leaves, both in the form of fresh
106 leaves and water steeped in powdered Pluchea leaves, have been identified. Pluchea is classified as plant
107 that has high polyphenol content and relatively large antioxidant capacity compared to other herbaceous
108 plants (Andarwulan et al., 2010; Andarwulan et al., 2012). Research conducted by Widyawati et al. (2016)
109 showed that the phytochemical compounds contained in the brewed water of Pluchea leaf powder
110 include alkaloids, flavonoids, phenolics, saponins, tannins, and cardiac glycosides. According to Penglly
111 (2004), each phytochemical compound has physiological effects including alkaloids as analgesic,
112 mydriatic, miotic, hypertensive, hypotensive, bronchodilator, stimulant, antimicrobial, and antileukemic,
113 flavonoids as antioxidant, antiviral, hepatoprotective, antiatheromatous, anti-inflammatory, and
114 antihypertensive, phenolic as antioxidant, antimicrobial, anti-inflammatory, antiplatelet, and antiallergic,
115 saponins as anticancer, anti-inflammatory, immunomodulatory, antihepatotoxic, and antidiabetic,
116 tannins as antioxidant, antitumor, antihemorrhagic, and antiatherogenic, as well as cardiac glycosides that
117 can increase strength and speed of systolic contraction. Flavonoids are one of the important constituents
118 that can provide real benefits for the health of the human body.

119 The use of Pluchea leaves in food products continues to be developed through various studies as
120 shown in Table 1., however, the use of Pluchea leaves to increase the functional value of wheat flour-

121 based food products has not been widely studied. So far the research that has been carried out regarding
122 the use of Pluchea leaves in the formulation of wheat flour-based food products is in the manufacture of
123 Pluchea bun (Chiang, 2018) and Pluchea wet noodles (Wibisono, 2021), both of which use Pluchea leaf
124 powder steeping water which is added to the product formulation.

125 *3.2 The Effect of Pluchea Leaves on the Content of Phytochemical Compounds of Wet Noodles*

126 The largest group of phytochemical compounds in plants includes alkaloids, terpenes, and
127 phenolic compounds. Phenolic compounds are a group of phytochemical compounds that are widely
128 distributed in various plants, where this group of compounds can be used as the main source of natural
129 antioxidants and are able to act as antimicrobial, anticarcinogenic, and other biological activities (Kennedy
130 and Wightman, 2011; Aziman et al., 2012). Pluchea leaves contain phenolic compounds in the form of
131 flavonoids, 1,3,4,5-tetra-O-cafeoilquinic acid, 3,4,5-tri-O-cafeoilquinic acid, chlorogenic acid, and ferulic
132 acid (Mahasuari et al., 2020).

133 Flavonoids as secondary metabolites as well as the main and largest compounds in the group of
134 phenolic compounds are commonly found in plant tissues in free form or glycosides (Aberoumand and
135 Deokule, 2008; Sulaiman and Balachandran, 2012; Agbo et al., 2015). In plants, flavonoids are found in
136 the form of flavonoid glycosides, flavonols, flavan-3-ol, flavones, flavanones, chalcones, anthocyanins, and
137 proanthocyanidins (Dehkharghanian et al., 2010; Vichapong et al., 2010; Chen, 2013). Flavonoids have the
138 ability to chelate metals and donate hydrogen atoms so that they can act as antioxidants that are able to
139 provide certain physiological effects on the human body (Erlidawati et al., 2018). This has become one of
140 the basis for the use of herbal plants for traditional medicine and supports various functional food product
141 innovations such as Pluchea wet noodles.

142 Research by Wibisono (2021) showed that the use of Pluchea leaf powder steeped water was able
143 to contribute in increasing the content of phytochemical compounds (especially flavonoids) in wet
144 noodles, that the lowest (5%) and the highest (30%) concentration of Pluchea leaf powder in steeping

145 water were able to increase the total flavonoid content (TFC) of wet noodles as much as 1.43 times and
146 4.07 times compared to the control wet noodles (without the use of *Pluchea* leaf powder steeping water),
147 respectively. The potential use of *Pluchea* leaves in the manufacture of wet noodles can be seen by
148 comparing the TFC of *Pluchea* wet noodles in Wibisono's study (2021) with other herbal noodles and
149 *Pluchea* bun as another form of wheat flour-based product. Comparison of the total flavonoids of *Pluchea*
150 wet noodles with sidondo wet noodles, pegagan wet noodles, and *Pluchea* bun from existing studies can
151 be seen in Figure 1.

152 The group of flavonoids found in *Pluchea* leaves are flavonols and flavones, including quercetin,
153 myrisetin, kaempferol, apigenin, luteolin, and chrysoeriol (Andarwulan et al., 2010; Andarwulan et al.,
154 2012; Koirewoa et al., 2012; Mahasuari et al., 2020), sidondo flavonoids consist of castikin, orientin,
155 isoorientin, luteolin, lutekin-7-O-glucoside, corimbosin, gardenins A and B, 3-O-desmethylartemethin, 5-
156 O-desmethylnobiletin, and 3',4',5,5',6,7,8-heptamethoxyflavones (Lakshmanashetty et al., 2010; Ullah et
157 al., 2012), while the flavonoids of pegagan include quercetin, myrisetin, and kaempferol (Andarwulan et
158 al., 2010; Andarwulan et al., 2012). The TFC value of wet noodles with the addition of 5% concentration
159 of *Pluchea* leaf powder in steeping water was greater than the TFC of wet noodles with the addition of
160 20% pegagan extract, but the TFC of *Pluchea* wet noodles 5% was lower than the TFC of sidondo wet
161 noodles which used 0.66% sidondo leaf powder from the total weight of the noodles ingredients. Based
162 on this comparison, it can be indicated that the use of *Pluchea* leaf powder steeping water with a
163 concentration of 5% can increase the flavonoids content of wet noodles far exceeding the flavonoids
164 content that can be given by 20% pegagan extract solution in wet noodles (total flavonoids of *Pluchea* wet
165 noodles 5% is 51.67 times compared to pegagan noodles 20%). The total flavonoids of the *Pluchea* wet
166 noodles 5% is 1.53 times lower than the total flavonoids of sidondo wet noodles. The flavonoids content
167 of sidondo wet noodles which was higher than *Pluchea* wet noodles 5% could be caused by the addition
168 of sidondo leaf powder directly to the making of wet noodles dough in Syahirah and Rabeta's research

169 (2018), while Pluchea wet noodles dough in Wibisono's study (2021) was made with using Pluchea leaf
170 powder steeping water in the formulation of wet noodles. In addition, several factors such as differences
171 in formulation, sequence of processing and analysis stages, as well as stated standards and product
172 sample forms analyzed in each study also affect the difference in TFC values compared between types of
173 herbal wet noodles.

174 The TFC of wet noodles with the addition of 5% concentration of Pluchea leaf powder in steeping
175 water was higher than the TFC of bun with the addition of 10% concentration of Pluchea leaf powder in
176 steeping water. This shows that the flavonoids content of Pluchea wet noodles is higher than the
177 flavonoids content of Pluchea bun even though the concentration of Pluchea leaf powder in steeping
178 water in the manufacture of Pluchea wet noodles is lower than the concentration of Pluchea leaf powder
179 in steeping water in the manufacture of Pluchea bun (the TFC of Pluchea wet noodles 5% is 2.54 times
180 compared to Pluchea bun 10%). According to Li et al. (2015), antioxidant compounds, one of which is
181 flavonoids, are easily degraded in the heating process, and are lost during the process of mixing and
182 kneading the dough. The degradation of flavonoids during heating and the extraction of glycosides by
183 water vapor can be the cause of the low TFC value of Pluchea bun. On the other hand, Saikia and Mahanta
184 (2013) stated that the high flavonoids content could be caused by breaking the glycosidic bond of
185 flavonoids with sugar by heating treatment. The wet noodles cooking process is thought to have an effect
186 on breaking the glycosidic bond so that aglycones are formed which can improve the detection results of
187 flavonoids compounds in the analysis. Various factors can affect the TFC value in different food products,
188 including differences in ingredient formulations, specifications of the methods used, and the stages of the
189 process in the manufacture of food products.

190 The TFC of Pluchea wet noodles 5% showed that Pluchea leaves have the potency to increase the
191 content of phytochemical compounds (in this case flavonoids) in wet noodles as a wheat flour-based food
192 product. Wibisono (2021) also stated that the use of higher concentration of Pluchea leaf powder in

193 steeping water in the formulation of wet noodles was able to provide a significant increase in the TFC of
194 wet noodles. There has been no research on the effect of adding Pluchea leaf powder steeping water on
195 the type and amount of phytochemical compounds other than flavonoids in Pluchea wet noodles
196 products, so the use of Pluchea leaves in the manufacture of wet noodles still needs to be developed and
197 further investigated its effect on the phytochemical component content of wet noodles.

198 *3.3 The Effect of Pluchea Leaves on the Functional Properties of Wet Noodles*

199 The functional properties of functional food products mainly focus on the ability of bioactive
200 components in food products to help maintain the health of the human body. One of the properties
201 possessed by bioactive components is that they can act as antioxidants. Carotenoids, flavonoids, and
202 phenolic compounds are classified as natural antioxidants that can be found in various foodstuffs
203 (Marsono, 2008). Antioxidant activity can be in the form of DPPH free radical scavenging ability, iron ion
204 reducing power, reactive oxygen species scavenging activity, and β -carotene-linoleic acid system
205 inhibitory activity (Widyawati et al., 2017).

206 Iron ion reducing power (RP) is one of the parameters of antioxidant potential which is measured
207 as secondary antioxidant activity based on the ability of antioxidant compounds to reduce Fe^{3+} to Fe^{2+} .
208 Secondary antioxidants play a role in the mechanism of binding metal ions, scavenging oxygen, converting
209 hydrogen peroxide into non-radical compounds, absorbing UV radiation, or deactivating singlet oxygen
210 (Pokorny *et al.*, 2001). According to Widyawati, Suteja, Suseno *et al.* (2014), iron ion is one of the pro-
211 oxidants that has the potency to generate new free radicals. Antioxidant components are able to
212 neutralize iron ions by acting as a substrate that will be oxidized first. Based on the research of Wibisono
213 (2021), the use of the lowest (5%) and the highest (30%) concentration of Pluchea leaf powder were able
214 to increase the RP value of wet noodles by 1.33 times and 3.27 times compared to control wet noodles,
215 respectively. The potency of Pluchea leaves in increasing the antioxidant activity of wet noodles products
216 can be described by comparing the RP value of Pluchea wet noodles with other products such as rice flour

217 paste and Plucheabun. The comparison of secondary antioxidant activity in the form of the iron ion
218 reducing power of Plucheawet noodles with rice flour paste and Plucheabun can be seen in Figure 2.

219 Plucheawet noodles 5% in the Wibisono's study (2021) had the RP value 1.78 times higher than
220 the RP value of Plucheabun 10% in Chiang's research (2018), but 1.94 times lower than the RP value of
221 paste made from rice flour in the research of Nithya *et al.* (2013). The RP value indicates that the use of
222 Pluchealeaf powder steeping water with 5% concentration of Pluchealeaf powder in steeping water has
223 potency to provide greater secondary antioxidant activity in wet noodles than in bun products. The TFC
224 of Plucheawet noodles 5% which is greater than the TFC of Plucheabun 10%, as shown in Figure 1., can
225 contribute to the large iron ion reducing power of Plucheawet noodles 5% and Plucheabun 10%, that the
226 phenolic group compounds, one of which is flavonoids, capable of donating hydrogen atoms/electrons so
227 that they can reduce iron ions (Widyawati, Budianta, Kusuma *et al.*, 2014). The flavonoids content of
228 Plucheawet noodles which is higher than the flavonoids content of Plucheabun can cause the iron ion
229 reducing power of wet noodles is higher compared to Plucheabun.

230 RP value of Plucheawet noodles 5% which is lower than the RP value of rice flour paste can be
231 due to the use of different types of raw materials (related to the number and types of bioactive
232 components in the ingredients) and the shape of the product samples analyzed in each study. Based on
233 the research of Widyawati, Suteja, Suseno *et al.* (2014), white rice has total phenolic content (TPC) of 4.12
234 ± 0.05 mg gallic acid equivalent/g dry basis which is greater than the TPC of Pluchealeaves in the study of
235 Andarwulan *et al.* (2010), which was 0.831 ± 0.129 mg gallic acid equivalent/g fresh leaf weight. According
236 to Wibisono (2021), the iron ion reducing power of Plucheawet noodles can be increased by using higher
237 concentration of Pluchealeaf powder in steeping water in the formulation of wet noodles.

238 RP value of Plucheawet noodles 5% shows the potency of Pluchealeaves to increase the
239 antioxidant activity of wet noodles products as an effort to increase the functional value of wheat flour-
240 based food products such as wet noodles. The effect of adding Pluchealeaf powder steeping water on the

241 antioxidant activity of Pluchea wet noodles using a type of analysis other than the iron ion reducing power
242 has not been studied further, so it is necessary to measure other antioxidant parameters to support the
243 potency of Pluchea leaves in making wet noodles.

244 Research on the potency of Pluchea leaves in improving the functional properties of wet noodles
245 is still limited to being studied on product antioxidants, while Pluchea leaves have been known to have
246 various other functional properties that are beneficial to health and are able to maintain the quality of
247 food products. Several other functional properties that have the potency to be provided by Pluchea leaves
248 in food products include activities as anti-warmed over flavor, anti-inflammatory, antidiabetic (Widyawati
249 *et al.*, 2017), and antimicrobial properties that have the potency to prevent food spoilage (Ardiansyah *et*
250 *al.*, 2003). This ability is inseparable from the presence of bioactive compounds in Pluchea leaves which
251 have the capacity as antioxidant and antihyperglycemic agents (Widyawati, Budianta, Kusuma *et al.*, 2014;
252 Widyawati *et al.*, 2015). According to Li *et al.* (2014), herbal plant extracts are potential preservatives that
253 are currently being developed to be applied to bread, pasta, and noodles products due to the presence of
254 phenolic components that have high antimicrobial activity. Tiwari *et al.* (2009) stated that the
255 antimicrobial activity of phenolic compounds is related to the ability of phenolics to affect the
256 permeability of microbial cells which causes the release of important macromolecules from the microbial
257 cell, as well as the ability of phenolics to interact with membrane proteins that cause deformation of the
258 structure and function of microbial cell membranes.

259

260 **4. Conclusion**

261 Pluchea (*Pluchea indica* Less) leaves have the potency to increase the functional value of wet noodles
262 in terms of the phytochemical content and functional properties of the wet noodles. The use of Pluchea
263 leaves increases the content of phytochemical compounds, in this case flavonoids, in wet noodles. The
264 increase in the content of phytochemical compounds with the use of Pluchea leaves affects the increase

265 in the functional properties of wet noodles products, especially antioxidant activity in the form of the iron
266 ion reducing power of wet noodles.

267

268 **Conflict of interest**

269 The authors declare no conflict of interest.

270

271 **Acknowledgments**

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273 University for the opportunity to participate in IFC 2021, as well as all team members who played a role
274 in this research.

275

276 **References**

277 Abbas. (2020). Potensi pangan fungsional dan perannya dalam meningkatkan kesehatan manusia yang
278 semakin rentan-mini review. *Jurnal Teknosains*, 14(2), 176-186.

279 Aberoumand, A. and Deokule, S.S. (2008). Comparison of phenolic compounds of some edible plant of
280 Iran and India. *Pakistan Journal of Nutrition* 7(4), 582-585.

281 Adventi, B.S., Widyawati, P.S. and Utomo, A.R. (2015). Pengaruh konsentrasi garam terhadap sifat
282 fisikokimia dan organoleptik telur asin Beluntas (*Pluchea indica* Less)-teh hitam (*Camelia sinensis*).
283 *Jurnal Teknologi Pangan dan Gizi* 14(2), 55-60.

284 Agbo, M.O., Uzor, P.F., Akazie-Nneji, U.N., Eze-Odurukwe, C.U., Ogbatue, U.B. and Mbaaji, E.C. (2015).
285 Antioxidant, total phenolic and flavonoid content of selected Nigerian medical plants. *Dhaka*
286 *University Journal of Pharmaceutical Sciences* 14(1), 1-7.

287 Andarwulan, N., Kurniasih, D., Apriady, R.A., Rahmat, H., Roto, A.V. and Bolling, B.W. (2012). Polyphenols,
288 carotenoids, and ascorbic acid in underutilized medicinal vegetables. *Journal of Functional Foods* 4,
289 339-347.

290 Andarwulan, N., Batari, R., Sandrasari, D.A., Bolling, B. and Wijaya, H. (2010). Flavonoid content and
291 antioxidant activity of vegetables from Indonesia. *Food Chemistry* 121, 1231-1235.

292 Ardiansyah, Nuraida, L. and Andarwulan, N. (2003). Aktivitas antimikroba ekstrak daun Beluntas (*Pluchea*
293 *indica* L.) dan stabilitas aktivitasnya pada berbagai konsentrasi garam dan tingkat pH. *Jurnal. Teknol.*
294 *Dan Industri Pangan* 14(2), 90-97.

295 Aziman, N., Abdullah N., Noor, Z.M., Zulkifli, K.S. and Kamarudin, W.S.S.W. (2012). Phytochemical
296 constituents and in vitro bioactivity of ethanolic aromatic herb extracts. *Sains Malaysiana* 41(11),
297 1437-1444.

298 Chen, X.G.Q. (2013). Identification and antioxidant capacity of anthocyanin pigment, and expressional
299 analysis of flavonoid biosynthetic genes in colored rice strains. Japan: University of Hiroshima, PhD.
300 Dissertation.

301 Chiang, I. (2018). Pengaruh konsentrasi bubuk daun beluntas (*Pluchea indica* Less) dalam air seduhan
302 terhadap aktivitas antioksidan bakpao. Indonesia: Universitas Katolik Widya Mandala Surabaya,
303 Skripsi S-1.

304 Dehkharghanian, M., Adenier, H. and Vijayalakshmi, M.A. (2010). Study of flavonoids in aqueous spinach
305 extract using positive electrospray ionisation tandem quadrupole mass spectrometry. *Food Chemistry*
306 121, 863-870.

307 Erlidawati, Safrida and Mukhlis. (2018). Potensi Antioksidan sebagai Antidiabetes. Banda Aceh: Syiah
308 Kuala University Press.

309 Estiasih, T., Putri, W.D.R. and Waziroh, E. (2017). Umbi-umbian dan Pengolahannya. Malang: UB Press.

310 Fadzil, N.F., Bakar, M.F.A., Yusop, M.H.M. and Bakar, F.I.A. (2020). Sensorial and physicochemical
311 characteristics of herbal noodle enriched with *Centella asiatica*. *Food Research* 4(4), 1030-1037.

312 Firdausi, M.H. (2017). Kualitas fisikokimia dan organoleptik telur asin metode kering dengan penambahan
313 daun beluntas (*Pluchea indica* L). Indonesia: Universitas Brawijaya, Skripsi S-1.

314 Hudha, M. and Widyaningsih, T.D. (2015). Serbuk *effervescent* berbasis ekstrak daun Beluntas (*Pluchea*
315 *indica* Less) sebagai sumber antioksidan alami. *Jurnal Pangan dan Agroindustri* 3(4), 1412-1422.

316 Khasanah, V. and Astuti, P. (2019). Pengaruh penambahan ekstrak daun kelor (*Moringa oleifera*) terhadap
317 kualitas inderawi dan kandungan protein mie basah substitusi tepung mocaf. *Jurnal Kompetensi*
318 *Teknik* 11(2), 15-21.

319 Kennedy, D.O. and Wightman, E.L. (2011). Herbal extracts and phytochemicals: plant secondary
320 metabolites and the enhancement of human brain function. *Advances in Nutrition* 2, 32-50.

321 Koirewoa, Y.A., Fatimawali and Wiyono, W.I. (2012). Isolasi dan identifikasi senyawa flavonoid dalam daun
322 Beluntas (*Pluchea indica* L.). *Pharmakon UNSRAT* 1(1), 47-52.

323 Koswara, S. (2009). Teknologi Pengolahan Mie. Retrieved on July 10, 2020 from Teknologi Pangan
324 Universitas Muhammadiyah Semarang Website: [http://tekpan.unimus.ac.id/wp-](http://tekpan.unimus.ac.id/wp-content/uploads/2013/07/Teknologi-Pengolahan-Mie-teori-dan-praktek.pdf)
325 [content/uploads/2013/07/Teknologi-Pengolahan-Mie-teori-dan-praktek.pdf](http://tekpan.unimus.ac.id/wp-content/uploads/2013/07/Teknologi-Pengolahan-Mie-teori-dan-praktek.pdf)

326 Lakshmanashetty, R.H., Nagaraj, V.B., Hiremath, M.G. and Kumar V. (2010). In vitro antioxidant activity of
327 *Vitex negundo* L. leaf extracts. *Chiang Mai Journal of Science* 37(3), 489-497.

328 Li, M., Zhu, K.X., Guo, X.N., Brijs, K. dan Zhou, H.M. (2014). Natural additives in wheat-based pasta and
329 noodle products: opportunities for enhanced nutritional and functional properties. *Comprehensive*
330 *Reviews in Food Science and Food Safety* 13, 347-357.

331 Li, Y., Ma, D., Sun, D., Wang, C., Zhang, J., Xie, Y. dan Guo, T. (2015). Total phenolic, flavonoid content, and
332 antioxidant activity of flour, noodles, and steamed bread made from different colored wheat grains
333 by three milling methods. *The Crop Journal* 3(4), 328-334.

334 Magatra, P. (2013). Aktivitas antioksidan, kandungan fenolik total dan uji organoleptik pada tempe dengan
335 ekstrak daun beluntas (*Pluchea indica* L.). Indonesia: Universitas Kristen Satya Wacana, Skripsi S-1.

336 Mahasuari, N.P.S., Paramita, N.L.P.V. and Putra, A.A.G.R.Y. (2020). Effect of methanol concentration as a
337 solvent on total phenolic and flavonoid content of Beluntas leaf extract (*Pluchea indica* L.). *Journal of*
338 *Pharmaceutical Science and Application* 2(2), 77-84.

339 Marsono, Y. (2008). Prospek pengembangan makanan fungsional. *Jurnal Teknologi Pangan dan Gizi* 7(1),
340 19-27.

341 Nithya, D.J., Bosco, K.A.S., Jagan Mohan, R. and Alagusundaram, K. (2013). Antioxidant activity of rice bran
342 pasta. *Journal of Microbiology, Biotechnology and Food Sciences* 2(6), 2423-2425.

343 Norlaili, A.H., Roselina, K. and Muhammad, T.S. (2014). Effect of *Cosmos caudatus* Kunth. (Ulam Raja)
344 aqueous and dry extracts on the physicochemical and functional properties, and sensory acceptability
345 of Herbal Yellow Alkaline Noodles. *Malaysian Journal of Nutrition* 20(3), 403-415.

346 Pengelly, A. (2004). The Constituents of Medicinal Plants: an Introduction to the Chemistry and
347 Therapeutics of Herbal Medicines, 2nd ed. Australia: CABI Publishing.

348 Pokorny, J., Yanishlieva, N. and Gordon, M. (2001). Antioxidants in Food: Practical Applications.
349 Cambridge: Woodhead Publishing Ltd.

350 Saikia, S. and Mahanta, C.L. (2013). Effect of steaming, boiling and microwave cooking on the total
351 phenolics, flavonoids and antioxidant properties of different vegetables of Assam, India. *International*
352 *Journal of Food and Nutritional Sciences* 2(3), 47-53.

353 Sari, E.T. (2014). Faktor-faktor yang mempengaruhi konsumsi *functional food* di Surabaya. *Jurnal Ilmiah*
354 *Administrasi Niaga* 12(2), 1-10.

355 Shamim, M.Z., Verma, A., Sheikh, S. and Singh, S. (2016). Sensory evaluation of nutritious herbal noodles
356 developed by utilization of *Aegle marmelos* leaves powder. *IMPACT: International Journal of Research*
357 *in Applied, Natural and Social Sciences* 4(4), 109-114.

358 Stojanovic, Z., Filipovic, J. and Mugosa, B. (2013). Consumer acceptance of functional foods in
359 Montenegro. *Montenegrin Journal of Economics* 9(3), 65-74.

360 Sulaiman, C.T. and Balachandran, I. (2012). Total phenolics and total flavonoids in selected Indian medical
361 plants. *Indian Journal of Pharmaceutical Sciences* 74(3), 258-260.

362 Suter, I.K. (2013). Pangan Fungsional dan Prospek Pengembangannya. Retrieved on February 15, 2021
363 from Repositori Universitas Udayana Website:
364 [https://repositori.unud.ac.id/protected/storage/upload/repositori/ID3_1950123119760210032309](https://repositori.unud.ac.id/protected/storage/upload/repositori/ID3_19501231197602100323091304927makalah-gizi.pdf)
365 [1304927makalah-gizi.pdf](https://repositori.unud.ac.id/protected/storage/upload/repositori/ID3_19501231197602100323091304927makalah-gizi.pdf)

366 Suyanti. (2008). Membuat Mi Sehat Bergizi dan Bebas Pengawet. Depok: Penebar Swadaya.

367 Syahirah, J. and Rabeta, M.S. (2018). Antioxidant and antimicrobial activity of lemuni noodle. *Food*
368 *Research* 3(1), 7-13.

369 Tiwari, B.K., Valdramidis, V.P., Donnell, C.P.O., Muthukumarappan, K., Bourke, P. and Cullen, P.J. (2009).
370 Application of natural antimicrobials or food preservation. *Journal of Agricultural and Food Chemistry*
371 57(14), 5987-6000.

372 Ullah, Z., Ullah, R., Shah, A.H.A., Ahmad, I. and Haider, S. (2012). Phytochemical and biological evaluation
373 of *Vitex negundo* Linn: a review. *International Journal of Pharmaceutical Sciences and Research* 3(8),
374 2421-2431.

375 Vichapong, J., Sookserm, M., Srijesdaruk, V., Swatsitang, P. and Srijaranai, S. (2010). High performance
376 liquid chromatographic analysis of phenolic compounds and their antioxidant activities in rice
377 varieties. *LWT-Food Science and Technology* 43, 1325-1330.

378 Wibisono, D.A.S. (2021). Pengaruh konsentrasi bubuk daun beluntas (*Pluchea indica* (L.) Less) dalam air
379 seduhan terhadap total flavonoid dan kemampuan mereduksi ion besi mi basah. Indonesia:
380 Universitas Katolik Widya Mandala Surabaya, Skripsi S-1.

381 Widyawati, P.S., Budianta, T.D.W., Gunawan, D.I. and Wongso, R.S. (2015). Evaluation antidiabetic activity
382 of various leaf extracts of *Pluchea indica* Less. *International Journal of Pharmacognosy and*
383 *Phytochemical Research* 7(3), 597-603.

384 Widyawati, P.S., Budianta, T.D.W., Kusuma, F.A. and Wijaya, E.L. (2014). Difference of solvent polarity to
385 phytochemical content and antioxidant activity of *Pluchea indica* Less leaves extracts. *International*
386 *Journal of Pharmacognosy and Phytochemical Research* 6(4), 850-855.

387 Widyawati, P.S., Ristiarini, S., Werdani, Y.D.W., Kuswardani, I. and Herwina, I. N. (2019). Perubahan sifat
388 fisikokimia dan organoleptik sari kedelai dengan penambahan air seduhan Beluntas. *Jurnal Teknologi*
389 *Pangan dan Gizi* 18(2), 98-111.

390 Widyawati, P.S., Suteja, A.M., Suseno, T.I.P., Monika, P., Saputrajaya, W. and Liguori, C. (2014). Pengaruh
391 perbedaan warna pigmen beras organik terhadap aktivitas antioksidan. *Agritech* 34(4), 399-406.

392 Widyawati, P.S., Werdani, Y.D.W., Setiokusumo, C. and Kartikasari, A. (2017). In vitro antioxidant
393 capacities and antidiabetic properties of *Pluchea* leaves and green tea mixtures at various
394 proportions. *International Journal of Pharmacy and Pharmaceutical Sciences* 9(8), 203-208.

395 Wijaya, J.P. (2019). Pengaruh konsentrasi campuran bubuk daun beluntas (*Pluchea indica* L.)-teh hijau
396 (*Camellia sinensis* L.) 1:1 (b/b) dalam air seduhan terhadap aktivitas antioksidan *jelly drink*. Indonesia:
397 Universitas Katolik Widya Mandala Surabaya, Skripsi S-1.

398

399 **Tables and Figures**

400 Table 1. The use of *Pluchea* leaves in food sector

Type of food product	<i>Pluchea</i> leaf form	Stages of use	References
Tempeh	<i>Pluchea</i> leaf water extract	Soak soybeans before adding tempeh yeast	Magatra, 2013
<i>Pluchea</i> -black tea salted egg	<i>Pluchea</i> leaf flour	Mixed in salt solution for the ripening stage	Adventi <i>et al.</i> , 2015

Effervescent powder	Water extract (infusion) and ethanol extract (maceration)	Evaporated and mixed according to the formulation	Hudha and Widyaningsih, 2015
Dry method salted egg	Fresh Pluchea leaves	Added to pasta dough to coat eggs	Firdausi, 2017
Bun	Pluchea leaf powder steeping water	Added during dough making	Chiang, 2018
Soy milk	Pluchea leaf powder steeping water	Added to soy milk	Widyawati <i>et al.</i> , 2019
Pluchea-green tea jelly drink	Pluchea leaf powder	Brewed with green tea powder	Wijaya, 2019
Wet noodles	Pluchea leaf powder steeping water	Added during dough making	Wibisono, 2021

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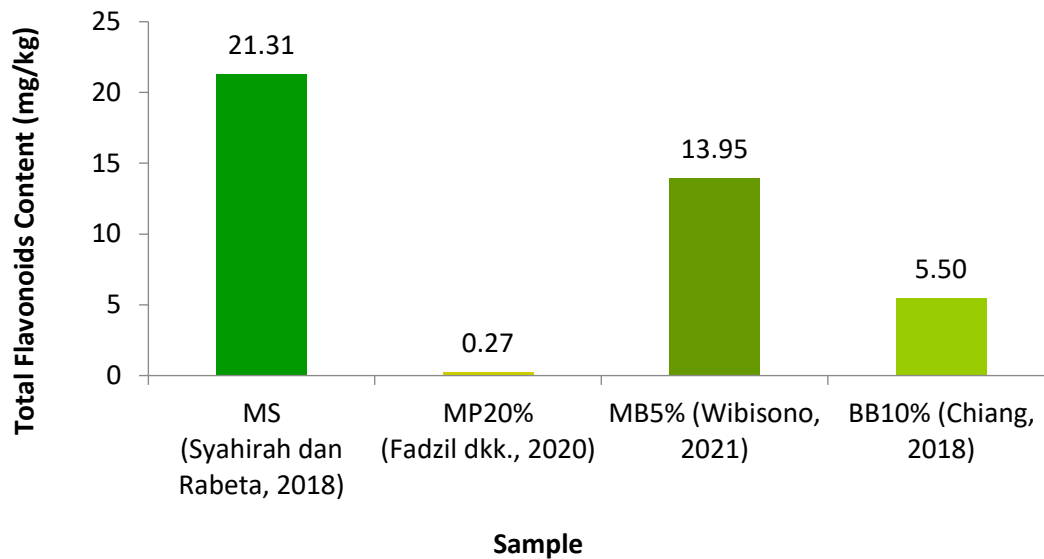
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409 Figure 1. Total flavonoid content (TFC) of Pluchea wet noodles 5% (MB5%) compared to sidondo wet
 410 noodles (MS), pegagan wet noodles 60% (MP60%), and Pluchea bun 10% (BB10%). The TFC of sidondo
 411 and pegagan wet noodles were respectively expressed in terms of quercetin equivalent per weight of wet
 412 noodles and rutin equivalent per weight of wet noodles extract, while the TFC of Pluchea noodles and
 413 Pluchea bun were expressed in terms of catechin equivalents per dry weight of freeze-dried results. TFC
 414 of MP20%, MB5%, and BB10% were expressed by the values that have been subtracted with the TFC of
 415 control from each study.

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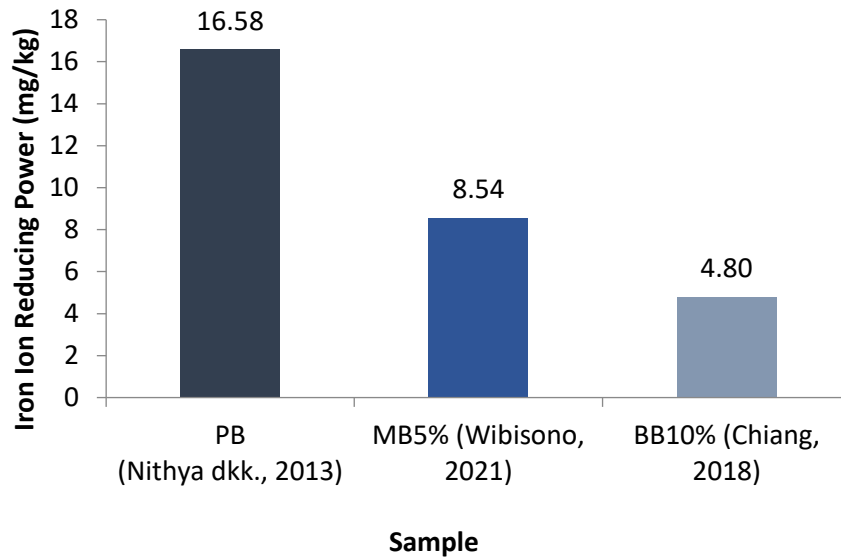
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426 Figure 2. Iron ion reducing power (RP) of Plucheia wet noodles 5% (MB5%) compared to rice flour paste
 427 (PB) and Plucheia bun 10% (BB10%). RP value of rice flour paste was stated to be equivalent to BHT per
 428 weight of pasta, while the RP value of Plucheia wet noodles and Plucheia bun was expressed in gallic acid
 429 equivalent per dry weight of freeze-dried results. Iron ion reducing power of MB5% and BB10% are
 430 expressed by the value that has been reduced by the RP value of control from each study.

3. Submitted to Food Research (5-2-2022)

-Correspondence

-Letter of Acceptance



Paini Sri Widyawati <paini@ukwms.ac.id>

Manuscript ID: FR-IFC-021

Food Research <foodresearch.my@outlook.com>
To: Paini Sri Widyawati <paini@ukwms.ac.id>

Sat, Feb 5, 2022 at 1:30 AM

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5th February 2022

Authors: Widyawati, P.S., Darmoatmodjo, L.M.Y.D., Wibisono, D.A.S., Putra, E.W. and Dharma, A.W.

Manuscript title: Potency of pluchea (*Pluchea indica* Less) leaves to increase functional value of wet noodles: a review

Manuscript ID: FR-IFC-021

Dear Dr. Paini Sri Widyawati,

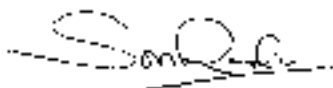
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4. First Revision: Major Revision (10-3-2022)

- Correspondence
- Evaluation Form
- Document



Paini Sri Widyawati <paini@ukwms.ac.id>

Manuscript ID: FR-IFC-021

Food Research <foodresearch.my@outlook.com>
To: Paini Sri Widyawati <paini@ukwms.ac.id>

Thu, Mar 10, 2022 at 2:53 AM

Dear Dr. Paini Sri Widyawati,

Manuscript FR-IFC-021 entitled " Potency of pluchea (Pluchea indica Less) leaves to increase functional value of wet noodles: a review " which you submitted to Food Research, has been reviewed. The comments of the reviewer(s) are included in the attached file.

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1 **Potency of pluchea (*Pluchea indica* Less) leaves to increase functional value of wet noodles: a review**

2
3 **Abstract**

4 Wet noodles are lack of nutritional components that are beneficial for health, thus it is necessary
5 to add other food ingredients that can increase the functional value of wet noodles. One of the food
6 ingredients that can be added in wet noodles formulation is *Pluchea indica* Less leaves, which have been
7 known as sources of antioxidants and used by the community as a traditional medicine to treat various
8 health problems. The use of *Pluchea indica* Less leaves in making wet noodles is expected to increase the
9 functional value of wet noodles. This research was aimed to determine the potency of *Pluchea indica* Less
10 leaves in affecting the phytochemical compounds content and functional properties of wet noodles. The
11 use of *Pluchea indica* Less leaves showed potential to increase the phytochemical compounds contents of
12 wet noodles, such as alkaloids, flavonoids, phenolics, saponins, tannins, and cardiac glycosides, which play
13 an important role in the health of human body and maintaining the quality of wet noodles, such as
14 antioxidant, anti-warmed over flavor, anti-inflammatory, antidiabetic, and antimicrobial activities.
15 Accordingly, the increase in phytochemical compounds in wet noodles could also affect the functional
16 properties of wet noodles.

17
18 **Keywords:** *Pluchea indica* Less, wet noodles, functional value

19
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21 **1. Introduction**

22 Noodles as one of the wheat flour-based product are quiet popular among various levels of society in
23 Indonesia. Noodles can be classified into five forms based on processing stage and water content of the
24 noodles product, including raw noodles, wet noodles, dry noodles, fried noodles, and instant noodles.
25 Wet noodles are noodles product that has water content of about 52% and is produced through the
26 cooking stage of raw noodles before being marketed (Koswara, 2009). According to Estiasih *et al.* (2017),
27 the high moisture content of wet noodles causes the shelf life of wet noodles to only reach 40 hours at
28 room temperature storage.

29 Increased awareness and interest in functional food supports the development of various food
30 products with high functional value (Abbas, 2020). The functional value of a food product depends on the
31 nutrients contained in the food ingredients that make up the food product. Raw materials in the
32 manufacture of noodles generally include wheat flour, eggs, water, and other additives so that noodles
33 are known to be low in nutritional content that is beneficial to health (Suyanti, 2008). Therefore, various
34 efforts have been made to overcome the shortcomings of these wet noodles products. Increasing the
35 functional value of wet noodles can be done by adding other food ingredients that contain bioactive
36 compounds in the manufacture of wet noodles, one of which is the addition of pluchea leaves.

37 *Pluchea* (*Pluchea indica* Less) is an herbaceous plant that contains phytochemical compounds,
38 including alkaloids, saponins, tannins, phenol hydroquinone, flavonoids, cardiac glycosides, and sterols so
39 that they are potential sources of natural antioxidants (Widyawati *et al.*, 2015). In addition, *Pluchea* leaves
40 also have antimicrobial activity that has the potency to prevent food damage (Ardiansyah *et al.*, 2003).
41 The use of *pluchea* leaves in the manufacture of wet noodles is expected to produce wet noodles that are
42 able to provide antioxidant effects that are good for health, and have an impact on increasing the shelf
43 life of the wet noodles product.

44 Currently, the use of *pluchea* leaves is only limited as fresh vegetables and drinks, but there have been
45 many studies on the use of *pluchea* leaves in the food sector that continue to be developed, including
46 making tempeh with *pluchea* leaf extract (Magatra, 2013), *Pluchea*-black tea salted eggs (Adventi *et al.*,
47 2015), effervescent powder based on *Pluchea* leaf extract (Hudha and Widyaningsih, 2015), *pluchea* bun
48 products (Chiang, 2018), *pluchea* soy milk (Widyawati *et al.*, 2019), *pluchea*-green tea jelly drink (Wijaya,

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49 2019), and pluchea wet noodles (Wibisono, 2021). The use of pluchea leaves in the manufacture of wet
50 noodles was studied further as an effort to develop functional food products that were beneficial to the
51 health of the consumer's body.

52 53 2. Methods

54 Methods of this research were data collected from several appropriate literatures regarding the
55 utilization of pluchea (*Pluchea indica* Less) leaves in making wet noodles and the potency of pluchea leaves
56 in wet noodles by comparing the content of phytochemical compounds (represented by total flavonoid
57 content (TFC) value) and antioxidant activity (represented by iron ion reducing power (RP) value) of
58 pluchea wet noodles with other similar products from several studies. This study used literature and
59 comparative study method by collecting data that show the potency of pluchea leaves in wet noodles.

60 61 3. Results and Discussion

62 Several factors such as individual education, household standards and level of knowledge about food
63 products with health claims, as well as perceptions of some existing functional food product attributes
64 affect the development of public interest in functional food products (Stojanovic *et al.*, 2013; Sari, 2014).
65 Marsono (2008) also stated that increasing awareness of the importance of food in preventing or curing
66 disease, consumer demands for foods with more properties (containing functional ingredients),
67 experiences with alternative medicines, and studies on the prevalence of certain diseases that are
68 influenced by diet have also become the basis for the rapid development of functional food products in
69 various countries.

70 Functional food is defined as a food product that is able to provide benefits to the health of the body,
71 one of which is through the presence of bioactive components contained in a functional food product
72 (Suter, 2013; Abbas, 2020). According to Abbas (2020), there are five categories of functional food, i.e.
73 foodstuffs with a reduction or increase in the basic nutritional content, products that naturally do not
74 have certain nutrients and are added to them, milk-based products fermented with probiotics, products
75 that are specially formulated to fulfill certain needs, and foodstuffs containing herbal ingredients to help
76 overcome various health problems.

77 Herbal plants is a source of functional food, i.e. a source of natural antioxidants that can be used in
78 the food sector to improve the functional properties of processed food products, one of which is the use
79 of herbal plants to increase the content of bioactive components in wheat flour-based products such as
80 noodles. According to Fadzil *et al.* (2020), noodles are known to be low in nutritional components that are
81 beneficial to health, while noodles with functional properties such as high antioxidants are in high demand
82 at this time.

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85 3.1 Utilization of pluchea leaves in making wet noodles

86 The main ingredients in making noodles are generally wheat flour, eggs, water, and other
87 additives as needed so that noodles products only contain carbohydrates, proteins, fats, and minerals.
88 The content of carbohydrates, several minerals, and energy in noodles are very high, but the content of
89 protein, fat, and vitamins in noodles products are low (Suyanti, 2008). Several studies have been carried
90 out in an effort to improve the functional properties of noodles products, one of which is by using the
91 leaves of plants that have been known as traditional medicines to be added to the manufacture of
92 noodles, such as making herbal noodles with cosmos (*Cosmos caudatus* Kunth.) leaf extract (Norlaili *et al.*,
93 2014), manufacture of herbal noodles with leaves of the Indian bael plant (*Aegle marmelos*) (Shamim *et al.*,
94 2016), manufacture of sidondo (*Vitex negundo* Linn.) noodles (Syahirah and Rabeta, 2018), addition
95 of moringa (*Moringa oleifera*) leaf extract to wet noodles (Khasanah and Astuti, 2019), making herbal

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96 noodles with pegagan (*Centella asiatica*) extract (Fadzil *et al.*, 2020), and using pluchea (*Pluchea indica*
97 Less) leaf powder steeped water to make pluchea wet noodles (Wibisono, 2021).

98 The content and activity of phytochemical compounds in pluchea leaves, both in the form of fresh
99 leaves and water steeped in powdered pluchea leaves, have been identified. Pluchea is classified as plant
100 that has high polyphenol content and relatively large antioxidant capacity compared to other herbaceous
101 plants (Andarwulan *et al.*, 2010; Andarwulan *et al.*, 2012). Research conducted by Widyawati *et al.* (2016)
102 showed that the phytochemical compounds contained in the brewed water of Pluchea leaf powder
103 include alkaloids, flavonoids, phenolics, saponins, tannins, and cardiac glycosides. According to Pengly
104 (2004), each phytochemical compound has physiological effects including alkaloids as analgesic,
105 mydriatic, miotic, hypertensive, hypotensive, bronchodilator, stimulant, antimicrobial, and antileukemic,
106 flavonoids as antioxidant, antiviral, hepatoprotective, antiatheromatous, anti-inflammatory, and
107 antihypertensive, phenolic as antioxidant, antimicrobial, anti-inflammatory, antiplatelet, and antiallergic,
108 saponins as anticancer, anti-inflammatory, immunomodulatory, antihepatotoxic, and antidiabetic,
109 tannins as antioxidant, antitumor, antihemorrhagic, and antiatherogenic, as well as cardiac glycosides that
110 can increase strength and speed of systolic contraction. Flavonoids are one of the important constituents
111 that can provide real benefits for the health of the human body.

112 The use of pluchea leaves in food products continues to be developed through various studies as
113 shown in Table 1., however, the use of pluchea leaves to increase the functional value of wheat flour-
114 based food products has not been widely studied. So far the research that has been carried out regarding
115 the use of pluchea leaves in the formulation of wheat flour-based food products is in the manufacture of
116 pluchea bun (Chiang, 2018) and pluchea wet noodles (Wibisono, 2021), both of which use pluchea leaf
117 powder steeping water which is added to the product formulation.

118

119 3.2 The effect of pluchea leaves on the content of phytochemical compounds of wet noodles

120 The largest group of phytochemical compounds in plants includes alkaloids, terpenes, and
121 phenolic compounds. Phenolic compounds are a group of phytochemical compounds that are widely
122 distributed in various plants, where this group of compounds can be used as the main source of natural
123 antioxidants and are able to act as antimicrobial, anticarcinogenic, and other biological activities (Kennedy
124 and Wightman, 2011; Aziman *et al.*, 2012). Pluchea leaves contain phenolic compounds in the form of
125 flavonoids, 1,3,4,5-tetra-O-caffeoylquinic acid, 3,4,5-tri-O-caffeoylquinic acid, chlorogenic acid, and ferulic
126 acid (Mahasuari *et al.*, 2020).

127 Flavonoids as secondary metabolites as well as the main and largest compounds in the group of
128 phenolic compounds are commonly found in plant tissues in free form or glycosides (Aberoumand and
129 Deokule, 2008; Sulaiman and Balachandran, 2012; Agbo *et al.*, 2015). In plants, flavonoids are found in
130 the form of flavonoid glycosides, flavonols, flavan-3-ol, flavones, flavanones, chalcones, anthocyanins, and
131 proanthocyanidins (Dehkharghanian *et al.*, 2010; Vichapong *et al.*, 2010; Chen, 2013). Flavonoids have the
132 ability to chelate metals and donate hydrogen atoms so that they can act as antioxidants that are able to
133 provide certain physiological effects on the human body (Erlidawati *et al.*, 2018). This has become one of
134 the basis for the use of herbal plants for traditional medicine and supports various functional food product
135 innovations such as pluchea wet noodles.

136 Research by Wibisono (2021) showed that the use of pluchea leaf powder steeped water was able
137 to contribute in increasing the content of phytochemical compounds (especially flavonoids) in wet
138 noodles, that the lowest (5%) and the highest (30%) concentration of pluchea leaf powder in steeping
139 water were able to increase the total flavonoid content (TFC) of wet noodles as much as 1.43 times and
140 4.07 times compared to the control wet noodles (without the use of pluchea leaf powder steeping water),
141 respectively. The potential use of pluchea leaves in the manufacture of wet noodles can be seen by
142 comparing the TFC of pluchea wet noodles in Wibisono's study (2021) with other herbal noodles and
143 pluchea bun as another form of wheat flour-based product. Comparison of the total flavonoids of pluchea

144 wet noodles with sidondo wet noodles, pegagan wet noodles, and pluchea bun from existing studies can
145 be seen in Figure 1.

146 The group of flavonoids found in pluchea leaves are flavonols and flavones, including quercetin,
147 myrisetin, kaempferol, apigenin, luteolin, and chrysoeriol (Andarwulan *et al.*, 2010; Andarwulan *et al.*,
148 2012; Koirewoa *et al.*, 2012; Mahasuari *et al.*, 2020), sidondo flavonoids consist of castikin, orientin,
149 isoorientin, luteolin, lutekin-7-O-glucoside, corimbosin, gardenins A and B, 3-O-desmethylartemethin, 5-
150 O-desmethylnobiletin, and 3',4',5,5',6,7,8-heptamethoxyflavones (Lakshmanashetty *et al.*, 2010; Ullah *et al.*,
151 2012), while the flavonoids of pegagan include quercetin, myrisetin, and kaempferol (Andarwulan *et al.*,
152 2010; Andarwulan *et al.*, 2012). The TFC value of wet noodles with the addition of 5% concentration
153 of pluchea leaf powder in steeping water was greater than the TFC of wet noodles with the addition of
154 20% pegagan extract, but the TFC of pluchea wet noodles 5% was lower than the TFC of sidondo wet
155 noodles which used 0.66% sidondo leaf powder from the total weight of the noodles ingredients. Based
156 on this comparison, it can be indicated that the use of pluchea leaf powder steeping water with a
157 concentration of 5% can increase the flavonoids content of wet noodles far exceeding the flavonoids
158 content that can be given by 20% pegagan extract solution in wet noodles (total flavonoids of pluchea wet
159 noodles 5% is 51.67 times compared to pegagan noodles 20%). The total flavonoids of the pluchea wet
160 noodles 5% is 1.53 times lower than the total flavonoids of sidondo wet noodles. The flavonoids content
161 of sidondo wet noodles which was higher than pluchea wet noodles 5% could be caused by the addition
162 of sidondo leaf powder directly to the making of wet noodles dough in Syahirah and Rabeta's research
163 (2018), while pluchea wet noodles dough in Wibisono's study (2021) was made with using pluchea leaf
164 powder steeping water in the formulation of wet noodles. In addition, several factors such as differences
165 in formulation, sequence of processing and analysis stages, as well as stated standards and product
166 sample forms analyzed in each study also affect the difference in TFC values compared between types of
167 herbal wet noodles.

168 The TFC of wet noodles with the addition of 5% concentration of pluchea leaf powder in steeping
169 water was higher than the TFC of bun with the addition of 10% concentration of pluchea leaf powder in
170 steeping water. This shows that the flavonoids content of pluchea wet noodles is higher than the
171 flavonoids content of pluchea bun even though the concentration of pluchea leaf powder in steeping
172 water in the manufacture of pluchea wet noodles is lower than the concentration of pluchea leaf powder
173 in steeping water in the manufacture of pluchea bun (the TFC of pluchea wet noodles 5% is 2.54 times
174 compared to pluchea bun 10%). According to Li *et al.* (2015), antioxidant compounds, one of which is
175 flavonoids, are easily degraded in the heating process, and are lost during the process of mixing and
176 kneading the dough. The degradation of flavonoids during heating and the extraction of glycosides by
177 water vapor can be the cause of the low TFC value of pluchea bun. On the other hand, Saikia and Mahanta
178 (2013) stated that the high flavonoids content can be caused by breaking the glycosidic bond of flavonoids
179 with sugar by heating treatment. The wet noodles cooking process is thought to have an effect on breaking
180 the glycosidic bond so that aglycones are formed which can improve the detection results of flavonoids
181 compounds in the analysis. Various factors can affect the TFC value in different food products, including
182 differences in ingredient formulations, specifications of the methods used, and the stages of the process
183 in the manufacture of food products.

184 The TFC of pluchea wet noodles 5% showed that pluchea leaves have the potency to increase the
185 content of phytochemical compounds (in this case flavonoids) in wet noodles as a wheat flour-based food
186 product. Wibisono (2021) also stated that the use of higher concentration of pluchea leaf powder in
187 steeping water in the formulation of wet noodles is able to provide a significant increase in the TFC of wet
188 noodles. There has been no research on the effect of adding pluchea leaf powder steeping water on the
189 type and amount of phytochemical compounds other than flavonoids in pluchea wet noodles products,
190 so the use of pluchea leaves in the manufacture of wet noodles still needs to be developed and further
191 investigated its effect on the phytochemical component content of wet noodles.

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3.3 The effect of pluchea leaves on the functional properties of wet noodles

The functional properties of functional food products mainly focus on the ability of bioactive components in food products to help maintain the health of the human body. One of the properties possessed by bioactive components is that they can act as antioxidants. Carotenoids, flavonoids, and phenolic compounds are classified as natural antioxidants that can be found in various foodstuffs (Marsono, 2008). Antioxidant activity can be in the form of DPPH free radical scavenging ability, iron ion reducing power, reactive oxygen species scavenging activity, and β -carotene-linoleic acid system inhibitory activity (Widyawati *et al.*, 2017).

Iron ion reducing power (RP) is one of the parameters of antioxidant potential which is measured as secondary antioxidant activity based on the ability of antioxidant compounds to reduce Fe^{3+} to Fe^{2+} . Secondary antioxidants play a role in the mechanism of binding metal ions, scavenging oxygen, converting hydrogen peroxide into non-radical compounds, absorbing UV radiation, or deactivating singlet oxygen (Pokorny *et al.*, 2001). According to Widyawati *et al.* (2014), iron ion is one of the pro-oxidants that has the potency to generate new free radicals. Antioxidant components are able to neutralize iron ions by acting as a substrate that will be oxidized first. Based on the research of Wibisono (2021), the use of the lowest (5%) and the highest (30%) concentration of pluchea leaf powder were able to increase the RP value of wet noodles by 1.33 times and 3.27 times compared to control wet noodles, respectively. The potency of pluchea leaves in increasing the antioxidant activity of wet noodles products can be described by comparing the RP value of pluchea wet noodles with other products such as rice flour paste and pluchea bun. The comparison of secondary antioxidant activity in the form of the iron ion reducing power of pluchea wet noodles with rice flour paste and pluchea bun can be seen in Figure 2.

