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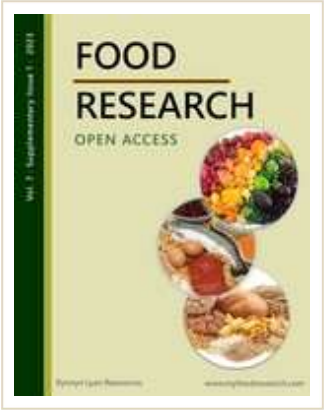

FOOD RESEARCH

Volume 7, Supplementary 1, 2023

International Food Conference 2021

In Progress

Search

Effects of frozen storage duration on the physicochemical and sensory properties of cassava sticks

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Available Online: 27 APRIL 2023 | https://doi.org/10.26656/fr.2017.7(S1).5

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Available Online: 27 APRIL 2023 | https://doi.org/10.26656/fr.2017.7(S1).11

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Pramanda *et al*. evaluated the changes in the microbial community structure via the starter cultures inoculation procedure during low-salt *moromi* fermentation.

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

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

Available Online: 27 APRIL 2023 | https://doi.org/10.26656/fr.2017.7(S1).21

Widyawati *et al*. reviewed the potency of pluchea (*Pluchea indica* Less) leaves to increase functional value of wet noodles.

Efficacy of soy biopeptide on serum iron, serum ferritin and hemoglobin levels of adolescent girls in Pandeglang district in Indonesia

Laily, N., Aji, G.K., Sukarti, I., Susanti, I., Illaningtyas, F. and Pranamuda, H.

Available Online: 27 APRIL 2023 | https://doi.org/10.26656/fr.2017.7(S1).20

The efficacy of soy biopeptide on serum iron, serum ferritin and hemoglobin levels of adolescent girls in Pandeglang district, Indonesia was evaluated by Laily *et al*.

Food Research 7 (Suppl. 1) : 103 - 110 (2023)
Journal homepage: https://www.myfoodresearch.com

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MINI REVIEW

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

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Article history:
Received: 5 February 2022
Received in revised form: 25 March 2022
Accepted: 4 October 2022
Available Online: 27 April 2023

Keywords:
Pluchea indica Less,
Wet noodles,
Functional value

DOI:
https://doi.org/10.26656/fr.2017.7(S1).21

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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eISSN: 2550-2166
Published by Rynnye Lyan Resources

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

https://doi.org/10.26656/fr.2017.7(S1).21

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 *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	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	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, corimbosin, gardenins A and B, 3-Odesmethylartemethin, 5-O-desmethylnobiletin, and 3',4',5,5',6,7,8-heptametioxyflavones (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%

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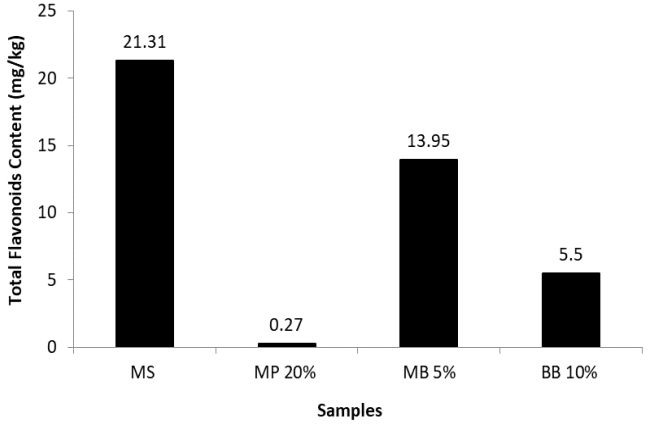

Figure 1. Total flavonoid content (TFC) of pluchea wet noodles 5% (MB 5% (Wibisono, 2021)) compared to sidondo wet noodles (MS (Syahirah and Rabeta, 2018)), pegagan wet noodles 60% (MP 60% (Fadzil *et al*., 2020)), and pluchea bun 10% (BB 10% (Chiang, 2018)). The TFC of sidondo and pegagan wet noodles 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

https://doi.org/10.26656/fr.2017.7(S1).21

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.

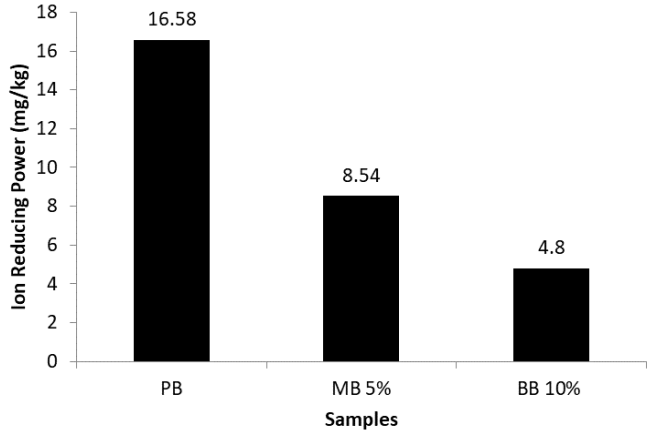

Figure 2. Iron ion reducing power (RP) of pluchea wet noodles 5% (MB 5% (Wibisono, 2021)) compared to rice flour paste (PB (Nitha *et al.,* 2013)) and pluchea bun 10% (BB 10% (Chiang, 2018)). RP value of rice flour paste was stated to be equivalent to BHT per weight of pasta, while the RP value of pluchea 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

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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.

Acknowledgments

The authors would like to thank the Agricultural Technology Faculty, Widya Mandala Surabaya Catholic University for the research grant.

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