Pluchea wet noodles 5% in the Wibisono's study (2021) had the RP value 1.78 times higher than the RP value of pluchea bun 10% in Chiang's research (2018), but 1.94 times lower than the RP value of paste made from rice flour in the research of Nithya *et al.* (2013). The RP value indicates that the use of pluchea leaf powder steeping water with 5% concentration of pluchea leaf powder in steeping water has potency to provide greater secondary antioxidant activity in wet noodles than in bun products. The TFC of pluchea wet noodles 5% which is greater than the TFC of pluchea bun 10%, as shown in Figure 1., can contribute to the large iron ion reducing power of pluchea wet noodles 5% and pluchea bun 10%, that the phenolic group compounds, one of which is flavonoids, capable of donating hydrogen atoms/electrons so that they can reduce iron ions (Widyawati *et al.*, 2014). The flavonoids content of pluchea wet noodles which is higher than the flavonoids content of pluchea bun can cause the iron ion reducing power of wet noodles is higher compared to pluchea bun.

RP value of pluchea wet noodles 5% which is lower than the RP value of rice flour paste can be due to the use of different types of raw materials (related to the number and types of bioactive components in the ingredients) and the shape of the product samples analyzed in each study. Based on the research of Widyawati *et al.* (2014), white rice has total phenolic content (TPC) of 4.12 ± 0.05 mg gallic acid equivalent/g dry basis which is greater than the TPC of pluchea leaves in the study of Andarwulan *et al.* (2010), which was 0.831 ± 0.129 mg gallic acid equivalent/g fresh leaf weight. According to Wibisono (2021), the iron ion reducing power of pluchea wet noodles can be increased by using higher concentration of pluchea leaf powder in steeping water in the formulation of wet noodles.

RP value of pluchea wet noodles 5% shows the potency of pluchea leaves to increase the antioxidant activity of wet noodles products as an effort to increase the functional value of wheat flour-based food products such as wet noodles. The effect of adding pluchea leaf powder steeping water on the antioxidant activity of pluchea wet noodles using a type of analysis other than the iron ion reducing power has not been studied further, so it is necessary to measure other antioxidant parameters to support the potency of pluchea leaves in making wet noodles.

239 Research on the potency of pluchea leaves in improving the functional properties of wet noodles
240 is still limited to being studied on product antioxidants, while pluchea leaves have been known to have
241 various other functional properties that are beneficial to health and are able to maintain the quality of
242 food products. Several other functional properties that have the potency to be provided by pluchea leaves
243 in food products include activities as anti-warmed over flavor, anti-inflammatory, antidiabetic (Widyawati
244 *et al.*, 2017), and antimicrobial properties that have the potency to prevent food spoilage (Ardiansyah *et*
245 *al.*, 2003). This ability is inseparable from the presence of bioactive compounds in pluchea leaves which
246 have the capacity as antioxidant and antihyperglycemic agents (Widyawati *et al.*, 2014; Widyawati *et al.*,
247 2015). According to Li *et al.*, 2014), herbal plant extracts are potential preservatives that are currently
248 being developed to be applied to bread, pasta, and noodles products due to the presence of phenolic
249 components that have high antimicrobial activity. Tiwari *et al.* (2009) stated that the antimicrobial activity
250 of phenolic compounds is related to the ability of phenolics to affect the permeability of microbial cells
251 which causes the release of important macromolecules from the microbial cell, as well as the ability of
252 phenolics to interact with membrane proteins that cause deformation of the structure and function of
253 microbial cell membranes.

254

255 **4. Conclusion**

256 Pluchea (*Pluchea indica* Less) leaves have the potency to increase the functional value of wet noodles
257 in terms of the phytochemical content and functional properties of the wet noodles. The use of pluchea
258 leaves increases the content of phytochemical compounds, in this case flavonoids, in wet noodles. The
259 increase in the content of phytochemical compounds with the use of pluchea leaves affects the increase
260 in the functional properties of wet noodles products, especially antioxidant activity in the form of the iron
261 ion reducing power of wet noodles.

262

263 **Conflict of interest**

264 The authors declare no conflict of interest.

265

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271 **References**

- 272 Abbas. (2020). Potency of functional food and its role in improving health of an increasingly vulnerable
273 human being-mini review. *Journal of Teknosains* 14(2), 176-186. (In Bahasa).
274
- 275 Aberoumand, A. and Deokule, S.S. (2008). Comparison of phenolic compounds of some edible plant of
276 Iran and India. *Pakistan Journal of Nutrition* 7(4), 582-585.
277
- 278 Adventi, B.S., Widyawati, P.S. and Utomo, A.R. (2015). Effect of salt concentration for physicochemical
279 and organoleptics salted egg pluchea (*Pluchea indica* Less)-black tea (*Camelia sinensis*). *Journal of Food*
280 *Technology and Nutrition* 14(2), 55-60. (In Bahasa).
281
- 282 Agbo, M.O., Uzor, P.F., Akazie-Nneji, U.N., Eze-Oduruwe, C.U., Ogbatue, U.B. and Mbaaji, E.C. (2015).
283 Antioxidant, total phenolic and flavonoid content of selected Nigerian medical plants. *Dhaka University*
284 *Journal of Pharmaceutical Sciences* 14(1), 1-7.
285
- 286 Andarwulan, N., Kurniasih, D., Apriady, R.A., Rahmat, H., Roto, A.V. and Bolling, B.W. (2012). Polyphenols,
287 carotenoids, and ascorbic acid in underutilized medicinal vegetables. *Journal of Functional Foods* 4, 339-
288 347.
289
- 290 Andarwulan, N., Batari, R., Sandrasari, D.A., Bolling, B. and Wijaya, H. (2010). Flavonoid content and
291 antioxidant activity of vegetables from Indonesia. *Food Chemistry* 121, 1231-1235.
292
- 293 Ardiansyah, Nuraida, L. and Andarwulan, N. (2003). Antimicrobial activity of pluchea (*Pluchea indica* L.)
294 leaves extract and stability of the activity at different salt concentrations and pHs. *Journal of Food*
295 *Technology and Industry* 14(2), 90-97. (In Bahasa).
296
- 297 Aziman, N., Abdullah N., Noor, Z.M., Zulkifli, K.S. and Kamarudin, W.S.S.W. (2012). Phytochemical
298 constituents and in vitro bioactivity of ethanolic aromatic herb extracts. *Sains Malaysiana* 41(11), 1437-
299 1444.
300
- 301 Chen, X.G.Q. (2013). Identification and antioxidant capacity of anthocyanin pigment, and expressional
302 analysis of flavonoid biosynthetic genes in colored rice strains. Japan: University of Hiroshima, PhD.
303 Dissertation.
304
- 305 Chiang, I. (2018). The effect of Pluchea leaves powder (*Pluchea indica* Less) in steeping water of pao
306 antioxidant activity. Indonesia: Widya Mandala Surabaya Catholic University, Bachelor. Final Project. (In
307 Bahasa)
308
- 309 Dehkharghanian, M., Adenier, H. and Vijayalakshmi, M.A. (2010). Study of flavonoids in aqueous spinach
310 extract using positive electrospray ionisation tandem quadrupole mass spectrometry. *Food Chemistry*
311 121, 863-870.
312
- 313 Erlidawati, Safrida and Mukhlis. (2018). Antioxidant Potency as Antidiabetic. Banda Aceh: Syiah Kuala
314 University Press. (In Bahasa).
315
- 316 Estiasih, T., Putri, W.D.R. and Waziroh, E. (2017). Tubers and Their Processing. Malang: UB Press. (In
317 Bahasa).
318

319 Fadzil, N.F., Bakar, M.F.A., Yusop, M.H.M. and Bakar, F.I.A. (2020). Sensorial and physicochemical
320 characteristics of herbal noodle enriched with *Centella asiatica*. *Food Research* 4(4), 1030-1037.
321
322 Firdausi, M.H. (2017). Physicochemical and organoleptic quality of dry method salted eggs with addition
323 of beluntas leaves (*Pluchea indica* L). Indonesia: Brawijaya University, Bachelor. Final Project. (In Bahasa).
324
325 Hudha, M. and Widyaningsih, T.D. (2015). The effervescent powder uses pluchea leaf (*Pluchea indica* Less)
326 extract as natural antioxidant source. *Journal of Food and Agroindustry* 3(4), 1412-1422. (In Bahasa).
327
328 Khasanah, V. and Astuti, P. (2019). Effect of addition of Moringa leaf extract (*Moringa oleifera*) on sensory
329 quality and protein content of wet noodles substituted with modified cassava flour. *Journal of Technical*
330 *Competence* 11(2), 15-21. (In Bahasa).
331
332 Kennedy, D.O. and Wightman, E.L. (2011). Herbal extracts and phytochemicals: plant secondary
333 metabolites and the enhancement of human brain function. *Advances in Nutrition* 2, 32-50.
334
335 Koirewoa, Y.A., Fatimawali and Wiyono, W.I. (2012). Isolation and identification flavonoid compounds in
336 beluntas leaf (*Pluchea indica* L.). *Pharmakon* 1(1), 47-52. (In Bahasa).
337
338 Koswara, S. (2009). Noodles Processing Technology. Retrieved on July 10, 2020 from Food Technology of
339 Muhammadiyah University Semarang Website: [http://tekpan.unimus.ac.id/wp-](http://tekpan.unimus.ac.id/wp-content/uploads/2013/07/Teknologi-Pengolahan-Mie-teori-dan-praktek.pdf)
340 [content/uploads/2013/07/Teknologi-Pengolahan-Mie-teori-dan-praktek.pdf](http://tekpan.unimus.ac.id/wp-content/uploads/2013/07/Teknologi-Pengolahan-Mie-teori-dan-praktek.pdf) (In Bahasa).
341
342 Lakshmanashetty, R.H., Nagaraj, V.B., Hiremath, M.G. and Kumar V. (2010). In vitro antioxidant activity of
343 *Vitex negundo* L. leaf extracts. *Chiang Mai Journal of Science* 37(3), 489-497.
344
345 Li, M., Zhu, K.X., Guo, X.N., Brijs, K. dan Zhou, H.M. (2014). Natural additives in wheat-based pasta and
346 noodle products: opportunities for enhanced nutritional and functional properties. *Comprehensive*
347 *Reviews in Food Science and Food Safety* 13, 347-357.
348
349 Li, Y., Ma, D., Sun, D., Wang, C., Zhang, J., Xie, Y. dan Guo, T. (2015). Total phenolic, flavonoid content, and
350 antioxidant activity of flour, noodles, and steamed bread made from different colored wheat grains by
351 three milling methods. *The Crop Journal* 3(4), 328-334.
352
353 Magatra, P. (2013). Antioxidant activity, total phenolic content, and organoleptic test in tempe with marsh
354 fleabane leaf extract (*Pluchea indica* L.). Indonesia: Satya Wacana Christian University, Bachelor. Final
355 Project. (In Bahasa).
356
357 Mahasuari, N.P.S., Paramita, N.L.P.V. and Putra, A.A.G.R.Y. (2020). Effect of methanol concentration as a
358 solvent on total phenolic and flavonoid content of Beluntas leaf extract (*Pluchea indica* L.). *Journal of*
359 *Pharmaceutical Science and Application* 2(2), 77-84.
360
361 Marsono, Y. (2008). Functional food development prospects. *Journal of Food Technology and Nutrition*
362 7(1), 19-27. (In Bahasa).
363
364 Nithya, D.J., Bosco, K.A.S., Jagan Mohan, R. and Alagusundaram, K. (2013). Antioxidant activity of rice bran
365 pasta. *Journal of Microbiology, Biotechnology and Food Sciences* 2(6), 2423-2425.
366

367 Norlaili, A.H., Roselina, K. and Muhammad, T.S. (2014). Effect of *Cosmos caudatus* Kunth. (Ulam Raja)
368 aqueous and dry extracts on the physicochemical and functional properties, and sensory acceptability of
369 Herbal Yellow Alkaline Noodles. *Malaysian Journal of Nutrition* 20(3), 403-415.
370
371 Pengelly, A. (2004). The Constituents of Medicinal Plants: An Introduction to the Chemistry and
372 Therapeutics of Herbal Medicines, 2nd ed. Australia: CABI Publishing.
373
374 Pokorny, J., Yanishlieva, N. and Gordon, M. (2001). Antioxidants in Food: Practical Applications.
375 Cambridge: Woodhead Publishing Ltd.
376
377 Saikia, S. and Mahanta, C.L. (2013). Effect of steaming, boiling and microwave cooking on the total
378 phenolics, flavonoids and antioxidant properties of different vegetables of Assam, India. *International*
379 *Journal of Food and Nutritional Sciences* 2(3), 47-53.
380
381 Sari, E.T. (2014). Factors influencing consumption of functional food in Surabaya. *Scientific Journal of*
382 *Commerce Administration* 12(2), 1-10. (In Bahasa).
383
384 Shamim, M.Z., Verma, A., Sheikh, S. and Singh, S. (2016). Sensory evaluation of nutritious herbal noodles
385 developed by utilization of *Aegle marmelos* leaves powder. *IMPACT: International Journal of Research in*
386 *Applied, Natural and Social Sciences* 4(4), 109-114.
387
388 Stojanovic, Z., Filipovic, J. and Mugosa, B. (2013). Consumer acceptance of functional foods in
389 Montenegro. *Montenegrin Journal of Economics* 9(3), 65-74.
390
391 Sulaiman, C.T. and Balachandran, I. (2012). Total phenolics and total flavonoids in selected Indian medical
392 plants. *Indian Journal of Pharmaceutical Sciences* 74(3), 258-260.
393
394 Suter, I.K. (2013). Functional Foods and Their Development Prospects. Retrieved on February 15, 2021
395 from Udayana University Repository Website:
396 [https://repositori.unud.ac.id/protected/storage/upload/repositori/ID3_19501231197602100323091304](https://repositori.unud.ac.id/protected/storage/upload/repositori/ID3_19501231197602100323091304927makalah-gizi.pdf)
397 [927makalah-gizi.pdf](https://repositori.unud.ac.id/protected/storage/upload/repositori/ID3_19501231197602100323091304927makalah-gizi.pdf) (In Bahasa).
398
399 Suyanti. (2008). Making Healthy Nutritious and Preservative-free Noodles. Depok: Penebar Swadaya. (In
400 Bahasa).
401
402 Syahirah, J. and Rabeta, M.S. (2018). Antioxidant and antimicrobial activity of lemuni noodle. *Food*
403 *Research* 3(1), 7-13.
404
405 Tiwari, B.K., Valdramidis, V.P., Donnell, C.P.O., Muthukumarappan, K., Bourke, P. and Cullen, P.J. (2009).
406 Application of natural antimicrobials or food preservation. *Journal of Agricultural and Food Chemistry*
407 57(14), 5987-6000.
408
409 Ullah, Z., Ullah, R., Shah, A.H.A., Ahmad, I. and Haider, S. (2012). Phytochemical and biological evaluation
410 of *Vitex negundo* Linn: a review. *International Journal of Pharmaceutical Sciences and Research* 3(8), 2421-
411 2431.
412

413 Vichapong, J., Sookserm, M., Srijesdaruk, V., Swatsitang, P. and Srijaranai, S. (2010). High performance
414 liquid chromatographic analysis of phenolic compounds and their antioxidant activities in rice varieties.
415 *LWT-Food Science and Technology* 43, 1325-1330.
416
417 Wibisono, D.A.S. (2021). Effect of concentration of *Pluchea (Pluchea indica (L.) Less)* leaves powder in
418 steeping water on total flavonoids and iron ion reducing power of wet noodle. Indonesia: Widya Mandala
419 Surabaya Catholic University, Bachelor. Final Project. (In Bahasa).
420
421 Widyawati, P.S., Budianta, T.D.W., Gunawan, D.I. and Wongso, R.S. (2015). Evaluation antidiabetic activity
422 of various leaf extracts of *Pluchea indica* Less. *International Journal of Pharmacognosy and Phytochemical*
423 *Research* 7(3), 597-603.
424
425 Widyawati, P.S., Budianta, T.D.W., Kusuma, F.A. and Wijaya, E.L. (2014). Difference of solvent polarity to
426 phytochemical content and antioxidant activity of *Pluchea indica* Less leaves extracts. *International*
427 *Journal of Pharmacognosy and Phytochemical Research* 6(4), 850-855.
428
429 Widyawati, P.S., Ristiari, S., Werdani, Y.D.W., Kuswardani, I. and Herwina, I. N. (2019). Physicochemical
430 and organoleptic properties changes of soymilk with *Pluchea* brewing water addition. *Journal of Food*
431 *Technology and Nutrition* 18(2), 98-111. (In Bahasa).
432
433 Widyawati, P.S., Suteja, A.M., Suseno, T.I.P., Monika, P., Saputrajaya, W. and Liguori, C. (2014). Effect of
434 pigment color difference in organic rice on antioxidant activity. *Agritech* 34(4), 399-406. (In Bahasa).
435
436 Widyawati, P.S., Werdani, Y.D.W., Setiokusumo, C. and Kartikasari, A. (2017). In vitro antioxidant
437 capacities and antidiabetic properties of *Pluchea* leaves and green tea mixtures at various proportions.
438 *International Journal of Pharmacy and Pharmaceutical Sciences* 9(8), 203-208.
439
440 Wijaya, J.P. (2019). Effect of concentration of mixture of *Pluchea (Pluchea indica L.)* leaves powder – green
441 tea (*Camellia sinensis L.*) 1:1 (b/b) in steeping water on antioxidant activity of jelly drink. Indonesia: Widya
442 Mandala Surabaya Catholic University, Bachelor. Final Project. (In Bahasa).
443
444

445 Table 1. The use of Pluchea leaves in food sector

Type of food product	Pluchea leaf form	Stages of use	References
Tempeh	Pluchea leaf water extract	Soak soybeans before adding tempeh yeast	Magatra, 2013
Pluchea -black tea salted egg	Pluchea leaf flour	Mixed in salt solution for the ripening stage	Adventi <i>et al.</i> , 2015
Effervescent powder	Water extract (infusion) and ethanol extract (maceration)	Evaporated and mixed according to the formulation	Hudha and Widyaningsih, 2015
Dry method salted egg	Fresh pluchea leaves	Added to pasta dough to coat eggs	Firdausi, 2017
Bun	Pluchea leaf powder steeping water	Added during dough making	Chiang, 2018
Soy milk	Pluchea leaf powder steeping water	Added to soy milk	Widyawati <i>et al.</i> , 2019
Pluchea- green tea jelly drink	Pluchea leaf powder	Brewed with green tea powder	Wijaya, 2019
Wet noodles	Pluchea leaf powder steeping water	Added during dough making	Wibisono, 2021

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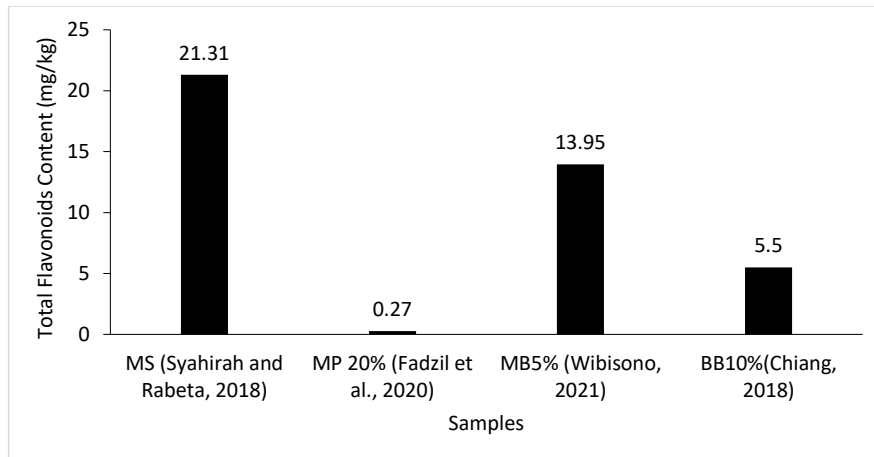
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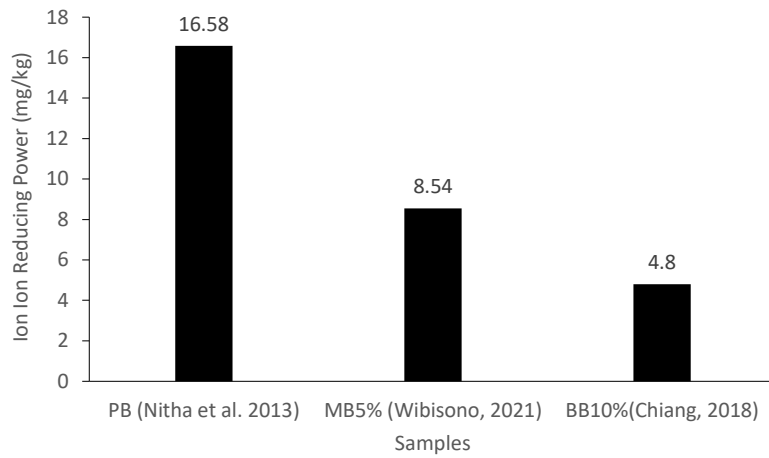
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 454 Figure 1. Total flavonoid content (TFC) of plucea wet noodles 5% (MB5%) compared to sidondo wet
 455 noodles (MS), pegagan wet noodles 60% (MP60%), and plucea bun 10% (BB10%). The TFC of sidondo
 456 and pegagan wet noodles were respectively expressed in terms of quercetin equivalent per weight of wet
 457 noodles and rutin equivalent per weight of wet noodles extract, while the TFC of plucea noodles and
 458 plucea bun were expressed in terms of catechin equivalents per dried weight of freeze-dried results. TFC
 459 of MP20%, MB5%, and BB10% were expressed by the values that have been subtracted with the TFC of
 460 control from each study.

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471 Figure 2. Iron ion reducing power (RP) of pluchea wet noodles 5% (MB5%) compared to rice flour paste
472 (PB) and pluchea bun 10% (BB10%). RP value of rice flour paste was stated to be equivalent to BHT per
473 weight of pasta, while the RP value of pluchea wet noodles and pluchea bun was expressed in gallic acid
474 equivalent per dried weight of freeze-dried results. Iron ion reducing power of MB5% and BB10% are
475 expressed by the value that has been reduced by the RP value of control from each study.



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Fri, Mar 18, 2022 at 2:31 PM

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I have revised my manuscript with the title " Potency of pluchea (*Pluchea indica* Less) leaves to increase functional value of wet noodles: a review" and I send it again.

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2.	Abstract <i>Background, Aim, Methodology and Conclusion</i>	The word functional has been added and the research objectives have been changed. This review only discusses the increase in the functional value of wet noodles due to the addition of pluchea leaves.
3.	Keywords <i>Min. 3 and Max. 6</i>	-
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Potency of pluchea (*Pluchea indica* Less) leaves to increase functional value of wet noodles: a review

Abstract

Wet noodles are lack of functional nutritional components that are beneficial for health, thus it is necessary to add other food ingredients that can increase the functional value of wet noodles. One of the food ingredients that can be added in wet noodles formulation is *Pluchea indica* Less leaves, which have been known as sources of antioxidants and used by the community as a traditional medicine to treat various health problems. The use of *Pluchea indica* Less leaves in making wet noodles is expected to increase the functional value of wet noodles. For this reason, this review paper discussed the potency of *Pluchea indica* Less leaves in affecting the phytochemical compounds content and functional properties of wet noodles. The use of *Pluchea indica* Less leaves showed potential to increase the phytochemical compounds contents of wet noodles, such as alkaloids, flavonoids, phenolics, saponins, tannins, and cardiac glycosides, which play an important role in the health of human body and maintaining the quality of wet noodles, such as antioxidant, anti-warmed over flavor, anti-inflammatory, antidiabetic, and antimicrobial activities. Accordingly, the increase in phytochemical compounds in wet noodles could also affect the functional properties of wet noodles.

Keywords: *Pluchea indica* Less, wet noodles, functional value

1. Introduction

Noodles as one of the wheat flour-based product are quiet popular among various levels of society in Indonesia. Noodles can be classified into five forms based on processing stage and water content of the noodles product, including raw noodles, wet noodles, dry noodles, fried noodles, and instant noodles. Wet noodles are noodles product that has water content of about 52%50-52% (Nuraida et al., 2009), 52.10-52.85% (Billina et al., 2014) 58-70% (Zhou et al., 2021), and is produced through the cooking stage of raw noodles before being marketed. (Billina et al., 2014) (Koswara, 2009). According to Nuraida et al. (2009)Estiasih et al. (2017), the high moisture content of wet noodles causes the shelf life of wet noodles to only reach 420 hours at room temperature storage.

Increased awareness and interest in functional food supports the development of various food products with high functional value (Essa et al., Abbas, 20210). The functional value of a food product depends on the nutrients contained in the food ingredients that make up the food product. Raw materials in the manufacture of noodles generally include wheat flour, eggs, water, and other additives so that noodles are known to be low in nutritional content that is beneficial to health (Akbar, 2018; Khasanah and Astuti, 2019), Suyanti, 2008). Therefore, various efforts have been made to overcome the shortcomings of these wet noodles products. Increasing the functional value of wet noodles can be done by adding other food ingredients that contain bioactive compounds in the manufacture of wet noodles, one of which is the addition of pluchea leaves.

Pluchea (*Pluchea indica* Less) is an herbaceous plant that contains phytochemical compounds, including alkaloids, saponins, tannins, phenol hydroquinone, flavonoids, cardiac glycosides, and sterols so that they are potential sources of natural antioxidants (Widyawati et al., 2015). In addition, *Pluchea* leaves also have antimicrobial activity that has the potency to prevent food damage (Ardiansyah et al., 2003). The use of *pluchea* leaves in the manufacture of wet noodles is

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47 expected to produce wet noodles that are able to provide antioxidant effects that are good for
48 health, and have an impact on increasing the shelf life of the wet noodles product.

49 Currently, the use of pluchea leaves is only limited as fresh vegetables and drinks, but there
50 have been many studies on the use of pluchea leaves in the food sector that continue to be
51 developed, including making tempeh with pluchea leaf extract (Magatra, 2013), Pluchea-black tea
52 salted eggs (Adventi et al., 2015), effervescent powder based on Pluchea leaf extract (Hudha and
53 Widyarningsih, 2015), pluchea bun products (Chiang, 2018), pluchea soy milk (Widyawati et al.,
54 2019), pluchea-green tea jelly drink (Wijaya, 2019), and pluchea wet noodles (Wibisono, 2021).
55 The use of pluchea leaves in the manufacture of wet noodles was studied further as an effort to
56 develop functional food products that were beneficial to the health of the consumer's body.

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58 2.— 59 3.2 Results and Discussion

60 Several factors such as individual education, household standards and level of knowledge
61 about food products with health claims, as well as perceptions of some existing functional food
62 product attributes affect the development of public interest in functional food products (Stojanovic
63 et al., 2013; Sari, 2014). Marsono (2008) also stated that increasing awareness of the importance
64 of food in preventing or curing disease, consumer demands for foods with more properties
65 (containing functional ingredients), experiences with alternative medicines, and studies on the
66 prevalence of certain diseases that are influenced by diet have also become the basis for the rapid
67 development of functional food products in various countries.

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68 Functional food is defined as a food product that is able to provide benefits to the health of the
69 body, one of which is through the presence of bioactive components contained in a functional food
70 product (Suter, 2013; Essa et al., 2021). According to Essa et al. (2021), there are
71 five categories of functional food, i.e. foodstuffs with a reduction or increase in the basic nutritional
72 content, products that naturally do not have certain nutrients and are added to them, milk-based
73 products fermented with probiotics, products that are specially formulated to fulfill certain needs,
74 and foodstuffs containing herbal ingredients to help overcome various health problems.

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75 Herbal plants are a source of functional food, i.e. a source of natural antioxidants that can
76 be used in the food sector to improve the functional properties of processed food products, one of
77 which is the use of herbal plants to increase the content of bioactive components in wheat flour-
78 based products such as noodles. According to Fadzil et al. (2020), noodles are known to be low in
79 nutritional components that are beneficial to health, while noodles with functional properties such
80 as high antioxidants are in high demand at this time.

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82 2.1 Utilization of pluchea leaves in making wet noodles

83 The main ingredients in making noodles are generally wheat flour, eggs, water, and other
84 additives as needed so that noodles products only contain carbohydrates, proteins, fats, and
85 minerals. The content of carbohydrates, several minerals, and energy in noodles are very high, but
86 the content of protein, fat, and vitamins in noodles products are low (Akbar, 2018; Khasanah and
87 Astuti, 2019). Several studies have been carried out in an effort to improve the
88 functional properties of noodles products, one of which is by using the leaves of plants that have
89 been known as traditional medicines to be added to the manufacture of noodles, such as making
90 herbal noodles with cosmos (*Cosmos caudatus* Kunth.) leaf extract (Norlaili et al., 2014),
91 manufacture of herbal noodles with leaves of the Indian bael plant (*Aegle marmelos*) (Shamim et
92 al., 2016), manufacture of sidondo (*Vitex negundo* Linn.) noodles (Syahirah and Rabeta, 2018),

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93 addition of moringa (*Moringa oleifera*) leaf extract to wet noodles (Khasanah and Astuti, 2019),
94 making herbal noodles with pegagan (*Centella asiatica*) extract (Fadzil et al., 2020), and using
95 pluchea (*Pluchea indica* Less) leaf powder steeped water to make pluchea wet noodles (Wibisono,
96 2021).

97 The content and activity of phytochemical compounds in pluchea leaves, both in the form
98 of fresh leaves and water steeped in powdered pluchea leaves, have been identified. Pluchea is
99 classified as plant that has high polyphenol content and relatively large antioxidant capacity
100 compared to other herbaceous plants (Andarwulan et al., 2010; Andarwulan et al., 2012). Research
101 conducted by Widyawati et al. (2016) showed that the phytochemical compounds contained in the
102 brewed water of pluchea leaf powder include alkaloids, flavonoids, phenolics, saponins, tannins,
103 and cardiac glycosides. According to Pengly (2004), each phytochemical compound has
104 physiological effects including alkaloids as analgesic, mydriatic, miotic, hypertensive,
105 hypotensive, bronchodilator, stimulant, antimicrobial, and antileukemic, flavonoids as antioxidant,
106 antiviral, hepatoprotective, antiatheromatous, anti-inflammatory, and antihypertensive, phenolic
107 as antioxidant, antimicrobial, anti-inflammatory, antiplatelet, and anti-allergic, saponins as
108 anticancer, anti-inflammatory, immunomodulatory, antihepatotoxic, and antidiabetic, tannins as
109 antioxidant, antitumor, antihemorrhagic, and antiatherogenic, as well as cardiac glycosides that
110 can increase strength and speed of systolic contraction. Flavonoids are one of the important
111 constituents that can provide real benefits for the health of the human body.

112 The use of pluchea leaves in food products continues to be developed through various
113 studies as shown in Table 1. Using pluchea leaves in many food products (tempeh, beverage,
114 salted egg, bun, jelly drink, and soymilk) to increase their functional value can be added in the
115 form of extract, powder/flour, or fresh with different stages of processing each food product.
116 However, the use of pluchea leaves to increase the functional value of wheat flour-based food
117 However, the use of pluchea leaves to increase the functional
118 value of wheat flour-based food products has not been widely studied. So far the research that has
119 been carried out regarding the use of pluchea leaves in the formulation of wheat flour-based food
120 products is in the manufacture of pluchea bun (Chiang, 2018) and pluchea wet noodles (Wibisono,
121 2021), both of which use pluchea leaf powder steeping water which is added to the product
122 formulation.

123 2.2 The effect of pluchea leaves on the content of phytochemical compounds of wet 124 noodles

125 The largest group of phytochemical compounds in plants includes alkaloids, terpenes, and
126 phenolic compounds. Phenolic compounds are a group of phytochemical compounds that are
127 widely distributed in various plants, where this group of compounds can be used as the main source
128 of natural antioxidants and are able to act as antimicrobial, anticarcinogenic, and other biological
129 activities (Kennedy and Wightman, 2011; Aziman et al., 2012). Pluchea leaves contain phenolic
130 compounds in the form of flavonoids, 1,3,4,5-tetra-O-cafeoilquinic acid, 3,4,5-tri-O-cafeoilquinic
131 acid, chlorogenic acid, and ferulic acid (Mahasuari et al., 2020).

132 Flavonoids as secondary metabolites as well as the main and largest compounds in the
133 group of phenolic compounds are commonly found in plant tissues in free form or glycosides
134 (Aberoumand and Deokule, 2008; Sulaiman and Balachandran, 2012; Agbo et al., 2015). In plants,
135 flavonoids are found in the form of flavonoid glycosides, flavonols, flavan-3-ol, flavones,
136 flavanones, chalcones, anthocyanins, and proanthocyanidins (Dehkharghanian et al., 2010;
137 Vichapong et al., 2010; Chen, 2013). Flavonoids have the ability to chelate metals and donate
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139 hydrogen atoms so that they can act as antioxidants that are able to provide certain physiological
140 effects on the human body (Erlidawati *et al.*, 2018). This has become one of the basis for the use
141 of herbal plants for traditional medicine and supports various functional food product innovations
142 such as pluchea wet noodles.

143 Research by Wibisono (2021) showed that the use of pluchea leaf powder steeped water
144 was able to contribute in increasing the content of phytochemical compounds (especially
145 flavonoids) in wet noodles, that the lowest (5%) and the highest (30%) concentration of pluchea
146 leaf powder in steeping water were able to increase the total flavonoid content (TFC) of wet
147 noodles as much as 1.43 times and 4.07 times compared to the control wet noodles (without the
148 use of pluchea leaf powder steeping water), respectively. The potential use of pluchea leaves in
149 the manufacture of wet noodles can be seen by comparing the TFC of pluchea wet noodles in
150 Wibisono's study (2021) with other herbal noodles and pluchea bun as another form of wheat flour-
151 based product. Comparison of the total flavonoids of pluchea wet noodles with sidondo wet
152 noodles, pegagan wet noodles, and pluchea bun from existing studies can be seen in Figure 1.

153 The group of flavonoids found in pluchea leaves are flavonols and flavones, including
154 quercetin, myrisetin, kaempferol, apigenin, luteolin, and chrysoeriol (Andarwulan *et al.*, 2010;
155 Andarwulan *et al.*, 2012; Koirewoa *et al.*, 2012; Mahasuari *et al.*, 2020), sidondo flavonoids
156 consist of castikin, orientin, isoorientin, luteolin, lutekin-7-O-glucoside, corimbosin, gardenins A
157 and B, 3-O-desmethylartemethin, 5-O-desmethylnobiletin, and 3',4',5',6,7,8-
158 heptamethoxyflavones (Lakshmanashetty *et al.*, 2010; Ullah *et al.*, 2012), while the flavonoids of
159 pegagan include quercetin, myrisetin, and kaempferol (Andarwulan *et al.*, 2010; Andarwulan *et al.*,
160 2012). The TFC value of wet noodles with the addition of 5% concentration of pluchea leaf
161 powder in steeping water was greater than the TFC of wet noodles with the addition of 20%
162 pegagan extract, but the TFC of pluchea wet noodles 5% was lower than the TFC of sidondo wet
163 noodles which used 0.66% sidondo leaf powder from the total weight of the noodles ingredients.
164 Based on this comparison, it can be indicated that the use of pluchea leaf powder steeping water
165 with a concentration of 5% can increase the flavonoids content of wet noodles far exceeding the
166 flavonoids content that can be given by 20% pegagan extract solution in wet noodles (total
167 flavonoids of pluchea wet noodles 5% is 51.67 times compared to pegagan noodles 20%). The
168 total flavonoids of the pluchea wet noodles 5% is 1.53 times lower than the total flavonoids of
169 sidondo wet noodles. The flavonoids content of sidondo wet noodles which was higher than
170 pluchea wet noodles 5% could be caused by the addition of sidondo leaf powder directly to the
171 making of wet noodles dough in Syahirah and Rabeta's research (2018), while pluchea wet noodles
172 dough in Wibisono's study (2021) was made with using pluchea leaf powder steeping water in the
173 formulation of wet noodles. In addition, several factors such as differences in formulation,
174 sequence of processing and analysis stages, as well as stated standards and product sample forms
175 analyzed in each study also affect the difference in TFC values compared between types of herbal
176 wet noodles.

177 The TFC of wet noodles with the addition of 5% concentration of pluchea leaf powder in
178 steeping water was higher than the TFC of bun with the addition of 10% concentration of pluchea
179 leaf powder in steeping water. This shows that the flavonoids content of pluchea wet noodles is
180 higher than the flavonoids content of pluchea bun even though the concentration of pluchea leaf
181 powder in steeping water in the manufacture of pluchea wet noodles is lower than the concentration
182 of pluchea leaf powder in steeping water in the manufacture of pluchea bun (the TFC of pluchea
183 wet noodles 5% is 2.54 times compared to pluchea bun 10%). According to Li *et al.* (2015),
184 antioxidant compounds, one of which is flavonoids, are easily degraded in the heating process, and

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185 are lost during the process of mixing and kneading the dough. The degradation of flavonoids during
186 heating and the extraction of glycosides by water vapor can be the cause of the low TFC value of
187 pluchea bun. On the other hand, Saikia and Mahanta (2013) stated that the high flavonoids content
188 can be caused by breaking the glycosidic bond of flavonoids with sugar by heating treatment. The
189 wet noodles cooking process is thought to have an effect on breaking the glycosidic bond so that
190 aglycones are formed which can improve the detection results of flavonoids compounds in the
191 analysis. Various factors can affect the TFC value in different food products, including differences
192 in ingredient formulations, specifications of the methods used, and the stages of the process in the
193 manufacture of food products.

194 The TFC of pluchea wet noodles 5% showed that pluchea leaves have the potency to
195 increase the content of phytochemical compounds (in this case flavonoids) in wet noodles as a
196 wheat flour-based food product. Wibisono (2021) also stated that the use of higher concentration
197 of pluchea leaf powder in steeping water in the formulation of wet noodles is able to provide a
198 significant increase in the TFC of wet noodles. There has been no research on the effect of adding
199 pluchea leaf powder steeping water on the type and amount of phytochemical compounds other
200 than flavonoids in pluchea wet noodles products, so the use of pluchea leaves in the manufacture
201 of wet noodles still needs to be developed and further investigated its effect on the phytochemical
202 component content of wet noodles.

203 *2.3 The effect of pluchea leaves on the functional properties of wet noodles*

204 The functional properties of functional food products mainly focus on the ability of
205 bioactive components in food products to help maintain the health of the human body. One of the
206 properties possessed by bioactive components is that they can act as antioxidants. Carotenoids,
207 flavonoids, and phenolic compounds are classified as natural antioxidants that can be found in
208 various foodstuffs (Marsono, 2008). Antioxidant activity can be in the form of DPPH free radical
209 scavenging ability, iron ion reducing power, reactive oxygen species scavenging activity, and β -
210 carotene-linoleic acid system inhibitory activity (Widyawati et al., 2017).

211 Iron ion reducing power (RP) is one of the parameters of antioxidant potential which is
212 measured as secondary antioxidant activity based on the ability of antioxidant compounds to
213 reduce Fe^{3+} to Fe^{2+} . Secondary antioxidants play a role in the mechanism of binding metal ions,
214 scavenging oxygen, converting hydrogen peroxide into non-radical compounds, absorbing UV
215 radiation, or deactivating singlet oxygen (Pokorny et al., 2001). According to Widyawati et al.
216 (2014), iron ion is one of the pro-oxidants that has the potency to generate new free radicals.
217 Antioxidant components are able to neutralize iron ions by acting as a substrate that will be
218 oxidized first. Based on the research of Wibisono (2021), the use of the lowest (5%) and the highest
219 (30%) concentration of pluchea leaf powder were able to increase the RP value of wet noodles by
220 1.33 times and 3.27 times compared to control wet noodles, respectively. The potency of pluchea
221 leaves in increasing the antioxidant activity of wet noodles products can be described by
222 comparing the RP value of pluchea wet noodles with other products such as rice flour paste and
223 pluchea bun. The comparison of secondary antioxidant activity in the form of the iron ion reducing
224 power of pluchea wet noodles with rice flour paste and pluchea bun can be seen in Figure 2.

225 Pluchea wet noodles 5% in the Wibisono's study (2021) had the RP value 1.78 times higher
226 than the RP value of pluchea bun 10% in Chiang's research (2018), but 1.94 times lower than the
227 RP value of paste made from rice flour in the research of Nithya et al. (2013). The RP value
228 indicates that the use of pluchea leaf powder steeping water with 5% concentration of pluchea leaf
229 powder in steeping water has potency to provide greater secondary antioxidant activity in wet
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231 noodles than in bun products. The TFC of pluchea wet noodles 5% which is greater than the TFC
232 of pluchea bun 10%, as shown in Figure 1., can contribute to the large iron ion reducing power of
233 pluchea wet noodles 5% and pluchea bun 10%, that the phenolic group compounds, one of which
234 is flavonoids, capable of donating hydrogen atoms/electrons so that they can reduce iron ions
235 (Widyawati et al., 2014). The flavonoids content of pluchea wet noodles which is higher than the
236 flavonoids content of pluchea bun can cause the iron ion reducing power of wet noodles is higher
237 compared to pluchea bun.

238 RP value of pluchea wet noodles 5% which is lower than the RP value of rice flour paste
239 can be due to the use of different types of raw materials (related to the number and types of
240 bioactive components in the ingredients) and the shape of the product samples analyzed in each
241 study. Based on the research of Widyawati et al. (2014), white rice has total phenolic content
242 (TPC) of 4.12 ± 0.05 mg gallic acid equivalent/g dry basis which is greater than the TPC of pluchea
243 leaves in the study of Andarwulan et al. (2010), which was 0.831 ± 0.129 mg gallic acid
244 equivalent/g fresh leaf weight. According to Wibisono (2021), the iron ion reducing power of
245 pluchea wet noodles can be increased by using higher concentration of pluchea leaf powder in
246 steeping water in the formulation of wet noodles.

247 RP value of pluchea wet noodles 5% shows the potency of pluchea leaves to increase the
248 antioxidant activity of wet noodles products as an effort to increase the functional value of wheat
249 flour-based food products such as wet noodles. The effect of adding pluchea leaf powder steeping
250 water on the antioxidant activity of pluchea wet noodles using a type of analysis other than the
251 iron ion reducing power has not been studied further, so it is necessary to measure other antioxidant
252 parameters to support the potency of pluchea leaves in making wet noodles.

253 Research on the potency of pluchea leaves in improving the functional properties of wet
254 noodles is still limited to being studied on product antioxidants, while pluchea leaves have been
255 known to have various other functional properties that are beneficial to health and are able to
256 maintain the quality of food products. Several other functional properties that have the potency to
257 be provided by pluchea leaves in food products include activities as anti-warmed over flavor, anti-
258 inflammatory, antidiabetic (Widyawati et al., 2017), and antimicrobial properties that have the
259 potency to prevent food spoilage (Ardiansyah et al., 2003). This ability is inseparable from the
260 presence of bioactive compounds in pluchea leaves which have the capacity as antioxidant and
261 antihyperglycemic agents (Widyawati et al., 2014; Widyawati et al., 2015). According to Li et al.,
262 2014), herbal plant extracts are potential preservatives that are currently being developed to be
263 applied to bread, pasta, and noodles products due to the presence of phenolic components that have
264 high antimicrobial activity. Tiwari et al. (2009) stated that the antimicrobial activity of phenolic
265 compounds is related to the ability of phenolics to affect the permeability of microbial cells which
266 causes the release of important macromolecules from the microbial cell, as well as the ability of
267 phenolics to interact with membrane proteins that cause deformation of the structure and function
268 of microbial cell membranes.

269 4.3 Conclusion

270
271 Pluchea (*Pluchea indica* Less) leaves have the potency to increase the functional value of wet
272 noodles in terms of the phytochemical content and functional properties of the wet noodles. The
273 use of pluchea leaves increases the content of phytochemical compounds, in this case flavonoids,
274 in wet noodles. The increase in the content of phytochemical compounds with the use of pluchea
275 leaves affects the increase in the functional properties of wet noodles products, especially
276 antioxidant activity in the form of the iron ion reducing power of wet noodles.

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Conflict of interest

The authors declare no conflict of interest.

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References

Aberoumand, A. and Deokule, S.S. (2008). Comparison of phenolic compounds of some edible
Aberoumand, A. and Deokule, S.S. (2008). Comparison of phenolic compounds of some edible

Adventi, B.S., Widyawati, P.S. and Utomo, A.R. (2015). Effect of salt concentration for
physicochemical and organoleptics salted egg pluchea (*Pluchea indica* Less)-black tea (*Camelia
sinensis*). *Journal of Food Technology and Nutrition* 14(2), 55-60. (In Bahasa).

Agbo, M.O., Uzor, P.F., Akazie-Nneji, U.N., Eze-Odurukwe, C.U., Ogbatue, U.B. and Mbaaji,
E.C. (2015). Antioxidant, total phenolic and flavonoid content of selected Nigerian medical plants.
Dhaka University Journal of Pharmaceutical Sciences 14(1), 1-7.

Akbar, A. (2018). Physical, chemical and organoleptic analysis of wet noodle based on taro
(*Colocasia esculenta* L). *Agritepa* 4(2), 159-170. (In Bahasa).

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Andarwulan, N., Kurniasih, D., Apriady, R.A., Rahmat, H., Roto, A.V. and Bolling, B.W. (2012).
Polyphenols, carotenoids, and ascorbic acid in underutilized medicinal vegetables. *Journal of
Functional Foods* 4, 339-347.

Andarwulan, N., Batari, R., Sandrasari, D.A., Bolling, B. and Wijaya, H. (2010). Flavonoid
content and antioxidant activity of vegetables from Indonesia. *Food Chemistry* 121, 1231-1235.

Ardiansyah, Nuraida, L. and Andarwulan, N. (2003). Antimicrobial activity of pluchea (*Pluchea
indica* L.) leaves extract and stability of the activity at different salt concentrations and pHs.
Journal of Food Technology and Industry 14(2), 90-97. (In Bahasa).

Aziman, N., Abdullah N., Noor, Z.M., Zulkifli, K.S. and Kamarudin, W.S.S.W. (2012).
Phytochemical constituents and in vitro bioactivity of ethanolic aromatic herb extracts. *Sains
Malaysiana* 41(11), 1437-1444.

Billina, A., Waluyo, S. and Suhandy, D. (2014). Study of the physical properties of wet noodles
with addition of sea weed. *Lampung Agricultural Engineering Journal*, 4(2), 109-116. (In Bahasa).

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Chen, X.G.Q. (2013). Identification and antioxidant capacity of anthocyanin pigment, and
expressional analysis of flavonoid biosynthetic genes in colored rice strains. Japan: University of
Hiroshima, PhD. Dissertation.

- 322 Chiang, I. (2018). The effect of **plu**chea leaves powder (*Pluchea indica* Less) in steeping water of
323 pao antioxidant activity. Indonesia: Widya Mandala Surabaya Catholic University, Bachelor. Final
324 Project. (In Bahasa)
- 325
- 326 Dehkharghanian, M., Adenier, H. and Vijayalakshmi, M.A. (2010). Study of flavonoids in aqueous
327 spinach extract using positive electrospray ionisation tandem quadrupole mass spectrometry. *Food*
328 *Chemistry* 121, 863-870.
- 329
- 330 Erlidawati, Safrida and Mukhlis. (2018). Antioxidant Potency as Antidiabetic. Banda Aceh: Syiah
331 Kuala University Press. (In Bahasa).
- 332
- 333 **Essa, M.M. et al. (2021). Functional foods and their impact on health . Journal of Food Science**
334 **and Technology. <https://doi.org/10.1007/s13197-021-05193-3>.**
- 335
- 336 Estiasih, T., Putri, W.D.R. and Waziroh, E. (2017). Tubers and Their Processing. Malang: UB
337 Press. (In Bahasa).
- 338
- 339 Fadzil, N.F., Bakar, M.F.A., Yusop, M.H.M. and Bakar, F.I.A. (2020). Sensorial and
340 physicochemical characteristics of herbal noodle enriched with *Centella asiatica*. *Food Research*
341 4(4), 1030-1037.
- 342
- 343 Firdausi, M.H. (2017). Physicochemical and organoleptic quality of dry method salted eggs with
344 addition of **plu**chea leaves (*Pluchea indica* L). Indonesia: Brawijaya University, Bachelor.
345 Final Project. (In Bahasa).
- 346
- 347 Hudha, M. and Widyaningsih, T.D. (2015). The effervescent powder uses plu chea leaf (*Pluchea*
348 *indica* Less) extract as natural antioxidant source. *Journal of Food and Agroindustry* 3(4), 1412-
349 1422. (In Bahasa).
- 350
- 351 Khasanah, V. and Astuti, P. (2019). Effect of addition of Moringa leaf extract (*Moringa oleifera*)
352 on sensory quality and protein content of wet noodles substituted with modified cassava flour.
353 *Journal of Technical Competence* 11(2), 15-21. (In Bahasa).
- 354
- 355 Kennedy, D.O. and Wightman, E.L. (2011). Herbal extracts and phytochemicals: plant secondary
356 metabolites and the enhancement of human brain function. *Advances in Nutrition* 2, 32-50.
- 357
- 358 Koirewoa, Y.A., Fatimawali and Wiyono, W.I. (2012). Isolation and identification flavonoid
359 compounds in **plu**chea leaf (*Pluchea indica* L.). *Pharmakon* 1(1), 47-52. (In Bahasa).
- 360
- 361 Lakshmanashetty, R.H., Nagaraj, V.B., Hiremath, M.G. and Kumar V. (2010). In vitro antioxidant
362 Lakshmanashetty, R.H., Nagaraj, V.B., Hiremath, M.G. and Kumar V. (2010). In vitro antioxidant
363 Lakshmanashetty, R.H., Nagaraj, V.B., Hiremath, M.G. and Kumar V. (2010). In vitro antioxidant
364
- 365 Li, M., Zhu, K.X., Guo, X.N., Brijs, K. dan Zhou, H.M. (2014). Natural additives in wheat-based
366 pasta and noodle products: opportunities for enhanced nutritional and functional properties.
367 *Comprehensive Reviews in Food Science and Food Safety* 13, 347-357.

368
369 Li, Y., Ma, D., Sun, D., Wang, C., Zhang, J., Xie, Y. dan Guo, T. (2015). Total phenolic, flavonoid
370 content, and antioxidant activity of flour, noodles, and steamed bread made from different colored
371 wheat grains by three milling methods. *The Crop Journal* 3(4), 328-334.

372
373 **Nuraida, L., Andarwulan, N., Sukmawati, M. and Yohana, E. (2008). Application of herbs and**
374 **spices extracts as preservatives for wet noodles. Investing in Food Quality, Safety and Nutrition.**
375 **International Conference Proceeding Investing in Food Quality, Safety & Nutrition: Lessons**
376 **Learned from Current Food Crisis Jakarta, October 27-28, 2008.**

377
378 Magatra, P. (2013). Antioxidant activity, total phenolic content, and organoleptic test in tempe
379 with marsh fleabane leaf extract (*Pluchea indica* L.). Indonesia: Satya Wacana Christian
380 University, Bachelor. Final Project. (In Bahasa).

381
382 Mahasuari, N.P.S., Paramita, N.L.P.V. and Putra, A.A.G.R.Y. (2020). Effect of methanol
383 concentration as a solvent on total phenolic and flavonoid content of **pluchea** leaf extract
384 (*Pluchea indica* L.). *Journal of Pharmaceutical Science and Application* 2(2), 77-84.

385
386 Marsono, Y. (2008). Functional food development prospects. *Journal of Food Technology and*
387 *Nutrition* 7(1), 19-27. (In Bahasa).

388
389 Nithya, D.J., Bosco, K.A.S., Jagan Mohan, R. and Alagusundaram, K. (2013). Antioxidant activity
390 of rice bran pasta. *Journal of Microbiology, Biotechnology and Food Sciences* 2(6), 2423-2425.

391
392 Norlaili, A.H., Roselina, K. and Muhammad, T.S. (2014). Effect of *Cosmos caudatus* Kunth.
393 (Ulam Raja) aqueous and dry extracts on the physicochemical and functional properties, and
394 sensory acceptability of Herbal Yellow Alkaline Noodles. *Malaysian Journal of Nutrition* 20(3),
395 403-415.

396
397 Pengelly, A. (2004). *The Constituents of Medicinal Plants: An Introduction to the Chemistry and*
398 *Therapeutics of Herbal Medicines*, 2nd ed. Australia: CABI Publishing.

399
400 Pokorny, J., Yanishlieva, N. and Gordon, M. (2001). *Antioxidants in Food: Practical Applications*.
401 Cambridge: Woodhead Publishing Ltd.

402
403 Saikia, S. and Mahanta, C.L. (2013). Effect of steaming, boiling and microwave cooking on the
404 total phenolics, flavonoids and antioxidant properties of different vegetables of Assam, India.
405 *International Journal of Food and Nutritional Sciences* 2(3), 47-53.

406
407 Sari, E.T. (2014). Factors influencing consumption of functional food in Surabaya. *Scientific*
408 *Journal of Commerce Administration* 12(2), 1-10. (In Bahasa).

409
410 Shamim, M.Z., Verma, A., Sheikh, S. and Singh, S. (2016). Sensory evaluation of nutritious
411 herbal noodles developed by utilization of *Aegle marmelos* leaves powder. *IMPACT: International*
412 *Journal of Research in Applied, Natural and Social Sciences* 4(4), 109-114.

413

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414 Stojanovic, Z., Filipovic, J. and Mugosa, B. (2013). Consumer acceptance of functional foods in
415 Montenegro. *Montenegrin Journal of Economics* 9(3), 65-74.

416
417 Sulaiman, C.T. and Balachandran, I. (2012). Total phenolics and total flavonoids in selected Indian
418 medical plants. *Indian Journal of Pharmaceutical Sciences* 74(3), 258-260.

419
420 Suter, I.K. (2013). Functional foods and their development prospects. Retrieved on February 15,
421 2021 from Udayana University Repository Website:
422 [https://repositori.unud.ac.id/protected/storage/upload/repositori/ID3_1950123119760210032309](https://repositori.unud.ac.id/protected/storage/upload/repositori/ID3_19501231197602100323091304927makalah-gizi.pdf)
423 [1304927makalah-gizi.pdf](https://repositori.unud.ac.id/protected/storage/upload/repositori/ID3_19501231197602100323091304927makalah-gizi.pdf). (In Bahasa).

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424 Syahirah, J. and Rabeta, M.S. (2018). Antioxidant and antimicrobial activity of lemuni noodle.

425
426
427 Tiwari, B.K., Valdramidis, V.P., Donnell, C.P.O., Muthukumarappan, K., Bourke, P. and Cullen,
428 P.J. (2009). Application of natural antimicrobials or food preservation. *Journal of Agricultural and*
429 *Food Chemistry* 57(14), 5987-6000.

430
431 Ullah, Z., Ullah, R., Shah, A.H.A., Ahmad, I. and Haider, S. (2012). Phytochemical and biological
432 evaluation of *Vitex negundo* Linn: a review. *International Journal of Pharmaceutical Sciences and*
433 *Research* 3(8), 2421-2431.

434
435 Vichapong, J., Sookserm, M., Srijedaruk, V., Swatsitang, P. and Srijaranai, S. (2010). High
436 performance liquid chromatographic analysis of phenolic compounds and their antioxidant
437 activities in rice varieties. *LWT-Food Science and Technology* 43, 1325-1330.

438
439 Wibisono, D.A.S. (2021). Effect of concentration of *pluchea* (*Pluchea indica* (L.) Less) leaves
440 powder in steeping water on total flavonoids and iron ion reducing power of wet noodle. Indonesia:
441 Widya Mandala Surabaya Catholic University, Bachelor. Final Project. (In Bahasa).

442
443 Widyawati, P.S., Budianta, T.D.W., Gunawan, D.I. and Wongso, R.S. (2015). Evaluation
444 antidiabetic activity of various leaf extracts of *Pluchea indica* Less. *International Journal of*
445 *Pharmacognosy and Phytochemical Research* 7(3), 597-603.

446
447 Widyawati, P.S., Budianta, T.D.W., Kusuma, F.A. and Wijaya, E.L. (2014). Difference of solvent
448 polarity to phytochemical content and antioxidant activity of *Pluchea indica* Less leaves extracts.
449 *International Journal of Pharmacognosy and Phytochemical Research* 6(4), 850-855.

450
451 Widyawati, P.S., Ristiarini, S., Werdani, Y.D.W., Kuswardani, I. and Herwina, I. N. (2019).
452 Physicochemical and organoleptic properties changes of soymilk with *pluchea* brewing water
453 addition. *Journal of Food Technology and Nutrition* 18(2), 98-111. (In Bahasa).

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454
455 Widyawati, P.S., Suteja, A.M., Suseno, T.I.P., Monika, P., Saputrajaya, W. and Liguori, C. (2014).
456 Effect of pigment color difference in organic rice on antioxidant activity. *Agritech* 34(4), 399-406.
457 (In Bahasa).

458

459 Widyawati, P.S., Werdani, Y.D.W., Setiokusumo, C. and Kartikasari, A. (2017). In vitro
460 antioxidant capacities and antidiabetic properties of **pluchea** leaves and green tea mixtures at
461 various proportions. *International Journal of Pharmacy and Pharmaceutical Sciences* 9(8), 203-
462 208.

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463
464 Wijaya, J.P. (2019). Effect of concentration of mixture of **pluchea** (*Pluchea indica* L.) leaves
465 powder – green tea (*Camellia sinensis* L.) 1:1 (b/b) in steeping water on antioxidant activity of
466 jelly drink. Indonesia: Widya Mandala Surabaya Catholic University, Bachelor. Final Project. (In
467 Bahasa).

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468
469 **Zou, S., Wang, L., Wang, A., Zhang, Q., Li, Z., and Qiu, J. (2021). Effect of moisture distribution**
470 **changes induced by different cooking temperature on cooking quality and texture properties of**
471 **noodles made from whole tartary buckwheat. *Foods* 10(2543),1-12.**
472

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473 Table 1. The use of Pluchea leaves in food **product**

Type of food product	Pluchea leaf form	Stages of use	References
▲ Tempeh	Pluchea leaf water extract	Soak soybeans before adding tempeh yeast	Magatra, 2013
▲ Pluchea -black tea salted egg	Pluchea leaf flour	Mixed in salt solution for the ripening stage	Adventi et al., 2015
▲ Effervescent powder	Water extract (infusion) and ethanol extract (maceration)	Evaporated and mixed according to the formulation	Hudha and Widyaningsih, 2015
▲ Dry method salted egg	Fresh pluchea leaves	Added to pasta dough to coat eggs	Firdausi, 2017
▲ Bun	Pluchea leaf powder steeping water	Added during dough making	Chiang, 2018
▲ Soy milk	Pluchea leaf powder steeping water	Added to soy milk	Widyawati et al., 2019
▲ Pluchea- green tea jelly drink	Pluchea leaf powder	Brewed with green tea powder	Wijaya, 2019
▲ Wet noodles	Pluchea leaf powder steeping water	Added during dough making	Wibisono, 2021

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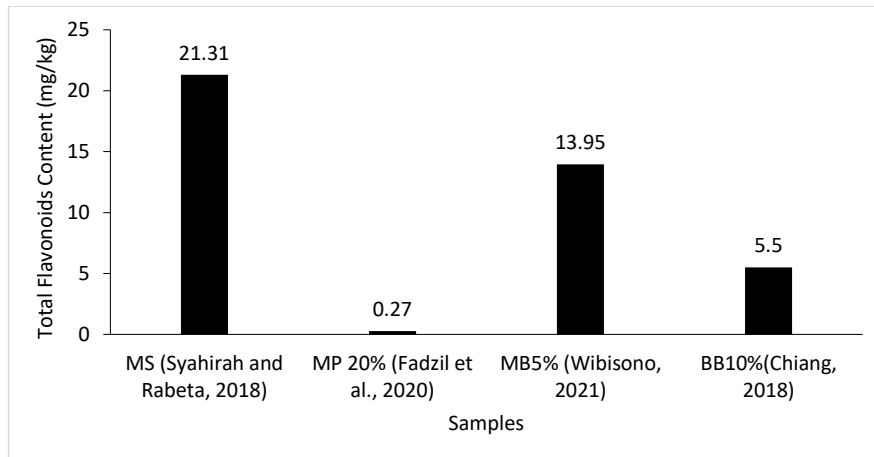
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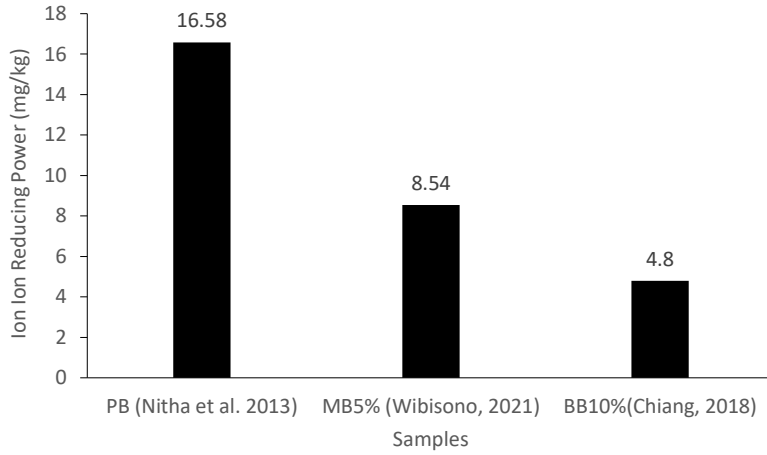
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 482 Figure 1. Total flavonoid content (TFC) of pluchea wet noodles 5% (MB5%) compared to sidondo
 483 wet noodles (MS), pegagan wet noodles 60% (MP60%), and pluchea bun 10% (BB10%). The TFC
 484 of sidondo and pegagan wet noodles were respectively expressed in terms of quercetin equivalent
 485 per weight of wet noodles and rutin equivalent per weight of wet noodles extract, while the TFC
 486 of pluchea noodles and pluchea bun were expressed in terms of catechin equivalents per dried
 487 weight of freeze-dried results. TFC of MP20%, MB5%, and BB10% were expressed by the values
 488 that have been subtracted with the TFC of control from each study.

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499 Figure 2. Iron ion reducing power (RP) of pluchea wet noodles 5% (MB5%) compared to rice flour
500 paste (PB) and pluchea bun 10% (BB10%). RP value of rice flour paste was stated to be equivalent
501 to BHT per weight of pasta, while the RP value of pluchea wet noodles and pluchea bun was
502 expressed in gallic acid equivalent per dried weight of freeze-dried results. Iron ion reducing power
503 of MB5% and BB10% are expressed by the value that has been reduced by the RP value of control
504 from each study.

5. Second Revision: Linguistic Aspects (19-3-2022)
-Correspondence
-Document



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manuscript revise

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Sat, Mar 19, 2022 at 3:41 AM


Dear Dr. Paini Sri Widyawati

Please revise the manuscript in terms of its linguistic aspects as well as the format. We would strongly recommend the manuscript be proofread by a native English speaker, those highlighted in green require grammatical and format revisions.

Best regards,
Son Radu, PhD
Chief Editor

From: Paini Sri Widyawati <paini@ukwms.ac.id>
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Potency of pluchea (*Pluchea indica* Less) leaves to increase functional value of wet noodles: a review

Abstract

Wet noodles are lack of functional nutritional components that are beneficial for health, thus it is necessary to add other food ingredients that can increase the functional value of wet noodles. One of the food ingredients that can be added in wet noodles formulation is *Pluchea indica* Less leaves, which have been known as sources of antioxidants and used by the community as a traditional medicine to treat various health problems. The use of *Pluchea indica* Less leaves in making wet noodles is expected to increase the functional value of wet noodles. For this reason, this review paper discussed the potency of *Pluchea indica* Less leaves in affecting the phytochemical compounds content and functional properties of wet noodles. The use of *Pluchea indica* Less leaves showed potential to increase the phytochemical compounds contents of wet noodles, such as alkaloids, flavonoids, phenolics, saponins, tannins, and cardiac glycosides, which play an important role in the health of human body and maintaining the quality of wet noodles, such as antioxidant, anti-warmed over flavor, anti-inflammatory, antidiabetic, and antimicrobial activities. Accordingly, the increase in phytochemical compounds in wet noodles could also affect the functional properties of wet noodles.

Keywords: *Pluchea indica* Less, wet noodles, functional value

1. Introduction

Noodles as one of the wheat flour-based product are quiet popular among various levels of society in Indonesia. Noodles can be classified into five forms based on processing stage and water content of the noodles product, including raw noodles, wet noodles, dry noodles, fried noodles, and instant noodles. Wet noodles are noodles product that has water content of about 50-52% (Nuraida et al., 2009), 52,10-52,85% (Billina et al., 2014) 58-70% (Zhou et al., 2021), and is produced through the cooking stage of raw noodles before being marketed (Billina et al., 2014). According to Nuraida et al. (2009), the high moisture content of wet noodles causes the shelf life of wet noodles to only reach 42 hours at room temperature storage.

Increased awareness and interest in functional food supports the development of various food products with high functional value (Essa et al., 2021). The functional value of a food product depends on the nutrients contained in the food ingredients that make up the food product. Raw materials in the manufacture of noodles generally include wheat flour, eggs, water, and other additives so that noodles are known to be low in nutritional content that is beneficial to health (Akbar, 2018; Khasanah and Astuti, 2019). Therefore, various efforts have been made to overcome the shortcomings of these wet noodles products. Increasing the functional value of wet noodles can be done by adding other food ingredients that contain bioactive compounds in the manufacture of wet noodles, one of which is the addition of pluchea leaves.

Pluchea (Pluchea indica Less) is an herbaceous plant that contains phytochemical compounds, including alkaloids, saponins, tannins, phenol hydroquinone, flavonoids, cardiac glycosides, and sterols so that they are potential sources of natural antioxidants (Widyawati et al., 2015). In addition, *Pluchea* leaves also have antimicrobial activity that has the potency to prevent food damage (Ardiansyah et al., 2003). The use of *pluchea* leaves in the manufacture of wet noodles is

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46 expected to produce wet noodles that are able to provide antioxidant effects that are good for
47 health, and have an impact on increasing the shelf life of the wet noodles product.

48 Currently, the use of pluchea leaves is only limited to fresh vegetables and drinks, but there
49 have been many studies on the use of pluchea leaves in the food sector that continue to be
50 developed, including making tempeh with pluchea leaf extract (Magatra, 2013), Pluchea-black tea
51 salted eggs (Adventi et al., 2015), effervescent powder based on Pluchea leaf extract (Hudha and
52 Widyarningsih, 2015), pluchea bun products (Chiang, 2018), pluchea soy milk (Widyawati et al.,
53 2019), pluchea-green tea jelly drink (Wijaya, 2019), and pluchea wet noodles (Wibisono, 2021).
54 The use of pluchea leaves in the manufacture of wet noodles was studied further as an effort to
55 develop functional food products that were beneficial to the health of the consumer's body.

56
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58 2. Results and Discussion

59 Several factors such as individual education, household standards and level of knowledge
60 about food products with health claims, as well as perceptions of some existing functional food
61 product attributes affect the development of public interest in functional food products (Stojanovic
62 et al., 2013; Sari, 2014). Marsono (2008) also stated that increasing awareness of the importance
63 of food in preventing or curing disease, consumer demands for foods with more properties
64 (containing functional ingredients), experiences with alternative medicines, and studies on the
65 prevalence of certain diseases that are influenced by diet have also become the basis for the rapid
66 development of functional food products in various countries.

67 Functional food is defined as a food product that is able to provide benefits to the health of the
68 body, one of which is through the presence of bioactive components contained in a functional food
69 product (Suter, 2013; Essa et al., 2021). According to Essa et al. (2021), there are five categories
70 of functional food, i.e. foodstuffs with a reduction or increase in the basic nutritional content,
71 products that naturally do not have certain nutrients and are added to them, milk-based products
72 fermented with probiotics, products that are specially formulated to fulfill certain needs, and
73 foodstuffs containing herbal ingredients to help overcome various health problems.

74 Herbal plants are a source of functional food, i.e. a source of natural antioxidants that can be
75 used in the food sector to improve the functional properties of processed food products, one of
76 which is the use of herbal plants to increase the content of bioactive components in wheat flour-
77 based products such as noodles. According to Fadzil et al. (2020), noodles are known to be low in
78 nutritional components that are beneficial to health, while noodles with functional properties such
79 as high antioxidants are in high demand at this time.

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81 2.1 Utilization of pluchea leaves in making wet noodles

82 The main ingredients in making noodles are generally wheat flour, eggs, water, and other
83 additives as needed so that noodles products only contain carbohydrates, proteins, fats, and
84 minerals. The content of carbohydrates, several minerals, and energy in noodles are very high, but
85 the content of protein, fat, and vitamins in noodles products are low (Akbar, 2018; Khasanah and
86 Astuti, 2019). Several studies have been carried out in an effort to improve the functional
87 properties of noodles products, one of which is by using the leaves of plants that have been known
88 as traditional medicines to be added to the manufacture of noodles, such as making herbal noodles
89 with cosmos (*Cosmos caudatus* Kunth.) leaf extract (Norlaili et al., 2014), manufacture of herbal
90 noodles with leaves of the Indian bael plant (*Aegle marmelos*) (Shamim et al., 2016), manufacture
91 of sidondo (*Vitex negundo* Linn.) noodles (Syahirah and Rabeta, 2018), addition of moringa

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92 (*Moringa oleifera*) leaf extract to wet noodles (Khasanah and Astuti, 2019), making herbal noodles
93 with pegagan (*Centella asiatica*) extract (Fadzil et al., 2020), and using pluchea (*Pluchea indica*
94 Less) leaf powder steeped water to make pluchea wet noodles (Wibisono, 2021).

95 The content and activity of phytochemical compounds in pluchea leaves, both in the form
96 of fresh leaves and water steeped in powdered pluchea leaves have been identified. Pluchea is
97 classified as plant that has high polyphenol content and relatively large antioxidant capacity
98 compared to other herbaceous plants (Andarwulan et al., 2010; Andarwulan et al., 2012). Research
99 conducted by Widyawati et al. (2016) showed that the phytochemical compounds contained in the
100 brewed water of **pluchea** leaf powder include alkaloids, flavonoids, phenolics, saponins, tannins,
101 and cardiac glycosides. According to Pengly (2004), each phytochemical compound has
102 physiological effects including alkaloids as analgesic, mydriatic, miotic, hypertensive,
103 hypotensive, bronchodilator, stimulant, antimicrobial, and antileukemic, flavonoids as antioxidant,
104 antiviral, hepatoprotective, antiatheromatous, anti-inflammatory, and antihypertensive, phenolic
105 as antioxidant, antimicrobial, anti-inflammatory, antiplatelet, and antiallergic, saponins as
106 anticancer, anti-inflammatory, immunomodulatory, antihepatotoxic, and antidiabetic, tannins as
107 antioxidant, antitumor, antihemorrhagic, and antiatherogenic, as well as cardiac glycosides that
108 can increase strength and speed of systolic contraction. Flavonoids are one of the important
109 constituents that can provide real benefits for the health of the human body.

110 The use of pluchea leaves in food products continues to be developed through various
111 studies as shown in Table 1. **Using pluchea leaves in many food products (tempeh, beverage, salted**
112 **egg, bun, jelly drink, and soymilk) to increase their functional value can be added in the form of**
113 **extract, powder/flour, or fresh with different stages of processing each food product.** However,
114 the use of pluchea leaves to increase the functional value of wheat flour-based food products has
115 not been widely studied. So far the research that has been carried out regarding the use of pluchea
116 leaves in the formulation of wheat flour-based food products is in the manufacture of pluchea bun
117 (Chiang, 2018) and pluchea wet noodles (Wibisono, 2021), both of which use pluchea leaf powder
118 steeping water which is added to the product formulation.

119
120 *2.2 The effect of pluchea leaves on the content of phytochemical compounds of wet noodles*

121 The largest group of phytochemical compounds in plants includes alkaloids, terpenes, and
122 phenolic compounds. Phenolic compounds are a group of phytochemical compounds that are
123 widely distributed in various plants, where this group of compounds can be used as the main source
124 of natural antioxidants and are able to act as antimicrobial, anticarcinogenic, and other biological
125 activities (Kennedy and Wightman, 2011; Aziman et al., 2012). Pluchea leaves contain phenolic
126 compounds in the form of flavonoids, 1,3,4,5-tetra-O-caffeoylquinic acid, 3,4,5-tri-O-caffeoylquinic
127 acid, chlorogenic acid, and ferulic acid (Mahasuari et al., 2020).

128 Flavonoids as secondary metabolites as well as the main and largest compounds in the
129 group of phenolic compounds are commonly found in plant tissues in free form or glycosides
130 (Aberoumand and Deokule, 2008; Sulaiman and Balachandran, 2012; Agbo et al., 2015). In plants,
131 flavonoids are found in the form of flavonoid glycosides, flavonols, flavan-3-ol, flavones,
132 flavanones, chalcones, anthocyanins, and proanthocyanidins (Dehkharghanian et al., 2010;
133 Vichapong et al., 2010; Chen, 2013). Flavonoids have the ability to chelate metals and donate
134 hydrogen atoms **so that** they can act as antioxidants that are able to provide certain physiological
135 effects on the human body (Erlidawati et al., 2018). This has become one of the basis for the use
136 of herbal plants for traditional medicine and supports various functional food product innovations
137 such as pluchea wet noodles.

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138 Research by Wibisono (2021) showed that the use of pluchea leaf powder steeped water
139 was able to contribute in increasing the content of phytochemical compounds (especially
140 flavonoids) in wet noodles, that the lowest (5%) and the highest (30%) concentration of pluchea
141 leaf powder in steeping water were able to increase the total flavonoid content (TFC) of wet
142 noodles as much as 1.43 times and 4.07 times compared to the control wet noodles (without the
143 use of pluchea leaf powder steeping water), respectively. The potential use of pluchea leaves in
144 the manufacture of wet noodles can be seen by comparing the TFC of pluchea wet noodles in
145 Wibisono's study (2021) with other herbal noodles and pluchea bun as another form of wheat flour-
146 based product. Comparison of the total flavonoids of pluchea wet noodles with sidondo wet
147 noodles, pegagan wet noodles, and pluchea bun from existing studies can be seen in Figure 1.

148 The group of flavonoids found in pluchea leaves are flavonols and flavones, including
149 quercetin, myrisetin, kaempferol, apigenin, luteolin, and chrysoeriol (Andarwulan et al., 2010;
150 Andarwulan et al., 2012; Koirewoa et al., 2012; Mahasuari et al., 2020), sidondo flavonoids consist
151 of castikin, orientin, isoorientin, luteolin, lutekin-7-O-glucoside, corimbosin, gardenins A and B,
152 3-Odesmethylartemethin, 5-O-desmethylnobiletin, and 3',4',5,5',6,7,8-heptamethoxyflavones
153 (Lakshmanashetty et al., 2010; Ullah et al., 2012), while the flavonoids of pegagan include
154 quercetin, myrisetin, and kaempferol (Andarwulan et al., 2010; Andarwulan et al., 2012). The TFC
155 value of wet noodles with the addition of 5% concentration of pluchea leaf powder in steeping
156 water was greater than the TFC of wet noodles with the addition of 20% pegagan extract, but the
157 TFC of pluchea wet noodles 5% was lower than the TFC of sidondo wet noodles which used 0.66%
158 sidondo leaf powder from the total weight of the noodles ingredients. Based on this comparison,
159 it can be indicated that the use of pluchea leaf powder steeping water with a concentration of 5%
160 can increase the flavonoids content of wet noodles far exceeding the flavonoids content that can
161 be given by 20% pegagan extract solution in wet noodles (total flavonoids of pluchea wet noodles
162 5% is 51.67 times compared to pegagan noodles 20%). The total flavonoids of the pluchea wet
163 noodles 5% is 1.53 times lower than the total flavonoids of sidondo wet noodles. The flavonoids
164 content of sidondo wet noodles which was higher than pluchea wet noodles 5% could be caused
165 by the addition of sidondo leaf powder directly to the making of wet noodles dough in Syahirah
166 and Rabeta's research (2018), while pluchea wet noodles dough in Wibisono's study (2021) was
167 made with using pluchea leaf powder steeping water in the formulation of wet noodles. In addition,
168 several factors such as differences in formulation, sequence of processing and analysis stages, as
169 well as stated standards and product sample forms analyzed in each study also affect the difference
170 in TFC values compared between types of herbal wet noodles.

171 The TFC of wet noodles with the addition of 5% concentration of pluchea leaf powder in
172 steeping water was higher than the TFC of bun with the addition of 10% concentration of pluchea
173 leaf powder in steeping water. This shows that the flavonoids content of pluchea wet noodles is
174 higher than the flavonoids content of pluchea bun even though the concentration of pluchea leaf
175 powder in steeping water in the manufacture of pluchea wet noodles is lower than the concentration
176 of pluchea leaf powder in steeping water in the manufacture of pluchea bun (the TFC of pluchea
177 wet noodles 5% is 2.54 times compared to pluchea bun 10%). According to Li *et al.* (2015),
178 antioxidant compounds, one of which is flavonoids, are easily degraded in the heating process, and
179 are lost during the process of mixing and kneading the dough. The degradation of flavonoids during
180 heating and the extraction of glycosides by water vapor can be the cause of the low TFC value of
181 pluchea bun. On the other hand, Saikia and Mahanta (2013) stated that the high flavonoids content
182 can be caused by breaking the glycosidic bond of flavonoids with sugar by heating treatment. The
183 wet noodles cooking process is thought to have an effect on breaking the glycosidic bond so that

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184 aglycones are formed which can improve the detection results of flavonoids compounds in the
185 analysis. Various factors can affect the TFC value in different food products, including differences
186 in ingredient formulations, specifications of the methods used, and the stages of the process in the
187 manufacture of food products.

188 The TFC of pluchea wet noodles 5% showed that pluchea leaves have the potency to
189 increase the content of phytochemical compounds (in this case flavonoids) in wet noodles as a
190 wheat flour-based food product. Wibisono (2021) also stated that the use of higher concentration
191 of pluchea leaf powder in steeping water in the formulation of wet noodles is able to provide a
192 significant increase in the TFC of wet noodles. There has been no research on the effect of adding
193 pluchea leaf powder steeping water on the type and amount of phytochemical compounds other
194 than flavonoids in pluchea wet noodles products, so the use of pluchea leaves in the manufacture
195 of wet noodles still needs to be developed and further investigated its effect on the phytochemical
196 component content of wet noodles.

197

198 2.3 *The effect of pluchea leaves on the functional properties of wet noodles*

199 The functional properties of functional food products mainly focus on the ability of
200 bioactive components in food products to help maintain the health of the human body. One of the
201 properties possessed by bioactive components is that they can act as antioxidants. Carotenoids,
202 flavonoids, and phenolic compounds are classified as natural antioxidants that can be found in
203 various foodstuffs (Marsono, 2008). Antioxidant activity can be in the form of DPPH free radical
204 scavenging ability, iron ion reducing power, reactive oxygen species scavenging activity, and β -
205 carotene-linoleic acid system inhibitory activity (Widyawati et al., 2017).

206 Iron ion reducing power (RP) is one of the parameters of antioxidant potential which is
207 measured as secondary antioxidant activity based on the ability of antioxidant compounds to
208 reduce Fe^{3+} to Fe^{2+} . Secondary antioxidants play a role in the mechanism of binding metal ions,
209 scavenging oxygen, converting hydrogen peroxide into non-radical compounds, absorbing UV
210 radiation, or deactivating singlet oxygen (Pokorny et al., 2001). According to Widyawati et al.
211 (2014), iron ion is one of the pro-oxidants that has the potency to generate new free radicals.
212 Antioxidant components are able to neutralize iron ions by acting as a substrate that will be
213 oxidized first. Based on the research of Wibisono (2021), the use of the lowest (5%) and the highest
214 (30%) concentration of pluchea leaf powder were able to increase the RP value of wet noodles by
215 1.33 times and 3.27 times compared to control wet noodles, respectively. The potency of pluchea
216 leaves in increasing the antioxidant activity of wet noodles products can be described by
217 comparing the RP value of pluchea wet noodles with other products such as rice flour paste and
218 pluchea bun. The comparison of secondary antioxidant activity in the form of the iron ion reducing
219 power of pluchea wet noodles with rice flour paste and pluchea bun can be seen in Figure 2.

220 Pluchea wet noodles 5% in the Wibisono's study (2021) had the RP value 1.78 times higher
221 than the RP value of pluchea bun 10% in Chiang's research (2018), but 1.94 times lower than the
222 RP value of paste made from rice flour in the research of Nithya et al. (2013). The RP value
223 indicates that the use of pluchea leaf powder steeping water with 5% concentration of pluchea leaf
224 powder in steeping water has potency to provide greater secondary antioxidant activity in wet
225 noodles than in bun products. The TFC of pluchea wet noodles 5% which is greater than the TFC
226 of pluchea bun 10%, as shown in Figure 1., can contribute to the large iron ion reducing power of
227 pluchea wet noodles 5% and pluchea bun 10%, that the phenolic group compounds, one of which
228 is flavonoids, capable of donating hydrogen atoms/electrons so that they can reduce iron ions
229 (Widyawati et al., 2014). The flavonoids content of pluchea wet noodles which is higher than the

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230 flavonoids content of pluchea b bun can cause the iron ion reducing power of wet noodles is higher
231 compared to pluchea bun.

232 RP value of pluchea wet noodles 5% which is lower than the RP value of rice flour paste
233 can be due to the use of different types of raw materials (related to the number and types of
234 bioactive components in the ingredients) and the shape of the product samples analyzed in each
235 study. Based on the research of Widyawati et al. (2014), white rice has total phenolic content
236 (TPC) of 4.12 ± 0.05 mg gallic acid equivalent/g dry basis which is greater than the TPC of pluchea
237 leaves in the study of Andarwulan et al. (2010), which was 0.831 ± 0.129 mg gallic acid
238 equivalent/g fresh leaf weight. According to Wibisono (2021), the iron ion reducing power of
239 pluchea wet noodles can be increased by using higher concentration of pluchea leaf powder in
240 steeping water in the formulation of wet noodles.

241 RP value of pluchea wet noodles 5% shows the potency of pluchea leaves to increase the
242 antioxidant activity of wet noodles products as an effort to increase the functional value of wheat
243 flour-based food products such as wet noodles. The effect of adding pluchea leaf powder steeping
244 water on the antioxidant activity of pluchea wet noodles using a type of analysis other than the
245 iron ion reducing power has not been studied further, so it is necessary to measure other antioxidant
246 parameters to support the potency of pluchea leaves in making wet noodles.

247 Research on the potency of pluchea leaves in improving the functional properties of wet
248 noodles is still limited to being studied on product antioxidants, while pluchea leaves have been
249 known to have various other functional properties that are beneficial to health and are able to
250 maintain the quality of food products. Several other functional properties that have the potency to
251 be provided by pluchea leaves in food products include activities as anti-warmed over flavor, anti-
252 inflammatory, antidiabetic (Widyawati et al., 2017), and antimicrobial properties that have the
253 potency to prevent food spoilage (Ardiansyah et al., 2003). This ability is inseparable from the
254 presence of bioactive compounds in pluchea leaves which have the capacity as antioxidant and
255 antihyperglycemic agents (Widyawati et al., 2014; Widyawati et al., 2015). According to Li et al.
256 2014, herbal plant extracts are potential preservatives that are currently being developed to be
257 applied to bread, pasta, and noodles products due to the presence of phenolic components that have
258 high antimicrobial activity. Tiwari et al. (2009) stated that the antimicrobial activity of phenolic
259 compounds is related to the ability of phenolics to affect the permeability of microbial cells which
260 causes the release of important macromolecules from the microbial cell, as well as the ability of
261 phenolics to interact with membrane proteins that cause deformation of the structure and function
262 of microbial cell membranes.

263

264 3. Conclusion

265 Pluchea (*Pluchea indica* Less) leaves have the potency to increase the functional value of wet
266 noodles in terms of the phytochemical content and functional properties of the wet noodles. The
267 use of pluchea leaves increases the content of phytochemical compounds, in this case flavonoids,
268 in wet noodles. The increase in the content of phytochemical compounds with the use of pluchea
269 leaves affects the increase in the functional properties of wet noodles products, especially
270 antioxidant activity in the form of the iron ion reducing power of wet noodles.

271

272 Conflict of interest

273 The authors declare no conflict of interest.

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276 **Acknowledgments**

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278 Catholic University for the research grant.

279 **References**

280 Aberoumand, A. and Deokule, S.S. (2008). Comparison of phenolic compounds of some edible
281 plant of Iran and India. *Pakistan Journal of Nutrition* 7(4), 582-585.

282
283 Adventi, B.S., Widyawati, P.S. and Utomo, A.R. (2015). Effect of salt concentration for
284 physicochemical and organoleptics salted egg pluchea (*Pluchea indica* Less)-black tea (*Camelia*
285 *sinensis*). *Journal of Food Technology and Nutrition* 14(2), 55-60. (In Bahasa).

286
287 Agbo, M.O., Uzor, P.F., Akazie-Nneji, U.N., Eze-Odurukwe, C.U., Ogbatue, U.B. and Mbaoji,
288 E.C. (2015). Antioxidant, total phenolic and flavonoid content of selected Nigerian medical plants.
289 *Dhaka University Journal of Pharmaceutical Sciences* 14(1), 1-7.

290
291 Akbar, A. (2018). Physical, chemical and organoleptic analysis of wet noodle based on taro
292 (*Colocasia esculenta* L.). *Agritepa* 4(2), 159-170. (In Bahasa).

293
294 Andarwulan, N., Kurniasih, D., Apriady, R.A., Rahmat, H., Roto, A.V. and Bolling, B.W. (2012).
295 Polyphenols, carotenoids, and ascorbic acid in underutilized medicinal vegetables. *Journal of*
296 *Functional Foods* 4, 339-347.

297
298 Andarwulan, N., Batari, R., Sandrasari, D.A., Bolling, B. and Wijaya, H. (2010). Flavonoid
299 content and antioxidant activity of vegetables from Indonesia. *Food Chemistry* 121, 1231-1235.

300
301 Ardiansyah, Nuraida, L. and Andarwulan, N. (2003). Antimicrobial activity of pluchea (*Pluchea*
302 *indica* L.) leaves extract and stability of the activity at different salt concentrations and pHs.
303 *Journal of Food Technology and Industry* 14(2), 90-97. (In Bahasa).

304
305 Aziman, N., Abdullah N., Noor, Z.M., Zulkifli, K.S. and Kamarudin, W.S.S.W. (2012).
306 Phytochemical constituents and in vitro bioactivity of ethanolic aromatic herb extracts. *Sains*
307 *Malaysiana* 41(11), 1437-1444.

308
309 Billina, A., Waluyo, S. and Suhandy, D. (2014). Study of the physical properties of wet noodles
310 with addition of sea weed. *Lampung Agricultural Engineering Journal* 4 (2), 109-116. (In Bahasa).

311
312 Chen, X.G.Q. (2013). Identification and antioxidant capacity of anthocyanin pigment, and
313 expressional analysis of flavonoid biosynthetic genes in colored rice strains. Japan: University of
314 Hiroshima, PhD. Dissertation.

315
316 Chiang, I. (2018). The effect of pluchea leaves powder (*Pluchea indica* Less) in steeping water of
317 pao antioxidant activity. Indonesia: Widya Mandala Surabaya Catholic University, Bachelor. Final
318 Project. (In Bahasa)

319

320 Dehkharghanian, M., Adenier, H. and Vijayalakshmi, M.A. (2010). Study of flavonoids in aqueous
321 spinach extract using positive electrospray ionisation tandem quadrupole mass spectrometry. *Food*
322 *Chemistry* 121, 863-870.
323
324 Erlidawati, Safrida and Mukhlis. (2018). Antioxidant Potency as Antidiabetic. Banda Aceh: Syiah
325 Kuala University Press. (In Bahasa).
326
327 Essa, M.M. et al. (2021). Functional foods and their impact on health . *Journal of Food Science*
328 *and Technology*. <https://doi.org/10.1007/s13197-021-05193-3>.
329
330 Estiasih, T., Putri, W.D.R. and Waziroh, E. (2017). Tubers and Their Processing. Malang: UB
331 Press. (In Bahasa).
332
333 Fadzil, N.F., Bakar, M.F.A., Yusop, M.H.M. and Bakar, F.I.A. (2020). Sensorial and
334 physicochemical characteristics of herbal noodle enriched with *Centella asiatica*. *Food Research*
335 4(4), 1030-1037.
336
337 Firdausi, M.H. (2017). Physicochemical and organoleptic quality of dry method salted eggs with
338 addition of pluchea leaves (*Pluchea indica* L). Indonesia: Brawijaya University, Bachelor. Final
339 Project. (In Bahasa).
340
341 Hudha, M. and Widyaningsih, T.D. (2015). The effervescent powder uses pluchea leaf (*Pluchea*
342 *indica* Less) extract as natural antioxidant source. *Journal of Food and Agroindustry* 3(4), 1412-
343 1422. (In Bahasa).
344
345 Khasanah, V. and Astuti, P. (2019). Effect of addition of Moringa leaf extract (*Moringa oleifera*)
346 on sensory quality and protein content of wet noodles substituted with modified cassava flour.
347 *Journal of Technical Competence* 11(2), 15-21. (In Bahasa).
348
349 Kennedy, D.O. and Wightman, E.L. (2011). Herbal extracts and phytochemicals: plant secondary
350 metabolites and the enhancement of human brain function. *Advances in Nutrition* 2, 32-50.
351
352 Koirewoa, Y.A., Fatimawali and Wiyono, W.I. (2012). Isolation and identification flavonoid
353 compounds in pluchea leaf (*Pluchea indica* L.). *Pharmacon* 1(1), 47-52. (In Bahasa).
354
355 Lakshmanashetty, R.H., Nagaraj, V.B., Hiremath, M.G. and Kumar V. (2010). In vitro antioxidant
356 activity of *Vitex negundo* L. leaf extracts. *Chiang Mai Journal of Science* 37(3), 489-497.
357
358 Li, M., Zhu, K.X., Guo, X.N., Brijs, K. dan Zhou, H.M. (2014). Natural additives in wheat-based
359 pasta and noodle products: opportunities for enhanced nutritional and functional properties.
360 *Comprehensive Reviews in Food Science and Food Safety* 13, 347-357.
361
362 Li, Y., Ma, D., Sun, D., Wang, C., Zhang, J., Xie, Y. dan Guo, T. (2015). Total phenolic, flavonoid
363 content, and antioxidant activity of flour, noodles, and steamed bread made from different colored
364 wheat grains by three milling methods. *The Crop Journal* 3(4), 328-334.
365

366 Nuraida, L., Andarwulan, N., Sukmawati, M. and Yohana, E. (2008). Application of herbs and
367 spices extracts as preservatives for wet noodles. Investing in Food Quality, Safety and Nutrition.
368 International Conference Proceeding Investing in Food Quality, Safety & Nutrition: Lessons
369 Learned from Current Food Crisis Jakarta, October 27-28, 2008.

370

371 Magatra, P. (2013). Antioxidant activity, total phenolic content, and organoleptic test in tempe
372 with marsh fleabane leaf extract (*Pluchea indica* L.). Indonesia: Satya Wacana Christian
373 University, Bachelor. Final Project. (In Bahasa).

374

375 Mahasuari, N.P.S., Paramita, N.L.P.V. and Putra, A.A.G.R.Y. (2020). Effect of methanol
376 concentration as a solvent on total phenolic and flavonoid content of pluchea leaf extract (*Pluchea*
377 *indica* L.). *Journal of Pharmaceutical Science and Application* 2(2), 77-84.

378

379 Marsono, Y. (2008). Functional food development prospects. *Journal of Food Technology and*
380 *Nutrition* 7(1), 19-27. (In Bahasa).

381

382 Nithya, D.J., Bosco, K.A.S., Jagan Mohan, R. and Alagusundaram, K. (2013). Antioxidant activity
383 of rice bran pasta. *Journal of Microbiology, Biotechnology and Food Sciences* 2(6), 2423-2425.

384

385 Norlaili, A.H., Roselina, K. and Muhammad, T.S. (2014). Effect of *Cosmos caudatus* Kunth.
386 (Ulam Raja) aqueous and dry extracts on the physicochemical and functional properties, and
387 sensory acceptability of Herbal Yellow Alkaline Noodles. *Malaysian Journal of Nutrition* 20(3),
388 403-415.

389

390 Pengelly, A. (2004). The Constituents of Medicinal Plants: An Introduction to the Chemistry and
391 Therapeutics of Herbal Medicines, 2nd ed. Australia: CABI Publishing.

392

393 Pokorny, J., Yanishlieva, N. and Gordon, M. (2001). Antioxidants in Food: Practical Applications.
394 Cambridge: Woodhead Publishing Ltd.

395

396 Saikia, S. and Mahanta, C.L. (2013). Effect of steaming, boiling and microwave cooking on the
397 total phenolics, flavonoids and antioxidant properties of different vegetables of Assam, India.
398 *International Journal of Food and Nutritional Sciences* 2(3), 47-53.

399

400 Sari, E.T. (2014). Factors influencing consumption of functional food in Surabaya. *Scientific*
401 *Journal of Commerce Administration* 12(2), 1-10. (In Bahasa).

402

403 Shamim, M.Z., Verma, A., Sheikh, S. and Singh, S. (2016). Sensory evaluation of nutritious herbal
404 noodles developed by utilization of *Aegle marmelos* leaves powder. *IMPACT: International*
405 *Journal of Research in Applied, Natural and Social Sciences* 4(4), 109-114.

406

407 Stojanovic, Z., Filipovic, J. and Mugosa, B. (2013). Consumer acceptance of functional foods in
408 Montenegro. *Montenegrin Journal of Economics* 9(3), 65-74.

409

410 Sulaiman, C.T. and Balachandran, I. (2012). Total phenolics and total flavonoids in selected Indian
411 medical plants. *Indian Journal of Pharmaceutical Sciences* 74(3), 258-260.

412
413 Suter, I.K. (2013). Functional foods and their development prospects. Retrieved on February 15,
414 2021 from Udayana University Repository Website:
415 [https://repositori.unud.ac.id/protected/storage/upload/repositori/ID3_1950123119760210032309](https://repositori.unud.ac.id/protected/storage/upload/repositori/ID3_19501231197602100323091304927makalah-gizi.pdf)
416 [1304927makalah-gizi.pdf](https://repositori.unud.ac.id/protected/storage/upload/repositori/ID3_19501231197602100323091304927makalah-gizi.pdf) (In Bahasa).
417
418 Syahirah, J. and Rabeta, M.S. (2018). Antioxidant and antimicrobial activity of lemuni noodle.
419 *Food Research* 3(1), 7-13.
420
421 Tiwari, B.K., Valdramidis, V.P., Donnell, C.P.O., Muthukumarappan, K., Bourke, P. and Cullen,
422 P.J. (2009). Application of natural antimicrobials or food preservation. *Journal of Agricultural and*
423 *Food Chemistry* 57(14), 5987-6000.
424
425 Ullah, Z., Ullah, R., Shah, A.H.A., Ahmad, I. and Haider, S. (2012). Phytochemical and biological
426 evaluation of *Vitex negundo* Linn: a review. *International Journal of Pharmaceutical Sciences and*
427 *Research* 3(8), 2421-2431.
428
429 Vichapong, J., Sookserm, M., Srijesdaruk, V., Swatsitang, P. and Srijaranai, S. (2010). High
430 performance liquid chromatographic analysis of phenolic compounds and their antioxidant
431 activities in rice varieties. *LWT-Food Science and Technology* 43, 1325-1330.
432
433 Wibisono, D.A.S. (2021). Effect of concentration of pluchea (*Pluchea indica* (L.) Less) leaves
434 powder in steeping water on total flavonoids and iron ion reducing power of wet noodle. Indonesia:
435 Widya Mandala Surabaya Catholic University, Bachelor. Final Project. (In Bahasa).
436
437 Widyawati, P.S., Budianta, T.D.W., Gunawan, D.I. and Wongso, R.S. (2015). Evaluation
438 antidiabetic activity of various leaf extracts of *Pluchea indica* Less. *International Journal of*
439 *Pharmacognosy and Phytochemical Research* 7(3), 597-603.
440
441 Widyawati, P.S., Budianta, T.D.W., Kusuma, F.A. and Wijaya, E.L. (2014). Difference of solvent
442 polarity to phytochemical content and antioxidant activity of *Pluchea indica* Less leaves extracts.
443 *International Journal of Pharmacognosy and Phytochemical Research* 6(4), 850-855.
444
445 Widyawati, P.S., Ristiari, S., Werdani, Y.D.W., Kuswardani, I. and Herwina, I. N. (2019).
446 Physicochemical and organoleptic properties changes of soymilk with **pluchea** brewing water
447 addition. *Journal of Food Technology and Nutrition* 18(2), 98-111. (In Bahasa).
448
449 Widyawati, P.S., Suteja, A.M., Suseno, T.I.P., Monika, P., Saputrajaya, W. and Liguori, C. (2014).
450 Effect of pigment color difference in organic rice on antioxidant activity. *Agritech* 34(4), 399-406.
451 (In Bahasa).
452
453 Widyawati, P.S., Werdani, Y.D.W., Setiokusumo, C. and Kartikasari, A. (2017). In vitro
454 antioxidant capacities and antidiabetic properties of **pluchea** leaves and green tea mixtures at
455 various proportions. *International Journal of Pharmacy and Pharmaceutical Sciences* 9(8), 203-
456 208.
457

458 Wijaya, J.P. (2019). Effect of concentration of mixture of **pluchea** (*Pluchea indica* L.) leaves
459 powder – green tea (*Camellia sinensis* L.) 1:1 (b/b) in steeping water on antioxidant activity of
460 jelly drink. Indonesia: Widya Mandala Surabaya Catholic University, Bachelor. Final Project. (In
461 Bahasa).

462
463 Zou, S., Wang, L., Wang, A., Zhang, Q., Li, Z., and Qiu, J. (2021). Effect of moisture distribution
464 changes induced by different cooking temperature on cooking quality and texture properties of
465 noodles made from whole tartary buckwheat. *Foods* 10(2543),1-12.

466

467 Table 1. The use of Pluchea leaves in food product

Type of food product	Pluchea leaf form	Stages of use	References
Tempeh	Pluchea leaf water extract	Soak soybeans before adding tempeh yeast	Magatra, 2013
Pluchea -black tea salted egg	Pluchea leaf flour	Mixed in salt solution for the ripening stage	Adventi et al., 2015
Effervescent powder	Water extract (infusion) and ethanol extract (maceration)	Evaporated and mixed according to the formulation	Hudha and Widyaningsih, 2015
Dry method salted egg	Fresh pluchea leaves	Added to pasta dough to coat eggs	Firdausi, 2017
Bun	Pluchea leaf powder steeping water	Added during dough making	Chiang, 2018
Soy milk	Pluchea leaf powder steeping water	Added to soy milk	Widyawati et al., 2019
Pluchea- green tea jelly drink	Pluchea leaf powder	Brewed with green tea powder	Wijaya, 2019
Wet noodles	Pluchea leaf powder steeping water	Added during dough making	Wibisono, 2021

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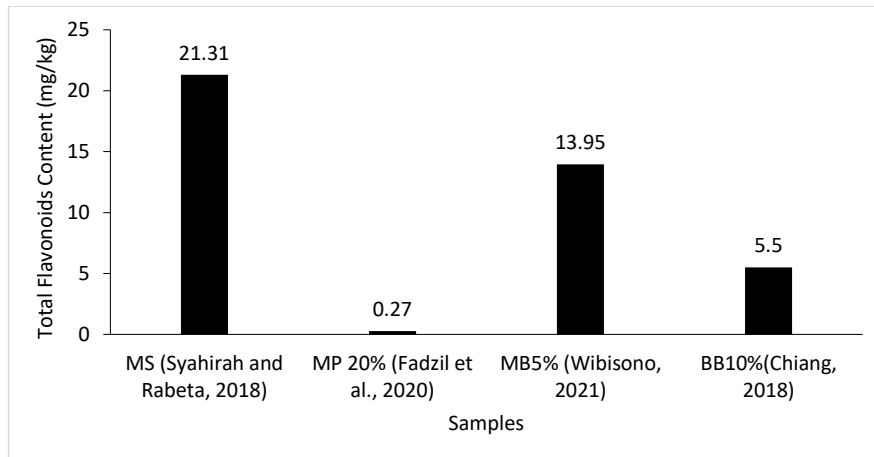
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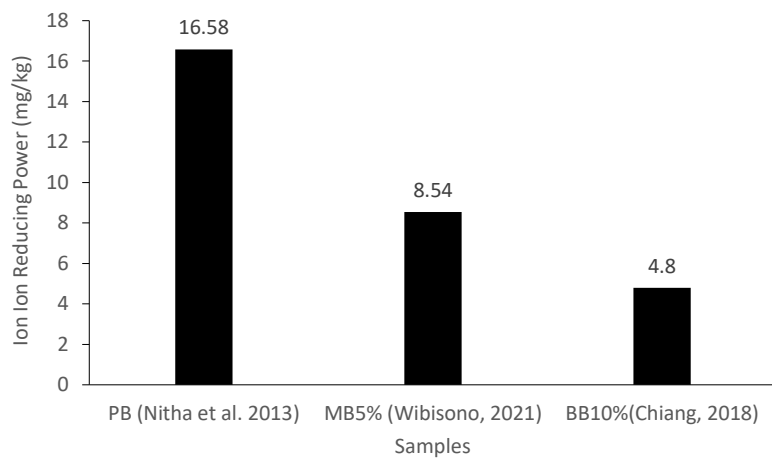
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 476 Figure 1. Total flavonoid content (TFC) of pluchea wet noodles 5% (MB5%) compared to sidondo
 477 wet noodles (MS), pegagan wet noodles 60% (MP60%), and pluchea bun 10% (BB10%). The TFC
 478 of sidondo and pegagan wet noodles were respectively expressed in terms of quercetin equivalent
 479 per weight of wet noodles and rutin equivalent per weight of wet noodles extract, while the TFC
 480 of pluchea noodles and pluchea bun were expressed in terms of catechin equivalents per dried
 481 weight of freeze-dried results. TFC of MP20%, MB5%, and BB10% were expressed by the values
 482 that have been subtracted with the TFC of control from each study.

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493 Figure 2. Iron ion reducing power (RP) of pluchea wet noodles 5% (MB5%) compared to rice flour
494 paste (PB) and pluchea bun 10% (BB10%). RP value of rice flour paste was stated to be equivalent
495 to BHT per weight of pasta, while the RP value of pluchea wet noodles and pluchea bun was
496 expressed in gallic acid equivalent per dried weight of freeze-dried results. Iron ion reducing power
497 of MB5% and BB10% are expressed by the value that has been reduced by the RP value of control
498 from each study.

6. Third Revision: Final Revision (21-3-2022)
-Correspondence
-Document



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Revised Manuscript

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Mon, Mar 21, 2022 at 2:08 PM

Dear Prof Dr. Son Radu

I have revised my manuscript with title : **Potency of pluchea (*Pluchea indica* Less) leaves to increase functional value of wet noodles: a review**"as recommended and I send again.

Thanks for attention

The Best Regards

Paini Sri Widyawati



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Potency of pluchea (*Pluchea indica* Less) leaves to increase functional value of wet noodles: a review

Abstract

Wet noodles are lack of functional nutritional components/nutrients that are beneficial for health, thus it is necessary to add other food ingredients that can increase the functional value of wet noodles. One of the food ingredients that can be added in wet noodles formulation is *Pluchea indica* Less leaves, which have been known as a sources of antioxidants and used by the community as a traditional medicine to treat various health problems. The use of *Pluchea indica* Less leaves in making wet noodles is expected to increase the functional value of wet noodles. For this reason, this review paper discussed the potency of *Pluchea indica* Less leaves in affecting the phytochemical compounds content and functional properties of wet noodles. The use of *Pluchea indica* Less leaves showed potential to increase the phytochemical compounds contents of wet noodles, such as alkaloids, flavonoids, phenolics, saponins, tannins, and cardiac glycosides, which play an important role in the health of human body and maintaining the quality of wet noodles, such as antioxidant, anti-warmed over flavor, anti-inflammatory, antidiabetic, and antimicrobial activities. Thus, Accordingly, the addition of pluchea leaves has potential to increase the functional value of wet noodles including the phytochemical content and functional properties.

increase in phytochemical compounds in wet noodles could also affect the functional properties of wet noodles.

Keywords: *Pluchea indica* Less, wet noodles, functional value

1. Introduction

Noodles as one of the wheat flour-based product are quiet popular among various levels of society in Indonesia. Noodles can be classified into five forms based on processing stage and water content of the noodles product, including raw noodles, wet noodles, dry noodles, fried noodles, and instant noodles. Wet noodles are noodles product that have a water content of about 50-52% (Nuraida et al., 2009), 52,10-52,85% (Billina et al., 2014) 58-70% (Zhou et al., 2021), and is produced through the cooking stage of raw noodles before being marketed (Billina et al., 2014). According to Nuraida et al. (2009), the high moisture content of wet noodles causes the shelf life of wet noodles to only reach 42 hours at room temperature storage.

Increased awareness and interest in functional food supports the development of various food products with high functional value (Essa et al., 2021). The functional value of a food product depends on the nutrients contained in the food ingredients that make up the food product. The raw materials in the manufacture of noodles of noodles generally include wheat flour, eggs, and water, and However other additives so that no noodles are known to be low in nutritional content/functional nutrients that are beneficial to health (Akbar, 2018; Khasanah and Astuti, 2019). Therefore, various efforts have been made to overcome the shortcomings of these wet noodless products. Increasing the functional value of wet noodles can be done by adding other food ingredients that contain bioactive compounds in the manufacture of wet noodles, one of which is the addition of pluchea leaves.

Pluchea (*Pluchea indica* Less) is an herbaceous plant that contains phytochemical compounds, including alkaloids, saponins, tannins, phenol hydroquinone, flavonoids, cardiac

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glycosides, and sterols, ~~so that they act as are potential sources of natural antioxidants~~ (Widyawati et al., 2015). In addition, pluche leaves also have antimicrobial activity that has the potency to prevent food damage (Ardiansyah et al., 2003). The use of pluche leaves in the manufacture of wet noodles is expected to produce wet noodles that are able to provide antioxidant effects that are good for health, and have an impact on increasing the shelf life of the wet noodles product.

Currently, the use of pluche leaves is only limited ~~as to~~ fresh vegetables and drinks, but there have been many studies on the use of pluche leaves in the food sector that continue to be developed, including making tempeh with pluche leaf extract (Magatra, 2013), pluche-black tea salted eggs (Adventi et al., 2015), effervescent powder based on pluche leaf extract (Hudha and Widyarningsih, 2015), pluche bun products (Chiang, 2018), pluche soy milk (Widyawati et al., 2019), pluche-green tea jelly drink (Wijaya, 2019), and pluche wet noodles (Wibisono, 2021). The use of pluche leaves in the manufacture of wet noodles was studied further as an effort to develop functional food products that were beneficial to the health of the consumer's body.

2. Results and Discussion

Several factors such as individual education, household standards and level of knowledge about food products with health claims, as well as perceptions of some existing functional food product attributes affect the development of public interest in functional food products (Stojanovic et al., 2013; Sari, 2014). Marsono (2008) also ~~declared stated~~ that increasing awareness of the importance of food in preventing or curing disease, consumer demands for foods with more properties (containing functional ingredients), experiences with alternative medicines, and studies on the prevalence of certain diseases that are influenced by diet have also become the basis for the rapid development of functional food products in various countries.

Functional food is defined as a food product that is able to provide benefits to the health of the body, one of which is through the presence of bioactive components contained in a functional food product (Suter, 2013; Essa et al., 2021). According to Essa et al. (2021), there are five categories of functional food, i.e. foodstuffs with a reduction or increase in the basic nutritional content, products that naturally do not have certain nutrients and are added to them, milk-based products fermented with probiotics, products that are specially formulated to fulfill certain needs, and foodstuffs containing herbal ingredients to help overcome various health problems.

Herbal plants ~~are~~ a source of functional food, i.e. -a source of natural antioxidants that can be used in the food sector to improve the functional properties of processed food products, one of which is the use of herbal plants to increase the content of bioactive components in wheat flour-based products such as noodles. According to Fadzil et al. (2020), noodles are known to be low in nutritional components that are beneficial to health, while noodles with functional properties such as high antioxidants are in high demand at this time.

2.1 Utilization of pluche leaves in making wet noodles

The main ingredients in making noodles are generally wheat flour, eggs, water, and other additives as needed, ~~making the so that~~ noodles products only contain carbohydrates, proteins, fats, and minerals. The content of carbohydrates, several minerals, and energy in noodles are very high, but the content of protein, fat, and vitamins in noodles products are ~~relatively~~ low (Akbar, 2018; Khasanah and Astuti, 2019). Several studies have been carried out in an effort to improve the functional properties of noodles products, one of which is by using the leaves of plants that have been known as traditional medicines to be added to the manufacture of noodles, such as

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93 making herbal noodles with cosmos (*Cosmos caudatus* Kunth.) leaf extract (Norlaili et al., 2014),
94 manufacture of herbal noodles with leaves of the Indian bael plant (*Aegle marmelos*) (Shamim et
95 al., 2016), manufacture of sidondo (*Vitex negundo* Linn.) noodles (Syahirah and Rabeta, 2018),
96 addition of moringa (*Moringa oleifera*) leaf extract to wet noodles (Khasanah and Astuti, 2019),
97 making herbal noodles with pegagan (*Centella asiatica*) extract (Fadzil et al., 2020), and using
98 pluchea (*Pluchea indica* Less) leaf powder steeped water to make pluchea wet noodles (Wibisono,
99 2021).

100 The content and activity of phytochemical compounds in pluchea leaves, both in the form
101 of fresh leaves and water steeped in powdered pluchea leaves, have been identified. Pluchea is
102 classified as plant that has high polyphenol content and relatively large antioxidant capacity
103 compared to other herbaceous plants (Andarwulan et al., 2010; Andarwulan et al., 2012). Research
104 conducted by Widyawati et al. (2016) showed that the phytochemical compounds contained in the
105 brewed water of pluchea leaf powder include alkaloids, flavonoids, phenolics, saponins, tannins,
106 and cardiac glycosides. According to Pengly (2004), each phytochemical compound has
107 physiological effects including alkaloids as analgesic, mydriatic, miotic, hypertensive,
108 hypotensive, bronchodilator, stimulant, antimicrobial, and antileukemic, flavonoids as antioxidant,
109 antiviral, hepatoprotective, antiatheromatous, anti-inflammatory, and antihypertensive, phenolic
110 as antioxidant, antimicrobial, anti-inflammatory, antiplatelet, and antiallergic, saponins as
111 anticancer, anti-inflammatory, immunomodulatory, antihepatotoxic, and antidiabetic, tannins as
112 antioxidant, antitumor, antihemorrhagic, and antiatherogenic, as well as cardiac glycosides that
113 can increase strength and speed of systolic contraction. Flavonoids are one of the important
114 constituents that can provide real benefits for the health of the human body.

115 The use of pluchea leaves in food products continues to be developed through various
116 studies as shown in Table 1. Using pluchea leaves in many food products (tempeh, beverage, salted
117 egg, bun, jelly drink, and soymilk) to increase their functional value can be added in the form of
118 extract, powder/flour, or fresh with different stages of processing each food product. However,
119 the use of pluchea leaves to increase the functional value of wheat flour-based food products has
120 not been widely studied. So far the research that has been carried out regarding the use of pluchea
121 leaves in the formulation of wheat flour-based food products is in the manufacture of pluchea bun
122 (Chiang, 2018) and pluchea wet noodles (Wibisono, 2021), both of which use pluchea leaf powder
123 steeping water which is added to the product formulation.

124

125 2.2 The effect of pluchea leaves on the content of phytochemical compounds of wet noodles

126 The largest group of phytochemical compounds in plants includes alkaloids, terpenes, and
127 phenolic compounds. Phenolic compounds are a group of phytochemical compounds that are
128 widely distributed in various plants, where this group of compounds can be used as the main source
129 of natural antioxidants and are able to act as antimicrobial, anticarcinogenic, and other biological
130 activities (Kennedy and Wightman, 2011; Aziman et al., 2012). Pluchea leaves contain phenolic
131 compounds in the form of flavonoids, 1,3,4,5-tetra-O-cafeoilquinic acid, 3,4,5-tri-O-cafeoilquinic
132 acid, chlorogenic acid, and ferulic acid (Mahasuari et al., 2020).

133 Flavonoids as secondary metabolites as well as the main and largest compounds in the
134 group of phenolic compounds are commonly found in plant tissues in free form or glycosides
135 (Aberoumand and Deokule, 2008; Sulaiman and Balachandran, 2012; Agbo et al., 2015). In plants,
136 flavonoids are found in the form of flavonoid glycosides, flavonols, flavan-3-ol, flavones,
137 flavanones, chalcones, anthocyanins, and proanthocyanidins (Dehkharghanian et al., 2010;
138 Vichapong et al., 2010; Chen, 2013). Flavonoids act as antioxidants by have the ability to

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139 ~~chelatechelating~~ metals and ~~donate-donating~~ hydrogen atoms, ~~thus - as the~~ ~~they can act as~~
140 ~~antioxidants that are able to~~ provide certain physiological effects on the human body (Erlidawati
141 et al., 2018). This has become one of the basis for the use of herbal plants for traditional medicine
142 and supports various functional food product innovations such as pluchea wet noodles.

143 Research by Wibisono (2021) showed that the use of pluchea leaf powder steeped water
144 was able to contribute in increasing the content of phytochemical compounds (especially
145 flavonoids) in wet noodles, that the lowest (5%) and the highest (30%) concentration of pluchea
146 leaf powder in steeping water were able to increase the total flavonoid content (TFC) of wet
147 noodles as much as 1.43 times and 4.07 times compared to the control wet noodles (without the
148 use of pluchea leaf powder steeping water), respectively. The potential use of pluchea leaves in
149 the manufacture of wet noodles can be seen by comparing the TFC of pluchea wet noodles in
150 Wibisono's study (2021) with other herbal noodles and pluchea bun as another form of wheat flour-
151 based product. Comparison of the total flavonoids of pluchea wet noodles with sidondo wet
152 noodles, pegagan wet noodles, and pluchea bun from existing studies can be seen in Figure 1.

153 The group of flavonoids found in pluchea leaves are flavonols and flavones, including
154 quercetin, myrisetin, kaempferol, apigenin, luteolin, and chrysoeriol (Andarwulan et al., 2010;
155 Andarwulan et al., 2012; Koirewoa et al., 2012; Mahasuari et al., 2020), sidondo flavonoids consist
156 of castikin, orientin, isoorientin, luteolin, lutekin-7-O-glucoside, corimbosin, gardenins A and B,
157 3-O-desmethylnobiletin, 5-O-desmethylnobiletin, and 3',4',5',6,7,8-heptamethoxyflavones
158 (Lakshmanashetty et al., 2010; Ullah et al., 2012), while the flavonoids of pegagan include
159 quercetin, myrisetin, and kaempferol (Andarwulan et al., 2010; Andarwulan et al., 2012). The TFC
160 value of wet noodles with the addition of 5% concentration of pluchea leaf powder in steeping
161 water was greater than the TFC of wet noodles with the addition of 20% pegagan extract, but the
162 TFC of pluchea wet noodles 5% was lower than the TFC of sidondo wet noodles which used 0.66%
163 sidondo leaf powder from the total weight of the noodles ingredients. Based on this comparison,
164 it can be indicated that the use of pluchea leaf powder steeping water with a concentration of 5%
165 can increase the flavonoids content of wet noodles far exceeding the flavonoids content that can
166 be given by 20% pegagan extract solution in wet noodles (total flavonoids of pluchea wet noodles
167 5% is 51.67 times compared to pegagan noodles 20%). The total flavonoids of the pluchea wet
168 noodles 5% is 1.53 times lower than the total flavonoids of sidondo wet noodles. The flavonoids
169 content of sidondo wet noodles which was higher than pluchea wet noodles 5% could be caused
170 by the addition of sidondo leaf powder directly to the making of wet noodles dough in Syahirah
171 and Rabeta's research (2018), while pluchea wet noodles dough in Wibisono's study (2021) was
172 made with using pluchea leaf powder steeping water in the formulation of wet noodles. In addition,
173 several factors such as differences in formulation, sequence of processing and analysis stages, as
174 well as stated standards and product sample forms analyzed in each study also affect the difference
175 in TFC values compared between types of herbal wet noodles.

176 The TFC of wet noodles with the addition of 5% concentration of pluchea leaf powder in
177 steeping water was higher than the TFC of bun with the addition of 10% concentration of pluchea
178 leaf powder in steeping water. This shows that the flavonoids content of pluchea wet noodles is
179 higher than the flavonoids content of pluchea bun even though the concentration of pluchea leaf
180 powder in steeping water in the manufacture of pluchea wet noodles is lower than the concentration
181 of pluchea leaf powder in steeping water in the manufacture of pluchea bun (the TFC of pluchea
182 wet noodles 5% is 2.54 times compared to pluchea bun 10%). According to Li et al. (2015),
183 antioxidant compounds, one of which is flavonoids, are easily degraded in the heating process, and
184 are lost during the process of mixing and kneading the dough. The degradation of flavonoids during

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185 heating and the extraction of glycosides by water vapor can be the cause of the low TFC value of
186 pluchea bun. On the other hand, a study conducted by Saikia and Mahanta (2013) stated showed
187 that the high flavonoids content can be caused by breaking the glycosidic bond of flavonoids with
188 sugar by heating treatment. The wet noodles cooking process is thought to have an effect on
189 breaking the glycosidic bond so that aglycones are formed which can improve the detection results
190 of flavonoids compounds in the analysis. Various factors can affect the TFC value in different food
191 products, including differences in ingredient formulations, specifications of the methods used, and
192 the stages of the process in the manufacture of food products.

193 The TFC of pluchea wet noodles 5% showed that pluchea leaves have the potency to
194 increase the content of phytochemical compounds (in this case flavonoids) in wet noodles as a
195 wheat flour-based food product. Wibisono (2021) also stated mentioned that the use of higher
196 concentration of pluchea leaf powder in steeping water in the formulation of wet noodles is able
197 to provide a significant increase in the TFC of wet noodles. There has been no research on the
198 effect of adding pluchea leaf powder steeping water on the type and amount of phytochemical
199 compounds other than flavonoids in pluchea wet noodles products, so the use of pluchea leaves in
200 the manufacture of wet noodles still needs to be developed and further investigated its effect on
201 the phytochemical component content of wet noodles.

202

203 2.3 The effect of pluchea leaves on the functional properties of wet noodles

204 The functional properties of functional food products mainly focus on the ability of
205 bioactive components in food products to help maintain the health of the human body. One of the
206 properties possessed by bioactive components is that they can act as antioxidants. Carotenoids,
207 flavonoids, and phenolic compounds are classified as natural antioxidants that can be found in
208 various foodstuffs (Marsono, 2008). Antioxidant activity can be in the form of DPPH free radical
209 scavenging ability, iron ion reducing power, reactive oxygen species scavenging activity, and β -
210 carotene-linoleic acid system inhibitory activity (Widyawati et al., 2017).

211 Iron ion reducing power (RP) is one of the parameters of antioxidant potential which is
212 measured as secondary antioxidant activity based on the ability of antioxidant compounds to
213 reduce Fe^{3+} to Fe^{2+} . Secondary antioxidants play a role in the mechanism of binding metal ions,
214 scavenging oxygen, converting hydrogen peroxide into non-radical compounds, absorbing UV
215 radiation, or deactivating singlet oxygen (Pokorny et al., 2001). According to Widyawati et al.
216 (2014), iron ion is one of the pro-oxidants that have the potency to generate new free radicals.
217 Antioxidant components are able to neutralize iron ions by acting as a substrate that will be
218 oxidized first. Based on the research of Wibisono (2021), the use of the lowest (5%) and the highest
219 (30%) concentration of pluchea leaf powder were able to increase the RP value of wet noodles by
220 1.33 times and 3.27 times compared to control wet noodles, respectively. The potency of pluchea
221 leaves in increasing the antioxidant activity of wet noodles products can be described by
222 comparing the RP value of pluchea wet noodles with other products such as rice flour paste and
223 pluchea bun. The comparison of secondary antioxidant activity in the form of the iron ion reducing
224 power of pluchea wet noodles with rice flour paste and pluchea bun can be seen in Figure 2.

225 Pluchea wet noodles 5% in the Wibisono's study (2021) had the RP value 1.78 times higher
226 than the RP value of pluchea bun 10% in Chiang's research (2018), but 1.94 times lower than the
227 RP value of paste made from rice flour in the research of Nithya et al. (2013). The RP value
228 indicates that the use of pluchea leaf powder steeping water with 5% concentration of pluchea leaf
229 powder in steeping water has potency to provide greater secondary antioxidant activity in wet
230 noodles than in bun products. The TFC of pluchea wet noodles 5% which is greater than the TFC

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231 of pluchea bun 10%, as shown in Figure 1., can contribute to the large iron ion reducing power of
232 pluchea wet noodles 5% and pluchea bun 10%, that the phenolic group compounds, one of which
233 is flavonoids, capable of donating hydrogen atoms/electrons so that they can reduce iron ions
234 (Widyawati et al., 2014). The flavonoids content of pluchea wet noodles which is higher than the
235 flavonoids content of pluchea bun, can cause the iron ion reducing power of wet noodles is higher
236 compared to pluchea bun.

237 RP value of pluchea wet noodles 5% which is lower than the RP value of rice flour paste
238 can be due to the use of different types of raw materials (related to the number and types of
239 bioactive components in the ingredients) and the shape of the product samples analyzed in each
240 study. Based on the research of Widyawati et al. (2014), white rice has total phenolic content
241 (TPC) of 4.12 ± 0.05 mg gallic acid equivalent/g dry basis which is greater than the TPC of pluchea
242 leaves in the study of Andarwulan et al. (2010), which was 0.831 ± 0.129 mg gallic acid
243 equivalent/g fresh leaf weight. According to Wibisono (2021), the iron ion reducing power of
244 pluchea wet noodles can be increased by using higher concentration of pluchea leaf powder in
245 steeping water in the formulation of wet noodles.

246 RP value of pluchea wet noodles 5% shows the potency of pluchea leaves to increase the
247 antioxidant activity of wet noodles products as an effort to increase the functional value of wheat
248 flour-based food products such as wet noodles. The effect of adding pluchea leaf powder steeping
249 water on the antioxidant activity of pluchea wet noodles using a type of analysis other than the
250 iron ion reducing power has not been studied further, so it is necessary to measure other antioxidant
251 parameters to support the potency of pluchea leaves in making wet noodles.

252 Research on the potency of pluchea leaves in improving the functional properties of wet
253 noodles is still limited to being studied on product antioxidants, while pluchea leaves have been
254 known to have various other functional properties that are beneficial to health and are able to
255 maintain the quality of food products. Several other functional properties that have the potency to
256 be provided by pluchea leaves in food products include activities as anti-warmed over flavor, anti-
257 inflammatory, antidiabetic (Widyawati et al., 2017), and antimicrobial properties that have the
258 potency to prevent food spoilage (Ardiansyah et al., 2003). This ability is inseparable from the
259 presence of bioactive compounds in pluchea leaves which have the capacity as antioxidant and
260 antihyperglycemic agents (Widyawati et al., 2014; Widyawati et al., 2015). According to Li et al.
261 (2014), herbal plant extracts are potential preservatives that are currently being developed to be
262 applied to bread, pasta, and noodles products due to the presence of phenolic components that have
263 high antimicrobial activity. Tiwari et al. (2009) stated also proved that the antimicrobial activity
264 of phenolic compounds is related to the ability of phenolics to affect the permeability of microbial
265 cells which causes the release of important macromolecules from the microbial cell, as well as the
266 ability of phenolics to interact with membrane proteins that cause deformation of the structure and
267 function of microbial cell membranes.

269 3. Conclusion

270 Pluchea (*Pluchea indica* Less) leaves have the potency to increase the functional value of
271 wet noodles in terms of the phytochemical content and functional properties of the wet noodles.
272 The use of pluchea leaves increases the content of phytochemical compounds, in this case
273 flavonoids, in wet noodles. The increase in the content of phytochemical compounds with the use
274 of pluchea leaves affects the increase in the functional properties of wet noodles products,
275 especially antioxidant activity in the form of the iron ion reducing power of wet noodles.
276

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277 **Conflict of interest**

278 The authors declare no conflict of interest.

279

280

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284 **References**

285 Aberoumand, A. and Deokule, S.S. (2008). Comparison of phenolic compounds of some edible
286 plant of Iran and India. *Pakistan Journal of Nutrition* 7(4), 582-585.

287

288 Adventi, B.S., Widyawati, P.S. and Utomo, A.R. (2015). Effect of salt concentration for
289 physicochemical and organoleptics salted egg pluchea (*Pluchea indica* Less)-black tea (*Camelia*
290 *sinensis*). *Journal of Food Technology and Nutrition* 14(2), 55-60. [\(In Bahasa\)](#).

291

292 Agbo, M.O., Uzor, P.F., Akazie-Nneji, U.N., Eze-Odurukwe, C.U., Ogbatue, U.B. and Mbaaji,
293 E.C. (2015). Antioxidant, total phenolic and flavonoid content of selected Nigerian medical plants.
294 *Dhaka University Journal of Pharmaceutical Sciences* 14(1), 1-7.

295

296 Akbar, A. (2018). Physical, chemical and organoleptic analysis of wet noodle based on taro
297 (*Colocasia esculenta* L). *Agritepa* 4(2), 159-170. [\(In Bahasa\)](#).

298

299 Andarwulan, N., Kurniasih, D., Apriady, R.A., Rahmat, H., Roto, A.V. and Bolling, B.W. (2012).
300 Polyphenols, carotenoids, and ascorbic acid in underutilized medicinal vegetables. *Journal of*
301 *Functional Foods* 4, 339-347.

302

303 Andarwulan, N., Batari, R., Sandrasari, D.A., Bolling, B. and Wijaya, H. (2010). Flavonoid
304 content and antioxidant activity of vegetables from Indonesia. *Food Chemistry* 121, 1231-1235.

305

306 Ardiansyah, Nuraida, L. and Andarwulan, N. (2003). Antimicrobial activity of pluchea (*Pluchea*
307 *indica* L.) leaves extract and stability of the activity at different salt concentrations and pHs.
308 *Journal of Food Technology and Industry* 14(2), 90-97. [\(In Bahasa\)](#).

309

310 Aziman, N., Abdullah N., Noor, Z.M., Zulkifli, K.S. and Kamarudin, W.S.S.W. (2012).
311 Phytochemical constituents and in vitro bioactivity of ethanolic aromatic herb extracts. *Sains*
312 *Malaysiana* 41(11), 1437-1444.

313

314 Billina, A., Waluyo, S. and Suhandy, D. (2014). Study of the physical properties of wet noodles
315 with addition of sea weed. *Lampung Agricultural Engineering Journal* 4 (2), 109-116. [\(In Bahasa\)](#).

316

317 Chen, X.G.Q. (2013). Identification and antioxidant capacity of anthocyanin pigment, and
318 expressional analysis of flavonoid biosynthetic genes in colored rice strains. Japan: University of
319 Hiroshima, PhD. Dissertation.

320

321 Chiang, I. (2018). The effect of pluchea leaves powder (*Pluchea indica* Less) in steeping water of
322 pao antioxidant activity. Indonesia: Widya Mandala Surabaya Catholic University, Bachelor. Final
323 Project. [\(In Bahasa\)](#)
324

325 Dehkharghanian, M., Adenier, H. and Vijayalakshmi, M.A. (2010). Study of flavonoids in aqueous
326 spinach extract using positive electrospray ionisation tandem quadrupole mass spectrometry. *Food*
327 *Chemistry* 121, 863-870.
328

329 Erlidawati, Safrida and Mukhlis. (2018). Antioxidant Potency as Antidiabetic. Banda Aceh: Syiah
330 Kuala University Press. [\(In Bahasa\)](#)
331

332 **Essa, M.M. et al. (2021). Functional foods and their impact on health . Journal of Food Science**
333 **and Technology. <https://doi.org/10.1007/s13197-021-05193-3>.**
334

335 Estiasih, T., Putri, W.D.R. and Waziroh, E. (2017). Tubers and Their Processing. Malang: UB
336 Press. [\(In Bahasa\)](#)
337

338 Fadzil, N.F., Bakar, M.F.A., Yusop, M.H.M. and Bakar, F.I.A. (2020). Sensorial and
339 physicochemical characteristics of herbal noodle enriched with *Centella asiatica*. *Food Research*
340 4(4), 1030-1037.
341

342 Firdausi, M.H. (2017). Physicochemical and organoleptic quality of dry method salted eggs with
343 addition of pluchea leaves (*Pluchea indica* L). Indonesia: Brawijaya University, Bachelor. Final
344 Project. [\(In Bahasa\)](#)
345

346 Hudha, M. and Widyaningsih, T.D. (2015). The effervescent powder uses pluchea leaf (*Pluchea*
347 *indica* Less) extract as natural antioxidant source. *Journal of Food and Agroindustry* 3(4), 1412-
348 1422. [\(In Bahasa\)](#)
349

350 Khasanah, V. and Astuti, P. (2019). Effect of addition of Moringa leaf extract (*Moringa oleifera*)
351 on sensory quality and protein content of wet noodles substituted with modified cassava flour.
352 *Journal of Technical Competence* 11(2), 15-21. [\(In Bahasa\)](#)
353

354 Kennedy, D.O. and Wightman, E.L. (2011). Herbal extracts and phytochemicals: plant secondary
355 metabolites and the enhancement of human brain function. *Advances in Nutrition* 2, 32-50.
356

357 Koirewoa, Y.A., Fatimawali and Wiyono, W.I. (2012). Isolation and identification flavonoid
358 compounds in pluchea leaf (*Pluchea indica* L.). *Pharmacon* 1(1), 47-52. [\(In Bahasa\)](#)
359

360 Lakshmanashetty, R.H., Nagaraj, V.B., Hiremath, M.G. and Kumar V. (2010). In vitro antioxidant
361 activity of *Vitex negundo* L. leaf extracts. *Chiang Mai Journal of Science* 37(3), 489-497.
362

363 Li, M., Zhu, K.X., Guo, X.N., Brijs, K. dan Zhou, H.M. (2014). Natural additives in wheat-based
364 pasta and noodle products: opportunities for enhanced nutritional and functional properties.
365 *Comprehensive Reviews in Food Science and Food Safety* 13, 347-357.
366

367 Li, Y., Ma, D., Sun, D., Wang, C., Zhang, J., Xie, Y. dan Guo, T. (2015). Total phenolic, flavonoid
368 content, and antioxidant activity of flour, noodles, and steamed bread made from different colored
369 wheat grains by three milling methods. *The Crop Journal* 3(4), 328-334.
370

371 Nuraida, L., Andarwulan, N., Sukmawati, M. and Yohana, E. (2008). Application of herbs and
372 spices extracts as preservatives for wet noodles. Investing in Food Quality, Safety and Nutrition.
373 International Conference Proceeding Investing in Food Quality, Safety & Nutrition: Lessons
374 Learned from Current Food Crisis Jakarta, October 27--28, 2008.
375

376 Magatra, P. (2013). Antioxidant activity, total phenolic content, and organoleptic test in tempe
377 with marsh fleabane leaf extract (*Pluchea indica* L.). Indonesia: Satya Wacana Christian
378 University, Bachelor. Final Project. [\(In Bahasa\)-](#)
379

380 Mahasuari, N.P.S., Paramita, N.L.P.V. and Putra, A.A.G.R.Y. (2020). Effect of methanol
381 concentration as a solvent on total phenolic and flavonoid content of pluchea leaf extract (*Pluchea*
382 *indica* L.). *Journal of Pharmaceutical Science and Application* 2(2), 77-84.
383

384 Marsono, Y. (2008). Functional food development prospects. *Journal of Food Technology and*
385 *Nutrition* 7(1), 19-27. [\(In Bahasa\)-](#)
386

387 Nithya, D.J., Bosco, K.A.S., Jagan Mohan, R. and Alagusundaram, K. (2013). Antioxidant activity
388 of rice bran pasta. *Journal of Microbiology, Biotechnology and Food Sciences* 2(6), 2423-2425.
389

390 Norlaili, A.H., Roselina, K. and Muhammad, T.S. (2014). Effect of *Cosmos caudatus* Kunth.
391 (Ulam Raja) aqueous and dry extracts on the physicochemical and functional properties, and
392 sensory acceptability of Herbal Yellow Alkaline Noodles. *Malaysian Journal of Nutrition* 20(3),
393 403-415.
394

395 Pengelly, A. (2004). *The Constituents of Medicinal Plants: An Introduction to the Chemistry and*
396 *Therapeutics of Herbal Medicines*, 2nd ed. Australia: CABI Publishing.
397

398 Pokorny, J., Yanishlieva, N. and Gordon, M. (2001). *Antioxidants in Food: Practical Applications*.
399 Cambridge: Woodhead Publishing Ltd.
400

401 Saikia, S. and Mahanta, C.L. (2013). Effect of steaming, boiling and microwave cooking on the
402 total phenolics, flavonoids and antioxidant properties of different vegetables of Assam, India.
403 *International Journal of Food and Nutritional Sciences* 2(3), 47-53.
404

405 Sari, E.T. (2014). Factors influencing consumption of functional food in Surabaya. *Scientific*
406 *Journal of Commerce Administration* 12(2), 1-10. [\(In Bahasa\)-](#)
407

408 Shamim, M.Z., Verma, A., Sheikh, S. and Singh, S. (2016). Sensory evaluation of nutritious herbal
409 noodles developed by utilization of *Aegle marmelos* leaves powder. *IMPACT: International*
410 *Journal of Research in Applied, Natural and Social Sciences* 4(4), 109-114.
411

412 Stojanovic, Z., Filipovic, J. and Mugosa, B. (2013). Consumer acceptance of functional foods in
413 Montenegro. *Montenegrin Journal of Economics* 9(3), 65-74.
414

415 Sulaiman, C.T. and Balachandran, I. (2012). Total phenolics and total flavonoids in selected Indian
416 medical plants. *Indian Journal of Pharmaceutical Sciences* 74(3), 258-260.
417

418 Suter, I.K. (2013). Functional foods and their development prospects. Retrieved on February 15,
419 2021 from Udayana University Repository Website:
420 [https://repositori.unud.ac.id/protected/storage/upload/repositori/ID3_1950123119760210032309](https://repositori.unud.ac.id/protected/storage/upload/repositori/ID3_19501231197602100323091304927makalah-gizi.pdf)
421 [1304927makalah-gizi.pdf](https://repositori.unud.ac.id/protected/storage/upload/repositori/ID3_19501231197602100323091304927makalah-gizi.pdf) (In Bahasa).
422

423 Syahirah, J. and Rabeta, M.S. (2018). Antioxidant and antimicrobial activity of lemuni noodle.
424 *Food Research* 3(1), 7-13.
425

426 Tiwari, B.K., Valdramidis, V.P., Donnell, C.P.O., Muthukumarappan, K., Bourke, P. and Cullen,
427 P.J. (2009). Application of natural antimicrobials or food preservation. *Journal of Agricultural and*
428 *Food Chemistry* 57(14), 5987-6000.
429

430 Ullah, Z., Ullah, R., Shah, A.H.A., Ahmad, I. and Haider, S. (2012). Phytochemical and biological
431 evaluation of *Vitex negundo* Linn: a review. *International Journal of Pharmaceutical Sciences and*
432 *Research* 3(8), 2421-2431.
433

434 Vichapong, J., Sookserm, M., Srijesdaruk, V., Swatsitang, P. and Srijaranai, S. (2010). High
435 performance liquid chromatographic analysis of phenolic compounds and their antioxidant
436 activities in rice varieties. *LWT-Food Science and Technology* 43, 1325-1330.
437

438 Wibisono, D.A.S. (2021). Effect of concentration of pluchea (*Pluchea indica* (L.) Less) leaves
439 powder in steeping water on total flavonoids and iron ion reducing power of wet noodle. Indonesia:
440 Widya Mandala Surabaya Catholic University, Bachelor. Final Project. (In Bahasa).
441

442 Widyawati, P.S., Budianta, T.D.W., Gunawan, D.I. and Wongso, R.S. (2015). Evaluation
443 antidiabetic activity of various leaf extracts of *Pluchea indica* Less. *International Journal of*
444 *Pharmacognosy and Phytochemical Research* 7(3), 597-603.
445

446 Widyawati, P.S., Budianta, T.D.W., Kusuma, F.A. and Wijaya, E.L. (2014). Difference of solvent
447 polarity to phytochemical content and antioxidant activity of *Pluchea indica* Less leaves extracts.
448 *International Journal of Pharmacognosy and Phytochemical Research* 6(4), 850-855.
449

450 Widyawati, P.S., Ristiarini, S., Werdani, Y.D.W., Kuswardani, I. and Herwina, I. N. (2019).
451 Physicochemical and organoleptic properties changes of soymilk with pluchea brewing water
452 addition. *Journal of Food Technology and Nutrition* 18(2), 98-111. (In Bahasa).
453

454 Widyawati, P.S., Suteja, A.M., Suseno, T.I.P., Monika, P., Saputrajaya, W. and Liguori, C. (2014).
455 Effect of pigment color difference in organic rice on antioxidant activity. *Agritech* 34(4), 399-406.
456 (In Bahasa).
457

458 Widyawati, P.S., Werdani, Y.D.W., Setiokusumo, C. and Kartikasari, A. (2017). In vitro
459 antioxidant capacities and antidiabetic properties of **pluchea** leaves and green tea mixtures at
460 various proportions. *International Journal of Pharmacy and Pharmaceutical Sciences* 9(8), 203-
461 208.

462

463 Wijaya, J.P. (2019). Effect of concentration of mixture of **pluchea** (*Pluchea indica* L.) leaves
464 powder – green tea (*Camellia sinensis* L.) 1:1 (b/b) in steeping water on antioxidant activity of
465 jelly drink. Indonesia: Widya Mandala Surabaya Catholic University, Bachelor. Final Project. [↵](#)
466 [Bahasa](#).

467

468 **Zou, S., Wang, L., Wang, A., Zhang, Q., Li, Z., and Qiu, J. (2021). Effect of moisture distribution**
469 **changes induced by different cooking temperature on cooking quality and texture properties of**
470 **noodles made from whole tartary buckwheat. *Foods* 10(2543),1-12.**

471

472 Table 1. The use of Pluchea leaves in food product

Type of food product	Pluchea leaf form	Stages of use	References
Tempeh	Pluchea leaf water extract	Soak soybeans before adding tempeh yeast	Magatra, 2013
Pluchea -black tea salted egg	Pluchea leaf flour	Mixed in salt solution for the ripening stage	Adventi et al., 2015
Effervescent powder	Water extract (infusion) and ethanol extract (maceration)	Evaporated and mixed according to the formulation	Hudha and Widyaningsih, 2015
Dry method salted egg	Fresh pluchea leaves	Added to pasta dough to coat eggs	Firdausi, 2017
Bun	Pluchea leaf powder steeping water	Added during dough making	Chiang, 2018
Soy milk	Pluchea leaf powder steeping water	Added to soy milk	Widyawati et al., 2019
Pluchea- green tea jelly drink	Pluchea leaf powder	Brewed with green tea powder	Wijaya, 2019
Wet noodles	Pluchea leaf powder steeping water	Added during dough making	Wibisono, 2021

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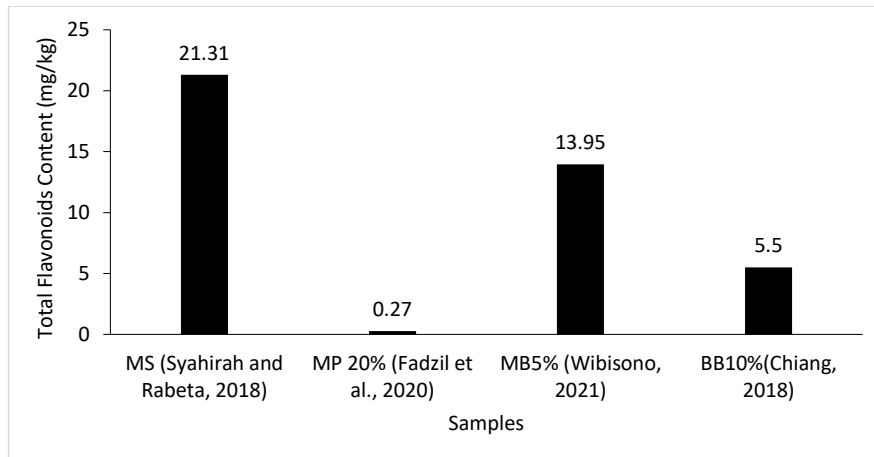
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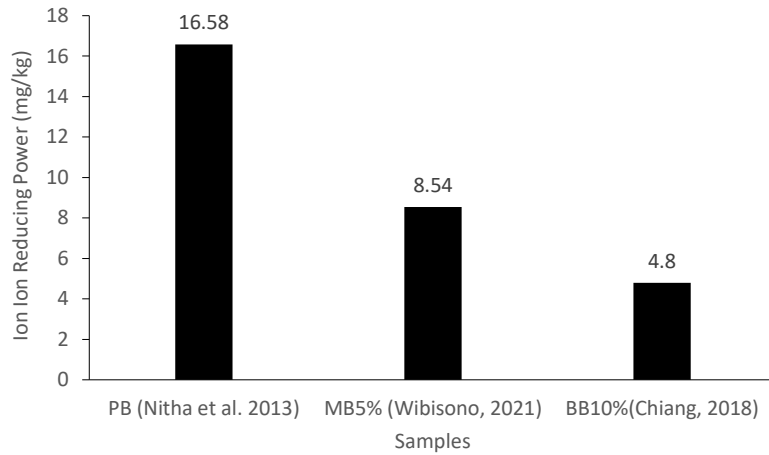
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 481 Figure 1. Total flavonoid content (TFC) of pluchea wet noodles 5% (MB_5%) compared to sidondo
 482 wet noodles (MS), pegagan wet noodles 60% (MP_60%), and pluchea bun 10% (BB_10%). The
 483 TFC of sidondo and pegagan wet noodles were respectively expressed in terms of quercetin
 484 equivalent per weight of wet noodles and rutin equivalent per weight of wet noodles extract, while
 485 the TFC of pluchea noodles and pluchea bun were expressed in terms of catechin equivalents per
 486 dried weight of freeze-dried results. TFC of MP_20%, MB_5%, and BB_10% were expressed by
 487 the values that have been subtracted with the TFC of control from each study.

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498 Figure 2. Iron ion reducing power (RP) of pluchea wet noodles 5% (MB_5%) compared to rice
499 flour paste (PB) and pluchea bun 10% (BB_10%). RP value of rice flour paste was stated to be
500 equivalent to BHT per weight of pasta, while the RP value of pluchea wet noodles and pluchea
501 bun was expressed in gallic acid equivalent per dried weight of freeze-dried results. Iron ion
502 reducing power of MB_5% and BB_10% are expressed by the value that has been reduced by the
503 RP value of control from each study.



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Dear Paini Sri Widyawati,

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6. Third Revision: Final Revision (4-6-2022)
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1 **Potency of pluchea (*Pluchea indica* Less) leaves to increase functional value of wet noodles:**
2 **a review**

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9 **Abstract**

10 Wet noodles are lack of functional nutrients that are beneficial for health, thus it is
11 necessary to add other food ingredients that can increase the functional value of wet noodles. One
12 of the food ingredients that can be added in wet noodles formulation is *Pluchea indica* Less leaves,
13 which have been known as a source of antioxidants and used by the community as a traditional
14 medicine to treat various health problems. The use of *Pluchea indica* Less leaves in making wet
15 noodles is expected to increase the functional value of wet noodles. For this reason, this review
16 paper discussed the potency of *Pluchea indica* Less leaves in affecting the phytochemical
17 compounds content and functional properties of wet noodles. The use of *Pluchea indica* Less
18 leaves showed potential to increase the phytochemical compounds contents of wet noodles, such
19 as alkaloids, flavonoids, phenolics, saponins, tannins, and cardiac glycosides, which play an
20 important role in the health of human body and maintaining the quality of wet noodles, such as
21 antioxidant, anti-warmed over flavor, anti-inflammatory, antidiabetic, and antimicrobial activities.
22 Thus, the addition of pluchea leaves has potential to increase the functional value of wet noodles
23 including the phytochemical content and functional properties.

24 **Keywords:** *Pluchea indica* Less, Wet noodles, Functional value

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27
28 **1. Introduction**

29 Noodles as one of the wheat flour-based product are quiet popular among various levels of
30 society in Indonesia. Noodles can be classified into five forms based on processing stage and water
31 content of the noodles product, including raw noodles, wet noodles, dry noodles, fried noodles,
32 and instant noodles. Wet noodles have water content of about 50-52% (Nuraida *et al.*, 2009),
33 52.10-52.85% (Billina *et al.*, 2014) 58-70% (Zhou *et al.*, 2021), and is produced through the
34 cooking stage of raw noodles before being marketed (Billina *et al.*, 2014). According to Nuraida
35 *et al.* (2009), the high moisture content of wet noodles causes the shelf life of wet noodles to only
36 reach 42 hours at room temperature storage.

37 Increased awareness and interest in functional food supports the development of various
38 food products with high functional value (Essa *et al.*, 2021). The functional value of a food product
39 depends on the nutrients contained in the food ingredients that make up the food product. The raw
40 materials of noodles generally include wheat flour, eggs, and water. However, noodles are known
41 to be low in functional nutrients that are beneficial to health (Akbar, 2018; Khasanah and Astuti,
42 2019). Therefore, various efforts have been made to overcome the shortcomings of wet noodles.
43 Increasing the functional value of wet noodles can be done by adding other food ingredients that
44 contain bioactive compounds, one of which is the addition of pluchea leaves.

45 Pluchea (*Pluchea indica* Less) is an herbaceous plant that contains phytochemical
46 compounds, including alkaloids, saponins, tannins, phenol hydroquinone, flavonoids, cardiac

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glycosides, and sterols, that act as sources of natural antioxidants (Widyawati *et al.*, 2015). In addition, pluchea leaves also have antimicrobial activity that has the potency to prevent food damage (Ardiansyah *et al.*, 2003). The use of pluchea leaves in the manufacture of wet noodles is expected to produce wet noodles that are able to provide antioxidant effects that are good for health, and have an impact on increasing the shelf life of the wet noodle's product.

Currently, the use of pluchea leaves is only limited to fresh vegetables and drinks, but there have been many studies on the use of pluchea leaves in the food sector that continue to be developed, including making tempeh with pluchea leaf extract (Magatra, 2013), pluchea-black tea salted eggs (Adventi *et al.*, 2015), effervescent powder based on pluchea leaf extract (Hudha and Widyarningsih, 2015), pluchea bun products (Chiang, 2018), pluchea soy milk (Widyawati *et al.*, 2019), pluchea-green tea jelly drink (Wijaya, 2019), and pluchea wet noodles (Wibisono, 2021). The use of pluchea leaves in the manufacture of wet noodles was studied further as an effort to develop functional food products that were beneficial to the health of the consumer's body.

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62 **2. Pluchea leaves as functional supplement**

Several factors such as individual education, household standards and level of knowledge about food products with health claims, as well as perceptions of some existing functional food product attributes affect the development of public interest in functional food products (Stojanovic *et al.*, 2013; Sari, 2014). Marsono (2008) also declared that increasing awareness of the importance of food in preventing or curing disease, consumer demands for foods with more properties (containing functional ingredients), experiences with alternative medicines, and studies on the prevalence of certain diseases that are influenced by diet have also become the basis for the rapid development of functional food products in various countries.

Functional food is defined as a food product that is able to provide benefits to the health of the body, one of which is through the presence of bioactive components contained in a functional food product (Suter, 2013; Essa *et al.*, 2021). According to Essa *et al.* (2021), there are five categories of functional food, i.e. foodstuffs with a reduction or increase in the basic nutritional content, products that naturally do not have certain nutrients and are added to them, milk-based products fermented with probiotics, products that are specially formulated to fulfill certain needs, and foodstuffs containing herbal ingredients to help overcome various health problems.

Herbal plants are a source of functional food, i.e. a source of natural antioxidants that can be used in the food sector to improve the functional properties of processed food products, one of which is the use of herbal plants to increase the content of bioactive components in wheat flour-based products such as noodles. According to Fadzil *et al.* (2020), noodles are known to be low in nutritional components that are beneficial to health, while noodles with functional properties such as high antioxidants are in high demand at this time.

84

85 *2.1 Utilization of pluchea leaves in making wet noodles*

The main ingredients in making noodles are generally wheat flour, eggs, water, and other additives as needed, making the noodles products only contain carbohydrates, proteins, fats, and minerals. The content of carbohydrates, several minerals, and energy in noodles are very high, but the content of protein, fat, and vitamins in noodles products are relatively low (Akbar, 2018; Khasanah and Astuti, 2019). Several studies have been carried out in an effort to improve the functional properties of noodles products, one of which is by using the leaves of plants that have been known as traditional medicines to be added to the manufacture of noodles, such as making

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93 herbal noodles with cosmos (*Cosmos caudatus* Kunth.) leaf extract (Norlaili *et al.*, 2014),
94 manufacture of herbal noodles with leaves of the Indian bael plant (*Aegle marmelos*) (Shamim *et*
95 *al.*, 2016), manufacture of sidondo (*Vitex negundo* Linn.) noodles (Syahirah and Rabeta, 2018),
96 addition of moringa (*Moringa oleifera*) leaf extract to wet noodles (Khasanah and Astuti, 2019),
97 making herbal noodles with pegagan (*Centella asiatica*) extract (Fadzil *et al.*, 2020), and using
98 pluchea (*Pluchea indica* Less) leaf powder steeped water to make pluchea wet noodles (Wibisono,
99 2021).

100 The content and activity of phytochemical compounds in pluchea leaves, both in the form
101 of fresh leaves and water steeped in powdered pluchea leaves have been identified. Pluchea is
102 classified as plant that has high polyphenol content and relatively large antioxidant capacity
103 compared to other herbaceous plants (Andarwulan *et al.*, 2010; Andarwulan *et al.*, 2012). Research
104 conducted by Widyawati *et al.* (2016) showed that the phytochemical compounds contained in the
105 brewed water of pluchea leaf powder include alkaloids, flavonoids, phenolics, saponins, tannins,
106 and cardiac glycosides. According to Pengilly (2004), each phytochemical compound has
107 physiological effects including alkaloids as analgesic, mydriatic, miotic, hypertensive,
108 hypotensive, bronchodilator, stimulant, antimicrobial, and antileukemic, flavonoids as antioxidant,
109 antiviral, hepatoprotective, antiatheromatous, anti-inflammatory, and antihypertensive, phenolic
110 as antioxidant, antimicrobial, anti-inflammatory, antiplatelet, and antiallergic, saponins as
111 anticancer, anti-inflammatory, immunomodulatory, antihepatotoxic, and antidiabetic, tannins as
112 antioxidant, antitumor, antihemorrhagic, and antiatherogenic, as well as cardiac glycosides that
113 can increase strength and speed of systolic contraction. Flavonoids are one of the important
114 constituents that can provide real benefits for the health of the human body.

115 The use of pluchea leaves in food products continues to be developed through various
116 studies as shown in Table 1. Using pluchea leaves in many food products (tempeh, beverage, salted
117 egg, bun, jelly drink, and soymilk) to increase their functional value can be added in the form of
118 extract, powder/flour, or fresh with different stages of processing each food product. However,
119 the use of pluchea leaves to increase the functional value of wheat flour-based food products has
120 not been widely studied. So far the research that has been carried out regarding the use of pluchea
121 leaves in the formulation of wheat flour-based food products is in the manufacture of pluchea bun
122 (Chiang, 2018) and pluchea wet noodles (Wibisono, 2021), both of which use pluchea leaf powder
123 steeping water which is added to the product formulation.

124

125 2.2 The effect of pluchea leaves on the content of phytochemical compounds of wet noodles

126 The largest group of phytochemical compounds in plants includes alkaloids, terpenes, and
127 phenolic compounds. Phenolic compounds are a group of phytochemical compounds that are
128 widely distributed in various plants, where this group of compounds can be used as the main source
129 of natural antioxidants and are able to act as antimicrobial, anticarcinogenic, and other biological
130 activities (Kennedy and Wightman, 2011; Aziman *et al.*, 2012). Pluchea leaves contain phenolic
131 compounds in the form of flavonoids, 1,3,4,5-tetra-O-cafeoilquinic acid, 3,4,5-tri-O-cafeoilquinic
132 acid, chlorogenic acid, and ferulic acid (Mahasuari *et al.*, 2020).

133 Flavonoids as secondary metabolites as well as the main and largest compounds in the
134 group of phenolic compounds are commonly found in plant tissues in free form or glycosides
135 (Aberoumand and Deokule, 2008; Sulaiman and Balachandran, 2012; Agbo *et al.*, 2015). In plants,
136 flavonoids are found in the form of flavonoid glycosides, flavonols, flavan-3-ol, flavones,
137 flavanones, chalcones, anthocyanins, and proanthocyanidins (Dehkharghanian *et al.*, 2010;
138 Vichapong *et al.*, 2010; Chen, 2013). Flavonoids act as antioxidants by chelating metals and

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139 donating hydrogen atoms, thus provide certain physiological effects on the human body
140 (Erlidawati *et al.*, 2018). This has become one of the basis for the use of herbal plants for traditional
141 medicine and supports various functional food product innovations such as pluchea wet noodles.

142 Research by Wibisono (2021) showed that the use of pluchea leaf powder steeped water
143 was able to contribute in increasing the content of phytochemical compounds (especially
144 flavonoids) in wet noodles, that the lowest (5%) and the highest (30%) concentration of pluchea
145 leaf powder in steeping water were able to increase the total flavonoid content (TFC) of wet
146 noodles as much as 1.43 times and 4.07 times compared to the control wet noodles (without the
147 use of pluchea leaf powder steeping water), respectively. The potential use of pluchea leaves in
148 the manufacture of wet noodles can be seen by comparing the TFC of pluchea wet noodles in
149 Wibisono's study (2021) with other herbal noodles and pluchea bun as another form of wheat flour-
150 based product. Comparison of the total flavonoids of pluchea wet noodles with sidondo wet
151 noodles, pegagan wet noodles, and pluchea bun from existing studies can be seen in Figure 1.

152 The group of flavonoids found in pluchea leaves are flavonols and flavones, including
153 quercetin, myrisetin, kaempferol, apigenin, luteolin, and chrysoeriol (Andarwulan *et al.*, 2010;
154 Andarwulan *et al.*, 2012; Koirewoa *et al.*, 2012; Mahasuari *et al.*, 2020), sidondo flavonoids
155 consist of castikin, orientin, isoorientin, luteolin, lutekin-7-O-glucoside, corimbosin, gardenins A
156 and B, 3-O-desmethylartemethin, 5-O-desmethylnobiletin, and 3',4',5,5',6,7,8-
157 heptamethoxyflavones (Lakshmanashetty *et al.*, 2010; Ullah *et al.*, 2012), while the flavonoids of
158 pegagan include quercetin, myrisetin, and kaempferol (Andarwulan *et al.*, 2010; Andarwulan *et al.*,
159 *et al.*, 2012). The TFC value of wet noodles with the addition of 5% concentration of pluchea leaf
160 powder in steeping water was greater than the TFC of wet noodles with the addition of 20%
161 pegagan extract, but the TFC of pluchea wet noodles 5% was lower than the TFC of sidondo wet
162 noodles which used 0.66% sidondo leaf powder from the total weight of the noodles ingredients.
163 Based on this comparison, it can be indicated that the use of pluchea leaf powder steeping water
164 with a concentration of 5% can increase the flavonoids content of wet noodles far exceeding the
165 flavonoids content that can be given by 20% pegagan extract solution in wet noodles (total
166 flavonoids of pluchea wet noodles 5% is 51.67 times compared to pegagan noodles 20%). The
167 total flavonoids of the pluchea wet noodles 5% is 1.53 times lower than the total flavonoids of
168 sidondo wet noodles. The flavonoids content of sidondo wet noodles which was higher than
169 pluchea wet noodles 5% could be caused by the addition of sidondo leaf powder directly to the
170 making of wet noodles dough in Syahirah and Rabeta's research (2018), while pluchea wet noodles
171 dough in Wibisono's study (2021) was made with using pluchea leaf powder steeping water in the
172 formulation of wet noodles. In addition, several factors such as differences in formulation,
173 sequence of processing and analysis stages, as well as stated standards and product sample forms
174 analyzed in each study also affect the difference in TFC values compared between types of herbal
175 wet noodles.

176 The TFC of wet noodles with the addition of 5% concentration of pluchea leaf powder in
177 steeping water was higher than the TFC of bun with the addition of 10% concentration of pluchea
178 leaf powder in steeping water. This shows that the flavonoids content of pluchea wet noodles is
179 higher than the flavonoids content of pluchea bun even though the concentration of pluchea leaf
180 powder in steeping water in the manufacture of pluchea wet noodles is lower than the concentration
181 of pluchea leaf powder in steeping water in the manufacture of pluchea bun (the TFC of pluchea
182 wet noodles 5% is 2.54 times compared to pluchea bun 10%). According to Li *et al.* (2015),
183 antioxidant compounds, one of which is flavonoids, are easily degraded in the heating process, and
184 are lost during the process of mixing and kneading the dough. The degradation of flavonoids during

185 heating and the extraction of glycosides by water vapor can be the cause of the low TFC value of
186 pluchea bun. On the other hand, a study conducted by Saikia and Mahanta (2013) showed that the
187 high flavonoids content can be caused by breaking the glycosidic bond of flavonoids with sugar
188 by heating treatment. The wet noodles cooking process is thought to have an effect on breaking
189 the glycosidic bond so that aglycones are formed which can improve the detection results of
190 flavonoids compounds in the analysis. Various factors can affect the TFC value in different food
191 products, including differences in ingredient formulations, specifications of the methods used, and
192 the stages of the process in the manufacture of food products.

193 The TFC of pluchea wet noodles 5% showed that pluchea leaves have the potency to
194 increase the content of phytochemical compounds (in this case flavonoids) in wet noodles as a
195 wheat flour-based food product. Wibisono (2021) also mentioned that the use of higher
196 concentration of pluchea leaf powder in steeping water in the formulation of wet noodles is able
197 to provide a significant increase in the TFC of wet noodles. There has been no research on the
198 effect of adding pluchea leaf powder steeping water on the type and amount of phytochemical
199 compounds other than flavonoids in pluchea wet noodles products, so the use of pluchea leaves in
200 the manufacture of wet noodles still needs to be developed and further investigated its effect on
201 the phytochemical component content of wet noodles.

202

203 2.3 *The effect of pluchea leaves on the functional properties of wet noodles*

204 The functional properties of functional food products mainly focus on the ability of
205 bioactive components in food products to help maintain the health of the human body. One of the
206 properties possessed by bioactive components is that they can act as antioxidants. Carotenoids,
207 flavonoids, and phenolic compounds are classified as natural antioxidants that can be found in
208 various foodstuffs (Marsono, 2008). Antioxidant activity can be in the form of DPPH free radical
209 scavenging ability, iron ion reducing power, reactive oxygen species scavenging activity, and β -
210 carotene-linoleic acid system inhibitory activity (Widyawati *et al.*, 2017).

211 Iron ion reducing power (RP) is one of the parameters of antioxidant potential which is
212 measured as secondary antioxidant activity based on the ability of antioxidant compounds to
213 reduce Fe^{3+} to Fe^{2+} . Secondary antioxidants play a role in the mechanism of binding metal ions,
214 scavenging oxygen, converting hydrogen peroxide into non-radical compounds, absorbing UV
215 radiation, or deactivating singlet oxygen (Pokorny *et al.*, 2001). According to Widyawati *et al.*
216 (2014), iron ion is one of the pro-oxidants that have the potency to generate new free radicals.
217 Antioxidant components are able to neutralize iron ions by acting as a substrate that will be
218 oxidized first. Based on the research of Wibisono (2021), the use of the lowest (5%) and the highest
219 (30%) concentration of pluchea leaf powder were able to increase the RP value of wet noodles by
220 1.33 times and 3.27 times compared to control wet noodles, respectively. The potency of pluchea
221 leaves in increasing the antioxidant activity of wet noodles products can be described by
222 comparing the RP value of pluchea wet noodles with other products such as rice flour paste and
223 pluchea bun. The comparison of secondary antioxidant activity in the form of the iron ion reducing
224 power of pluchea wet noodles with rice flour paste and pluchea bun can be seen in Figure 2.

225 Pluchea wet noodles 5% in the Wibisono's study (2021) had the RP value 1.78 times higher
226 than the RP value of pluchea bun 10% in Chiang's research (2018), but 1.94 times lower than the
227 RP value of paste made from rice flour in the research of Nithya *et al.* (2013). The RP value
228 indicates that the use of pluchea leaf powder steeping water with 5% concentration of pluchea leaf
229 powder in steeping water has potency to provide greater secondary antioxidant activity in wet
230 noodles than in bun products. The TFC of pluchea wet noodles 5% which is greater than the TFC

231 of pluchea bun 10%, as shown in Figure 1., can contribute to the large iron ion reducing power of
232 pluchea wet noodles 5% and pluchea bun 10%, that the phenolic group compounds, one of which
233 is flavonoids, capable of donating hydrogen atoms/electrons so that they can reduce iron ions
234 (Widyawati *et al.*, 2014). The flavonoids content of pluchea wet noodles which is higher than the
235 flavonoids content of pluchea bun, can cause the iron ion reducing power of wet noodles is higher
236 compared to pluchea bun.

237 RP value of pluchea wet noodles 5% which is lower than the RP value of rice flour paste
238 can be due to the use of different types of raw materials (related to the number and types of
239 bioactive components in the ingredients) and the shape of the product samples analyzed in each
240 study. Based on the research of Widyawati *et al.* (2014), white rice has total phenolic content
241 (TPC) of 4.12 ± 0.05 mg gallic acid equivalent/g dry basis which is greater than the TPC of pluchea
242 leaves in the study of Andarwulan *et al.* (2010), which was 0.831 ± 0.129 mg gallic acid
243 equivalent/g fresh leaf weight. According to Wibisono (2021), the iron ion reducing power of
244 pluchea wet noodles can be increased by using higher concentration of pluchea leaf powder in
245 steeping water in the formulation of wet noodles.

246 RP value of pluchea wet noodles 5% shows the potency of pluchea leaves to increase the
247 antioxidant activity of wet noodles products as an effort to increase the functional value of wheat
248 flour-based food products such as wet noodles. The effect of adding pluchea leaf powder steeping
249 water on the antioxidant activity of pluchea wet noodles using a type of analysis other than the
250 iron ion reducing power has not been studied further, so it is necessary to measure other antioxidant
251 parameters to support the potency of pluchea leaves in making wet noodles.

252 Research on the potency of pluchea leaves in improving the functional properties of wet
253 noodles is still limited to being studied on product antioxidants, while pluchea leaves have been
254 known to have various other functional properties that are beneficial to health and are able to
255 maintain the quality of food products. Several other functional properties that have the potency to
256 be provided by pluchea leaves in food products include activities as anti-warmed-over flavor, anti-
257 inflammatory, antidiabetic (Widyawati *et al.*, 2017), and antimicrobial properties that have the
258 potency to prevent food spoilage (Ardiansyah *et al.*, 2003). This ability is inseparable from the
259 presence of bioactive compounds in pluchea leaves which have the capacity as antioxidant and
260 antihyperglycemic agents (Widyawati *et al.*, 2014; Widyawati *et al.*, 2015). According to Li *et al.*
261 (2014), herbal plant extracts are potential preservatives that are currently being developed to be
262 applied to bread, pasta, and noodles products due to the presence of phenolic components that have
263 high antimicrobial activity. Tiwari *et al.* (2009) also proved that the antimicrobial activity of
264 phenolic compounds is related to the ability of phenolics to affect the permeability of microbial
265 cells which causes the release of important macromolecules from the microbial cell, as well as the
266 ability of phenolics to interact with membrane proteins that cause deformation of the structure and
267 function of microbial cell membranes.

268 3. Conclusion

270 Pluchea (*Pluchea indica* Less) leaves have the potency to increase the functional value of
271 wet noodles in terms of the phytochemical content and functional properties of the wet noodles.
272 The use of pluchea leaves increases the content of phytochemical compounds, in this case
273 flavonoids, in wet noodles. The increase in the content of phytochemical compounds with the use
274 of pluchea leaves affects the increase in the functional properties of wet noodles products,
275 especially antioxidant activity in the form of the iron ion reducing power of wet noodles.
276

277 **Conflict of interest**

278 The authors declare no conflict of interest.

279

280

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284 **References**

285 Aberoumand, A. and Deokule, S.S. (2008). Comparison of phenolic compounds of some edible
286 plant of Iran and India. *Pakistan Journal of Nutrition*, 7(4), 582-585.

287

288 Adventi, B.S., Widyawati, P.S. and Utomo, A.R. (2015). Effect of salt concentration for
289 physicochemical and organoleptics salted egg pluchea (*Pluchea indica* Less)-black tea (*Camelia*
290 *sinensis*). *Journal of Food Technology and Nutrition*, 14(2), 55-60.

291

292 Agbo, M.O., Uzor, P.F., Akazie-Nneji, U.N., Eze-Odurukwe, C.U., Ogbatue, U.B. and Mbaaji,
293 E.C. (2015). Antioxidant, total phenolic and flavonoid content of selected Nigerian medical plants.
294 *Dhaka University Journal of Pharmaceutical Sciences* 14(1), 1-7.

295

296 Akbar, A. (2018). Physical, chemical and organoleptic analysis of wet noodle based on taro
297 (*Colocasia esculenta* L). *Agritepa*, 4(2), 159-170.

298

299 Andarwulan, N., Kurniasih, D., Apriady, R.A., Rahmat, H., Roto, A.V. and Bolling, B.W. (2012).
300 Polyphenols, carotenoids, and ascorbic acid in underutilized medicinal vegetables. *Journal of*
301 *Functional Foods*, 4, 339-347.

302

303 Andarwulan, N., Batari, R., Sandrasari, D.A., Bolling, B. and Wijaya, H. (2010). Flavonoid
304 content and antioxidant activity of vegetables from Indonesia. *Food Chemistry*, 121, 1231-1235.

305

306 Ardiansyah, Nuraida, L. and Andarwulan, N. (2003). Antimicrobial activity of pluchea (*Pluchea*
307 *indica* L.) leaves extract and stability of the activity at different salt concentrations and pHs.
308 *Journal of Food Technology and Industry*, 14(2), 90-97.

309

310 Aziman, N., Abdullah N., Noor, Z.M., Zulkifli, K.S. and Kamarudin, W.S.S.W. (2012).
311 Phytochemical constituents and in vitro bioactivity of ethanolic aromatic herb extracts. *Sains*
312 *Malaysiana*, 41(11), 1437-1444.

313

314 Billina, A., Waluyo, S. and Suhandy, D. (2014). Study of the physical properties of wet noodles
315 with addition of sea weed. *Lampung Agricultural Engineering Journal*, 4(2), 109-116.

316

317 Chen, X.G.Q. (2013). Identification and antioxidant capacity of anthocyanin pigment, and
318 expressional analysis of flavonoid biosynthetic genes in colored rice strains. Japan: University of
319 Hiroshima, PhD. Dissertation.

320

321 Chiang, I. (2018). The effect of pluchea leaves powder (*Pluchea indica* Less) in steeping water of
322 pao antioxidant activity. Indonesia: Widya Mandala Surabaya Catholic University, Bachelor. Final
323 Project.
324
325 Dehkharghanian, M., Adenier, H. and Vijayalakshmi, M.A. (2010). Study of flavonoids in aqueous
326 spinach extract using positive electrospray ionisation tandem quadrupole mass spectrometry. *Food*
327 *Chemistry*, 121, 863-870.
328
329 Erlidawati, Safrida and Mukhlis. (2018). Antioxidant Potency as Antidiabetic. Banda Aceh: Syiah
330 Kuala University Press.
331
332 Essa, M.M., Bishir, M., Bhat, A., Chidambaram, S.B., Al-Balushi, B., Hamdan, H., Govindarajan,
333 N., Friedland, R.P. and Qoronfleh, M.W. (2021). Functional foods and their impact on health.
334 *Journal of Food Science and Technology*. <https://doi.org/10.1007/s13197-021-05193-3>.
335
336 Estiasih, T., Putri, W.D.R. and Waziroh, E. (2017). Tubers and Their Processing. Malang: UB
337 Press.
338
339 Fadzil, N.F., Bakar, M.F.A., Yusop, M.H.M. and Bakar, F.I.A. (2020). Sensorial and
340 physicochemical characteristics of herbal noodle enriched with *Centella asiatica*. *Food Research*,
341 4(4), 1030-1037.
342
343 Firdausi, M.H. (2017). Physicochemical and organoleptic quality of dry method salted eggs with
344 addition of pluchea leaves (*Pluchea indica* L). Indonesia: Brawijaya University, Bachelor. Final
345 Project.
346
347 Hudha, M. and Widyaningsih, T.D. (2015). The effervescent powder uses pluchea leaf (*Pluchea*
348 *indica* Less) extract as natural antioxidant source. *Journal of Food and Agroindustry*, 3(4), 1412-
349 1422.
350
351 Khasanah, V. and Astuti, P. (2019). Effect of addition of Moringa leaf extract (*Moringa oleifera*)
352 on sensory quality and protein content of wet noodles substituted with modified cassava flour.
353 *Journal of Technical Competence*, 11(2), 15-21.
354
355 Kennedy, D.O. and Wightman, E.L. (2011). Herbal extracts and phytochemicals: plant secondary
356 metabolites and the enhancement of human brain function. *Advances in Nutrition*, 2, 32-50.
357
358 Koirewoa, Y.A., Fatimawali and Wiyono, W.I. (2012). Isolation and identification flavonoid
359 compounds in pluchea leaf (*Pluchea indica* L.). *Pharmacon*, 1(1), 47-52.
360
361 Lakshmanashetty, R.H., Nagaraj, V.B., Hiremath, M.G. and Kumar V. (2010). *In vitro* antioxidant
362 activity of *Vitex negundo* L. leaf extracts. *Chiang Mai Journal of Science*, 37(3), 489-497.
363
364 Li, M., Zhu, K.X., Guo, X.N., Brijs, K. dan Zhou, H.M. (2014). Natural additives in wheat-based
365 pasta and noodle products: opportunities for enhanced nutritional and functional properties.
366 *Comprehensive Reviews in Food Science and Food Safety*, 13, 347-357.

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367
368 Li, Y., Ma, D., Sun, D., Wang, C., Zhang, J., Xie, Y. and Guo, T. (2015). Total phenolic, flavonoid
369 content, and antioxidant activity of flour, noodles, and steamed bread made from different colored
370 wheat grains by three milling methods. *The Crop Journal* 3(4), 328-334.
371
372 Nuraida, L., Andarwulan, N., Sukmawati, M. and Yohana, E. (2008). Application of herbs and
373 spices extracts as preservatives for wet noodles. Investing in Food Quality, Safety and Nutrition.
374 International Conference Proceeding Investing in Food Quality, Safety & Nutrition: Lessons
375 Learned from Current Food Crisis Jakarta, October 27-28, 2008.
376
377 Magatra, P. (2013). Antioxidant activity, total phenolic content, and organoleptic test in tempe
378 with marsh fleabane leaf extract (*Pluchea indica* L.). Indonesia: Satya Wacana Christian
379 University, Bachelor. Final Project.
380
381 Mahasuari, N.P.S., Paramita, N.L.P.V. and Putra, A.A.G.R.Y. (2020). Effect of methanol
382 concentration as a solvent on total phenolic and flavonoid content of pluchea leaf extract (*Pluchea*
383 *indica* L.). *Journal of Pharmaceutical Science and Application*, 2(2), 77-84.
384
385 Marsono, Y. (2008). Functional food development prospects. *Journal of Food Technology and*
386 *Nutrition* 7(1), 19-27.
387
388 Nithya, D.J., Bosco, K.A.S., Jagan Mohan, R. and Alagusundaram, K. (2013). Antioxidant activity
389 of rice bran pasta. *Journal of Microbiology, Biotechnology and Food Sciences*, 2(6), 2423-2425.
390
391 Norlaili, A.H., Roselina, K. and Muhammad, T.S. (2014). Effect of *Cosmos caudatus* Kunth.
392 (Ulam Raja) aqueous and dry extracts on the physicochemical and functional properties, and
393 sensory acceptability of Herbal Yellow Alkaline Noodles. *Malaysian Journal of Nutrition*, 20(3),
394 403-415.
395
396 Pengelly, A. (2004). The Constituents of Medicinal Plants: An Introduction to the Chemistry and
397 Therapeutics of Herbal Medicines, 2nd ed. Australia: CABI Publishing.
398
399 Pokorny, J., Yanishlieva, N. and Gordon, M. (2001). Antioxidants in Food: Practical Applications.
400 Cambridge: Woodhead Publishing Ltd.
401
402 Saikia, S. and Mahanta, C.L. (2013). Effect of steaming, boiling and microwave cooking on the
403 total phenolics, flavonoids and antioxidant properties of different vegetables of Assam, India.
404 *International Journal of Food and Nutritional Sciences*, 2(3), 47-53.
405
406 Sari, E.T. (2014). Factors influencing consumption of functional food in Surabaya. *Scientific*
407 *Journal of Commerce Administration*, 12(2), 1-10.
408
409 Shamim, M.Z., Verma, A., Sheikh, S. and Singh, S. (2016). Sensory evaluation of nutritious herbal
410 noodles developed by utilization of *Aegle marmelos* leaves powder. *IMPACT: International*
411 *Journal of Research in Applied, Natural and Social Sciences*, 4(4), 109-114.
412

413 Stojanovic, Z., Filipovic, J. and Mugosa, B. (2013). Consumer acceptance of functional foods in
414 Montenegro. *Montenegrin Journal of Economics*, 9(3), 65-74.
415

416 Sulaiman, C.T. and Balachandran, I. (2012). Total phenolics and total flavonoids in selected Indian
417 medical plants. *Indian Journal of Pharmaceutical Sciences*, 74(3), 258-260.
418

419 Suter, I.K. (2013). Functional foods and their development prospects. Retrieved on February 15,
420 2021 from Udayana University Repository Website:
421 [https://repositori.unud.ac.id/protected/storage/upload/repositori/ID3_1950123119760210032309](https://repositori.unud.ac.id/protected/storage/upload/repositori/ID3_19501231197602100323091304927makalah-gizi.pdf)
422 [1304927makalah-gizi.pdf](https://repositori.unud.ac.id/protected/storage/upload/repositori/ID3_19501231197602100323091304927makalah-gizi.pdf).
423

424 Syahirah, J. and Rabeta, M.S. (2018). Antioxidant and antimicrobial activity of lemuni noodle.
425 *Food Research*, 3(1), 7-13.
426

427 Tiwari, B.K., Valdramidis, V.P., Donnell, C.P.O., Muthukumarappan, K., Bourke, P. and Cullen,
428 P.J. (2009). Application of natural antimicrobials or food preservation. *Journal of Agricultural and*
429 *Food Chemistry*, 57(14), 5987-6000.
430

431 Ullah, Z., Ullah, R., Shah, A.H.A., Ahmad, I. and Haider, S. (2012). Phytochemical and biological
432 evaluation of *Vitex negundo* Linn: a review. *International Journal of Pharmaceutical Sciences and*
433 *Research*, 3(8), 2421-2431.
434

435 Vichapong, J., Sookserm, M., Srijesdaruk, V., Swatsitang, P. and Srijaranai, S. (2010). High
436 performance liquid chromatographic analysis of phenolic compounds and their antioxidant
437 activities in rice varieties. *LWT-Food Science and Technology*, 43, 1325-1330.
438

439 Wibisono, D.A.S. (2021). Effect of concentration of pluchea (*Pluchea indica* (L.) Less) leaves
440 powder in steeping water on total flavonoids and iron ion reducing power of wet noodle. Indonesia:
441 Widya Mandala Surabaya Catholic University, Bachelor. Final Project.
442

443 Widyawati, P.S., Budianta, T.D.W., Gunawan, D.I. and Wongso, R.S. (2015). Evaluation
444 antidiabetic activity of various leaf extracts of *Pluchea indica* Less. *International Journal of*
445 *Pharmacognosy and Phytochemical Research*, 7(3), 597-603.
446

447 Widyawati, P.S., Budianta, T.D.W., Kusuma, F.A. and Wijaya, E.L. (2014). Difference of solvent
448 polarity to phytochemical content and antioxidant activity of *Pluchea indica* Less leaves extracts.
449 *International Journal of Pharmacognosy and Phytochemical Research*, 6(4), 850-855.
450

451 Widyawati, P.S., Ristiarini, S., Werdani, Y.D.W., Kuswardani, I. and Herwina, I. N. (2019).
452 Physicochemical and organoleptic properties changes of soymilk with pluchea brewing water
453 addition. *Journal of Food Technology and Nutrition*, 18(2), 98-111.
454

455 Widyawati, P.S., Suteja, A.M., Suseno, T.I.P., Monika, P., Saputrajaya, W. and Liguori, C. (2014).
456 Effect of pigment color difference in organic rice on antioxidant activity. *Agritech*, 34(4), 399-
457 406.
458

459 Widyawati, P.S., Werdani, Y.D.W., Setiokusumo, C. and Kartikasari, A. (2017). In vitro
460 antioxidant capacities and antidiabetic properties of pluchea leaves and green tea mixtures at
461 various proportions. *International Journal of Pharmacy and Pharmaceutical Sciences*, 9(8), 203-
462 208.

463

464 Wijaya, J.P. (2019). Effect of concentration of mixture of pluchea (*Pluchea indica* L.) leaves
465 powder – green tea (*Camellia sinensis* L.) 1:1 (b/b) in steeping water on antioxidant activity of
466 jelly drink. Indonesia: Widya Mandala Surabaya Catholic University, Bachelor. Final Project.

467

468 Zou, S., Wang, L., Wang, A., Zhang, Q., Li, Z., and Qiu, J. (2021). Effect of moisture distribution
469 changes induced by different cooking temperature on cooking quality and texture properties of
470 noodles made from whole tartary buckwheat. *Foods*, 10(2543),1-12.

471

472 Table 1. The use of Pluchea leaves in food product

Type of food product	Pluchea leaf form	Stages of use	References
Tempeh	Pluchea leaf water extract	Soak soybeans before adding tempeh yeast	Magatra, 2013
Pluchea -black tea salted egg	Pluchea leaf flour	Mixed in salt solution for the ripening stage	Adventi <i>et al.</i> , 2015
Effervescent powder	Water extract (infusion) and ethanol extract (maceration)	Evaporated and mixed according to the formulation	Hudha and Widyaningsih, 2015
Dry method salted egg	Fresh pluchea leaves	Added to pasta dough to coat eggs	Firdausi, 2017
Bun	Pluchea leaf powder steeping water	Added during dough making	Chiang, 2018
Soy milk	Pluchea leaf powder steeping water	Added to soy milk	Widyawati <i>et al.</i> , 2019
Pluchea- green tea jelly drink	Pluchea leaf powder	Brewed with green tea powder	Wijaya, 2019
Wet noodles	Pluchea leaf powder steeping water	Added during dough making	Wibisono, 2021

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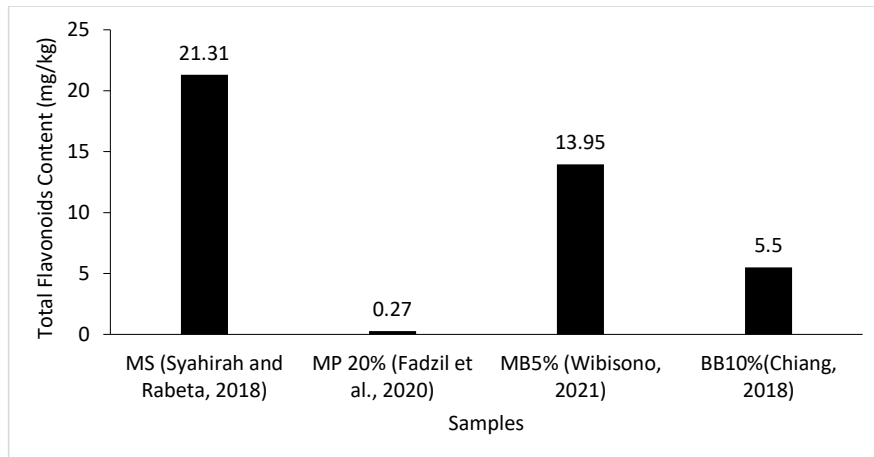
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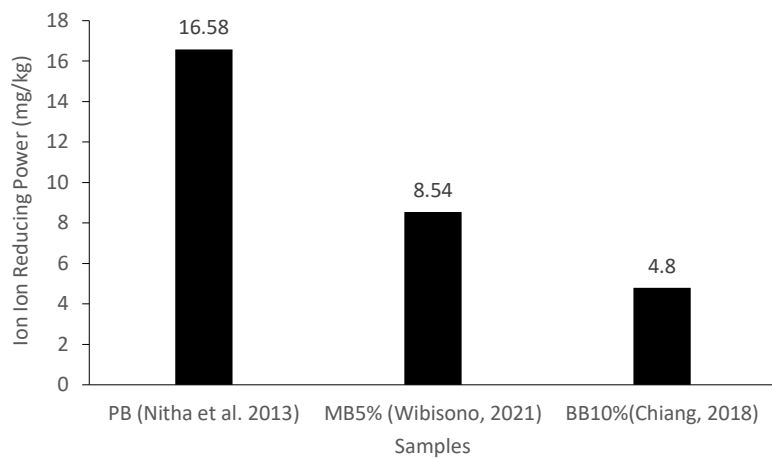


480
 481 **Figure 1.** Total flavonoid content (TFC) of pluchea wet noodles 5% (MB 5%) compared to sidondo
 482 wet noodles (MS), pegagan wet noodles 60% (MP 60%), and pluchea bun 10% (BB 10%). The
 483 TFC of sidondo and pegagan wet noodles were respectively expressed in terms of quercetin
 484 equivalent per weight of wet noodles and rutin equivalent per weight of wet noodles extract, while
 485 the TFC of pluchea noodles and pluchea bun were expressed in terms of catechin equivalents per
 486 dried weight of freeze-dried results. TFC of MP 20%, MB 5%, and BB 10% were expressed by
 487 the values that have been subtracted with the TFC of control from each study

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498 **Figure** 2. Iron ion reducing power (RP) of pluchea wet noodles 5% (MB 5%) compared to rice
499 flour paste (PB) and pluchea bun 10% (BB 10%). RP value of rice flour paste was stated to be
500 equivalent to BHT per weight of pasta, while the RP value of pluchea wet noodles and pluchea
501 bun was expressed in gallic acid equivalent per dried weight of freeze-dried results. Iron ion
502 reducing power of MB 5% and BB 10% are expressed by the value that has been reduced by the
503 RP value of control from each study

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1 **Potency of pluchea (*Pluchea indica* Less) leaves to increase functional value of wet noodles:**
2 **a review**

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9 **Abstract**

10 Wet noodles are lack of functional nutrients that are beneficial for health, thus it is
11 necessary to add other food ingredients that can increase the functional value of wet noodles. One
12 of the food ingredients that can be added in wet noodles formulation is *Pluchea indica* Less leaves,
13 which have been known as a source of antioxidants and used by the community as a traditional
14 medicine to treat various health problems. The use of *Pluchea indica* Less leaves in making wet
15 noodles is expected to increase the functional value of wet noodles. For this reason, this review
16 paper discussed the potency of *Pluchea indica* Less leaves in affecting the phytochemical
17 compounds content and functional properties of wet noodles. The use of *Pluchea indica* Less
18 leaves showed potential to increase the phytochemical compounds contents of wet noodles, such
19 as alkaloids, flavonoids, phenolics, saponins, tannins, and cardiac glycosides, which play an
20 important role in the health of human body and maintaining the quality of wet noodles, such as
21 antioxidant, anti-warmed over flavor, anti-inflammatory, antidiabetic, and antimicrobial activities.
22 Thus, the addition of pluchea leaves has potential to increase the functional value of wet noodles
23 including the phytochemical content and functional properties.

24 **Keywords:** *Pluchea indica* Less, Wet noodles, Functional value

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28 **1. Introduction**

29 Noodles as one of the wheat flour-based product are quiet popular among various levels of
30 society in Indonesia. Noodles can be classified into five forms based on processing stage and water
31 content of the noodles product, including raw noodles, wet noodles, dry noodles, fried noodles,
32 and instant noodles. Wet noodles have water content of about 50-52% (Nuraida *et al.*, 2009),
33 52.10-52.85% (Billina *et al.*, 2014) 58-70% (Zhou *et al.*, 2021), and is produced through the
34 cooking stage of raw noodles before being marketed (Billina *et al.*, 2014). According to Nuraida
35 *et al.* (2009), the high moisture content of wet noodles causes the shelf life of wet noodles to only
36 reach 42 hours at room temperature storage.

37 Increased awareness and interest in functional food supports the development of various
38 food products with high functional value (Essa *et al.*, 2021). The functional value of a food product
39 depends on the nutrients contained in the food ingredients that make up the food product. The raw
40 materials of noodles generally include wheat flour, eggs, and water. However, noodles are known
41 to be low in functional nutrients that are beneficial to health (Akbar, 2018; Khasanah and Astuti,
42 2019). Therefore, various efforts have been made to overcome the shortcomings of wet noodles.
43 Increasing the functional value of wet noodles can be done by adding other food ingredients that
44 contain bioactive compounds, one of which is the addition of pluchea leaves.

45 *Pluchea* (*Pluchea indica* Less) is an herbaceous plant that contains phytochemical
46 compounds, including alkaloids, saponins, tannins, phenol hydroquinone, flavonoids, cardiac

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glycosides, and sterols, that act as sources of natural antioxidants (Widyawati *et al.*, 2015). In addition, pluchea leaves also have antimicrobial activity that has the potency to prevent food damage (Ardiansyah *et al.*, 2003). The use of pluchea leaves in the manufacture of wet noodles is expected to produce wet noodles that are able to provide antioxidant effects that are good for health, and have an impact on increasing the shelf life of the wet noodle's product.

Currently, the use of pluchea leaves is only limited to fresh vegetables and drinks, but there have been many studies on the use of pluchea leaves in the food sector that continue to be developed, including making tempeh with pluchea leaf extract (Magatra, 2013), pluchea-black tea salted eggs (Adventi *et al.*, 2015), effervescent powder based on pluchea leaf extract (Hudha and Widyarningsih, 2015), pluchea bun products (Chiang, 2018), pluchea soy milk (Widyawati *et al.*, 2019), pluchea-green tea jelly drink (Wijaya, 2019), and pluchea wet noodles (Wibisono, 2021). The use of pluchea leaves in the manufacture of wet noodles was studied further as an effort to develop functional food products that were beneficial to the health of the consumer's body.

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62 **2. Pluchea leaves as functional supplement**

Several factors such as individual education, household standards and level of knowledge about food products with health claims, as well as perceptions of some existing functional food product attributes affect the development of public interest in functional food products (Stojanovic *et al.*, 2013; Sari, 2014). Marsono (2008) also declared that increasing awareness of the importance of food in preventing or curing disease, consumer demands for foods with more properties (containing functional ingredients), experiences with alternative medicines, and studies on the prevalence of certain diseases that are influenced by diet have also become the basis for the rapid development of functional food products in various countries.

Functional food is defined as a food product that is able to provide benefits to the health of the body, one of which is through the presence of bioactive components contained in a functional food product (Suter, 2013; Essa *et al.*, 2021). According to Essa *et al.* (2021), there are five categories of functional food, i.e. foodstuffs with a reduction or increase in the basic nutritional content, products that naturally do not have certain nutrients and are added to them, milk-based products fermented with probiotics, products that are specially formulated to fulfill certain needs, and foodstuffs containing herbal ingredients to help overcome various health problems.

Herbal plants are a source of functional food, i.e. a source of natural antioxidants that can be used in the food sector to improve the functional properties of processed food products, one of which is the use of herbal plants to increase the content of bioactive components in wheat flour-based products such as noodles. According to Fadzil *et al.* (2020), noodles are known to be low in nutritional components that are beneficial to health, while noodles with functional properties such as high antioxidants are in high demand at this time.

84

85 *2.1 Utilization of pluchea leaves in making wet noodles*

The main ingredients in making noodles are generally wheat flour, eggs, water, and other additives as needed, making the noodles products only contain carbohydrates, proteins, fats, and minerals. The content of carbohydrates, several minerals, and energy in noodles are very high, but the content of protein, fat, and vitamins in noodles products are relatively low (Akbar, 2018; Khasanah and Astuti, 2019). Several studies have been carried out in an effort to improve the functional properties of noodles products, one of which is by using the leaves of plants that have been known as traditional medicines to be added to the manufacture of noodles, such as making

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93 herbal noodles with cosmos (*Cosmos caudatus* Kunth.) leaf extract (Norlaili *et al.*, 2014),
94 manufacture of herbal noodles with leaves of the Indian bael plant (*Aegle marmelos*) (Shamim *et*
95 *al.*, 2016), manufacture of sidondo (*Vitex negundo* Linn.) noodles (Syahirah and Rabeta, 2018),
96 addition of moringa (*Moringa oleifera*) leaf extract to wet noodles (Khasanah and Astuti, 2019),
97 making herbal noodles with pegagan (*Centella asiatica*) extract (Fadzil *et al.*, 2020), and using
98 pluchea (*Pluchea indica* Less) leaf powder steeped water to make pluchea wet noodles (Wibisono,
99 2021).

100 The content and activity of phytochemical compounds in pluchea leaves, both in the form
101 of fresh leaves and water steeped in powdered pluchea leaves have been identified. Pluchea is
102 classified as plant that has high polyphenol content and relatively large antioxidant capacity
103 compared to other herbaceous plants (Andarwulan *et al.*, 2010; Andarwulan *et al.*, 2012). Research
104 conducted by Widyawati *et al.* (2016) showed that the phytochemical compounds contained in the
105 brewed water of pluchea leaf powder include alkaloids, flavonoids, phenolics, saponins, tannins,
106 and cardiac glycosides. According to Pengelly (2004), each phytochemical compound has
107 physiological effects including alkaloids as analgesic, mydriatic, miotic, hypertensive,
108 hypotensive, bronchodilator, stimulant, antimicrobial, and antileukemic, flavonoids as antioxidant,
109 antiviral, hepatoprotective, antiatheromatous, anti-inflammatory, and antihypertensive, phenolic
110 as antioxidant, antimicrobial, anti-inflammatory, antiplatelet, and antiallergic, saponins as
111 anticancer, anti-inflammatory, immunomodulatory, antihepatotoxic, and antidiabetic, tannins as
112 antioxidant, antitumor, antihemorrhagic, and antiatherogenic, as well as cardiac glycosides that
113 can increase strength and speed of systolic contraction. Flavonoids are one of the important
114 constituents that can provide real benefits for the health of the human body.

115 The use of pluchea leaves in food products continues to be developed through various
116 studies as shown in Table 1. Using pluchea leaves in many food products (tempeh, beverage, salted
117 egg, bun, jelly drink, and soymilk) to increase their functional value can be added in the form of
118 extract, powder/flour, or fresh with different stages of processing each food product. However,
119 the use of pluchea leaves to increase the functional value of wheat flour-based food products has
120 not been widely studied. So far the research that has been carried out regarding the use of pluchea
121 leaves in the formulation of wheat flour-based food products is in the manufacture of pluchea bun
122 (Chiang, 2018) and pluchea wet noodles (Wibisono, 2021), both of which use pluchea leaf powder
123 steeping water which is added to the product formulation.

124 2.2 The effect of pluchea leaves on the content of phytochemical compounds of wet noodles

125 The largest group of phytochemical compounds in plants includes alkaloids, terpenes, and
126 phenolic compounds. Phenolic compounds are a group of phytochemical compounds that are
127 widely distributed in various plants, where this group of compounds can be used as the main source
128 of natural antioxidants and are able to act as antimicrobial, anticarcinogenic, and other biological
129 activities (Kennedy and Wightman, 2011; Aziman *et al.*, 2012). Pluchea leaves contain phenolic
130 compounds in the form of flavonoids, 1,3,4,5-tetra-O-cafeoilquinic acid, 3,4,5-tri-O-cafeoilquinic
131 acid, chlorogenic acid, and ferulic acid (Mahasuari *et al.*, 2020).

132 Flavonoids as secondary metabolites as well as the main and largest compounds in the
133 group of phenolic compounds are commonly found in plant tissues in free form or glycosides
134 (Aberoumand and Deokule, 2008; Sulaiman and Balachandran, 2012; Agbo *et al.*, 2015). In plants,
135 flavonoids are found in the form of flavonoid glycosides, flavonols, flavan-3-ol, flavones,
136 flavanones, chalcones, anthocyanins, and proanthocyanidins (Dehkharghanian *et al.*, 2010;
137 Vichapong *et al.*, 2010; Chen, 2013). Flavonoids act as antioxidants by chelating metals and

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139 donating hydrogen atoms, thus provide certain physiological effects on the human body
140 (Erlidawati *et al.*, 2018). This has become one of the basis for the use of herbal plants for traditional
141 medicine and supports various functional food product innovations such as pluchea wet noodles.

142 Research by Wibisono (2021) showed that the use of pluchea leaf powder steeped water
143 was able to contribute in increasing the content of phytochemical compounds (especially
144 flavonoids) in wet noodles, that the lowest (5%) and the highest (30%) concentration of pluchea
145 leaf powder in steeping water were able to increase the total flavonoid content (TFC) of wet
146 noodles as much as 1.43 times and 4.07 times compared to the control wet noodles (without the
147 use of pluchea leaf powder steeping water), respectively. The potential use of pluchea leaves in
148 the manufacture of wet noodles can be seen by comparing the TFC of pluchea wet noodles in
149 Wibisono's study (2021) with other herbal noodles and pluchea bun as another form of wheat flour-
150 based product. Comparison of the total flavonoids of pluchea wet noodles with sidondo wet
151 noodles, pegagan wet noodles, and pluchea bun from existing studies can be seen in Figure 1.

152 The group of flavonoids found in pluchea leaves are flavonols and flavones, including
153 quercetin, myrisetin, kaempferol, apigenin, luteolin, and chrysoeriol (Andarwulan *et al.*, 2010;
154 Andarwulan *et al.*, 2012; Koirewoa *et al.*, 2012; Mahasuari *et al.*, 2020), sidondo flavonoids
155 consist of castikin, orientin, isoorientin, luteolin, lutekin-7-O-glucoside, corimbosin, gardenins A
156 and B, 3-O-desmethylnobiletin, 5-O-desmethylnobiletin, and 3',4',5,5',6,7,8-
157 heptamethoxyflavones (Lakshmanashetty *et al.*, 2010; Ullah *et al.*, 2012), while the flavonoids of
158 pegagan include quercetin, myrisetin, and kaempferol (Andarwulan *et al.*, 2010; Andarwulan *et al.*,
159 *et al.*, 2012). The TFC value of wet noodles with the addition of 5% concentration of pluchea leaf
160 powder in steeping water was greater than the TFC of wet noodles with the addition of 20%
161 pegagan extract, but the TFC of pluchea wet noodles 5% was lower than the TFC of sidondo wet
162 noodles which used 0.66% sidondo leaf powder from the total weight of the noodles ingredients.
163 Based on this comparison, it can be indicated that the use of pluchea leaf powder steeping water
164 with a concentration of 5% can increase the flavonoids content of wet noodles far exceeding the
165 flavonoids content that can be given by 20% pegagan extract solution in wet noodles (total
166 flavonoids of pluchea wet noodles 5% is 51.67 times compared to pegagan noodles 20%). The
167 total flavonoids of the pluchea wet noodles 5% is 1.53 times lower than the total flavonoids of
168 sidondo wet noodles. The flavonoids content of sidondo wet noodles which was higher than
169 pluchea wet noodles 5% could be caused by the addition of sidondo leaf powder directly to the
170 making of wet noodles dough in Syahirah and Rabeta's research (2018), while pluchea wet noodles
171 dough in Wibisono's study (2021) was made with using pluchea leaf powder steeping water in the
172 formulation of wet noodles. In addition, several factors such as differences in formulation,
173 sequence of processing and analysis stages, as well as stated standards and product sample forms
174 analyzed in each study also affect the difference in TFC values compared between types of herbal
175 wet noodles.

176 The TFC of wet noodles with the addition of 5% concentration of pluchea leaf powder in
177 steeping water was higher than the TFC of bun with the addition of 10% concentration of pluchea
178 leaf powder in steeping water. This shows that the flavonoids content of pluchea wet noodles is
179 higher than the flavonoids content of pluchea bun even though the concentration of pluchea leaf
180 powder in steeping water in the manufacture of pluchea wet noodles is lower than the concentration
181 of pluchea leaf powder in steeping water in the manufacture of pluchea bun (the TFC of pluchea
182 wet noodles 5% is 2.54 times compared to pluchea bun 10%). According to Li *et al.* (2015),
183 antioxidant compounds, one of which is flavonoids, are easily degraded in the heating process, and
184 are lost during the process of mixing and kneading the dough. The degradation of flavonoids during

185 heating and the extraction of glycosides by water vapor can be the cause of the low TFC value of
186 pluchea bun. On the other hand, a study conducted by Saikia and Mahanta (2013) showed that the
187 high flavonoids content can be caused by breaking the glycosidic bond of flavonoids with sugar
188 by heating treatment. The wet noodles cooking process is thought to have an effect on breaking
189 the glycosidic bond so that aglycones are formed which can improve the detection results of
190 flavonoids compounds in the analysis. Various factors can affect the TFC value in different food
191 products, including differences in ingredient formulations, specifications of the methods used, and
192 the stages of the process in the manufacture of food products.

193 The TFC of pluchea wet noodles 5% showed that pluchea leaves have the potency to
194 increase the content of phytochemical compounds (in this case flavonoids) in wet noodles as a
195 wheat flour-based food product. Wibisono (2021) also mentioned that the use of higher
196 concentration of pluchea leaf powder in steeping water in the formulation of wet noodles is able
197 to provide a significant increase in the TFC of wet noodles. There has been no research on the
198 effect of adding pluchea leaf powder steeping water on the type and amount of phytochemical
199 compounds other than flavonoids in pluchea wet noodles products, so the use of pluchea leaves in
200 the manufacture of wet noodles still needs to be developed and further investigated its effect on
201 the phytochemical component content of wet noodles.

202

203 2.3 *The effect of pluchea leaves on the functional properties of wet noodles*

204 The functional properties of functional food products mainly focus on the ability of
205 bioactive components in food products to help maintain the health of the human body. One of the
206 properties possessed by bioactive components is that they can act as antioxidants. Carotenoids,
207 flavonoids, and phenolic compounds are classified as natural antioxidants that can be found in
208 various foodstuffs (Marsono, 2008). Antioxidant activity can be in the form of DPPH free radical
209 scavenging ability, iron ion reducing power, reactive oxygen species scavenging activity, and β -
210 carotene-linoleic acid system inhibitory activity (Widyawati *et al.*, 2017).

211 Iron ion reducing power (RP) is one of the parameters of antioxidant potential which is
212 measured as secondary antioxidant activity based on the ability of antioxidant compounds to
213 reduce Fe^{3+} to Fe^{2+} . Secondary antioxidants play a role in the mechanism of binding metal ions,
214 scavenging oxygen, converting hydrogen peroxide into non-radical compounds, absorbing UV
215 radiation, or deactivating singlet oxygen (Pokorny *et al.*, 2001). According to Widyawati *et al.*
216 (2014), iron ion is one of the pro-oxidants that have the potency to generate new free radicals.
217 Antioxidant components are able to neutralize iron ions by acting as a substrate that will be
218 oxidized first. Based on the research of Wibisono (2021), the use of the lowest (5%) and the highest
219 (30%) concentration of pluchea leaf powder were able to increase the RP value of wet noodles by
220 1.33 times and 3.27 times compared to control wet noodles, respectively. The potency of pluchea
221 leaves in increasing the antioxidant activity of wet noodles products can be described by
222 comparing the RP value of pluchea wet noodles with other products such as rice flour paste and
223 pluchea bun. The comparison of secondary antioxidant activity in the form of the iron ion reducing
224 power of pluchea wet noodles with rice flour paste and pluchea bun can be seen in Figure 2.

225 Pluchea wet noodles 5% in the Wibisono's study (2021) had the RP value 1.78 times higher
226 than the RP value of pluchea bun 10% in Chiang's research (2018), but 1.94 times lower than the
227 RP value of paste made from rice flour in the research of Nithya *et al.* (2013). The RP value
228 indicates that the use of pluchea leaf powder steeping water with 5% concentration of pluchea leaf
229 powder in steeping water has potency to provide greater secondary antioxidant activity in wet
230 noodles than in bun products. The TFC of pluchea wet noodles 5% which is greater than the TFC

231 of pluchea bun 10%, as shown in Figure 1., can contribute to the large iron ion reducing power of
232 pluchea wet noodles 5% and pluchea bun 10%, that the phenolic group compounds, one of which
233 is flavonoids, capable of donating hydrogen atoms/electrons so that they can reduce iron ions
234 (Widyawati *et al.*, 2014). The flavonoids content of pluchea wet noodles which is higher than the
235 flavonoids content of pluchea bun, can cause the iron ion reducing power of wet noodles is higher
236 compared to pluchea bun.

237 RP value of pluchea wet noodles 5% which is lower than the RP value of rice flour paste
238 can be due to the use of different types of raw materials (related to the number and types of
239 bioactive components in the ingredients) and the shape of the product samples analyzed in each
240 study. Based on the research of Widyawati *et al.* (2014), white rice has total phenolic content
241 (TPC) of 4.12 ± 0.05 mg gallic acid equivalent/g dry basis which is greater than the TPC of pluchea
242 leaves in the study of Andarwulan *et al.* (2010), which was 0.831 ± 0.129 mg gallic acid
243 equivalent/g fresh leaf weight. According to Wibisono (2021), the iron ion reducing power of
244 pluchea wet noodles can be increased by using higher concentration of pluchea leaf powder in
245 steeping water in the formulation of wet noodles.

246 RP value of pluchea wet noodles 5% shows the potency of pluchea leaves to increase the
247 antioxidant activity of wet noodles products as an effort to increase the functional value of wheat
248 flour-based food products such as wet noodles. The effect of adding pluchea leaf powder steeping
249 water on the antioxidant activity of pluchea wet noodles using a type of analysis other than the
250 iron ion reducing power has not been studied further, so it is necessary to measure other antioxidant
251 parameters to support the potency of pluchea leaves in making wet noodles.

252 Research on the potency of pluchea leaves in improving the functional properties of wet
253 noodles is still limited to being studied on product antioxidants, while pluchea leaves have been
254 known to have various other functional properties that are beneficial to health and are able to
255 maintain the quality of food products. Several other functional properties that have the potency to
256 be provided by pluchea leaves in food products include activities as anti-warmed-over flavor, anti-
257 inflammatory, antidiabetic (Widyawati *et al.*, 2017), and antimicrobial properties that have the
258 potency to prevent food spoilage (Ardiansyah *et al.*, 2003). This ability is inseparable from the
259 presence of bioactive compounds in pluchea leaves which have the capacity as antioxidant and
260 antihyperglycemic agents (Widyawati *et al.*, 2014; Widyawati *et al.*, 2015). According to Li *et al.*
261 (2014), herbal plant extracts are potential preservatives that are currently being developed to be
262 applied to bread, pasta, and noodles products due to the presence of phenolic components that have
263 high antimicrobial activity. Tiwari *et al.* (2009) also proved that the antimicrobial activity of
264 phenolic compounds is related to the ability of phenolics to affect the permeability of microbial
265 cells which causes the release of important macromolecules from the microbial cell, as well as the
266 ability of phenolics to interact with membrane proteins that cause deformation of the structure and
267 function of microbial cell membranes.

268 3. Conclusion

270 Pluchea (*Pluchea indica* Less) leaves have the potency to increase the functional value of
271 wet noodles in terms of the phytochemical content and functional properties of the wet noodles.
272 The use of pluchea leaves increases the content of phytochemical compounds, in this case
273 flavonoids, in wet noodles. The increase in the content of phytochemical compounds with the use
274 of pluchea leaves affects the increase in the functional properties of wet noodles products,
275 especially antioxidant activity in the form of the iron ion reducing power of wet noodles.
276

277 **Conflict of interest**

278 The authors declare no conflict of interest.

279

280

281 **Acknowledgments**

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284 **References**

285 Aberoumand, A. and Deokule, S.S. (2008). Comparison of phenolic compounds of some edible
286 plant of Iran and India. *Pakistan Journal of Nutrition*, 7(4), 582-585.

287

288 Adventi, B.S., Widyawati, P.S. and Utomo, A.R. (2015). Effect of salt concentration for
289 physicochemical and organoleptics salted egg pluchea (*Pluchea indica* Less)-black tea (*Camelia*
290 *sinensis*). *Journal of Food Technology and Nutrition*, 14(2), 55-60.

291

292 Agbo, M.O., Uzor, P.F., Akazie-Nneji, U.N., Eze-Odurukwe, C.U., Ogbatue, U.B. and Mbaaji,
293 E.C. (2015). Antioxidant, total phenolic and flavonoid content of selected Nigerian medical plants.
294 *Dhaka University Journal of Pharmaceutical Sciences* 14(1), 1-7.

295

296 Akbar, A. (2018). Physical, chemical and organoleptic analysis of wet noodle based on taro
297 (*Colocasia esculenta* L). *Agritepa*, 4(2), 159-170.

298

299 Andarwulan, N., Kurniasih, D., Apriady, R.A., Rahmat, H., Roto, A.V. and Bolling, B.W. (2012).
300 Polyphenols, carotenoids, and ascorbic acid in underutilized medicinal vegetables. *Journal of*
301 *Functional Foods*, 4, 339-347.

302

303 Andarwulan, N., Batari, R., Sandrasari, D.A., Bolling, B. and Wijaya, H. (2010). Flavonoid
304 content and antioxidant activity of vegetables from Indonesia. *Food Chemistry*, 121, 1231-1235.

305

306 Ardiansyah, Nuraida, L. and Andarwulan, N. (2003). Antimicrobial activity of pluchea (*Pluchea*
307 *indica* L.) leaves extract and stability of the activity at different salt concentrations and pHs.
308 *Journal of Food Technology and Industry*, 14(2), 90-97.

309

310 Aziman, N., Abdullah N., Noor, Z.M., Zulkifli, K.S. and Kamarudin, W.S.S.W. (2012).
311 Phytochemical constituents and in vitro bioactivity of ethanolic aromatic herb extracts. *Sains*
312 *Malaysiana*, 41(11), 1437-1444.

313

314 Billina, A., Waluyo, S. and Suhandy, D. (2014). Study of the physical properties of wet noodles
315 with addition of sea weed. *Lampung Agricultural Engineering Journal*, 4(2), 109-116.

316

317 Chen, X.G.Q. (2013). Identification and antioxidant capacity of anthocyanin pigment, and
318 expressional analysis of flavonoid biosynthetic genes in colored rice strains. Japan: University of
319 Hiroshima, PhD. Dissertation.

320

321 Chiang, I. (2018). The effect of pluchea leaves powder (*Pluchea indica* Less) in steeping water of
322 pao antioxidant activity. Indonesia: Widya Mandala Surabaya Catholic University, Bachelor. Final
323 Project.
324
325 Dehkharghanian, M., Adenier, H. and Vijayalakshmi, M.A. (2010). Study of flavonoids in aqueous
326 spinach extract using positive electrospray ionisation tandem quadrupole mass spectrometry. *Food*
327 *Chemistry*, 121, 863-870.
328
329 Erlidawati, Safrida and Mukhlis. (2018). Antioxidant Potency as Antidiabetic. Banda Aceh: Syiah
330 Kuala University Press.
331
332 Essa, M.M., Bishir, M., Bhat, A., Chidambaram, S.B., Al-Balushi, B., Hamdan, H., Govindarajan,
333 N., Friedland, R.P. and Qoronfleh, M.W. (2021). Functional foods and their impact on health.
334 *Journal of Food Science and Technology*. <https://doi.org/10.1007/s13197-021-05193-3>.
335
336 Estiasih, T., Putri, W.D.R. and Waziroh, E. (2017). Tubers and Their Processing. Malang: UB
337 Press.
338
339 Fadzil, N.F., Bakar, M.F.A., Yusop, M.H.M. and Bakar, F.I.A. (2020). Sensorial and
340 physicochemical characteristics of herbal noodle enriched with *Centella asiatica*. *Food Research*,
341 4(4), 1030-1037.
342
343 Firdausi, M.H. (2017). Physicochemical and organoleptic quality of dry method salted eggs with
344 addition of pluchea leaves (*Pluchea indica* L). Indonesia: Brawijaya University, Bachelor. Final
345 Project.
346
347 Hudha, M. and Widyaningsih, T.D. (2015). The effervescent powder uses pluchea leaf (*Pluchea*
348 *indica* Less) extract as natural antioxidant source. *Journal of Food and Agroindustry*, 3(4), 1412-
349 1422.
350
351 Khasanah, V. and Astuti, P. (2019). Effect of addition of Moringa leaf extract (*Moringa oleifera*)
352 on sensory quality and protein content of wet noodles substituted with modified cassava flour.
353 *Journal of Technical Competence*, 11(2), 15-21.
354
355 Kennedy, D.O. and Wightman, E.L. (2011). Herbal extracts and phytochemicals: plant secondary
356 metabolites and the enhancement of human brain function. *Advances in Nutrition*, 2, 32-50.
357
358 Koirewoa, Y.A., Fatimawali and Wiyono, W.I. (2012). Isolation and identification flavonoid
359 compounds in pluchea leaf (*Pluchea indica* L.). *Pharmacon*, 1(1), 47-52.
360
361 Lakshmanashetty, R.H., Nagaraj, V.B., Hiremath, M.G. and Kumar V. (2010). *In vitro* antioxidant
362 activity of *Vitex negundo* L. leaf extracts. *Chiang Mai Journal of Science*, 37(3), 489-497.
363
364 Li, M., Zhu, K.X., Guo, X.N., Brijs, K. dan Zhou, H.M. (2014). Natural additives in wheat-based
365 pasta and noodle products: opportunities for enhanced nutritional and functional properties.
366 *Comprehensive Reviews in Food Science and Food Safety*, 13, 347-357.

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367
368 Li, Y., Ma, D., Sun, D., Wang, C., Zhang, J., Xie, Y. and Guo, T. (2015). Total phenolic, flavonoid
369 content, and antioxidant activity of flour, noodles, and steamed bread made from different colored
370 wheat grains by three milling methods. *The Crop Journal* 3(4), 328-334.
371
372 Nuraida, L., Andarwulan, N., Sukmawati, M. and Yohana, E. (2008). Application of herbs and
373 spices extracts as preservatives for wet noodles. Investing in Food Quality, Safety and Nutrition.
374 International Conference Proceeding Investing in Food Quality, Safety & Nutrition: Lessons
375 Learned from Current Food Crisis Jakarta, October 27-28, 2008.
376
377 Magatra, P. (2013). Antioxidant activity, total phenolic content, and organoleptic test in tempe
378 with marsh fleabane leaf extract (*Pluchea indica* L.). Indonesia: Satya Wacana Christian
379 University, Bachelor. Final Project.
380
381 Mahasuari, N.P.S., Paramita, N.L.P.V. and Putra, A.A.G.R.Y. (2020). Effect of methanol
382 concentration as a solvent on total phenolic and flavonoid content of pluchea leaf extract (*Pluchea*
383 *indica* L.). *Journal of Pharmaceutical Science and Application*, 2(2), 77-84.
384
385 Marsono, Y. (2008). Functional food development prospects. *Journal of Food Technology and*
386 *Nutrition* 7(1), 19-27.
387
388 Nithya, D.J., Bosco, K.A.S., Jagan Mohan, R. and Alagusundaram, K. (2013). Antioxidant activity
389 of rice bran pasta. *Journal of Microbiology, Biotechnology and Food Sciences*, 2(6), 2423-2425.
390
391 Norlaili, A.H., Roselina, K. and Muhammad, T.S. (2014). Effect of *Cosmos caudatus* Kunth.
392 (Ulam Raja) aqueous and dry extracts on the physicochemical and functional properties, and
393 sensory acceptability of Herbal Yellow Alkaline Noodles. *Malaysian Journal of Nutrition*, 20(3),
394 403-415.
395
396 Pengelly, A. (2004). *The Constituents of Medicinal Plants: An Introduction to the Chemistry and*
397 *Therapeutics of Herbal Medicines*, 2nd ed. Australia: CABI Publishing.
398
399 Pokorny, J., Yanishlieva, N. and Gordon, M. (2001). *Antioxidants in Food: Practical Applications*.
400 Cambridge: Woodhead Publishing Ltd.
401
402 Saikia, S. and Mahanta, C.L. (2013). Effect of steaming, boiling and microwave cooking on the
403 total phenolics, flavonoids and antioxidant properties of different vegetables of Assam, India.
404 *International Journal of Food and Nutritional Sciences*, 2(3), 47-53.
405
406 Sari, E.T. (2014). Factors influencing consumption of functional food in Surabaya. *Scientific*
407 *Journal of Commerce Administration*, 12(2), 1-10.
408
409 Shamim, M.Z., Verma, A., Sheikh, S. and Singh, S. (2016). Sensory evaluation of nutritious herbal
410 noodles developed by utilization of *Aegle marmelos* leaves powder. *IMPACT: International*
411 *Journal of Research in Applied, Natural and Social Sciences*, 4(4), 109-114.
412

413 Stojanovic, Z., Filipovic, J. and Mugosa, B. (2013). Consumer acceptance of functional foods in
414 Montenegro. *Montenegrin Journal of Economics*, 9(3), 65-74.
415

416 Sulaiman, C.T. and Balachandran, I. (2012). Total phenolics and total flavonoids in selected Indian
417 medical plants. *Indian Journal of Pharmaceutical Sciences*, 74(3), 258-260.
418

419 Suter, I.K. (2013). Functional foods and their development prospects. Retrieved on February 15,
420 2021 from Udayana University Repository Website:
421 [https://repositori.unud.ac.id/protected/storage/upload/repositori/ID3_1950123119760210032309](https://repositori.unud.ac.id/protected/storage/upload/repositori/ID3_19501231197602100323091304927makalah-gizi.pdf)
422 [1304927makalah-gizi.pdf](https://repositori.unud.ac.id/protected/storage/upload/repositori/ID3_19501231197602100323091304927makalah-gizi.pdf).
423

424 Syahirah, J. and Rabeta, M.S. (2018). Antioxidant and antimicrobial activity of lemuni noodle.
425 *Food Research*, 3(1), 7-13.
426

427 Tiwari, B.K., Valdramidis, V.P., Donnell, C.P.O., Muthukumarappan, K., Bourke, P. and Cullen,
428 P.J. (2009). Application of natural antimicrobials or food preservation. *Journal of Agricultural and*
429 *Food Chemistry*, 57(14), 5987-6000.
430

431 Ullah, Z., Ullah, R., Shah, A.H.A., Ahmad, I. and Haider, S. (2012). Phytochemical and biological
432 evaluation of *Vitex negundo* Linn: a review. *International Journal of Pharmaceutical Sciences and*
433 *Research*, 3(8), 2421-2431.
434

435 Vichapong, J., Sookserm, M., Srijesdaruk, V., Swatsitang, P. and Srijaranai, S. (2010). High
436 performance liquid chromatographic analysis of phenolic compounds and their antioxidant
437 activities in rice varieties. *LWT-Food Science and Technology*, 43, 1325-1330.
438

439 Wibisono, D.A.S. (2021). Effect of concentration of pluchea (*Pluchea indica* (L.) Less) leaves
440 powder in steeping water on total flavonoids and iron ion reducing power of wet noodle. Indonesia:
441 Widya Mandala Surabaya Catholic University, Bachelor. Final Project.
442

443 Widyawati, P.S., Budianta, T.D.W., Gunawan, D.I. and Wongso, R.S. (2015). Evaluation
444 antidiabetic activity of various leaf extracts of *Pluchea indica* Less. *International Journal of*
445 *Pharmacognosy and Phytochemical Research*, 7(3), 597-603.
446

447 Widyawati, P.S., Budianta, T.D.W., Kusuma, F.A. and Wijaya, E.L. (2014). Difference of solvent
448 polarity to phytochemical content and antioxidant activity of *Pluchea indica* Less leaves extracts.
449 *International Journal of Pharmacognosy and Phytochemical Research*, 6(4), 850-855.
450

451 Widyawati, P.S., Ristiarini, S., Werdani, Y.D.W., Kuswardani, I. and Herwina, I. N. (2019).
452 Physicochemical and organoleptic properties changes of soymilk with pluchea brewing water
453 addition. *Journal of Food Technology and Nutrition*, 18(2), 98-111.
454

455 Widyawati, P.S., Suteja, A.M., Suseno, T.I.P., Monika, P., Saputrajaya, W. and Liguori, C. (2014).
456 Effect of pigment color difference in organic rice on antioxidant activity. *Agritech*, 34(4), 399-
457 406.
458

459 Widyawati, P.S., Werdani, Y.D.W., Setiokusumo, C. and Kartikasari, A. (2017). In vitro
460 antioxidant capacities and antidiabetic properties of pluchea leaves and green tea mixtures at
461 various proportions. *International Journal of Pharmacy and Pharmaceutical Sciences*, 9(8), 203-
462 208.

463

464 Wijaya, J.P. (2019). Effect of concentration of mixture of pluchea (*Pluchea indica* L.) leaves
465 powder – green tea (*Camellia sinensis* L.) 1:1 (b/b) in steeping water on antioxidant activity of
466 jelly drink. Indonesia: Widya Mandala Surabaya Catholic University, Bachelor. Final Project.

467

468 Zou, S., Wang, L., Wang, A., Zhang, Q., Li, Z., and Qiu, J. (2021). Effect of moisture distribution
469 changes induced by different cooking temperature on cooking quality and texture properties of
470 noodles made from whole tartary buckwheat. *Foods*, 10(2543),1-12.

471

472 Table 1. The use of Pluchea leaves in food product

Type of food product	Pluchea leaf form	Stages of use	References
Tempeh	Pluchea leaf water extract	Soak soybeans before adding tempeh yeast	Magatra, 2013
Pluchea-black tea salted egg	Pluchea leaf flour	Mixed in salt solution for the ripening stage	Adventi <i>et al.</i> , 2015
Effervescent powder	Water extract (infusion) and ethanol extract (maceration)	Evaporated and mixed according to the formulation	Hudha and Widyaningsih, 2015
Dry method salted egg	Fresh pluchea leaves	Added to pasta dough to coat eggs	Firdausi, 2017
Bun	Pluchea leaf powder steeping water	Added during dough making	Chiang, 2018
Soy milk	Pluchea leaf powder steeping water	Added to soy milk	Widyawati <i>et al.</i> , 2019
Pluchea- green tea jelly drink	Pluchea leaf powder	Brewed with green tea powder	Wijaya, 2019
Wet noodles	Pluchea leaf powder steeping water	Added during dough making	Wibisono, 2021

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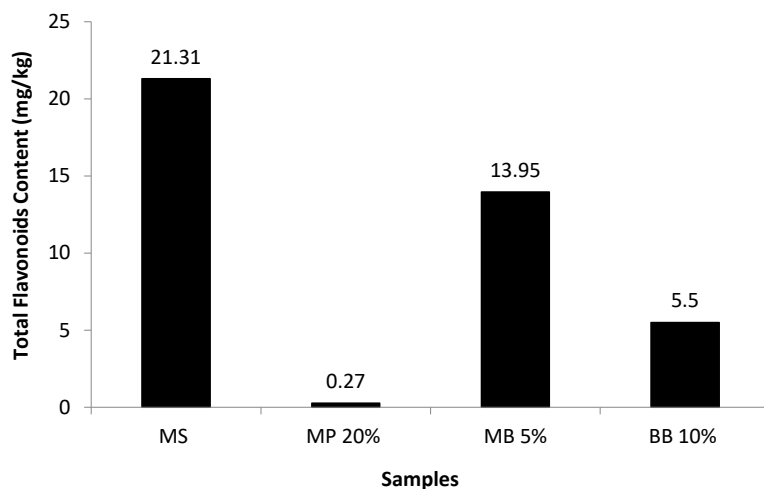
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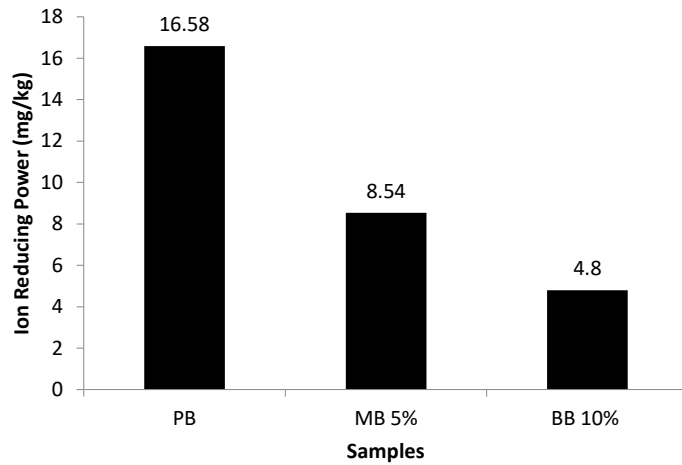
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 482 Figure 1. Total flavonoid content (TFC) of pluchea wet noodles 5% (MB 5% (Wibisono, 2021))
 483 compared to sidondo wet noodles (MS (Syahirah and Rabeta, 2018)), pegagan wet noodles 60%
 484 (MP 60% (Fadzil *et al.*, 2020)), and pluchea bun 10% (BB 10% (Chiang, 2018)). The TFC of
 485 sidondo and pegagan wet noodles were respectively expressed in terms of quercetin equivalent per
 486 weight of wet noodles and rutin equivalent per weight of wet noodles extract, while the TFC of
 487 pluchea noodles and pluchea bun were expressed in terms of catechin equivalents per dried weight
 488 of freeze-dried results. TFC of MP 20%, MB 5%, and BB 10% were expressed by the values that
 489 have been subtracted with the TFC of control from each study

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 497 Figure 2. Iron ion reducing power (RP) of pluchea wet noodles 5% (MB 5% (Wibisono, 2021))
 498 compared to rice flour paste (PB (Nitha *et al.*, 2013)) and pluchea bun 10% (BB 10% (Chiang,
 499 2018)). RP value of rice flour paste was stated to be equivalent to BHT per weight of pasta, while
 500 the RP value of pluchea wet noodles and pluchea bun was expressed in gallic acid equivalent per
 501 dried weight of freeze-dried results. Iron ion reducing power of MB 5% and BB 10% are expressed
 502 by the value that has been reduced by the RP value of control from each study

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Functional foods and their impact on health

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Abstract Functional foods play an important role in maintaining a healthy lifestyle and reducing the risk factors of various diseases. Most foods have a functional element which is responsible for improving the healthy state. All food substances such as fruits, vegetables, cereals, meat, fish, dairy contain functional ingredients. A wide range of naturally occurring substances from plant and animal sources having active components which play a role in physiological actions deserve attention for their optimal

use in maintaining health. The market for functional food is keep on expanding, and the global market is projected to reach a value of at least 91 billion USD soon. Overwhelming evidence from preclinical (*in vitro* and *in vivo*) and clinical studies have shown that intake of functional foods could have an impact on the prevention of chronic diseases, especially cancer, cardiovascular diseases, gastrointestinal tract disorders and neurological diseases. Extensive research needs to be done to determine the

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potential health benefits for the proper application of these foods to improve health state and combat chronic disease progression. The aim of this review is to conduct a thorough literature survey, to understand the various classification of functional foods and their health benefits.

Keywords Functional food · Nutraceuticals · Plant food · Fruits · Vegetables · Nuts · antioxidants · Probiotics

Introduction

Functional foods are regarded as foods that have potential beneficial effect on health beyond their basic nutritional value. They promote good health and lower the risk of diseases. Functional foods have received widespread popularity across the globe, and they are commonly known as “nutraceuticals” and “designer food”. The concept of functional food was started and regulated by the Ministry of Health and Welfare, Japan, in the year 1980s and then progressed to North America and other markets (Mellentin et al. 2014). Amount of biologically active compounds are very less in the food items and their beneficial effect have been studied in rodent models and clinical studies. Results from epidemiological studies have shown that consumption of specific fruits, animal products and vegetables that are rich in bioactive compounds reduced the risk of various metabolic disorders and cancer (Karasawa and Mohan 2018) (Fig. 1).

Natural bioactive molecules such as curcumin, resveratrol, quercetin, sulforaphane, epigallocatechin, lycopene, and ellagic acid have been studied for their direct and indirect effects on various molecular pathways. Curcumin is the major bioactive constituent in *Curcuma longa* and is found in the spice turmeric as well as other sources. It has been studied for its antioxidant and anti-inflammatory properties (Sneharani 2019). Resveratrol (3,5,4-trihydroxystilbene) is found in grapes and pomegranates and studies have shown its benefits on vascular function, immunity and the gut microbiota (Chaplin et al. 2018). Apples are abundant in quercetin, which has shown potent neuroprotective properties in neurodegenerative diseases (Elumalai and Lakshmi 2016). Cruciferous vegetables such as broccoli, cabbage and kale are abundant in sulforaphane, which is a potent activator of the Nrf2-ARE pathway and promoter of redox, thereby protecting from oxidative stress. In addition, sulforaphane modulates Phase I and II xenobiotic-metabolizing enzymes and directly inhibits binding of carcinogens to DNA, preventing DNA adduct formation (Juengel et al. 2017). Epigallocatechins are a group of compounds found in tea leaves which have been shown to have widespread pharmacological properties. Recent studies have determined that epigallocatechins inhibits the

expression and activity of indoleamine 2,3-dioxygenase in human colorectal cancer cells (Ogawa et al. 2012). (Table 1). Food production and eating habits have a pivotal role in the health, environmental and social life of human beings. The aim of this review is to conduct a thorough literature survey, to understand the various classification of functional foods and their health benefits.

Classification of functional foods

Functional foods are classified into three categories: (1) conventionally used food, (2) modified food, (3) food ingredients. Conventionally used foods have not undergone any modification and appear as a whole such as vegetables, fruits, fish, dairy, pulses and grains that have potent health benefits. Modified foods are those foods which have been enriched or fortified with a specific nutrient in order to promote health benefits. Modified foods include calcium, anti-oxidants and vitamin fortified beverages, calcium and folate enriched bread, products enriched with plant fibers, sterols and omega 3 fatty acids are common examples of modified functional foods (Hasler et al. 2009).

Fortification is a common term that describes the practice of enhancing the amount of a specific micronutrient in a food item. This is a sustainable, cost effective solution to overcome micronutrient deficiencies. Similar to fortification another common term used in the food enhancement is fortificants, which are normally found in the raw food, but lost during food processing. In order to overcome this issue techniques have been developed such as biofortification, in which the nutrient content of the food source had been increased through genetic engineering and selective breeding (Hasler et al. 2009).

The third class of functional foods is prebiotics. Gibson and Roberfroid were the first to define prebiotics, they defined it as “food components which nurture the growth and activity of a single and/or a specific group of microorganisms residing in the gastrointestinal tract, thereby improving the health condition of host”. The most common form of prebiotics is inulin and oligofructose. They selectively upregulate the useful gut microorganisms such as bacteria and fungi. The concept of prebiotics was first introduced in 1995 by Glenn Gibson and Marcel Roberfroid. Oligofructose such as fructo-oligosaccharides (FOS), galacto-oligosaccharides (GOS), and trans-galacto-oligosaccharides (TOS) are the most common prebiotics. Gut microbiota ferments these oligofructose to produce the short chain fatty acids (SCFAs) butyric acid, acetic acid and propionic acid which have potential health benefits. The major health benefits include improve cognition, immunity, Ca^{2+} absorption and decrease in the prevalence of irritable bowel syndrome (IBS) and colorectal cancer.

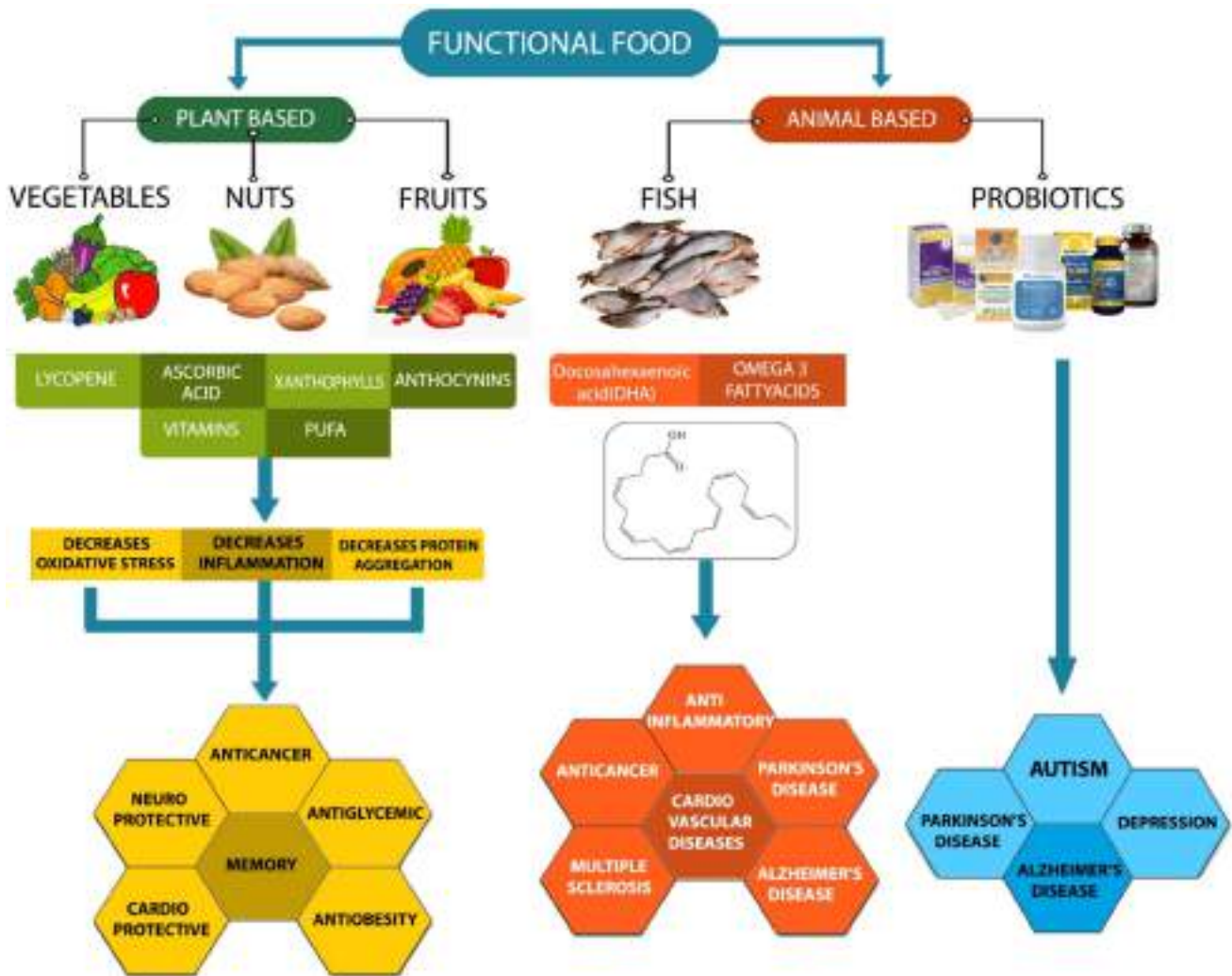


Fig. 1 Health benefits of functional foods

The bacteria that aerobically ferment dietary fiber produce the short chain fatty acids which enhance the integrity of the colonic epithelium intestinal epithelium improving the gut blood barrier. Short chain fatty acids also readily enter the bloodstream and pass the blood brain barrier producing satiety. They also epigenetically improve the production of regulatory lymphocytes that are actively anti-inflammatory (Blaak et al. 2020).

Functional food of plant origin



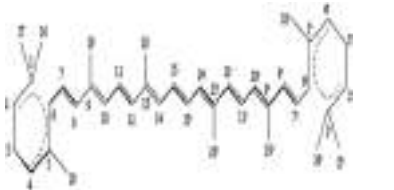
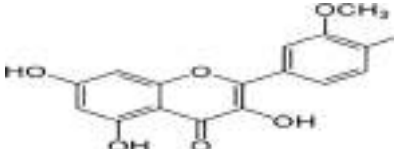
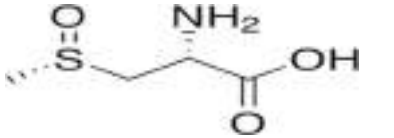
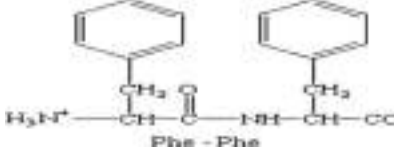
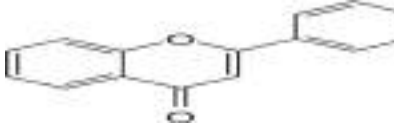
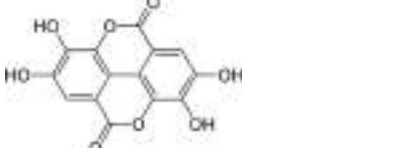
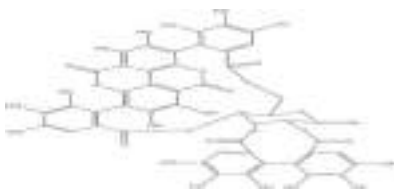
Plants are the rich source of natural oxidants and help to strengthen innate immunity and protects from the toxic effects of oxidants. Many molecules in living cells are prone to oxidation and antioxidant molecules which are present in the body and which are obtained from plant sources help to fight against the oxidants and their

deleterious effects on the body. Natural antioxidants are widely distributed in food and medicinal plants. Polyphenols are a key bioactive ingredient responsible for antioxidant properties. Moreover, they are proven to have anti-allergic, anti-carcinogenic, anti-mutagenicity (Alshatwi et al. 2010) and neuroprotective properties (Yu et al. 2017). In this review, we discuss some of the plant derived foods that are rich in polyphenols and other bioactive compounds.

Tomato

Tomatoes are the fruits of *Lycopersicon esculentum* and they originated in Mexico. They are regarded as vegetables and one of the highly consumed food products across the globe. The *Lycopersicon esculentum* has a deep red color which is associated with the carotenoid pigment synthesized during fruit ripening. Majority of the fruits and

Table 1 Chemical structures of some bioactive constituents

Bioactive constituent	Structure	Properties
Lycopene		Prevents DNA mutation (Lindshield et al. 2007), Improves lipid profile (Ibrahim et al. 2008), inhibits tumor growth (Tang et al. 2005)
Neoxanthin		Potent anti-oxidant properties (Lindshield et al. 2007)
Carotenoids		Potent anti-oxidant properties (Lindshield et al. 2007)
Isorhamnetin		Inhibits tumorigenesis (Damon et al. 2005)
S-methyl cysteine sulphoxide		Prevents DNA strand breakage. Inhibition of carcinogen activation by cytochrome P450 (H.Wiseman 2005)
peptide LPYPR		Reduces total cholesterol and LDL cholesterol (Yoshikawa et al. 2000)
Flavanoids		Potent antioxidant properties
Ellagic acid		Potent antioxidant and antiinflammatory properties (Akbar et al. 2015)
Punicalagin		Helps in reducing hypertension, arthritis, cancer, hyperglycaemia, oxidative stress and maintaining cholesterol levels (Zarfeshany et al. 2014)

vegetables contain which phenolic molecules belongs to the flavonoid family. Tomato contains a plethora of bioactive compounds such as lycopene, neoxanthin, violaxanthin, α -cryptoxanthin, zeaxanthin, lutein, β -

cryptoxanthin, β -carotene, γ -carotene, ζ -carotene, α -carotene, phytoene, phytofluene, cyclo-lycopene-neurosporene, and β -carotene 5, 6-epoxide (Burns et al. 2003).

Lycopene is the prominent bioactive compound in tomatoes and it has been widely studied over the past decade. Approximately 100 g of tomato contains 12 mg of lycopene. Chemically lycopene is acyclic carotene with 11 conjugated double bonds, these double bonds are contingent to isomerism and their isomers are reported to be found in blood plasma. The human body by itself is unable to synthesize carotenoids so the body is completely dependent on dietary sources. Studies have been reported that 85% of the lycopene in the human diet is obtained from tomato and tomato-based food products. Moreover, lycopene is a key intermediate in the biosynthesis of other essential carotenoids like β -carotene, and xanthophylls (Ruiz-Sola and Rodríguez-Concepción 2012).

It has been reported that consumption of foods that are rich in vitamins, carotenoids and tannins protect the body from oxidative damage. Lycopene is a potent antioxidant, and can protect DNA from free radicals and thereby prevent mutations that lead to cancer (Lindshield et al. 2007). In addition, higher lycopene (20 mg lycopene/kg diet) from tomato sauce and ketchup was reported to improve the lipid profiles of the hyperlipidemic rats (Ibrahim et al. 2008). This result suggest that increase consumption of tomatoes is beneficial in hyperlipidemic patients. Lycopene is also noted to be a potent anti- carcinogen. A study from Alshatwi et al. (2010) had shown that lycopene can protect cells from chromosomal aberration. Lycopene traps the singlet oxygen, impairs the free radical formation and thereby protect DNA from oxidative damage. In addition, it improves gene functioning, carcinogen metabolizing enzymes, apoptotic pathways and immune function. Clinical research suggests that lycopene is beneficial in prostate cancer. Most of the *in vivo* and *in vitro* studies have concentrated on prostate gland cancer models. Studies from Tang et al. analyzed the effect of Lycopene on the growth rate of DU145 prostate gland cell lines in BALB/c nude mice. They had found that lycopene at 100 and 300 mg/kg inhibited the tumor growth by 56% and 76% respectively (Tang et al. 2005).

Dietary intake of tomato prevents the development of high fat diet induced hepatocellular carcinoma in BCO1/BCO2 double knockout mice by decreasing the mRNA expression of proinflammatory mediators, increased NAD^+ production by upregulating the expression of sirtuin 1 and nicotinamide phosphoribosyltransferase. This action is mediated by increased microbial richness and diversity and reducing the *Clostridium* and *Mucispirillum* abundance. Tomato seeds have also been found to reduce *Firmicutes/Bacteroidetes* ratio, *Rikenella*, *Enterorhabdus* and increases abundance of *Lactobacillus* mice (Xia et al. 2018).

Several clinical trials have been conducted to evaluate the anti-cancer properties of the lycopene. Majority of the

studies focused on the concentration of prostate specific antigen (PSA), which determines the risk of prostate cancer. A study from Chen et al. (2001), 32 prostate cancer patients where supplemented with tomato sauce for 21 days (30 mg lycopene/day). They found that tomato sauce consumption decreased the PSA level by 20%. Moreover, biochemical estimation of the prostate tissue revealed a decrease in the ratio of 8-hydroxy-2'-deoxyguanosine (8-OHdG) (oxidative stress marker associated with cancer) to 2'-deoxyguanosine (a marker of oxidative DNA damage) in patients supplemented with tomato sauce as compared to normal control patients. Similar results were found in the study from Grainger et al. (2008), they found that consumption of tomato products daily (lycopene 25 mg/day) for 56 days reduced the PSA levels in 34% of the patients. Phase 2 clinical trial of Lyc-o-Mato® 15 mg/day lycopene has also shown decrease in the PSA levels (Vaishampayan et al. 2007).

The protective effects of Lycopene are well studied in cardiovascular diseases. Potent free radical quenching properties of lycopene protects endothelial cells. Oxidative stress leads to endothelial damage due to decline in nitric oxide (NO) levels causing damage to endothelial cells. Lycopene reduces oxidative stress, enhances the availability of NO, promotes endothelial vasodilation, and alleviates DNA, lipids, and mitochondrial damage (Abdel-Daim et al. 2018). Hung et al. 2008 showed the beneficial role of lycopene in atherosclerosis and other inflammation induced cardiovascular events. They found that lycopene can inhibit Tumor Necrosis Factor (TNF- α) induced activation of Nuclear Factor Kappa B (NF- κ B) and the expression of other molecules such as intracellular adhesion molecule-1 (ICAM-1). In addition, lycopene also inhibits the interaction between monocytes and endothelial cells, which may explain the beneficial role of lycopene in cardiovascular disease (Hung et al. 2008).

Some clinical studies have also reported the relationship between lycopene consumption and cardiovascular diseases. A randomized crossover study from Agarwal and Rao (1998) has reported significant decrease in the serum lipid peroxidation and LDL oxidation. The lipoprotein oxidation lag period, which is a measure of protection against oxidative stress was increased in healthy subjects consumed tomato soup for 15 days. Another clinical trial from Shen et al. (2007) treated 24 subjects with various tomato formulation (all the formulation delivering 40 mg lycopene/day) for 42 days, they found decrease in the triglyceride and LDL cholesterol levels and an increase in the High Density Lipoprotein levels.

Lycopene have been extensively studied in neurodegenerative diseases both in preclinical and clinical stages. Lycopene reduces oxidative stress, restores mitochondrial membrane potential and inhibited early apoptotic pathway

activation in rat cortical neurons exposed to amyloid β . Lycopene administration in Tau Transgenic Mice increased the memory consolidation by reducing tau phosphorylation, malonaldehyde (MDA) concentrations and increased Glutathione peroxidase (GSH-Px) activities (Yu et al. 2017). Lycopene reduces neuronal damage and increased the expression of BDNF in hippocampus region of AD rats. Lycopene also inhibits depletion of dopamine in substantia nigra and striatum and prevents neuronal damage in rodent model of Parkinson's disease. In addition, lycopene have also been reported to have beneficial effects in Huntington's disease, depression, cerebral ischemia by reducing oxidative stress and inhibiting proinflammatory release (Chen et al. 2019) (Fig. 2).

Broccoli

Broccoli are the flowers of *Brassica oleracea var. italica*. Its flowering head, leaves and stalk are consumed as vegetables across the globe. Broccoli originated in the Roman empire by the primitive cultivators and then became popular in the Italian Peninsula and Sicily. Broccoli is commonly regarded as the "Crown Jewel of Nutrition" because, it is immensely rich in variety of nutrients such as vitamins, minerals, fibres and secondary metabolites. 100 g of broccoli contains: calories (31 g), protein (2.5 g), carbohydrate (6 g), sugar (1.5 g), Fiber (2.4 g) and fat (0.4 g). Broccoli is rich in sulphur containing compounds and their biometabolic products glucosinolates, isothiocyanates have been reported to have potent anti-cancer properties. Moreover, broccoli is also rich in polyphenols such as isorhamnetin, sinapic acid, quercetin and rutin. In addition, it is rich in Vitamin K, B₁, B₂ (Damon et al. 2005) and

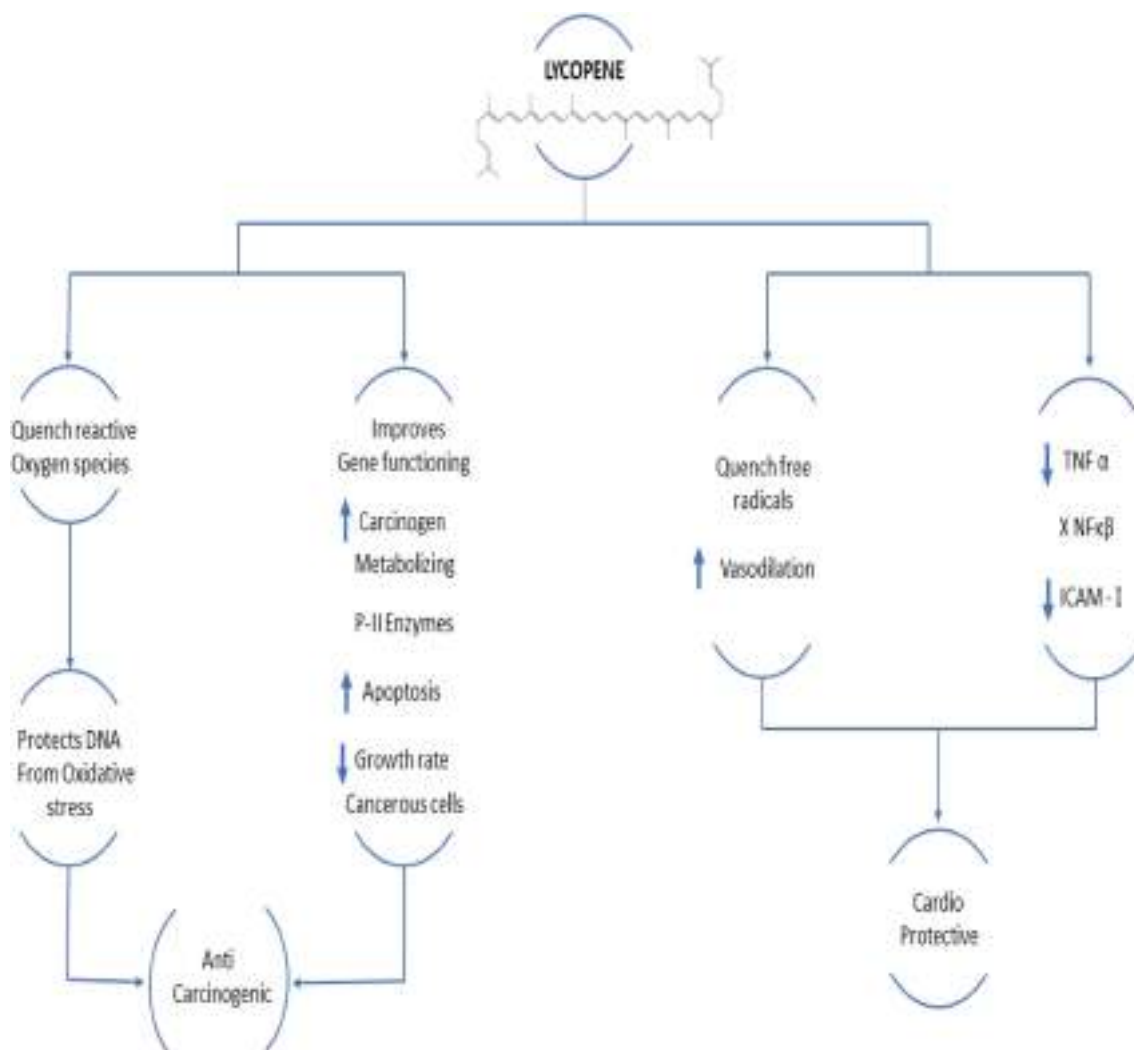


Fig. 2 Lycopene present in tomato is a potent antioxidant which provides several health benefits

minerals like Na, K, Ca, Mg, Cl, P and S. Dietary consumption of cruciferous vegetables is highly beneficial in preventing stomach, colon, thyroid, skin and prostate cancers. Anti—cancer property of broccoli is associated with sulforaphane, indoles, polyphenols, vitamins and minerals. It has been reported that sulforaphane prevents carcinogen induced tumorigenesis. It reduced incidence, multiplication and growth of breast cancer in dimethylbenzanthracene (DMBA)-treated rats. Moreover, sulforaphane or 4-methylsulfinylbutyl isothiocyanate induces phase 2 detoxification enzymes such as glutathione transferases, epoxide hydrolase, NAD(P)H: quinone reductase, and glucuronosyltransferases through inhibiting Nrf2-Keap 1 interactions and MAP Kinase activation (Bai Y et al. 2015)). In a clinical study where subjects consumed 250 gm/day (9 oz/day) of broccoli, it was found that broccoli consumption increased the urinary excretion of a potential carcinogen—2- amino-1-methyl-6-phenylimidazo [4, 5-b] pyridine (PhIP), which is commonly found in meat (Walters et al. 2004). Broccoli has also been reported to alter gut microbiome in humans.

Several studies have reported the cardioprotective properties of broccoli. Broccoli sprouts are rich in glucoraphanin which is a metabolic product of sulforaphane. It has been reported that glucoraphanin can induce phase II proteins which in turn decreases oxidative stress and inflammation in both kidneys and the cardiovascular system. Thus, it lowers the risk of hypertension and atherosclerosis in spontaneously hypertensive stroke prone rats (Wu et al. 2004). In a clinical study where the subjects consumed broccoli sprouts (100 gm/day) for a week it was found that total cholesterol levels and escalated HDL cholesterol levels declined (Murashima et al. 2004). Broccoli reduces mRNA and protein levels of thioredoxin super family members which are commonly found following ischemic reperfusion injury, thus broccoli improves the cardiac function, reduces the risk of myocardial infarction, and cardiomyocyte apoptosis (Mukherjee et al. 2008).

Sulforaphane, bioactive compound of broccoli has been found to be beneficial in neurodegenerative diseases. Broccoli inhibits glial cell activation and improves the expression of GABA, AMPA, and NMDA receptors in hippocampus region of rats. Broccoli consumption inhibits NF- κ B signaling cascade and proinflammatory cytokines which are responsible for neuroinflammation. Broccoli also upregulates the expression of Nrf2 pathway, inhibits neuronal apoptosis and enhances memory consolidation in mice (Subedi et al. 2019). Broccoli protects from A β -induced neurotoxicity in cell line model by mediating mitochondrial functioning, increased Hsp70 mRNA levels and improving the expression of Nrf2-ARE signalling (Masci et al. 2015).

Soya bean

Soya beans (*Glycine max*) are a legume species originated in Southeast Asia and it was first grown by Chinese farmers around 1100 BC. Soya beans consist of protein (35–40%), lipids (20%), and fiber (9%). The major bioactive fractions of soya beans include peptides, isoflavones, saponins, and protease inhibitors. The prominent protein fractions of soya beans are β -conglycinin (β CG, 7S) and glycinin (11S) which constitute around 80–90% of the whole proteins in the soya bean. Moreover, soya beans are also rich in isoflavones which have potent estrogenic and anti-estrogenic properties and saponins which are proven to have significant anti-inflammatory, anti-carcinogenic and cardioprotective properties (Guang et al. 2014).

The majority of the scientific studies have been focused on the hypolipidemic properties of soya beans. Yoshikawa et al. in 2000 have discovered the bioactive peptide LPYPR from the glycine fraction of soya beans. They found that administration of LPYPR (50 mg/kg) significantly reduced the total cholesterol and LDL cholesterol levels in rats (Yoshikawa et al. 2000). Further studies revealed that LPYP functions by inhibiting 3-hydroxy-3-methylglutaryl CoA reductase (HMGR) enzyme, which is the prominent rate limiting enzyme in cholesterol biosynthesis. In addition, other glycine derived peptides like IAVPGEVA and IAVPTGVA had shown potent inhibitory effects on HMGR enzyme, thus promoting hypolipidemic activity. Moreover, peptides derived from β CG like KNPQLR, EITPEKNPQLR, and RKQEEDEDEEQORE had found to be effective in inhibiting fatty acid synthase activity and thereby decreased serum triglyceride levels in rodents (Singh et al. 2014).

Bioactive peptides that are available in food products are well studied for their anti-hypertensive properties (Singh et al. 2014). The bioactive peptides isolated include: valyl-prolyl-proline (Val-Pro-Pro), isoleucyl-prolyl-proline (Ile-Pro-Pro) and (Tyr-Pro). These peptides elicit their action by inhibiting angiotensin-converting enzyme (ACE), which is a key enzyme in the regulation the blood pressure (Cam and de Mejia 2012). The marketed fermented soya bean food products like soya sauce, natto and tempeh are abundant in ACE inhibitory peptides (Hernández-Ledesma et al. 2004). Fermented Korean soya bean contain anti-hypertensive peptide HHL, also soya bean fermented with *Bacillus natto* or *Bacillus subtilis* contains two anti-hypertensive peptides VAHINVGZK and YVWK (Singh et al. 2014).

Soybean supplementation improve cholinergic transmission by increasing the levels of acetylcholine in cortex and hippocampus region of rats (Pan et al. 1999). Soybeans also promote the release of neurotrophic factors which have a critical role in brain development and functioning.

Soyabean upregulates the expression of brain derived neurotrophic factor in cortical region of rats, nerve growth factor in cortex and hippocampus of rats (Pan et al. 1999) and improve memory performance in mice which is corroborated to decrease in high blood lipid levels and increased activity of neurotransmitters in mice. Clinical studies have also found that intake of soya improves both short term and long-term memory. Soybeans have also been found to improve the motor functions in Parkinson's disease by inhibiting the levodopa metabolism in humans (Liu et al. 2007).

Spinach

Spinach (*Spinacia oleracea*) is a leafy green vegetable belonging to the family *Amaranthaceae* and originated from Persia in the 7th century. Spinach is consumed in both raw and cooked form. Primarily the major chemical constituents are water (91.4), carbohydrates (3.6%), proteins (2.9%) and fat (0.4%). The lipid fraction mainly consists of poly unsaturated fatty acids (PUFA) (Park 1966). In addition, spinach is an abundant source of the carotenoid leutin, which is highly beneficial for patients with macular degeneration and cataracts (Olmedilla et al. 2003). Compared to other leafy vegetables spinach is rich in flavonoids which includes patuletin, spinacetin, spinatocide, jaceidin, and flavone (Koh et al. 2012). These compounds are responsible for the potent antioxidant and anti-inflammatory properties of spinach.

Antioxidant properties of spinach are well established. Studies have reported that spinach scavenges 2,2'-Azino-bis(3-ethylbenzothiazoline-6-sulfonic acid; ABTS) radical, superoxide anion (O_2^-), Fe^{2+} , peroxy radical, hydroxyl radical, and peroxynitrite thereby protecting cells from oxidative damages (Jaiswal et al. 2011). A water-soluble natural antioxidant (NAO) mixture extracted from spinach contains polyphenols and flavonoids. NAO was found to be effective in preventing malonaldehyde (MDA) formation (Bergman et al. 2001). The anti-inflammatory properties of spinach are also well established. Animals treated with spinach derived NAO and then challenged with lipopolysaccharide have shown reduced severity of lesions and alleviated the COX2 mediated inflammation (Bergman et al. 2001). In addition, leutin has potential free radical scavenging property and thereby decreased the levels of PGE2, TNF- α , and IL-1 β in the LPS induced inflammatory model. Spinach intake reduces infarct volume, lowers caspase activity in cerebral cortex and increased locomotor activity in focal ischemic rat brain (Lingappan 2018).

Clinical studies have also proven the potential cardioprotective properties of spinach. In a Randomized, Controlled Trial Jovanovski et al. (2015) had hypothesized that short term consumption of spinach, which is high

nitrate content, this can affect arterial stiffness as well as central and peripheral blood pressure. The patients were supplemented with spinach (845 mg nitrate/day). They found postprandial reduction in augmentation index and concluded that spinach consumption contributes to hemodynamic properties, decreased arterial stiffness and central blood pressure.

Brown rice

Brown rice is a whole grain rice with the outer inedible husk removed. Green revolution in 1960's and 1970's has improved the crop yield and economy of the Asian countries like Japan and Korea. Since then, these countries focused on improving the taste, appearance and the texture of rice. A meta-analysis study from (Itani et al. 2002) has shown that increased consumption of sugar rich rice such as processed rice and sedentary life style raised the incidence of type 2 diabetes. This happened due to rice milling, which discards the micronutrients, proteins and fiber rich outer aleurone layer. Brown rice possesses prominent health benefits when compared to white rice. One cup of boiled brown rice has 216.4 cal of energy, monosaturated and polysaturated fat (0.64 g and 0.63 g respectively), 44.8 g of carbohydrates and 5.3 g of proteins. In addition, brown rice is also a rich source of fiber (3.5 g), thiamine (12%), riboflavin (15%), nicotinic acid, zinc (8%), iron (5%), magnesium (21%), phosphorous (16%) and pantothenic acid (6%). The vitamin E component of brown rice consists of eight lipid homologues α , β , γ and δ tocopherol or tocotrienol these are having potent lipid peroxyl radical scavenging properties thus preventing cellular ageing (Kim et al. 2015).

Lee et al., conducted a randomized 12-week clinical study where the type 2 diabetes patients were assigned to follow brown rice-based vegan diet. They found that brown rice-based vegan diet is more effective for glycaemic control in type 2 diabetic patients than conventional diet. In addition, they also found a reduction in the HbA1C levels among the vegan diet followed patients (Lee et al. 2016). Kozuka et al., have elucidated the underlying mechanism on how brown rice improves the glucose intolerance and impede the onset of diabetes. They investigated the effect of γ -oryzanol (orz) which is a major chemical constituent of brown rice on the feeding behavior and glucose homeostasis. They found that orz significantly improved the glucose intolerance and this was achieved by attenuating endoplasmic reticulum stress in mice fed with high fat diet. Using HEK293 cell line the revealed that orz prominently inhibits the transcriptional activity in the endoplasmic reticulum stress responsive element. In addition, they also found that orz significantly down-regulated the gene expression of endoplasmic reticulum stress related

molecules in fetal mouse brain derived neuronal cells. Moreover, orz also has shown to improve glucolipotoxicity induced pancreatic islets disruption via enhancing glucose-stimulated insulin secretion and inhibiting excessive secretion of glucan (Kozuka et al. 2015).

Buckwheat

Buckwheat (BW) is a gluten free commonly eaten functional food belonging to family *Polygonaceae* genus *Fagopyrum*. It is considered as a food of high nutritional value due to the presence of protein, lipid, dietary fiber, minerals, phenolic compounds, and sterols. Buckwheat contains flavonoids such as rutin and polyphenolic compounds like hyperin, quercitrin, and studies showed that quercetin could be responsible for the beneficial effects. BW is also rich in amino acid lysine, arginine and vitamins (Giménez-Bastida and Zieliński 2015). Recently it has been found that buckwheat also contains γ -aminobutyric acid (GABA) and 2''-hydroxynicotianamine. BW has shown to possess strong antioxidant activity and prevents the DNA damage induced by oxidative stress (Zhou et al. 2012). Phenolic compounds and flavonoids present in BW exert anti-inflammatory effect by reducing the expression of IL-6, IL-1 β , and TNF- α and inhibit NF- κ B (Hole et al. 2009). BW consumption reduces body fat, low density lipids (LDL) and increases the content of high density lipids (HDL) and lowers cholesterol and triglycerides (TG) in rats (Kayashita et al. 1996), thus inhibiting the development and progression of cardiovascular diseases. BW intake also affects the mRNA expression of enzymes responsible for lipid metabolism. BW decreases the expression of glucose-6-phosphate dehydrogenase and fatty acid synthase and downregulates expression of PPAR- γ , peroxisome proliferator activated receptor- γ , CCAAT/enhancer-binding protein- α , sterol regulatory element-binding protein 1c, and carbohydrate responsive element-binding protein and of lipogenic genes acetyl-coenzyme A carboxylase 1 or 2 (ACCI and 2), stearyl-coenzyme A oxidase, and FA synthase (Choi et al. 2007). Preclinical studies have shown that BW reduces the blood glucose levels in diabetic rats (Yao et al. 2008), inhibited α -amylase and α -glucosidase activity (Lee et al., 2015) and also modulates satiety, improve insulin sensitivity and glucose tolerance in hyperglycaemia patients (Qiu et al. 2016). Polyphenols present in buckwheat exert neuroprotection because of its free radical scavenging activity. Buckwheat has shown to improve spatial memory by inhibiting glutamate release and inhibiting production of nitric oxide in cerebral ischemia induced rat (Giménez-Bastida and Zieliński 2015). Buckwheat also improved the memory in *in vivo* model of AD by reducing oxidative stress in mice (Choi et al. 2007) (Fig. 3).

Several clinical studies have also shown potential health benefits of BW. He et al. (1995) has shown that daily intake of 100 g of lowered both total and LDL cholesterol in 850 people of ethnic minority in china. In a double blind crossover study from Wieslander et al. (2011) samples were supplemented with normal BW (16.5 mg rutin/day) and tartary BW cookies (359.7 mg rutin/day) for two weeks. They found that tartary BW cookies consumption reduced the serum myeloperoxidase, total serum cholesterol and HDL-cholesterol. Moreover, they also found that tartary BW consumption improved the lung vital capacity. Hence, consumption of BW reduces the inflammatory markers and cardiovascular events in human beings.

Fruits as a source of functional food

Fruits are a rich source of fiber, vitamins and polyphenolic and anthocyanin compounds. These compounds have many physiological functions and delays the onset of ageing related changes, helps in fighting infections and chronic diseases, impedes cancer, osteoporosis and neurological disease progression. Some of the fruits which act as functional food discussed below.

Blueberries

Blueberries were known as 'super fruit' because of their strong antioxidant activity and rich content of polyphenolic compounds. Blueberries contain flavonoid and non-flavonoid. Anthocyanins (60%) are the major components. Malvidin 3-galactoside, delphinidin 3-galactoside, delphinidin 3-arabinoside, petunidin 3-galactoside, petunidin 3-arabinoside, malvidin 3-arabino-side, cyanidin 3-glucoside, cyanidin 3-galactoside, cyanidin 3-arabinoside and delphinidin 3-glucoside are the major anthocyanins present in blueberries. Proanthocyanidins, flavonols and chlorogenic acid are also present in blueberries. The commercially available blueberries species are *Vaccinium corymbosum* L., *V. virgatum* Aiton, *V. angustifolium*, *V. myrtilus* L. The association between the higher intake of anthocyanin and health benefits have been well studied. Higher intake of anthocyanin was associated with a decrease in hypertension risk in women, improved vascular function and helps in weight maintenance (Bertoia et al. 2016). Blueberries are also found to be beneficial in diabetes. Higher intake of anthocyanins improved insulin sensitivity, reduced inflammation and oxidative stress in diabetic patients (Li et al. 2015). Anthocyanin intake also reduced the risk of Alzheimer's disease, dementia and PD (Gao et al. 2012). *In vitro* studies have shown that anthocyanins improved viability and differentiation of human corneal epithelial cells (Song et al. 2010) and improve



Fig. 3 Mechanism by which buckwheat intake provides benefits in different disease conditions

retinal photoreceptor sensitivity. Blueberries have been shown to reduce cancer progression by inhibiting production of pro-inflammatory molecules, oxidative stress and products of oxidative stress such as DNA damage, inhibition of cancer cell proliferation and increased apoptosis (Johnson and Arjmandi 2013).

Pomegranate

Pomegranate (*Punica granatum* L) fruits are rich source of phytochemical such as polyphenols, anthocyanins, tannins, flavonoids, lignans, terpenoids, and sterols. Ellagitannin which is broken down to ellagic acid is the main active constituent of pomegranate which is responsible for its strong antioxidant activity (Akbar et al. 2015). Punicalagin and punicalin are the two other ellagitannins having antioxidant and anti-inflammatory activity (Vučić et al. 2019). Numerous studies have claimed health benefits of pomegranates in preventing chronic diseases such as hypertension, arthritis, cancer, hyperglycaemia, reducing oxidative stress and maintaining cholesterol levels (Zarfe-shany et al. 2014).

Khan et al. (2007) has revealed that pomegranate juice inhibits cell growth, induces pro-apoptotic proteins and downregulates anti-apoptotic proteins and suppresses the progression of prostate cancer and breast cancer as well as lung and colon cancer (Khan et al. 2007). The pomegranate fruit extract (PFE) used in this study was rich in six

anthocyanins (pelargonidin 3-glucoside, cyanidine 3-glucoside, delphinidin 3-glucoside, pelargonidin 3,5-diglucoside, cyanidine 3,5-diglucoside and delphinidin 3,5-diglucoside), ellagitannins and hydrolysable tannins. In-vitro data has shown decreased cell viability in A549 following PFE administration. They found that PFE upregulates the cell cycle regulatory molecules like WAF1/p21 and KIP1/p27. WAF1/p21 and KIP1/p27 are regarded as the universal molecules of inhibitor of cyclin-cdk complexes. PFE administration has also significantly downregulated the cyclin-cdk associated molecules. In addition, the PFE administration declined progression of A549 human lung carcinoma cells in athymic mice. The potent anti-oxidant property aid to the chemoprotective nature of PFE.

Studies have showed the role of pomegranate juice in preventing hypertension and congestive heart disease (Esmaillzadeh et al. 2006). Pomegranate juice also promotes the expression of transcription factors such as CREB, and BDNF which play a critical role in brain development. Pomegranate juice reduces cerebral amyloid beta deposits by increasing the expression of CREB and synaptic proteins which were also found to be involved in the cleavage of amyloid precursor protein in transgenic mice model of Alzheimer's disease (Braidy et al. 2016). Decreased expression of amyloid beta in hippocampus due to pomegranate intake improves cognitive functions in mice. Pomegranate juice also enhances neuronal survival,

protects from oxidative stress, reduces α -synuclein aggregation and could be able to increase mitochondrial activity in rotenone model of Parkinson's disease. Pomegranate administration also reduces the neuroinflammation and improved motor functions in mice (Kujawska et al. 2019).

Mango

Mango (*Mangifera indica* L.) is rich in polyphenols and other micronutrients which exert several health benefits. Mangiferin, gallic acid, gallotannins, quercetin, isoquercetin, ellagic acid, and β -glucogallin are the polyphenols present in mango. Mango parts have been used in traditional system in the management of various diseases. Mango extracts counteract the oxidative damage induced by the excessive production of free radicals and exert anti-inflammatory activity in mice model of colitis by reducing the expression of inflammatory mediators via IGF1R/AKT/mTOR pathway (Kim et al. 2016). Mango extract has beneficial effects in hypoglycaemia by inhibiting α -amylase and α -glucosidase activities (Gondi and Prasada Rao 2015). Bioactive compounds of mango have also shown to possess anticancer activity which is mediated by down-regulating the anti-apoptotic factor Bcl-2 and activating caspase proteases. Mango intake reduces the risk of obesity and promotes endothelial function. Phytochemicals present in mango improve the lipid profile and reduced blood pressure surge in hypertensive rats (Liu et al. 2003). Mango intake also reduces the development of neurological diseases such as Alzheimer's disease. *In vitro* and *in vivo* studies have confirmed that magniferin protects the neurons by scavenges the ROS and restores mitochondrial membrane potential and improved cognitive performance (Bhatia et al. 2008).

Nuts as a source of functional food

Almond

Almonds are the most popular nut consumed by humans. They have a high nutritional value and are rich in polyphenols, vitamins, carbohydrates and polyphenols. Almonds are also rich in monounsaturated fatty acids such as oleic, linoleic and palmitic acids. Intake of almonds reduce chronic disease such as diabetes, hypertension and help in weight maintenance. *In vitro* and animal studies have reported that almonds reduce oxidative stress and DNA damage. Epidemiological studies have shown that higher intake of almonds in Mediterranean countries contributes to lower incidences of coronary heart disease, reduce inflammatory diseases and improve endothelial functions (Kamil and Chen 2012). Dietary elements present

in almonds improve memory consolidation in rodent models of amnesia (Batoool et al. 2016).

Walnut

Walnuts are one of the most nutritive nuts belonging to family *Juglandaceae*. They are rich in proteins, fats, vitamins, minerals, and polyphenols. The major triacylglycerols; free fatty acids found in the walnut kernel are oleic, linoleic, linolenic acids (Poulose et al. 2014). They also contain high quantity of omega-3 fat [α -linolenic acid] which has been linked with numerous health benefits. Walnuts also contain amino acids such as lysine and arginine which are converted to nitric oxide, which acts as a potent vasodilator, inhibiting platelet adhesion and aggregation, and reducing the progression of atherosclerosis. Ellagic acid present in the walnut reduces the risk of congestive heart disease and suppresses cancer progression. Melatonin present in walnut is a powerful antioxidant and regulates circadian rhythm. Dietary supplement of walnut improves memory consolidation and has been reported to delay the progression of neurological disorders. Moreover, walnut supplementation provided neuroprotection and improved motor functions in rodent model of Parkinson's disease (Choi et al. 2016). Taken together, evidences suggest that integration of nuts in a healthy diet could be an effective measure to maintain a health state and delay the onset of diseases.

Functional foods of animal origin

Fish

The chief bioactive component present in fish products are polyunsaturated fatty acids. Eicosapentaenoic acid and docosahexaenoic acid (DHA) form the major components of polyunsaturated fatty acids. DHA forms an essential component of cellular membranes in brain and retina. DHA is critical for normal functioning and development of organs in children. Preclinical and clinical studies have shown the beneficial effects of fatty acids in inflammatory diseases such as arthritis, psoriasis, Crohn's disease, and chronic diseases such as cancer and cardiovascular diseases. DHA have also been found to provide protective effect in neurological diseases (Wergeland et al. 2012).

Probiotics

Probiotics are the viable microorganisms that improve the intestine functions in the host organisms. Probiotics are known for their anti-carcinogenic, hypocholesterolemic and antagonistic action against enteric pathogen in the

intestines. Dairy products are the best source of calcium. Probiotics have been incorporated in milk products, mayonnaise, edible spreads (Begum et al. 2017). Probiotics constitute around 65% of functional food market. Probiotics inhibit pathogen growth by synthesizing biochemical compounds which possess antimicrobial activity, altering the pH, receptor binding of pathogens, and initiating immune response. Probiotics have also been found to be useful in the management of neurological disorders. Alteration in gut microbiome have been reported in autistic children. Lower levels of *Bifidobacterium* have been found in autism. Similarly, fecal matter of autistic children has higher levels of *Clostridium spp.* In case of Alzheimer's disease *Oscillospira* were found to be reduced while as *Enterobacter*, *Shigella* and *Roseburia* increased. Various clinical and animal studies have confirmed the beneficial effects of probiotics in autism. The key mechanism by which probiotics have an impact on the gut microbiome are by competing for dietary ingredients production of end products having inhibitory property increased innate immunity reduced inflammatory response. Some of the commonly used microorganisms in probiotics are *Lactobacillus rhamnosus*, *Lactobacillus reuteri*, *Bifidobacteria*, *Lactobacillus casei* *Lactobacillus acidophilus*, *Bacillus coagulans*, *Escherichia coli*, *Saccharomyces boulardii*. Probiotics may contain a single strain or mixture of these microorganisms.

FDA perspective on functional foods

The Federal Food Drug and Cosmetic Act (FFDCA) does not provide a specific definition for the functional food. Hence, FDA does not have an established regulation for the functional foods. Therefore, marketing functional foods come under the existing regulatory options. There is a rising concern to develop regulations to document the safety of the dietary ingredients and dietary supplements. Nutrition Labeling and Education Act which was developed (NLEA) in 1990 introduced food labels, this explains the relationship between food or a food component with disease or health conditions. These potential health benefit claims should be approved by FDA before marketing. In 1997, the FDA Modernization Act (FDAMA) had been implemented. This act smoothened the FDA preapproval process by implementing the "authoritative statements" on food labels as health claims. These statements should be published by US government bodies which are responsible for the public health like National Institute of Health (NIH). Manufacturers who intend to use the authoritative statement should notify the FDA 120 days prior to the marketing (Affairs 2019 p. 1).

The most significant change in the food regulation was implemented by Dietary Supplement Health and Education Act of 1994 (DSHEA). This act considered the food additives as vitamins, minerals, amino acids used by man to improve the health conditions. They introduced "significant Scientific agreement" which includes the reports of the safety and efficacy of these compounds in living system. This includes the role of the bioactive compound that affects the functioning of living systems and the mechanism by which the compound induces pharmacological effect. In addition, if the compound claims to treat any conventional nutrient deficiency diseases then the prevalence of the disease in the United States should be produced. Manufacturers who are using structural and functional claims on the label should notify the FDA within 30 days of marketing and the following statement should be kept as a disclaimer ("Dietary Supplement Health and Education Act of 1994," n.d.).

Conclusion

Functional foods have been receiving considerable global attention because of their nutritional value and the presence of constituents which are critical in regulation of physiological processes. Functional foods have all the ingredients necessary for a healthy diet and have been found to possess health benefits. Recommendation of functional foods is evolving and will be an essential strategy for maintenance of healthy state and delaying or preventing the onset of diseases.

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Author contributions MB, and AB performed literature research, gathered and analyzed information, and generated short preliminary write-ups. SBC, BB, HH and NG provided research insight, content examination and supported wide ranging aspects of the manuscript development process. MME, RPF and MWQ conceptual work, framework, final draft write-up, critical reading and editing. All authors read and approved the final manuscript.

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Declarations

Conflict of interest Authors declare no conflict of interest.

References

- Abdel-Daim MM, Eltaysh R, Hassan A, Mousa SA (2018) Lycopene attenuates tulathromycin and diclofenac sodium-induced cardiotoxicity in mice. *Int J Mol Sci*. <https://doi.org/10.3390/ijms19020344>
- Affairs, O. of R., (2019). Nutrition labeling and education act (NLEA) requirements-attachment 1. FDA.
- Akbar M, Song BJ, Essa MM, Khan MA (2015) Pomegranate: an ideal fruit for human health. *Int J Nutr Pharmacol Neurol Dis* 5:141. <https://doi.org/10.4103/2231-0738.167506>
- Alshatwi AA, Al Obaid MA, Al Sedair SA, Al-Assaf AH, Zhang JJ, Lei KY (2010) Tomato powder is more protective than lycopene supplement against lipid peroxidation in rats. *Nutr Res N Y N* 30:66–73. <https://doi.org/10.1016/j.nutres.2009.12.002>
- Batool Z, Sadir S, Liaquat L, Tabassum S, Madiha S, Rafiq S, Tariq S, Batool TS, Saleem S, Naqvi F, Perveen T, Haider S (2016) Repeated administration of almonds increases brain acetylcholine levels and enhances memory function in healthy rats while attenuates memory deficits in animal model of amnesia. *Brain Res Bull* 120:63–74. <https://doi.org/10.1016/j.brainresbull.2015.11.001>
- Bai Y, Wang X, Zhao S, Ma C, Cui J, Zheng Y (2015) Sulforaphane protects against cardiovascular disease via Nrf2 activation. *Oxid Med Cell Longev*. 2015:407580
- Begum PS, Madhavi G, Rajagopal S, Viswanath B, Razak MA, Venkataratnam V (2017) Probiotics as functional foods: potential effects on human health and its impact on neurological diseases. *Int J Nutr Pharmacol Neurol Dis* 7:23. https://doi.org/10.4103/ijnppnd.ijnppnd_90_16
- Bergman M, Varshavsky L, Gottlieb HE, Grossman S (2001) The antioxidant activity of aqueous spinach extract: chemical identification of active fractions. *Phytochemistry* 58:143–152. [https://doi.org/10.1016/s0031-9422\(01\)00137-6](https://doi.org/10.1016/s0031-9422(01)00137-6)
- Bertoia ML, Rimm EB, Mukamal KJ, Hu FB, Willett WC, Cassidy A (2016) Dietary flavonoid intake and weight maintenance: three prospective cohorts of 124 086 US men and women followed for up to 24 years. *BMJ* 352:i17. <https://doi.org/10.1136/bmj.i17>
- Bhatia HS, Candelario-Jalil E, de Oliveira ACP, Olajide OA, Martínez-Sánchez G, Fiebich BL (2008) Mangiferin inhibits cyclooxygenase-2 expression and prostaglandin E2 production in activated rat microglial cells. *Arch Biochem Biophys* 477:253–258. <https://doi.org/10.1016/j.abb.2008.06.017>
- Blaak EE, Canfora EE, Theis S, Frost G, Groen AK, Mithieux G, Nauta A, Scott K, Stahl B, van Harsselaar J, van Tol R, Vaughan EE, Verbeke K (2020) Short chain fatty acids in human gut and metabolic health. *Benef Microbes* 11:411–455. <https://doi.org/10.3920/BM2020.0057>
- Braidly N, Essa MM, Poljak A, Selvaraju S, Al-Aawi S, Manivasagam T, Thenmozhi AJ, Ooi L, Sachdev P, Guillemin GJ (2016) Consumption of pomegranates improves synaptic function in a transgenic mice model of Alzheimer's disease. *Oncotarget* 7: 64589–64604. <https://doi.org/10.18632/oncotarget.10905>
- Burns J, Fraser PD, Bramley PM (2003) Identification and quantification of carotenoids, tocopherols and chlorophylls in commonly consumed fruits and vegetables. *Phytochemistry* 62:939–947. [https://doi.org/10.1016/s0031-9422\(02\)00710-0](https://doi.org/10.1016/s0031-9422(02)00710-0)
- Cam A, de Mejia EG (2012) Role of dietary proteins and peptides in cardiovascular disease. *Mol Nutr Food Res* 56:53–66. <https://doi.org/10.1002/mnfr.201100535>
- Chaplin A, Carpené C, Mercader J (2018) Resveratrol, metabolic syndrome, and gut microbiota. *Nutrients*. <https://doi.org/10.3390/nu10111651>
- Chen D, Huang C, Chen Z (2019) A review for the pharmacological effect of lycopene in central nervous system disorders. *Biomed Pharmacother* 111:791–801. <https://doi.org/10.1016/j.biopha.2018.12.151>
- Chen L, Stacewicz-Sapuntzakis M, Duncan C, Sharifi R, Ghosh L, van Breemen R, Ashton D, Bowen PE (2001) Oxidative DNA damage in prostate cancer patients consuming tomato sauce-based entrees as a whole-food intervention. *J Natl Cancer Inst* 93:1872–1879. <https://doi.org/10.1093/jnci/93.24.1872>
- Choi I, Seog H, Park Y, Kim Y, Choi H (2007) Suppressive effects of germinated buckwheat on development of fatty liver in mice fed with high-fat diet. *Phytomedicine* 14:563–567. <https://doi.org/10.1016/j.phymed.2007.05.002>
- Choi JG, Par G, Kim HG, Oh DS, Kim H, Oh MS (2016) In Vitro and in vivo neuroprotective effects of walnut (*Juglandis Semen*) in models of parkinson's disease. *Int J Mol Sci*. <https://doi.org/10.3390/ijms17010108>
- Damon M, Zhang NZ, Haytowitz DB, Booth SL (2005) Phylloquinone (vitamin K1) content of vegetables. *J Food Compos Anal Off Publ UN Univ Int Netw Food Data Syst* 18:751–758. <https://doi.org/10.1016/j.jfca.2004.07.004>
- Dietary Supplement Health and Education Act of 1994 [WWW Document], n.d. URL https://ods.od.nih.gov/About/DSHEA_Wording.aspx (accessed 2.21.21).
- Elumalai P, Lakshmi S (2016) Role of Quercetin benefits in neurodegeneration. *Adv Neurobiol* 12:229–245. https://doi.org/10.1007/978-3-319-28383-8_12
- Esmailzadeh A, Tahbaz F, Gaieni I, Alavi-Majd H, Azadbakht L (2006) Cholesterol-lowering effect of concentrated pomegranate juice consumption in type II diabetic patients with hyperlipidemia. *J Int Vitaminol Nutr* 76:147–151. <https://doi.org/10.1024/0300-9831.76.3.147>
- Gao X, Cassid A, Schwarzschild MA, Rimm EB, Ascherio A (2012) Habitual intake of dietary flavonoids and risk of Parkinson disease. *Neurology* 78:1138–1145. <https://doi.org/10.1212/WNL.0b013e31824f7fc4>
- Grainger EM, Schwartz SJ, Wang S, Unlu NZ, Boileau TW-M, Ferketich AK, Monk JP, Gong MC, Bahnson RR, DeGroot VL, Clinton SK (2008) A combination of tomato and soy products for men with recurring prostate cancer and rising prostate specific antigen. *Nutr Cancer* 60:145–154. <https://doi.org/10.1080/01635580701621338>
- Giménez-Bastida JA, Zieliński H (2015) Buckwheat as a functional food and its effects on health. *J Agric Food Chem* 63:7896–7913. <https://doi.org/10.1021/acs.jafc.5b02498>
- Gondi M, Prasada Rao UJS (2015) Ethanol extract of mango (*Mangifera indica* L.) peel inhibits α -amylase and α -glucosidase activities, and ameliorates diabetes related biochemical parameters in streptozotocin (STZ)-induced diabetic rats. *J Food Sci Technol* 52:7883–7893. <https://doi.org/10.1007/s13197-015-1963-4>
- Guang C, Chen J, Sang S, Cheng S (2014) Biological functionality of soyasaponins and soyasapogenols. *J Agric Food Chem* 62:8247–8255. <https://doi.org/10.1021/jf503047a>
- Hasler CM, Brown AC, American Dietetic Association (2009) Position of the American dietetic association: functional foods. *J Am Diet Assoc* 109:735–746. <https://doi.org/10.1016/j.jada.2009.02.023>
- He J, Klag MJ, Whelton PK, Mo JP, Chen JY, Qian MC, Mo PS, He GQ (1995) Oats and buckwheat intakes and cardiovascular disease risk factors in an ethnic minority of China. *Am J Clin Nutr* 61:366–372. <https://doi.org/10.1093/ajcn/61.2.366>

- Hernández-Ledesma B, Amigo L, Ramos M, Recio I (2004) Angiotensin converting enzyme inhibitory activity in commercial fermented products. Formation of peptides under simulated gastrointestinal digestion. *J Agric Food Chem* 52:1504–1510. <https://doi.org/10.1021/jf034997b>
- Hole AS, Grimmer S, Natersta K, Jensen MR, Paur I, Johansen SG, Balstad TR, Blomhoff R, Sahlstrøm S (2009) Activation and inhibition of nuclear factor kappa B activity by cereal extracts: role of dietary phenolic acids. *J Agric Food Chem* 57:9481–9488. <https://doi.org/10.1021/jf9021459>
- Hung CF, Huang TF, Chen BH, Shieh JM, Wu PH, Wu WB (2008) Lycopene inhibits TNF-alpha-induced endothelial ICAM-1 expression and monocyte-endothelial adhesion. *Eur J Pharmacol* 586:275–282. <https://doi.org/10.1016/j.ejphar.2008.03.001>
- Ibrahim HS, Ahmed L, El-din ME (2008) The functional role of some tomato products on lipid profile and liver function in adult rats. *J Med Food* 11:551–559. <https://doi.org/10.1089/jmf.2007.0517>
- Itani T, Tamaki M, Arai E, Horino T (2002) Distribution of amylose, nitrogen, and minerals in rice kernels with various characters. *J Agric Food Chem* 50:5326–5332. <https://doi.org/10.1021/jf020073x>
- Jaiswal AK, Rajauria G, Abu-Ghannam N, Gupta S (2011) Phenolic composition, antioxidant capacity and antibacterial activity of selected Irish Brassica vegetables. *Nat Prod Commun* 6:1299–1304
- Johnson SA, Arjmandi BH (2013) Evidence for anti-cancer properties of blueberries: a mini-review. *Anticancer Agents Med Chem* 13:1142–1148. <https://doi.org/10.2174/18715206113139990137>
- Jovanovski E, Bosco L, Khan K, Au-Yeung F, Ho H, Zurbau A, Jenkins AL, Vuksan V (2015) Effect of spinach, a high dietary nitrate source, on arterial stiffness and related hemodynamic measures: a randomized, controlled trial in healthy adults. *Clin Nutr Res* 4:160–167. <https://doi.org/10.7762/cnr.2015.4.3.160>
- Juengel E, Euler S, Maxeiner S, Rutz J, Justin S, Roos F, Khoder W, Nelson BWO, Blaheta RA (2017) Sulforaphane as an adjunctive to everolimus counteracts everolimus resistance in renal cancer cell lines. *Phytomedicine Int J Phytother Phytopharm* 27:1–7. <https://doi.org/10.1016/j.phymed.2017.01.016>
- Kamil A, Chen CYO (2012) Health benefits of almonds beyond cholesterol reduction. *J Agric Food Chem* 60:6694–6702. <https://doi.org/10.1021/jf2044795>
- Karasawa MMG, Mohan C (2018) Fruits as prospective reserves of bioactive compounds: a review. *Nat Prod Bioprospecting* 8:335–346. <https://doi.org/10.1007/s13659-018-0186-6>
- Kayashita J, Shimaoka N, M, Kato N, (1996) Feeding of buckwheat protein extract reduces hepatic triglyceride concentration, adipose tissue weight, and hepatic lipogenesis in rats. *J Nutr Biochem* 7:555–559. [https://doi.org/10.1016/S0955-2863\(96\)00110-6](https://doi.org/10.1016/S0955-2863(96)00110-6)
- Khan N, Hadi N, Afaq F, Syed DN, Kweon MH, Mukhtar H (2007) Pomegranate fruit extract inhibits pro-survival pathways in human A549 lung carcinoma cells and tumor growth in athymic nude mice. *Carcinogenesis* 28:163–173. <https://doi.org/10.1093/carcin/bgl145>
- Kim H, Banerjee N, Ivanov I, Pfent CM, Prudhomme KR, Bisson WH, Dashwood RH, Talcott ST, Mertens-Talcott SU (2016) Comparison of anti-inflammatory mechanisms of mango (*Mangifera Indica L.*) and pomegranate (*Punica Granatum L.*) in a preclinical model of colitis. *Mol Nutr Food Res* 60:1912–1923. <https://doi.org/10.1002/mnfr.201501008>
- Kim NH, Kwak J, Baik JY, Yoon MR, Lee JS, Yoon SW, Kim IH (2015) Changes in lipid substances in rice during grain development. *Phytochemistry* 116:170–179. <https://doi.org/10.1016/j.phytochem.2015.05.004>
- Koh E, Charoenprasert S, Mitchell AE (2012) Effect of organic and conventional cropping systems on ascorbic acid, vitamin c, flavonoids, nitrate, and oxalate in 27 varieties of spinach (*Spinacia oleracea L.*). *J Agric Food Chem* 60:3144–3150. <https://doi.org/10.1021/jf300051f>
- Kozuka C, Sunagawa S, Ueda R, Higa M, Tanaka H, Shimizu-Okabe C, Ishiuchi S, Takayam C, Matsushita M, Tsutsui M, Miyazaki J, Oyadomari S, Shimabukuro M, Masuzaki H (2015) γ -Oryzanol protects pancreatic β -cells against endoplasmic reticulum stress in male mice. *Endocrinology* 156:1242–1250. <https://doi.org/10.1210/en.2014-1748>
- Kujawska M, Jourdes M, Kurpik M, Szulc M, Szafeer H, Chmielarz P, Kreiner G, Krajka-Kuźniak V, Mikolajczak PL, Teissedre PL, Jodynis-Liebert J (2019) Neuroprotective effects of pomegranate juice against parkinson's disease and presence of ellagitannin-derived metabolite—Urolithin a—In the brain. *Int J Mol Sci*. <https://doi.org/10.3390/ijms21010202>
- Lee C-C, Lee B-H, Lai Y-J (2015) Antioxidation and antiglycation of Fagopyrum tataricum ethanol extract. *J Food Sci Technol* 52:1110–1116. <https://doi.org/10.1007/s13197-013-1098-4>
- Lee YM, Kim SA, Lee IK, Kim JG, Park KG, Jeong JY, Jeon JH, Shin JY, Lee DH (2016) Effect of a brown rice based vegan diet and conventional diabetic diet on glycemic control of patients with type 2 diabetes: a 12-week randomized clinical trial. *PLoS ONE* 11:e0155918. <https://doi.org/10.1371/journal.pone.0155918>
- Li D, Zhang Y, Liu Y, Sun R, Xia M (2015) Purified anthocyanin supplementation reduces dyslipidemia, enhances antioxidant capacity, and prevents insulin resistance in diabetic patients. *J Nutr* 145:742–748. <https://doi.org/10.3945/jn.114.205674>
- Lindshield BL, Canene-Adams K, Erdman JW (2007) Lycopene: Are lycopene metabolites bioactive? *Arch Biochem Biophys* 458:136–140. <https://doi.org/10.1016/j.abb.2006.09.012>
- Lingappan K (2018) NF- κ B in oxidative stress. *Curr Opin Toxicol* 7:81–86. <https://doi.org/10.1016/j.cotox.2017.11.002>
- Liu Y, Xin T, Lü X, Ji Q, Jin Y, Yang H (2007) Memory performance of hypercholesterolemic mice in response to treatment with soy isoflavones. *Neurosci Res* 57:544–549. <https://doi.org/10.1016/j.neures.2006.12.013>
- Liu J-C, Hsu F-L, Tsai J-C, Chan P, Liu JY-H, Thomas GN, Tomlinson B, Lo M-Y, Lin J-Y (2003) Antihypertensive effects of tannins isolated from traditional Chinese herbs as non-specific inhibitors of angiotensin converting enzyme. *Life Sci* 73:1543–1555. [https://doi.org/10.1016/s0024-3205\(03\)00481-8](https://doi.org/10.1016/s0024-3205(03)00481-8)
- Masci A, Mattioli R, Costantino P, Baima S, Morelli G, Punzi P, Giordano C, Pinto A, Donini LM, d'Erme M, Mosca L (2015) Neuroprotective effect of brassica oleracea sprouts crude juice in a cellular model of alzheimer's disease. *Oxid Med Cell Longev* 2015:781938. <https://doi.org/10.1155/2015/781938>
- Mellentin J, Heasman M, Heasman M (2014) The functional foods revolution : healthy people. Routledge, Healthy Profits. <https://doi.org/10.4324/9781849776165>
- Mukherjee S, Gangopadhyay H, Das DK (2008) Broccoli: a unique vegetable that protects mammalian hearts through the redox cycling of the thioredoxin superfamily. *J Agric Food Chem* 56:609–617. <https://doi.org/10.1021/jf0728146>
- Murashima M, Watanabe S, Zhuo XG, Uehara M, Kurashige A (2004) Phase I study of multiple biomarkers for metabolism and oxidative stress after one-week intake of broccoli sprouts. *BioFactors Oxf Engl* 22:271–275. <https://doi.org/10.1002/biof.5520220154>
- Ogawa K, Hara T, Shimizu M, Nagano J, Ohno T, Hoshi M, Ito H, Tsurumi H, Saito K, Seishima M, Moriwaki H (2012) (-)-Epigallocatechin gallate inhibits the expression of indoleamine 2,3-dioxygenase in human colorectal cancer cells. *Oncol Lett* 4:546–550. <https://doi.org/10.3892/ol.2012.761>
- Olmedilla B, Granado F, Blanco I, Vaquero M (2003) Lutein, but not α -tocopherol, supplementation improves visual function in patients with age-related cataracts: a 2-y double-blind,

- placebo-controlled pilot study. *Nutrition* 19:21–24. [https://doi.org/10.1016/S0899-9007\(02\)00861-4](https://doi.org/10.1016/S0899-9007(02)00861-4)
- Pan Y, Anthony M, Clarkson TB (1999) Effect of estradiol and soy phytoestrogens on choline acetyltransferase and nerve growth factor mRNAs in the frontal cortex and hippocampus of female rats. *Soc Exp Biol Med N Y N* 221:118–125. <https://doi.org/10.1046/j.1525-1373.1999.d01-64.x>
- Park RB (1966) Subunits of Chloroplast Structure and Quantum Conversion in Photosynthesis, in: Bourne, G.H., Danielli, J.F. (Eds.), *International Review of Cytology*. Academic Press, pp. 67–95. DOI: [https://doi.org/10.1016/S0074-7696\(08\)60797-4](https://doi.org/10.1016/S0074-7696(08)60797-4)
- Poulose SM, Miller MG, Shukitt-Hale B (2014) Role of walnuts in maintaining brain health with age. *J Nutr* 144:561S–566S. <https://doi.org/10.3945/jn.113.184838>
- Qiu J, Liu Y, Yue Y, Qin Y, Li Z (2016) Dietary tartary buckwheat intake attenuates insulin resistance and improves lipid profiles in patients with type 2 diabetes: a randomized controlled trial. *Nutr Res n y N* 36:1392–1401. <https://doi.org/10.1016/j.nutres.2016.11.007>
- Rao AV, Agarwal S (1998) Bioavailability and in vivo antioxidant properties of lycopene from tomato products and their possible role in the prevention of cancer. *Nutr Cancer* 31:199–203. <https://doi.org/10.1080/01635589809514703>
- Ruiz-Sola MÁ, Rodríguez-Concepción M (2012) Carotenoid biosynthesis in arabidopsis: a colorful pathway. *Arab Book Am Soc Plant Biol*. <https://doi.org/10.1199/tab.0158>
- Shen Y-C, Chen S-L, Wang C-K (2007) Contribution of tomato phenolics to antioxidation and down-regulation of blood lipids. *J Agric Food Chem* 55:6475–6481. <https://doi.org/10.1021/jf070799z>
- Singh BP, Vij S, Hat S (2014) Functional significance of bioactive peptides derived from soybean. *Peptides* 54:171–179. <https://doi.org/10.1016/j.peptides.2014.01.022>
- Sneharani AH (2019) Curcumin-sunflower protein nanoparticles-a potential antiinflammatory agent. *J Food Biochem* 43:e12909. <https://doi.org/10.1111/jfbc.12909>
- Song J, Li Y, Ge J, Duan Y, Sze SCW, Tong Y, Shaw PC, Ng TB, Tsui KC, Zhuo Y, Zhang KY (2010) Protective effect of bilberry (*Vaccinium myrtillus L.*) extracts on cultured human corneal limbal epithelial cells (HCLEC). *Phytother Res PTR* 24:520–524. <https://doi.org/10.1002/ptr.2974>
- Subedi L, Cho K, Park YU, Choi H, Kim SY (2019) Sulforaphane-enriched broccoli sprouts pretreated by pulsed electric fields reduces neuroinflammation and ameliorates scopolamine-induced amnesia in mouse brain through its antioxidant ability via Nrf2-HO-1 activation. *Oxid Med Cell Longev*. <https://doi.org/10.1155/2019/3549274>
- Tang L, Jin T, Zeng X, Wang JS (2005) Lycopene inhibits the growth of human androgen-independent prostate cancer cells in vitro and in BALB/c nude mice. *J Nutr* 135:287–290. <https://doi.org/10.1093/jn/135.2.287>
- Vučić V, Grabež M, Trchounian A, Arsić A (2019) Composition and potential health benefits of pomegranate: a review. *Curr Pharm Des* 25:1817–1827. <https://doi.org/10.2174/1381612825666190708183941>
- Walters DG, Young PJ, Agus C, Knize MG, Boobis AR, Gooderham N, Lake BG (2004) Cruciferous vegetable consumption alters the metabolism of the dietary carcinogen 2-amino-1-methyl-6-phenylimidazo[4,5-b]pyridine (PhIP) in humans. *Carcinogenesis* 25:1659–1669. <https://doi.org/10.1093/carcin/bgh164>
- Wergeland S, Torkildsen Ø, Bø L, Myhr KM (2012) Polyunsaturated fatty acids in multiple sclerosis therapy. *Acta Neurol Scand Suppl*. <https://doi.org/10.1111/ane.12034>
- Wieslander G, Fabjan N, Vogrincic M, Kreft I, Janson C, Spetz-Nyström U, Vombergar B, Tagesson C, Leanderson P, Norbäck D (2011) Eating buckwheat cookies is associated with the reduction in serum levels of myeloperoxidase and cholesterol: a double blind crossover study in day-care centre staffs. *Tohoku J Exp Med* 225:123–130. <https://doi.org/10.1620/tjem.225.123>
- Vaishampayan U, Hussain M, Banerjee M, Seren S, Sarkar FH, Fontana J, Forman JD, Cher ML, Powell I, Pontes JE, Kucuk O (2007) Lycopene and soy isoflavones in the treatment of prostate cancer. *Nutr Cancer* 59:1–7. <https://doi.org/10.1080/01635580701413934>
- Wiseman H (2005) Potential importance of glucosinolate derivatives and related compounds to human health: molecular mechanisms of action. *PHYTOCHEMICALS | Epidemiological Factors*. 2:2005.
- Wu L, Ashraf MHN, Facci M, Wang R, Paterson PG, Ferrie A, Juurlink BHJ (2004) Dietary approach to attenuate oxidative stress, hypertension, and inflammation in the cardiovascular system. *Proc Natl Acad Sci U S A* 101:7094–7099. <https://doi.org/10.1073/pnas.0402004101>
- Xia H, Liu C, Li CC, Fu M, Takahashi S, Hu KQ, Aizawa K, Hiroyuki S, Wu G, Zhao L, Wang XD (2018) Dietary tomato powder inhibits high-fat diet-promoted hepatocellular carcinoma with alteration of gut microbiota in mice lacking carotenoid cleavage enzymes. *Cancer Prev Res* 11:797–810. <https://doi.org/10.1158/1940-6207.CAPR-18-0188>
- Yao Y, Shan F, Bian J, Chen F, Wang M, Ren G (2008) D-chiro-inositol-enriched tartary buckwheat bran extract lowers the blood glucose level in KK-Ay mice. *J Agric Food Chem* 56:10027–10031. <https://doi.org/10.1021/jf801879m>
- Yoshikawa M, Fujita H, Matoba N, Takenaka Y, Yamamoto T, Yamauchi R, Tsuruki H, Takahata K (2000) Bioactive peptides derived from food proteins preventing lifestyle-related diseases. *BioFactors Oxf Engl* 12:143–146. <https://doi.org/10.1002/biof.5520120122>
- Yu L, Wang W, Pang W, Xiao Z, Jiang Y, Hong Y (2017) Dietary lycopene supplementation improves cognitive performances in tau transgenic mice expressing P301L mutation via inhibiting oxidative stress and tau hyperphosphorylation. *J Alzheimers Dis JAD* 57:475–482. <https://doi.org/10.3233/JAD-161216>
- Zarfeshany A, Asgary S, Javanmard SH (2014) Potent health effects of pomegranate. *Adv Biomed Res*. <https://doi.org/10.4103/2277-9175.129371>
- Zhou J, Li P, Cheng N, Gao H, Wang B, Wei Y, Cao W (2012) Protective effects of buckwheat honey on DNA damage induced by hydroxyl radicals. *Food Chem Toxicol Int J Publ Br Ind Biol Res Assoc* 50:2766–2773. <https://doi.org/10.1016/j.fct.2012.05.046>

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Potency of pluchea (*Pluchea indica* Less) leaves to increase functional value of wet noodles: a review

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Abstract

Wet noodles lack functional nutrients that are beneficial for health, thus it is necessary to add other food ingredients that can increase the functional value of wet noodles. One of the food ingredients that can be added in wet noodles formulation is *Pluchea indica* Less leaves, which have been known as a source of antioxidants and used by the community as a traditional medicine to treat various health problems. The use of *Pluchea indica* Less leaves in making wet noodles is expected to increase the functional value of wet noodles. For this reason, this review paper discussed the potency of *Pluchea indica* Less leaves in affecting the phytochemical compounds content and functional properties of wet noodles. The use of *Pluchea indica* Less leaves showed potential to increase the phytochemical compounds contents of wet noodles, such as alkaloids, flavonoids, phenolics, saponins, tannins, and cardiac glycosides, which play an important role in the health of human body and maintaining the quality of wet noodles, such as antioxidant, anti-warmed over flavor, anti-inflammatory, antidiabetic, and antimicrobial activities. Thus, the addition of pluchea leaves has potential to increase the functional value of wet noodles including the phytochemical content and functional properties.

1. Introduction

Noodles as one of the wheat flour-based product are quiet popular among various levels of society in Indonesia. Noodles can be classified into five forms based on processing stage and water content of the noodles product, including raw noodles, wet noodles, dry noodles, fried noodles, and instant noodles. Wet noodles have water content of about 50-52% (Nuraida *et al.*, 2009), 52.10-52.85% (Billina *et al.*, 2014) 58-70% (Zhou *et al.*, 2021), and is produced through the cooking stage of raw noodles before being marketed (Billina *et al.*, 2014). According to Nuraida *et al.* (2009), the high moisture content of wet noodles causes the shelf life of wet noodles to only reach 42 hrs at room temperature storage.

Increased awareness and interest in functional food supports the development of various food products with high functional value (Essa *et al.*, 2021). The functional value of a food product depends on the nutrients contained in the food ingredients that make up the food product. The raw materials of noodles generally include wheat flour, eggs, and water. However, noodles are known to be low in functional nutrients that are beneficial to health (Akbar, 2018; Khasanah and Astuti,

2019). Therefore, various efforts have been made to overcome the shortcomings of wet noodles. Increasing the functional value of wet noodles can be done by adding other food ingredients that contain bioactive compounds, one of which is the addition of pluchea leaves.

Pluchea (*Pluchea indica* Less) is an herbaceous plant that contains phytochemical compounds, including alkaloids, saponins, tannins, phenol hydroquinone, flavonoids, cardiac glycosides, and sterols, that act as sources of natural antioxidants (Widyawati *et al.*, 2015). In addition, pluchea leaves also have antimicrobial activity that has the potency to prevent food damage (Ardiansyah *et al.*, 2003). The use of pluchea leaves in the manufacture of wet noodles is expected to produce wet noodles that are able to provide antioxidant effects that are good for health, and have an impact on increasing the shelf life of the wet noodle's product.

Currently, the use of pluchea leaves is only limited to fresh vegetables and drinks, but there have been many studies on the use of pluchea leaves in the food sector that continue to be developed, including making tempeh with pluchea leaf extract (Magatra, 2013), pluchea-black

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tea salted eggs (Adventi *et al.*, 2015), effervescent powder based on pluchea leaf extract (Hudha and Widyaningsih, 2015), pluchea bun products (Chiang, 2018), pluchea soy milk (Widyawati *et al.*, 2019), pluchea-green tea jelly drink (Wijaya, 2019), and pluchea wet noodles (Wibisono, 2021). The use of pluchea leaves in the manufacture of wet noodles was studied further as an effort to develop functional food products that were beneficial to the health of the consumer's body.

2. Pluchea leaves as functional supplement

Several factors such as individual education, household standards and level of knowledge about food products with health claims, as well as perceptions of some existing functional food product attributes affect the development of public interest in functional food products (Stojanovic *et al.*, 2013; Sari, 2014). Marsono (2008) also declared that increasing awareness of the importance of food in preventing or curing disease, consumer demands for foods with more properties (containing functional ingredients), experiences with alternative medicines, and studies on the prevalence of certain diseases that are influenced by diet have also become the basis for the rapid development of functional food products in various countries.

Functional food is defined as a food product that is able to provide benefits to the health of the body, one of which is through the presence of bioactive components contained in a functional food product (Suter, 2013; Essa *et al.*, 2021). According to Essa *et al.* (2021), there are five categories of functional food, i.e. foodstuffs with a reduction or increase in the basic nutritional content, products that naturally do not have certain nutrients and are added to them, milk-based products fermented with probiotics, products that are specially formulated to fulfill certain needs, and foodstuffs containing herbal ingredients to help overcome various health problems.

Herbal plants are a source of functional food, i.e. a source of natural antioxidants that can be used in the food sector to improve the functional properties of processed food products, one of which is the use of herbal plants to increase the content of bioactive components in wheat flour-based products such as noodles. According to Fadzil *et al.* (2020), noodles are known to be low in nutritional components that are beneficial to health, while noodles with functional properties such as high antioxidants are in high demand at this time.

2.1 Utilization of pluchea leaves in making wet noodles

The main ingredients in making noodles are

generally wheat flour, eggs, water, and other additives as needed, making the noodles products only contain carbohydrates, proteins, fats, and minerals. The content of carbohydrates, several minerals, and energy in noodles are very high, but the content of protein, fat, and vitamins in noodles products are relatively low (Akbar, 2018; Khasanah and Astuti, 2019). Several studies have been carried out in an effort to improve the functional properties of noodles products, one of which is by using the leaves of plants that have been known as traditional medicines to be added to the manufacture of noodles, such as making herbal noodles with cosmos (*Cosmos caudatus* Kunth.) leaf extract (Norlaili *et al.*, 2014), manufacture of herbal noodles with leaves of the Indian bael plant (*Aegle marmelos*) (Shamim *et al.*, 2016), manufacture of sidondo (*Vitex negundo* Linn.) noodles (Syahirah and Rabeta, 2018), addition of moringa (*Moringa oleifera*) leaf extract to wet noodles (Khasanah and Astuti, 2019), making herbal noodles with pegagan (*Centella asiatica*) extract (Fadzil *et al.*, 2020), and using pluchea (*Pluchea indica* Less) leaf powder steeped water to make pluchea wet noodles (Wibisono, 2021).

The content and activity of phytochemical compounds in pluchea leaves, both in the form of fresh leaves and water steeped in powdered pluchea leaves have been identified. Pluchea is classified as plant that has high polyphenol content and relatively large antioxidant capacity compared to other herbaceous plants (Andarwulan *et al.*, 2010; Andarwulan *et al.*, 2012). Research conducted by Widyawati *et al.* (2016) showed that the phytochemical compounds contained in the brewed water of pluchea leaf powder include alkaloids, flavonoids, phenolics, saponins, tannins, and cardiac glycosides. According to Pengelly (2004), each phytochemical compound has physiological effects including alkaloids as analgesic, mydriatic, miotic, hypertensive, hypotensive, bronchodilator, stimulant, antimicrobial, and antileukemic, flavonoids as antioxidant, antiviral, hepatoprotective, antiatheromatous, anti-inflammatory, and antihypertensive, phenolic as antioxidant, antimicrobial, anti-inflammatory, antiplatelet, and antiallergic, saponins as anticancer, anti-inflammatory, immunomodulatory, antihepatotoxic, and antidiabetic, tannins as antioxidant, antitumor, antihemorrhagic, and antiatherogenic, as well as cardiac glycosides that can increase strength and speed of systolic contraction. Flavonoids are one of the important constituents that can provide real benefits for the health of the human body.

The use of pluchea leaves in food products continues to be developed through various studies as shown in Table 1. Using pluchea leaves in many food products (tempeh, beverage, salted egg, bun, jelly drink, and

Table 1. The use of Pluchea leaves in food product

Type of food product	Pluchea leaf form	Stages of use	References
Tempeh	Pluchea leaf water extract	Soak soybeans before adding	Magatra (2013)
Pluchea-black tea salted egg	Pluchea leaf flour	Mixed in salt solution for the	Adventi <i>et al.</i> (2015)
Effervescent powder	Water extract (infusion) and ethanol extract (maceration)	Evaporated and mixed according to the formulation	Hudha and Widyaningsih (2015)
Dry method salted egg	Fresh pluchea leaves	Added to pasta dough to coat	Firdausi (2017)
Bun	Pluchea leaf powder steeping water	Added during dough making	Chiang (2018)
Soy milk	Pluchea leaf powder steeping water	Added to soy milk	Widyawati <i>et al.</i> (2019)
Pluchea- green tea jelly drink	Pluchea leaf powder	Brewed with green tea	Wijaya (2019)
Wet noodles	Pluchea leaf powder steeping water	Added during dough making	Wibisono (2021)

soymilk) to increase their functional value can be added in the form of extract, powder/flour, or fresh with different stages of processing each food product. However, the use of pluchea leaves to increase the functional value of wheat flour-based food products has not been widely studied. So far the research that has been carried out regarding the use of pluchea leaves in the formulation of wheat flour-based food products is in the manufacture of pluchea bun (Chiang, 2018) and pluchea wet noodles (Wibisono, 2021), both of which use pluchea leaf powder steeping water which is added to the product formulation.

2.2 The effect of pluchea leaves on the content of phytochemical compounds of wet noodles

The largest group of phytochemical compounds in plants includes alkaloids, terpenes, and phenolic compounds. Phenolic compounds are a group of phytochemical compounds that are widely distributed in various plants, where this group of compounds can be used as the main source of natural antioxidants and are able to act as antimicrobial, anticarcinogenic, and other biological activities (Kennedy and Wightman, 2011; Aziman *et al.*, 2012). Pluchea leaves contain phenolic compounds in the form of flavonoids, 1,3,4,5-tetra-O-cafeoilquinic acid, 3,4,5-tri-O-cafeoilquinic acid, chlorogenic acid, and ferulic acid (Mahasuari *et al.*, 2020).

Flavonoids as secondary metabolites as well as the main and largest compounds in the group of phenolic compounds are commonly found in plant tissues in free form or glycosides (Aberoumand and Deokule, 2008; Sulaiman and Balachandran, 2012; Agbo *et al.*, 2015). In plants, flavonoids are found in the form of flavonoid glycosides, flavonols, flavan-3-ol, flavones, flavanones, chalcones, anthocyanins, and proanthocyanidins (Dehkharghanian *et al.*, 2010; Vichapong *et al.*, 2010; Chen, 2013). Flavonoids act as antioxidants by chelating

metals and donating hydrogen atoms, thus provide certain physiological effects on the human body (Erlidawati *et al.*, 2018). This has become one of the basis for the use of herbal plants for traditional medicine and supports various functional food product innovations such as pluchea wet noodles.

The research by Wibisono (2021) showed that the use of pluchea leaf powder steeped water was able to contribute in increasing the content of phytochemical compounds (especially flavonoids) in wet noodles, that the lowest (5%) and the highest (30%) concentration of pluchea leaf powder in steeping water were able to increase the total flavonoid content (TFC) of wet noodles as much as 1.43 times and 4.07 times compared to the control wet noodles (without the use of pluchea leaf powder steeping water), respectively. The potential use of pluchea leaves in the manufacture of wet noodles can be seen by comparing the TFC of pluchea wet noodles in Wibisono's study (2021) with other herbal noodles and pluchea bun as another form of wheat flour-based product. Comparison of the total flavonoids of pluchea wet noodles with sidondo wet noodles, pegagan wet noodles, and pluchea bun from existing studies can be seen in Figure 1.

The group of flavonoids found in pluchea leaves are flavonols and flavones, including quercetin, myrisetin, kaempferol, apigenin, luteolin, and chrysoeriol (Andarwulan *et al.*, 2010; Andarwulan *et al.*, 2012; Koirewoa *et al.*, 2012; Mahasuari *et al.*, 2020), sidondo flavonoids consist of castikin, orientin, isoorientin, luteolin, lutekin-7-O-glucoside, corimboisin, gardenins A and B, 3-O-desmethylnobiletin, and 3',4',5,5',6,7,8-heptamethoxyflavones (Lakshmanashetty *et al.*, 2010; Ullah *et al.*, 2012), while the flavonoids of pegagan include quercetin, myrisetin, and kaempferol (Andarwulan *et al.*, 2010; Andarwulan *et al.*, 2012). The TFC value of wet noodles with the addition of 5%

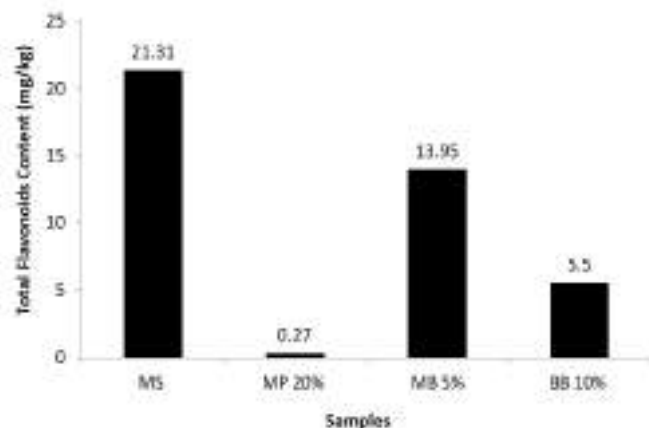


Figure 1. Total flavonoid content (TFC) of pluchea wet noodles 5% (MB 5% (Wibisono, 2021)) compared to sidondo wet noodles (MS (Syahirah and Rabeta, 2018)), pegagan wet noodles 60% (MP 60% (Fadzil *et al.*, 2020)), and pluchea bun 10% (BB 10% (Chiang, 2018)). The TFC of sidondo and pegagan wet noodles were respectively expressed in terms of quercetin equivalent per weight of wet noodles and rutin equivalent per weight of wet noodles extract, while the TFC of pluchea noodles and pluchea bun were expressed in terms of catechin equivalents per dried weight of freeze-dried results. TFC of MP 20%, MB 5%, and BB 10% were expressed by the values that have been subtracted with the TFC of control from each study.

concentration of pluchea leaf powder in steeping water was greater than the TFC of wet noodles with the addition of 20% pegagan extract, but the TFC of pluchea wet noodles 5% was lower than the TFC of sidondo wet noodles which used 0.66% sidondo leaf powder from the total weight of the noodles ingredients. Based on this comparison, it can be indicated that the use of pluchea leaf powder steeping water with a concentration of 5% can increase the flavonoids content of wet noodles far exceeding the flavonoids content that can be given by 20% pegagan extract solution in wet noodles (total flavonoids of pluchea wet noodles 5% is 51.67 times compared to pegagan noodles 20%). The total flavonoids of the pluchea wet noodles 5% is 1.53 times lower than the total flavonoids of sidondo wet noodles. The flavonoids content of sidondo wet noodles which was higher than pluchea wet noodles 5% could be caused by the addition of sidondo leaf powder directly to the making of wet noodles dough in Syahirah and Rabeta's research (2018), while pluchea wet noodles dough in Wibisono's study (2021) was made with using pluchea leaf powder steeping water in the formulation of wet noodles. In addition, several factors such as differences in formulation, sequence of processing and analysis stages, as well as stated standards and product sample forms analyzed in each study also affect the difference in TFC values compared between types of herbal wet noodles.

The TFC of wet noodles with the addition of 5%

concentration of pluchea leaf powder in steeping water was higher than the TFC of bun with the addition of 10% concentration of pluchea leaf powder in steeping water. This shows that the flavonoids content of pluchea wet noodles is higher than the flavonoids content of pluchea bun even though the concentration of pluchea leaf powder in steeping water in the manufacture of pluchea wet noodles is lower than the concentration of pluchea leaf powder in steeping water in the manufacture of pluchea bun (the TFC of pluchea wet noodles 5% is 2.54 times compared to pluchea bun 10%). According to Li *et al.* (2015), antioxidant compounds, one of which is flavonoids, are easily degraded in the heating process, and are lost during the process of mixing and kneading the dough. The degradation of flavonoids during heating and the extraction of glycosides by water vapor can be the cause of the low TFC value of pluchea bun. On the other hand, a study conducted by Saikia and Mahanta (2013) showed that the high flavonoids content can be caused by breaking the glycosidic bond of flavonoids with sugar by heating treatment. The wet noodles cooking process is thought to have an effect on breaking the glycosidic bond so that aglycones are formed which can improve the detection results of flavonoids compounds in the analysis. Various factors can affect the TFC value in different food products, including differences in ingredient formulations, specifications of the methods used, and the stages of the process in the manufacture of food products.

The TFC of pluchea wet noodles 5% showed that pluchea leaves have the potency to increase the content of phytochemical compounds (in this case flavonoids) in wet noodles as a wheat flour-based food product. Wibisono (2021) also mentioned that the use of higher concentration of pluchea leaf powder in steeping water in the formulation of wet noodles is able to provide a significant increase in the TFC of wet noodles. There has been no research on the effect of adding pluchea leaf powder steeping water on the type and amount of phytochemical compounds other than flavonoids in pluchea wet noodles products, so the use of pluchea leaves in the manufacture of wet noodles still needs to be developed and further investigated its effect on the phytochemical component content of wet noodles.

2.3 The effect of pluchea leaves on the functional properties of wet noodles

The functional properties of functional food products mainly focus on the ability of bioactive components in food products to help maintain the health of the human body. One of the properties possessed by bioactive components is that they can act as antioxidants. Carotenoids, flavonoids, and phenolic compounds are classified as natural antioxidants that can be found in

various foodstuffs (Marsono, 2008). Antioxidant activity can be in the form of DPPH free radical scavenging ability, iron ion reducing power, reactive oxygen species scavenging activity, and β -carotene-linoleic acid system inhibitory activity (Widyawati *et al.*, 2017).

Iron ion reducing power (RP) is one of the parameters of antioxidant potential which is measured as secondary antioxidant activity based on the ability of antioxidant compounds to reduce Fe^{3+} to Fe^{2+} . Secondary antioxidants play a role in the mechanism of binding metal ions, scavenging oxygen, converting hydrogen peroxide into non-radical compounds, absorbing UV radiation, or deactivating singlet oxygen (Pokorny *et al.*, 2001). According to Widyawati *et al.* (2014), iron ion is one of the pro-oxidants that have the potency to generate new free radicals. Antioxidant components are able to neutralize iron ions by acting as a substrate that will be oxidized first. Based on the research of Wibisono (2021), the use of the lowest (5%) and the highest (30%) concentration of pluchea leaf powder were able to increase the RP value of wet noodles by 1.33 times and 3.27 times compared to control wet noodles, respectively. The potency of pluchea leaves in increasing the antioxidant activity of wet noodles products can be described by comparing the RP value of pluchea wet noodles with other products such as rice flour paste and pluchea bun. The comparison of secondary antioxidant activity in the form of the iron ion reducing power of pluchea wet noodles with rice flour paste and pluchea bun can be seen in Figure 2.

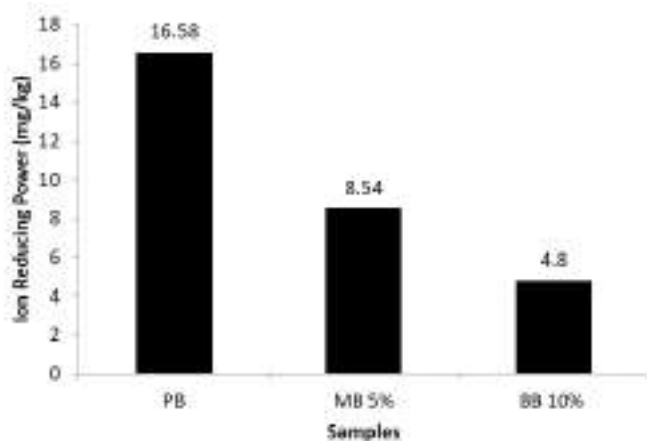


Figure 2. Iron ion reducing power (RP) of pluchea wet noodles 5% (MB 5% (Wibisono, 2021)) compared to rice flour paste (PB (Nitha *et al.*, 2013)) and pluchea bun 10% (BB 10% (Chiang, 2018)). RP value of rice flour paste was stated to be equivalent to BHT per weight of pasta, while the RP value of pluchea wet noodles and pluchea bun was expressed in gallic acid equivalent per dried weight of freeze-dried results. Iron ion reducing power of MB 5% and BB 10% are expressed by the value that has been reduced by the RP value of control from each study.

Pluchea wet noodles 5% in the Wibisono's study

(2021) had the RP value 1.78 times higher than the RP value of pluchea bun 10% in Chiang's research (2018), but 1.94 times lower than the RP value of paste made from rice flour in the research of Nithya *et al.* (2013). The RP value indicates that the use of pluchea leaf powder steeping water with 5% concentration of pluchea leaf powder in steeping water has potency to provide greater secondary antioxidant activity in wet noodles than in bun products. The TFC of pluchea wet noodles 5% which is greater than the TFC of pluchea bun 10%, as shown in Figure 1, can contribute to the large iron ion reducing power of pluchea wet noodles 5% and pluchea bun 10%, that the phenolic group compounds, one of which is flavonoids, capable of donating hydrogen atoms/electrons so that they can reduce iron ions (Widyawati *et al.*, 2014). The flavonoids content of pluchea wet noodles which is higher than the flavonoids content of pluchea bun, can cause the iron ion reducing power of wet noodles is higher compared to pluchea bun.

RP value of pluchea wet noodles 5% which is lower than the RP value of rice flour paste can be due to the use of different types of raw materials (related to the number and types of bioactive components in the ingredients) and the shape of the product samples analyzed in each study. Based on the research of Widyawati *et al.* (2014), white rice has total phenolic content (TPC) of 4.12 ± 0.05 mg gallic acid equivalent/g dry basis which is greater than the TPC of pluchea leaves in the study of Andarwulan *et al.* (2010), which was 0.831 ± 0.129 mg gallic acid equivalent/g fresh leaf weight. According to Wibisono (2021), the iron ion reducing power of pluchea wet noodles can be increased by using higher concentration of pluchea leaf powder in steeping water in the formulation of wet noodles.

RP value of pluchea wet noodles 5% shows the potency of pluchea leaves to increase the antioxidant activity of wet noodles products as an effort to increase the functional value of wheat flour-based food products such as wet noodles. The effect of adding pluchea leaf powder steeping water on the antioxidant activity of pluchea wet noodles using a type of analysis other than the iron ion reducing power has not been studied further, so it is necessary to measure other antioxidant parameters to support the potency of pluchea leaves in making wet noodles.

Research on the potency of pluchea leaves in improving the functional properties of wet noodles is still limited to being studied on product antioxidants, while pluchea leaves have been known to have various other functional properties that are beneficial to health and are able to maintain the quality of food products. Several other functional properties that have the potency to be

provided by pluchea leaves in food products include activities as anti-warmed-over flavor, anti-inflammatory, antidiabetic (Widyawati et al., 2017), and antimicrobial properties that have the potency to prevent food spoilage (Ardiansyah et al., 2003). This ability is inseparable from the presence of bioactive compounds in pluchea leaves which have the capacity as antioxidant and antihyperglycemic agents (Widyawati et al., 2014; Widyawati et al., 2015). According to Li et al. (2014), herbal plant extracts are potential preservatives that are currently being developed to be applied to bread, pasta, and noodles products due to the presence of phenolic components that have high antimicrobial activity. Tiwari et al. (2009) also proved that the antimicrobial activity of phenolic compounds is related to the ability of phenolics to affect the permeability of microbial cells which causes the release of important macromolecules from the microbial cell, as well as the ability of phenolics to interact with membrane proteins that cause deformation of the structure and function of microbial cell membranes.

3. Conclusion

Pluchea (*Pluchea indica* Less) leaves have the potency to increase the functional value of wet noodles in terms of the phytochemical content and functional properties of the wet noodles. The use of pluchea leaves increases the content of phytochemical compounds, in this case flavonoids, in wet noodles. The increase in the content of phytochemical compounds with the use of pluchea leaves affects the increase in the functional properties of wet noodles products, especially antioxidant activity in the form of the iron ion reducing power of wet noodles.

Conflict of interest

The authors declare no conflict of interest.

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References

- Aberoumand, A. and Deokule, S.S. (2008). Comparison of phenolic compounds of some edible plant of Iran and India. *Pakistan Journal of Nutrition*, 7(4), 582-585. <https://doi.org/10.3923/pjn.2008.582.585>
- Adventi, B.S., Widyawati, P.S. and Utomo, A.R. (2015). Effect of salt concentration for physicochemical and organoleptics salted egg pluchea (*Pluchea indica* Less)-black tea (*Camelia sinensis*). *Journal of Food Technology and Nutrition*, 14(2), 55-60.
- Agbo, M.O., Uzor, P.F., Akazie-Nneji, U.N., Eze-Odurukwe, C.U., Ogbatue, U.B. and Mbaogi, E.C. (2015). Antioxidant, total phenolic and flavonoid content of selected Nigerian medical plants. *Dhaka University Journal of Pharmaceutical Sciences* 14 (1), 1-7. <https://doi.org/10.3329/dujps.v14i1.23733>
- Akbar, A. (2018). Physical, chemical and organoleptic analysis of wet noodle based on taro (*Colocasia esculenta* L). *Agritepa*, 4(2), 159-170. <https://doi.org/10.37676/agritepa.v5i1.726>
- Andarwulan, N., Batari, R., Sandrasari, D.A., Bolling, B. and Wijaya, H. (2010). Flavonoid content and antioxidant activity of vegetables from Indonesia. *Food Chemistry*, 121(4), 1231-1235. <https://doi.org/10.1016/j.foodchem.2010.01.033>
- Andarwulan, N., Kurniasih, D., Apriady, R.A., Rahmat, H., Roto, A.V. and Bolling, B.W. (2012). Polyphenols, carotenoids, and ascorbic acid in underutilized medicinal vegetables. *Journal of Functional Foods*, 4(1), 339-347. <https://doi.org/10.1016/j.jff.2012.01.003>
- Ardiansyah, Nuraida, L. and Andarwulan, N. (2003). Antimicrobial activity of pluchea (*Pluchea indica* L.) leaves extract and stability of the activity at different salt concentrations and pHs. *Journal of Food Technology and Industry*, 14(2), 90-97.
- Aziman, N., Abdullah N., Noor, Z.M., Zulkifli, K.S. and Kamarudin, W.S.S.W. (2012). Phytochemical constituents and in vitro bioactivity of ethanolic aromatic herb extracts. *Sains Malaysiana*, 41(11), 1437-1444.
- Billina, A., Waluyo, S. and Suhandy, D. (2014). Study of the physical properties of wet noodles with addition of seaweed. *Lampung Agricultural Engineering Journal*, 4(2), 109-116.
- Chen, X.G.Q. (2013). Identification and antioxidant capacity of anthocyanin pigment, and expressional analysis of flavonoid biosynthetic genes in colored rice strains. Japan: University of Hiroshima, PhD. Dissertation.
- Chiang, I. (2018). The effect of pluchea leaves powder (*Pluchea indica* Less) in steeping water of pao antioxidant activity. Indonesia: Widya Mandala Surabaya Catholic University, BSc. Thesis
- Dehkharghanian, M., Adenier, H. and Vijayalakshmi, M.A. (2010). Study of flavonoids in aqueous spinach extract using positive electrospray ionisation tandem quadrupole mass spectrometry. *Food Chemistry*, 121 (3), 863-870. <https://doi.org/10.1016/j.foodchem.2010.01.007>
- Erlidawati, Safrida and Mukhlis. (2018). Antioxidant

- Potency as Antidiabetic. Banda Aceh, Indonesia: Syiah Kuala University Press.
- Essa, M.M., Bishir, M., Bhat, A., Chidambaram, S.B., Al-Balushi, B., Hamdan, H., Govindarajan, N., Friedland, R.P. and Qoronfleh, M.W. (2021). Functional foods and their impact on health. *Journal of Food Science and Technology*, 60, 820-834. <https://doi.org/10.1007/s13197-021-05193-3>.
- Estiasih, T., Putri, W.D.R. and Waziroh, E. (2017). Tubers and Their Processing. Malang, Indonesia: UB Press.
- Fadzil, N.F., Bakar, M.F.A., Yusop, M.H.M. and Bakar, F.I.A. (2020). Sensorial and physicochemical characteristics of herbal noodle enriched with *Centella asiatica*. *Food Research*, 4(4), 1030-1037. [https://doi.org/10.26656/fr.2017.4\(4\).408](https://doi.org/10.26656/fr.2017.4(4).408)
- Firdausi, M.H. (2017). Physicochemical and organoleptic quality of dry method salted eggs with addition of pluchea leaves (*Pluchea indica* L.). Indonesia: Brawijaya University, BSc. Thesis.
- Hudha, M. and Widyaningsih, T.D. (2015). The effervescent powder uses pluchea leaf (*Pluchea indica* Less) extract as natural antioxidant source. *Journal of Food and Agroindustry*, 3(4), 1412-1422.
- Kennedy, D.O. and Wightman, E.L. (2011). Herbal extracts and phytochemicals: plant secondary metabolites and the enhancement of human brain function. *Advances in Nutrition*, 2(1), 32-50. <https://doi.org/10.3945/an.110.000117>
- Khasanah, V. and Astuti, P. (2019). Effect of addition of Moringa leaf extract (*Moringa oleifera*) on sensory quality and protein content of wet noodles substituted with modified cassava flour. *Journal of Technical Competence*, 11(2), 15-21.
- Koirewoa, Y.A., Fatimawali and Wiyono, W.I. (2012). Isolation and identification flavonoid compounds in pluchea leaf (*Pluchea indica* L.). *Pharmacop*, 1(1), 47-52.
- Lakshmanashetty, R.H., Nagaraj, V.B., Hiremath, M.G. and Kumar V. (2010). *In vitro* antioxidant activity of *Vitex negundo* L. leaf extracts. *Chiang Mai Journal of Science*, 37(3), 489-497.
- Li, M., Zhu, K.X., Guo, X.N., Brijs, K. and Zhou, H.M. (2014). Natural additives in wheat-based pasta and noodle products: opportunities for enhanced nutritional and functional properties. *Comprehensive Reviews in Food Science and Food Safety*, 13(4), 347-357. <https://doi.org/10.1111/1541-4337.12066>
- Li, Y., Ma, D., Sun, D., Wang, C., Zhang, J., Xie, Y. and Guo, T. (2015). Total phenolic, flavonoid content, and antioxidant activity of flour, noodles, and steamed bread made from different colored wheat grains by three milling methods. *The Crop Journal* 3(4), 328-334. <https://doi.org/10.1016/j.cj.2015.04.004>
- Magatra, P. (2013). Antioxidant activity, total phenolic content, and organoleptic test in tempe with marsh fleabane leaf extract (*Pluchea indica* L.). Indonesia: Satya Wacana Christian University, BSc. Thesis.
- Mahasuari, N.P.S., Paramita, N.L.P.V. and Putra, A.A.G.R.Y. (2020). Effect of methanol concentration as a solvent on total phenolic and flavonoid content of pluchea leaf extract (*Pluchea indica* L.). *Journal of Pharmaceutical Science and Application*, 2(2), 77-84. <https://doi.org/10.24843/JPSA.2020.v02.i02.p05>
- Marsono, Y. (2008). Functional food development prospects. *Journal of Food Technology and Nutrition* 7(1), 19-27.
- Nithya, D.J., Bosco, K.A.S., Jagan Mohan, R. and Alagusundaram, K. (2013). Antioxidant activity of rice bran pasta. *Journal of Microbiology, Biotechnology and Food Sciences*, 2(6), 2423-2425.
- Norlaili, A.H., Roselina, K. and Muhammad, T.S. (2014). Effect of *Cosmos caudatus* Kunth. (Ulam Raja) aqueous and dry extracts on the physicochemical and functional properties, and sensory acceptability of Herbal Yellow Alkaline Noodles. *Malaysian Journal of Nutrition*, 20(3), 403-415.
- Nuraida, L., Andarwulan, N., Sukmawati, M. and Yohana, E. (2008). Application of herbs and spices extracts as preservatives for wet noodles, presented at the International Conference Proceeding Investing in Food Quality, Safety and Nutrition, October 27-28. Jakarta, Indonesia.
- Pengelly, A. (2004). The Constituents of Medicinal Plants: An Introduction to the Chemistry and Therapeutics of Herbal Medicines, 2nd ed. Australia: CABI Publishing.
- Pokorny, J., Yanishlieva, N. and Gordon, M. (2001). Antioxidants in Food: Practical Applications. Cambridge, United Kingdom: Woodhead Publishing Ltd. <https://doi.org/10.1201/9781439823057>
- Saikia, S. and Mahanta, C.L. (2013). Effect of steaming, boiling and microwave cooking on the total phenolics, flavonoids and antioxidant properties of different vegetables of Assam, India. *International Journal of Food and Nutritional Sciences*, 2(3), 47-53.
- Sari, E.T. (2014). Factors influencing consumption of functional food in Surabaya. *Scientific Journal of Commerce Administration*, 12(2), 1-10.
- Shamim, M.Z., Verma, A., Sheikh, S. and Singh, S.

- (2016). Sensory evaluation of nutritious herbal noodles developed by utilization of *Aegle marmelos* leaves powder. *IMPACT: International Journal of Research in Applied, Natural and Social Sciences*, 4 (4), 109-114.
- Stojanovic, Z., Filipovic, J. and Mugosa, B. (2013). Consumer acceptance of functional foods in Montenegro. *Montenegrin Journal of Economics*, 9 (3), 65-74.
- Sulaiman, C.T. and Balachandran, I. (2012). Total phenolics and total flavonoids in selected Indian medical plants. *Indian Journal of Pharmaceutical Sciences*, 74(3), 258-260. <https://doi.org/10.4103/0250-474X.106069>
- Suter, I.K. (2013). Functional foods and their development prospects. Retrieved on February 15, 2021 from Udayana University Repository Website: https://repositori.unud.ac.id/protected/storage/upload/repositori/ID3_19501231197602100323091304927makalah-gizi.pdf.
- Syahirah, J. and Rabeta, M.S. (2018). Antioxidant and antimicrobial activity of lemuni noodle. *Food Research*, 3(1), 7-13. [https://doi.org/10.26656/fr.2017.3\(1\).090](https://doi.org/10.26656/fr.2017.3(1).090)
- Tiwari, B.K., Valdramidis, V.P., Donnell, C.P.O., Muthukumarappan, K., Bourke, P. and Cullen, P.J. (2009). Application of natural antimicrobials or food preservation. *Journal of Agricultural and Food Chemistry*, 57(14), 5987-6000. <https://doi.org/10.1021/jf900668n>
- Ullah, Z., Ullah, R., Shah, A.H.A., Ahmad, I. and Haider, S. (2012). Phytochemical and biological evaluation of *Vitex negundo* Linn: a review. *International Journal of Pharmaceutical Sciences and Research*, 3(8), 2421-2431.
- Vichapong, J., Sookserm, M., Srijesdaruk, V., Swatsitang, P. and Srijaranai, S. (2010). High performance liquid chromatographic analysis of phenolic compounds and their antioxidant activities in rice varieties. *LWT-Food Science and Technology*, 43(9), 1325-1330. <https://doi.org/10.1016/j.lwt.2010.05.007>
- Wibisono, D.A.S. (2021). Effect of concentration of pluchea (*Pluchea indica* (L.) Less) leaves powder in steeping water on total flavonoids and iron ion reducing power of wet noodle. Indonesia: Widya Mandala Surabaya Catholic University, BSc. Thesis.
- Widyawati, P.S., Budianta, T.D.W., Gunawan, D.I. and Wongso, R.S. (2015). Evaluation antidiabetic activity of various leaf extracts of *Pluchea indica* Less. *International Journal of Pharmacognosy and Phytochemical Research*, 7(3), 597-603.
- Widyawati, P.S., Budianta, T.D.W., Kusuma, F.A. and Wijaya, E.L. (2014). Difference of solvent polarity to phytochemical content and antioxidant activity of *Pluchea indica* Less leaves extracts. *International Journal of Pharmacognosy and Phytochemical Research*, 6(4), 850-855.
- Widyawati, P.S., Ristiari, S., Werdani, Y.D.W., Kuswardani, I. and Herwina, I.N. (2019). Physicochemical and organoleptic properties changes of soymilk with pluchea brewing water addition. *Journal of Food Technology and Nutrition*, 18(2), 98-111.
- Widyawati, P.S., Suteja, A.M., Suseno, T.I.P., Monika, P., Saputrajaya, W. and Liguori, C. (2014). Effect of pigment color difference in organic rice on antioxidant activity. *Agritech*, 34(4), 399-406. <https://doi.org/10.22146/agritech.9434>
- Widyawati, P.S., Werdani, Y.D.W., Setiokusumo, C. and Kartikasari, A. (2017). In vitro antioxidant capacities and antidiabetic properties of pluchea leaves and green tea mixtures at various proportions. *International Journal of Pharmacy and Pharmaceutical Sciences*, 9(8), 203-208. <https://doi.org/10.22159/ijpps.2017v9i8.19545>
- Wijaya, J.P. (2019). Effect of concentration of mixture of pluchea (*Pluchea indica* L.) leaves powder – green tea (*Camellia sinensis* L.) 1:1 (b/b) in steeping water on antioxidant activity of jelly drink. Indonesia: Widya Mandala Surabaya Catholic University, BSc. Thesis.
- Zhou, S., Wang, L., Wang, A., Zhang, Q., Li, Z. and Qiu, J. (2021). Effect of moisture distribution changes induced by different cooking temperature on cooking quality and texture properties of noodles made from whole tartary buckwheat. *Foods*, 10, 2543. <https://doi.org/10.3390/foods10112543>



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Potency of pluchea (*Pluchea indica* Less) leaves to increase functional value of wet noodles: a review

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Abstract

Wet noodles lack functional nutrients that are beneficial for health, thus it is necessary to add other food ingredients that can increase the functional value of wet noodles. One of the food ingredients that can be added in wet noodles formulation is *Pluchea indica* Less leaves, which have been known as a source of antioxidants and used by the community as a traditional medicine to treat various health problems. The use of *Pluchea indica* Less leaves in making wet noodles is expected to increase the functional value of wet noodles. For this reason, this review paper discussed the potency of *Pluchea indica* Less leaves in affecting the phytochemical compounds content and functional properties of wet noodles. The use of *Pluchea indica* Less leaves showed potential to increase the phytochemical compounds contents of wet noodles, such as alkaloids, flavonoids, phenolics, saponins, tannins, and cardiac glycosides, which play an important role in the health of human body and maintaining the quality of wet noodles, such as antioxidant, anti-warmed over flavor, anti-inflammatory, antidiabetic, and antimicrobial activities. Thus, the addition of pluchea leaves has potential to increase the functional value of wet noodles including the phytochemical content and functional properties.

1. Introduction

Noodles as one of the wheat flour-based product are quiet popular among various levels of society in Indonesia. Noodles can be classified into five forms based on processing stage and water content of the noodles product, including raw noodles, wet noodles, dry noodles, fried noodles, and instant noodles. Wet noodles have water content of about 50-52% (Nuraida *et al.*, 2009), 52.10-52.85% (Billina *et al.*, 2014) 58-70% (Zhou *et al.*, 2021), and is produced through the cooking stage of raw noodles before being marketed (Billina *et al.*, 2014). According to Nuraida *et al.* (2009), the high moisture content of wet noodles causes the shelf life of wet noodles to only reach 42 hrs at room temperature storage.

Increased awareness and interest in functional food supports the development of various food products with high functional value (Essa *et al.*, 2021). The functional value of a food product depends on the nutrients contained in the food ingredients that make up the food product. The raw materials of noodles generally include wheat flour, eggs, and water. However, noodles are known to be low in functional nutrients that are beneficial to health (Akbar, 2018; Khasanah and Astuti,

2019). Therefore, various efforts have been made to overcome the shortcomings of wet noodles. Increasing the functional value of wet noodles can be done by adding other food ingredients that contain bioactive compounds, one of which is the addition of pluchea leaves.

Pluchea (*Pluchea indica* Less) is an herbaceous plant that contains phytochemical compounds, including alkaloids, saponins, tannins, phenol hydroquinone, flavonoids, cardiac glycosides, and sterols, that act as sources of natural antioxidants (Widyawati *et al.*, 2015). In addition, pluchea leaves also have antimicrobial activity that has the potency to prevent food damage (Ardiansyah *et al.*, 2003). The use of pluchea leaves in the manufacture of wet noodles is expected to produce wet noodles that are able to provide antioxidant effects that are good for health, and have an impact on increasing the shelf life of the wet noodle's product.

Currently, the use of pluchea leaves is only limited to fresh vegetables and drinks, but there have been many studies on the use of pluchea leaves in the food sector that continue to be developed, including making tempeh with pluchea leaf extract (Magatra, 2013), pluchea-black

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tea salted eggs (Adventi *et al.*, 2015), effervescent powder based on pluchea leaf extract (Hudha and Widyaningsih, 2015), pluchea bun products (Chiang, 2018), pluchea soy milk (Widyawati *et al.*, 2019), pluchea-green tea jelly drink (Wijaya, 2019), and pluchea wet noodles (Wibisono, 2021). The use of pluchea leaves in the manufacture of wet noodles was studied further as an effort to develop functional food products that were beneficial to the health of the consumer's body.

2. Pluchea leaves as functional supplement

Several factors such as individual education, household standards and level of knowledge about food products with health claims, as well as perceptions of some existing functional food product attributes affect the development of public interest in functional food products (Stojanovic *et al.*, 2013; Sari, 2014). Marsono (2008) also declared that increasing awareness of the importance of food in preventing or curing disease, consumer demands for foods with more properties (containing functional ingredients), experiences with alternative medicines, and studies on the prevalence of certain diseases that are influenced by diet have also become the basis for the rapid development of functional food products in various countries.

Functional food is defined as a food product that is able to provide benefits to the health of the body, one of which is through the presence of bioactive components contained in a functional food product (Suter, 2013; Essa *et al.*, 2021). According to Essa *et al.* (2021), there are five categories of functional food, i.e. foodstuffs with a reduction or increase in the basic nutritional content, products that naturally do not have certain nutrients and are added to them, milk-based products fermented with probiotics, products that are specially formulated to fulfill certain needs, and foodstuffs containing herbal ingredients to help overcome various health problems.

Herbal plants are a source of functional food, i.e. a source of natural antioxidants that can be used in the food sector to improve the functional properties of processed food products, one of which is the use of herbal plants to increase the content of bioactive components in wheat flour-based products such as noodles. According to Fadzil *et al.* (2020), noodles are known to be low in nutritional components that are beneficial to health, while noodles with functional properties such as high antioxidants are in high demand at this time.

2.1 Utilization of pluchea leaves in making wet noodles

The main ingredients in making noodles are

generally wheat flour, eggs, water, and other additives as needed, making the noodles products only contain carbohydrates, proteins, fats, and minerals. The content of carbohydrates, several minerals, and energy in noodles are very high, but the content of protein, fat, and vitamins in noodles products are relatively low (Akbar, 2018; Khasanah and Astuti, 2019). Several studies have been carried out in an effort to improve the functional properties of noodles products, one of which is by using the leaves of plants that have been known as traditional medicines to be added to the manufacture of noodles, such as making herbal noodles with cosmos (*Cosmos caudatus* Kunth.) leaf extract (Norlaili *et al.*, 2014), manufacture of herbal noodles with leaves of the Indian bael plant (*Aegle marmelos*) (Shamim *et al.*, 2016), manufacture of sidondo (*Vitex negundo* Linn.) noodles (Syahirah and Rabeta, 2018), addition of moringa (*Moringa oleifera*) leaf extract to wet noodles (Khasanah and Astuti, 2019), making herbal noodles with pegagan (*Centella asiatica*) extract (Fadzil *et al.*, 2020), and using pluchea (*Pluchea indica* Less) leaf powder steeped water to make pluchea wet noodles (Wibisono, 2021).

The content and activity of phytochemical compounds in pluchea leaves, both in the form of fresh leaves and water steeped in powdered pluchea leaves have been identified. Pluchea is classified as plant that has high polyphenol content and relatively large antioxidant capacity compared to other herbaceous plants (Andarwulan *et al.*, 2010; Andarwulan *et al.*, 2012). Research conducted by Widyawati *et al.* (2016) showed that the phytochemical compounds contained in the brewed water of pluchea leaf powder include alkaloids, flavonoids, phenolics, saponins, tannins, and cardiac glycosides. According to Pengelly (2004), each phytochemical compound has physiological effects including alkaloids as analgesic, mydriatic, miotic, hypertensive, hypotensive, bronchodilator, stimulant, antimicrobial, and antileukemic, flavonoids as antioxidant, antiviral, hepatoprotective, antiatheromatous, anti-inflammatory, and antihypertensive, phenolic as antioxidant, antimicrobial, anti-inflammatory, antiplatelet, and antiallergic, saponins as anticancer, anti-inflammatory, immunomodulatory, antihepatotoxic, and antidiabetic, tannins as antioxidant, antitumor, antihemorrhagic, and antiatherogenic, as well as cardiac glycosides that can increase strength and speed of systolic contraction. Flavonoids are one of the important constituents that can provide real benefits for the health of the human body.

The use of pluchea leaves in food products continues to be developed through various studies as shown in Table 1. Using pluchea leaves in many food products (tempeh, beverage, salted egg, bun, jelly drink, and

Table 1. The use of Pluchea leaves in food product

Type of food product	Pluchea leaf form	Stages of use	References
Tempeh	Pluchea leaf water extract	Soak soybeans before adding	Magatra (2013)
Pluchea-black tea salted egg	Pluchea leaf flour	Mixed in salt solution for the	Adventi <i>et al.</i> (2015)
Effervescent powder	Water extract (infusion) and ethanol extract (maceration)	Evaporated and mixed according to the formulation	Hudha and Widyaningsih (2015)
Dry method salted egg	Fresh pluchea leaves	Added to pasta dough to coat	Firdausi (2017)
Bun	Pluchea leaf powder steeping water	Added during dough making	Chiang (2018)
Soy milk	Pluchea leaf powder steeping water	Added to soy milk	Widyawati <i>et al.</i> (2019)
Pluchea- green tea jelly drink	Pluchea leaf powder	Brewed with green tea	Wijaya (2019)
Wet noodles	Pluchea leaf powder steeping water	Added during dough making	Wibisono (2021)

soymilk) to increase their functional value can be added in the form of extract, powder/flour, or fresh with different stages of processing each food product. However, the use of pluchea leaves to increase the functional value of wheat flour-based food products has not been widely studied. So far the research that has been carried out regarding the use of pluchea leaves in the formulation of wheat flour-based food products is in the manufacture of pluchea bun (Chiang, 2018) and pluchea wet noodles (Wibisono, 2021), both of which use pluchea leaf powder steeping water which is added to the product formulation.

2.2 The effect of pluchea leaves on the content of phytochemical compounds of wet noodles

The largest group of phytochemical compounds in plants includes alkaloids, terpenes, and phenolic compounds. Phenolic compounds are a group of phytochemical compounds that are widely distributed in various plants, where this group of compounds can be used as the main source of natural antioxidants and are able to act as antimicrobial, anticarcinogenic, and other biological activities (Kennedy and Wightman, 2011; Aziman *et al.*, 2012). Pluchea leaves contain phenolic compounds in the form of flavonoids, 1,3,4,5-tetra-O-cafeoilquinic acid, 3,4,5-tri-O-cafeoilquinic acid, chlorogenic acid, and ferulic acid (Mahasuari *et al.*, 2020).

Flavonoids as secondary metabolites as well as the main and largest compounds in the group of phenolic compounds are commonly found in plant tissues in free form or glycosides (Aberoumand and Deokule, 2008; Sulaiman and Balachandran, 2012; Agbo *et al.*, 2015). In plants, flavonoids are found in the form of flavonoid glycosides, flavonols, flavan-3-ol, flavones, flavanones, chalcones, anthocyanins, and proanthocyanidins (Dehkharghanian *et al.*, 2010; Vichapong *et al.*, 2010; Chen, 2013). Flavonoids act as antioxidants by chelating

metals and donating hydrogen atoms, thus provide certain physiological effects on the human body (Erlidawati *et al.*, 2018). This has become one of the basis for the use of herbal plants for traditional medicine and supports various functional food product innovations such as pluchea wet noodles.

The research by Wibisono (2021) showed that the use of pluchea leaf powder steeped water was able to contribute in increasing the content of phytochemical compounds (especially flavonoids) in wet noodles, that the lowest (5%) and the highest (30%) concentration of pluchea leaf powder in steeping water were able to increase the total flavonoid content (TFC) of wet noodles as much as 1.43 times and 4.07 times compared to the control wet noodles (without the use of pluchea leaf powder steeping water), respectively. The potential use of pluchea leaves in the manufacture of wet noodles can be seen by comparing the TFC of pluchea wet noodles in Wibisono's study (2021) with other herbal noodles and pluchea bun as another form of wheat flour-based product. Comparison of the total flavonoids of pluchea wet noodles with sidondo wet noodles, pegagan wet noodles, and pluchea bun from existing studies can be seen in Figure 1.

The group of flavonoids found in pluchea leaves are flavonols and flavones, including quercetin, myricetin, kaempferol, apigenin, luteolin, and chrysoeriol (Andarwulan *et al.*, 2010; Andarwulan *et al.*, 2012; Koirewoa *et al.*, 2012; Mahasuari *et al.*, 2020), sidondo flavonoids consist of castikin, orientin, isoorientin, luteolin, lutekin-7-O-glucoside, corimbosin, gardenins A and B, 3-O-desmethylnobiletin, and 3',4',5,5',6,7,8-heptamethoxyflavones (Lakshmanashetty *et al.*, 2010; Ullah *et al.*, 2012), while the flavonoids of pegagan include quercetin, myricetin, and kaempferol (Andarwulan *et al.*, 2010; Andarwulan *et al.*, 2012). The TFC value of wet noodles with the addition of 5%

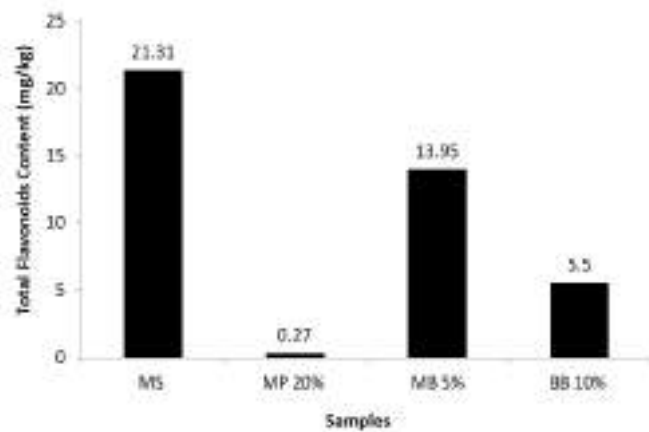


Figure 1. Total flavonoid content (TFC) of pluchea wet noodles 5% (MB 5% (Wibisono, 2021)) compared to sidondo wet noodles (MS (Syahirah and Rabeta, 2018)), pegagan wet noodles 60% (MP 60% (Fadzil *et al.*, 2020)), and pluchea bun 10% (BB 10% (Chiang, 2018)). The TFC of sidondo and pegagan wet noodles were respectively expressed in terms of quercetin equivalent per weight of wet noodles and rutin equivalent per weight of wet noodles extract, while the TFC of pluchea noodles and pluchea bun were expressed in terms of catechin equivalents per dried weight of freeze-dried results. TFC of MP 20%, MB 5%, and BB 10% were expressed by the values that have been subtracted with the TFC of control from each study.

concentration of pluchea leaf powder in steeping water was greater than the TFC of wet noodles with the addition of 20% pegagan extract, but the TFC of pluchea wet noodles 5% was lower than the TFC of sidondo wet noodles which used 0.66% sidondo leaf powder from the total weight of the noodles ingredients. Based on this comparison, it can be indicated that the use of pluchea leaf powder steeping water with a concentration of 5% can increase the flavonoids content of wet noodles far exceeding the flavonoids content that can be given by 20% pegagan extract solution in wet noodles (total flavonoids of pluchea wet noodles 5% is 51.67 times compared to pegagan noodles 20%). The total flavonoids of the pluchea wet noodles 5% is 1.53 times lower than the total flavonoids of sidondo wet noodles. The flavonoids content of sidondo wet noodles which was higher than pluchea wet noodles 5% could be caused by the addition of sidondo leaf powder directly to the making of wet noodles dough in Syahirah and Rabeta's research (2018), while pluchea wet noodles dough in Wibisono's study (2021) was made with using pluchea leaf powder steeping water in the formulation of wet noodles. In addition, several factors such as differences in formulation, sequence of processing and analysis stages, as well as stated standards and product sample forms analyzed in each study also affect the difference in TFC values compared between types of herbal wet noodles.

The TFC of wet noodles with the addition of 5%

concentration of pluchea leaf powder in steeping water was higher than the TFC of bun with the addition of 10% concentration of pluchea leaf powder in steeping water. This shows that the flavonoids content of pluchea wet noodles is higher than the flavonoids content of pluchea bun even though the concentration of pluchea leaf powder in steeping water in the manufacture of pluchea wet noodles is lower than the concentration of pluchea leaf powder in steeping water in the manufacture of pluchea bun (the TFC of pluchea wet noodles 5% is 2.54 times compared to pluchea bun 10%). According to Li *et al.* (2015), antioxidant compounds, one of which is flavonoids, are easily degraded in the heating process, and are lost during the process of mixing and kneading the dough. The degradation of flavonoids during heating and the extraction of glycosides by water vapor can be the cause of the low TFC value of pluchea bun. On the other hand, a study conducted by Saikia and Mahanta (2013) showed that the high flavonoids content can be caused by breaking the glycosidic bond of flavonoids with sugar by heating treatment. The wet noodles cooking process is thought to have an effect on breaking the glycosidic bond so that aglycones are formed which can improve the detection results of flavonoids compounds in the analysis. Various factors can affect the TFC value in different food products, including differences in ingredient formulations, specifications of the methods used, and the stages of the process in the manufacture of food products.

The TFC of pluchea wet noodles 5% showed that pluchea leaves have the potency to increase the content of phytochemical compounds (in this case flavonoids) in wet noodles as a wheat flour-based food product. Wibisono (2021) also mentioned that the use of higher concentration of pluchea leaf powder in steeping water in the formulation of wet noodles is able to provide a significant increase in the TFC of wet noodles. There has been no research on the effect of adding pluchea leaf powder steeping water on the type and amount of phytochemical compounds other than flavonoids in pluchea wet noodles products, so the use of pluchea leaves in the manufacture of wet noodles still needs to be developed and further investigated its effect on the phytochemical component content of wet noodles.

2.3 The effect of pluchea leaves on the functional properties of wet noodles

The functional properties of functional food products mainly focus on the ability of bioactive components in food products to help maintain the health of the human body. One of the properties possessed by bioactive components is that they can act as antioxidants. Carotenoids, flavonoids, and phenolic compounds are classified as natural antioxidants that can be found in

various foodstuffs (Marsono, 2008). Antioxidant activity can be in the form of DPPH free radical scavenging ability, iron ion reducing power, reactive oxygen species scavenging activity, and β -carotene-linoleic acid system inhibitory activity (Widyawati et al., 2017).

Iron ion reducing power (RP) is one of the parameters of antioxidant potential which is measured as secondary antioxidant activity based on the ability of antioxidant compounds to reduce Fe^{3+} to Fe^{2+} . Secondary antioxidants play a role in the mechanism of binding metal ions, scavenging oxygen, converting hydrogen peroxide into non-radical compounds, absorbing UV radiation, or deactivating singlet oxygen (Pokorny et al., 2001). According to Widyawati et al. (2014), iron ion is one of the pro-oxidants that have the potency to generate new free radicals. Antioxidant components are able to neutralize iron ions by acting as a substrate that will be oxidized first. Based on the research of Wibisono (2021), the use of the lowest (5%) and the highest (30%) concentration of pluchea leaf powder were able to increase the RP value of wet noodles by 1.33 times and 3.27 times compared to control wet noodles, respectively. The potency of pluchea leaves in increasing the antioxidant activity of wet noodles products can be described by comparing the RP value of pluchea wet noodles with other products such as rice flour paste and pluchea bun. The comparison of secondary antioxidant activity in the form of the iron ion reducing power of pluchea wet noodles with rice flour paste and pluchea bun can be seen in Figure 2.

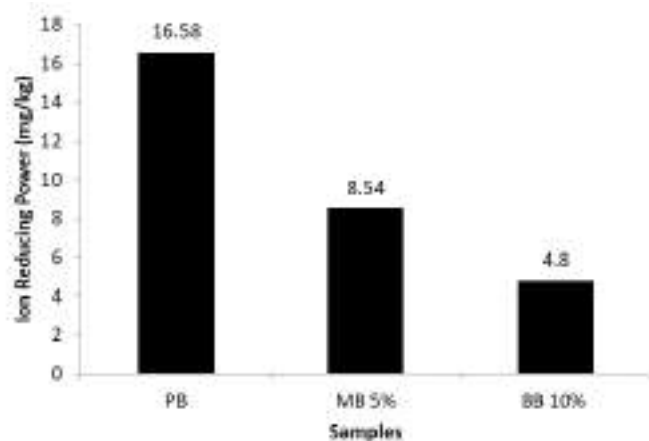


Figure 2. Iron ion reducing power (RP) of pluchea wet noodles 5% (MB 5% (Wibisono, 2021)) compared to rice flour paste (PB (Nitha et al., 2013)) and pluchea bun 10% (BB 10% (Chiang, 2018)). RP value of rice flour paste was stated to be equivalent to BHT per weight of pasta, while the RP value of pluchea wet noodles and pluchea bun was expressed in gallic acid equivalent per dried weight of freeze-dried results. Iron ion reducing power of MB 5% and BB 10% are expressed by the value that has been reduced by the RP value of control from each study.

Pluchea wet noodles 5% in the Wibisono's study

(2021) had the RP value 1.78 times higher than the RP value of pluchea bun 10% in Chiang's research (2018), but 1.94 times lower than the RP value of paste made from rice flour in the research of Nithya et al. (2013). The RP value indicates that the use of pluchea leaf powder steeping water with 5% concentration of pluchea leaf powder in steeping water has potency to provide greater secondary antioxidant activity in wet noodles than in bun products. The TFC of pluchea wet noodles 5% which is greater than the TFC of pluchea bun 10%, as shown in Figure 1, can contribute to the large iron ion reducing power of pluchea wet noodles 5% and pluchea bun 10%, that the phenolic group compounds, one of which is flavonoids, capable of donating hydrogen atoms/electrons so that they can reduce iron ions (Widyawati et al., 2014). The flavonoids content of pluchea wet noodles which is higher than the flavonoids content of pluchea bun, can cause the iron ion reducing power of wet noodles is higher compared to pluchea bun.

RP value of pluchea wet noodles 5% which is lower than the RP value of rice flour paste can be due to the use of different types of raw materials (related to the number and types of bioactive components in the ingredients) and the shape of the product samples analyzed in each study. Based on the research of Widyawati et al. (2014), white rice has total phenolic content (TPC) of 4.12 ± 0.05 mg gallic acid equivalent/g dry basis which is greater than the TPC of pluchea leaves in the study of Andarwulan et al. (2010), which was 0.831 ± 0.129 mg gallic acid equivalent/g fresh leaf weight. According to Wibisono (2021), the iron ion reducing power of pluchea wet noodles can be increased by using higher concentration of pluchea leaf powder in steeping water in the formulation of wet noodles.

RP value of pluchea wet noodles 5% shows the potency of pluchea leaves to increase the antioxidant activity of wet noodles products as an effort to increase the functional value of wheat flour-based food products such as wet noodles. The effect of adding pluchea leaf powder steeping water on the antioxidant activity of pluchea wet noodles using a type of analysis other than the iron ion reducing power has not been studied further, so it is necessary to measure other antioxidant parameters to support the potency of pluchea leaves in making wet noodles.

Research on the potency of pluchea leaves in improving the functional properties of wet noodles is still limited to being studied on product antioxidants, while pluchea leaves have been known to have various other functional properties that are beneficial to health and are able to maintain the quality of food products. Several other functional properties that have the potency to be

provided by pluchea leaves in food products include activities as anti-warmed-over flavor, anti-inflammatory, antidiabetic (Widyawati *et al.*, 2017), and antimicrobial properties that have the potency to prevent food spoilage (Ardiansyah *et al.*, 2003). This ability is inseparable from the presence of bioactive compounds in pluchea leaves which have the capacity as antioxidant and antihyperglycemic agents (Widyawati *et al.*, 2014; Widyawati *et al.*, 2015). According to Li *et al.* (2014), herbal plant extracts are potential preservatives that are currently being developed to be applied to bread, pasta, and noodles products due to the presence of phenolic components that have high antimicrobial activity. Tiwari *et al.* (2009) also proved that the antimicrobial activity of phenolic compounds is related to the ability of phenolics to affect the permeability of microbial cells which causes the release of important macromolecules from the microbial cell, as well as the ability of phenolics to interact with membrane proteins that cause deformation of the structure and function of microbial cell membranes.

3. Conclusion

Pluchea (*Pluchea indica* Less) leaves have the potency to increase the functional value of wet noodles in terms of the phytochemical content and functional properties of the wet noodles. The use of pluchea leaves increases the content of phytochemical compounds, in this case flavonoids, in wet noodles. The increase in the content of phytochemical compounds with the use of pluchea leaves affects the increase in the functional properties of wet noodles products, especially antioxidant activity in the form of the iron ion reducing power of wet noodles.

Conflict of interest

The authors declare no conflict of interest.

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References

- Aberoumand, A. and Deokule, S.S. (2008). Comparison of phenolic compounds of some edible plant of Iran and India. *Pakistan Journal of Nutrition*, 7(4), 582-585. <https://doi.org/10.3923/pjn.2008.582.585>
- Adventi, B.S., Widyawati, P.S. and Utomo, A.R. (2015). Effect of salt concentration for physicochemical and organoleptics salted egg pluchea (*Pluchea indica* Less)-black tea (*Camelia sinensis*). *Journal of Food*
- Technology and Nutrition*, 14(2), 55-60.
- Agbo, M.O., Uzor, P.F., Akazie-Nneji, U.N., Eze-Odurukwe, C.U., Ogbatue, U.B. and Mbaogi, E.C. (2015). Antioxidant, total phenolic and flavonoid content of selected Nigerian medical plants. *Dhaka University Journal of Pharmaceutical Sciences* 14 (1), 1-7. <https://doi.org/10.3329/dujps.v14i1.23733>
- Akbar, A. (2018). Physical, chemical and organoleptic analysis of wet noodle based on taro (*Colocasia esculenta* L). *Agritepa*, 4(2), 159-170. <https://doi.org/10.37676/agritepa.v5i1.726>
- Andarwulan, N., Batari, R., Sandrasari, D.A., Bolling, B. and Wijaya, H. (2010). Flavonoid content and antioxidant activity of vegetables from Indonesia. *Food Chemistry*, 121(4), 1231-1235. <https://doi.org/10.1016/j.foodchem.2010.01.033>
- Andarwulan, N., Kurniasih, D., Apriady, R.A., Rahmat, H., Roto, A.V. and Bolling, B.W. (2012). Polyphenols, carotenoids, and ascorbic acid in underutilized medicinal vegetables. *Journal of Functional Foods*, 4(1), 339-347. <https://doi.org/10.1016/j.jff.2012.01.003>
- Ardiansyah, Nuraida, L. and Andarwulan, N. (2003). Antimicrobial activity of pluchea (*Pluchea indica* L.) leaves extract and stability of the activity at different salt concentrations and pHs. *Journal of Food Technology and Industry*, 14(2), 90-97.
- Aziman, N., Abdullah N., Noor, Z.M., Zulkifli, K.S. and Kamarudin, W.S.S.W. (2012). Phytochemical constituents and in vitro bioactivity of ethanolic aromatic herb extracts. *Sains Malaysiana*, 41(11), 1437-1444.
- Billina, A., Waluyo, S. and Suhandy, D. (2014). Study of the physical properties of wet noodles with addition of seaweed. *Lampung Agricultural Engineering Journal*, 4(2), 109-116.
- Chen, X.G.Q. (2013). Identification and antioxidant capacity of anthocyanin pigment, and expressional analysis of flavonoid biosynthetic genes in colored rice strains. Japan: University of Hiroshima, PhD. Dissertation.
- Chiang, I. (2018). The effect of pluchea leaves powder (*Pluchea indica* Less) in steeping water of pao antioxidant activity. Indonesia: Widya Mandala Surabaya Catholic University, BSc. Thesis
- Dehkharghanian, M., Adenier, H. and Vijayalakshmi, M.A. (2010). Study of flavonoids in aqueous spinach extract using positive electrospray ionisation tandem quadrupole mass spectrometry. *Food Chemistry*, 121 (3), 863-870. <https://doi.org/10.1016/j.foodchem.2010.01.007>
- Erlidawati, Safrida and Mukhlis. (2018). Antioxidant

- Potency as Antidiabetic. Banda Aceh, Indonesia: Syiah Kuala University Press.
- Essa, M.M., Bishir, M., Bhat, A., Chidambaram, S.B., Al-Balushi, B., Hamdan, H., Govindarajan, N., Friedland, R.P. and Qoronfleh, M.W. (2021). Functional foods and their impact on health. *Journal of Food Science and Technology*, 60, 820-834. <https://doi.org/10.1007/s13197-021-05193-3>.
- Estiasih, T., Putri, W.D.R. and Waziroh, E. (2017). Tubers and Their Processing. Malang, Indonesia: UB Press.
- Fadzil, N.F., Bakar, M.F.A., Yusop, M.H.M. and Bakar, F.I.A. (2020). Sensorial and physicochemical characteristics of herbal noodle enriched with *Centella asiatica*. *Food Research*, 4(4), 1030-1037. [https://doi.org/10.26656/fr.2017.4\(4\).408](https://doi.org/10.26656/fr.2017.4(4).408)
- Firdausi, M.H. (2017). Physicochemical and organoleptic quality of dry method salted eggs with addition of pluchea leaves (*Pluchea indica* L.). Indonesia: Brawijaya University, BSc. Thesis.
- Hudha, M. and Widyaningsih, T.D. (2015). The effervescent powder uses pluchea leaf (*Pluchea indica* Less) extract as natural antioxidant source. *Journal of Food and Agroindustry*, 3(4), 1412-1422.
- Kennedy, D.O. and Wightman, E.L. (2011). Herbal extracts and phytochemicals: plant secondary metabolites and the enhancement of human brain function. *Advances in Nutrition*, 2(1), 32-50. <https://doi.org/10.3945/an.110.000117>
- Khasanah, V. and Astuti, P. (2019). Effect of addition of Moringa leaf extract (*Moringa oleifera*) on sensory quality and protein content of wet noodles substituted with modified cassava flour. *Journal of Technical Competence*, 11(2), 15-21.
- Koirewoa, Y.A., Fatimawali and Wiyono, W.I. (2012). Isolation and identification flavonoid compounds in pluchea leaf (*Pluchea indica* L.). *Pharmakon*, 1(1), 47-52.
- Lakshmanashetty, R.H., Nagaraj, V.B., Hiremath, M.G. and Kumar V. (2010). *In vitro* antioxidant activity of *Vitex negundo* L. leaf extracts. *Chiang Mai Journal of Science*, 37(3), 489-497.
- Li, M., Zhu, K.X., Guo, X.N., Brijs, K. and Zhou, H.M. (2014). Natural additives in wheat-based pasta and noodle products: opportunities for enhanced nutritional and functional properties. *Comprehensive Reviews in Food Science and Food Safety*, 13(4), 347-357. <https://doi.org/10.1111/1541-4337.12066>
- Li, Y., Ma, D., Sun, D., Wang, C., Zhang, J., Xie, Y. and Guo, T. (2015). Total phenolic, flavonoid content, and antioxidant activity of flour, noodles, and steamed bread made from different colored wheat grains by three milling methods. *The Crop Journal* 3(4), 328-334. <https://doi.org/10.1016/j.cj.2015.04.004>
- Magatra, P. (2013). Antioxidant activity, total phenolic content, and organoleptic test in tempe with marsh fleabane leaf extract (*Pluchea indica* L.). Indonesia: Satya Wacana Christian University, BSc. Thesis.
- Mahasuari, N.P.S., Paramita, N.L.P.V. and Putra, A.A.G.R.Y. (2020). Effect of methanol concentration as a solvent on total phenolic and flavonoid content of pluchea leaf extract (*Pluchea indica* L.). *Journal of Pharmaceutical Science and Application*, 2(2), 77-84. <https://doi.org/10.24843/JPSA.2020.v02.i02.p05>
- Marsono, Y. (2008). Functional food development prospects. *Journal of Food Technology and Nutrition* 7(1), 19-27.
- Nithya, D.J., Bosco, K.A.S., Jagan Mohan, R. and Alagusundaram, K. (2013). Antioxidant activity of rice bran pasta. *Journal of Microbiology, Biotechnology and Food Sciences*, 2(6), 2423-2425.
- Norlaili, A.H., Roselina, K. and Muhammad, T.S. (2014). Effect of *Cosmos caudatus* Kunth. (Ulam Raja) aqueous and dry extracts on the physicochemical and functional properties, and sensory acceptability of Herbal Yellow Alkaline Noodles. *Malaysian Journal of Nutrition*, 20(3), 403-415.
- Nuraida, L., Andarwulan, N., Sukmawati, M. and Yohana, E. (2008). Application of herbs and spices extracts as preservatives for wet noodles, presented at the International Conference Proceeding Investing in Food Quality, Safety and Nutrition, October 27-28. Jakarta, Indonesia.
- Pengelly, A. (2004). The Constituents of Medicinal Plants: An Introduction to the Chemistry and Therapeutics of Herbal Medicines, 2nd ed. Australia: CABI Publishing.
- Pokorny, J., Yanishlieva, N. and Gordon, M. (2001). Antioxidants in Food: Practical Applications. Cambridge, United Kingdom: Woodhead Publishing Ltd. <https://doi.org/10.1201/9781439823057>
- Saikia, S. and Mahanta, C.L. (2013). Effect of steaming, boiling and microwave cooking on the total phenolics, flavonoids and antioxidant properties of different vegetables of Assam, India. *International Journal of Food and Nutritional Sciences*, 2(3), 47-53.
- Sari, E.T. (2014). Factors influencing consumption of functional food in Surabaya. *Scientific Journal of Commerce Administration*, 12(2), 1-10.
- Shamim, M.Z., Verma, A., Sheikh, S. and Singh, S.

- (2016). Sensory evaluation of nutritious herbal noodles developed by utilization of *Aegle marmelos* leaves powder. *IMPACT: International Journal of Research in Applied, Natural and Social Sciences*, 4 (4), 109-114.
- Stojanovic, Z., Filipovic, J. and Mugosa, B. (2013). Consumer acceptance of functional foods in Montenegro. *Montenegrin Journal of Economics*, 9 (3), 65-74.
- Sulaiman, C.T. and Balachandran, I. (2012). Total phenolics and total flavonoids in selected Indian medical plants. *Indian Journal of Pharmaceutical Sciences*, 74(3), 258-260. <https://doi.org/10.4103/0250-474X.106069>
- Suter, I.K. (2013). Functional foods and their development prospects. Retrieved on February 15, 2021 from Udayana University Repository Website: https://repositori.unud.ac.id/protected/storage/upload/repositori/ID3_19501231197602100323091304927makalah-gizi.pdf.
- Syahirah, J. and Rabeta, M.S. (2018). Antioxidant and antimicrobial activity of lemuni noodle. *Food Research*, 3(1), 7-13. [https://doi.org/10.26656/fr.2017.3\(1\).090](https://doi.org/10.26656/fr.2017.3(1).090)
- Tiwari, B.K., Valdramidis, V.P., Donnell, C.P.O., Muthukumarappan, K., Bourke, P. and Cullen, P.J. (2009). Application of natural antimicrobials or food preservation. *Journal of Agricultural and Food Chemistry*, 57(14), 5987-6000. <https://doi.org/10.1021/jf900668n>
- Ullah, Z., Ullah, R., Shah, A.H.A., Ahmad, I. and Haider, S. (2012). Phytochemical and biological evaluation of *Vitex negundo* Linn: a review. *International Journal of Pharmaceutical Sciences and Research*, 3(8), 2421-2431.
- Vichapong, J., Sookserm, M., Srijesdaruk, V., Swatsitang, P. and Srijaranai, S. (2010). High performance liquid chromatographic analysis of phenolic compounds and their antioxidant activities in rice varieties. *LWT-Food Science and Technology*, 43(9), 1325-1330. <https://doi.org/10.1016/j.lwt.2010.05.007>
- Wibisono, D.A.S. (2021). Effect of concentration of pluchea (*Pluchea indica* (L.) Less) leaves powder in steeping water on total flavonoids and iron ion reducing power of wet noodle. Indonesia: Widya Mandala Surabaya Catholic University, BSc. Thesis.
- Widyawati, P.S., Budianta, T.D.W., Gunawan, D.I. and Wongso, R.S. (2015). Evaluation antidiabetic activity of various leaf extracts of *Pluchea indica* Less. *International Journal of Pharmacognosy and Phytochemical Research*, 7(3), 597-603.
- Widyawati, P.S., Budianta, T.D.W., Kusuma, F.A. and Wijaya, E.L. (2014). Difference of solvent polarity to phytochemical content and antioxidant activity of *Pluchea indica* Less leaves extracts. *International Journal of Pharmacognosy and Phytochemical Research*, 6(4), 850-855.
- Widyawati, P.S., Ristiari, S., Werdani, Y.D.W., Kuswardani, I. and Herwina, I.N. (2019). Physicochemical and organoleptic properties changes of soymilk with pluchea brewing water addition. *Journal of Food Technology and Nutrition*, 18(2), 98-111.
- Widyawati, P.S., Suteja, A.M., Suseno, T.I.P., Monika, P., Saputrajaya, W. and Liguori, C. (2014). Effect of pigment color difference in organic rice on antioxidant activity. *Agritech*, 34(4), 399-406. <https://doi.org/10.22146/agritech.9434>
- Widyawati, P.S., Werdani, Y.D.W., Setiokusumo, C. and Kartikasari, A. (2017). In vitro antioxidant capacities and antidiabetic properties of pluchea leaves and green tea mixtures at various proportions. *International Journal of Pharmacy and Pharmaceutical Sciences*, 9(8), 203-208. <https://doi.org/10.22159/ijpps.2017v9i8.19545>
- Wijaya, J.P. (2019). Effect of concentration of mixture of pluchea (*Pluchea indica* L.) leaves powder – green tea (*Camellia sinensis* L.) 1:1 (b/b) in steeping water on antioxidant activity of jelly drink. Indonesia: Widya Mandala Surabaya Catholic University, BSc. Thesis.
- Zhou, S., Wang, L., Wang, A., Zhang, Q., Li, Z. and Qiu, J. (2021). Effect of moisture distribution changes induced by different cooking temperature on cooking quality and texture properties of noodles made from whole tartary buckwheat. *Foods*, 10, 2543. <https://doi.org/10.3390/foods10112543>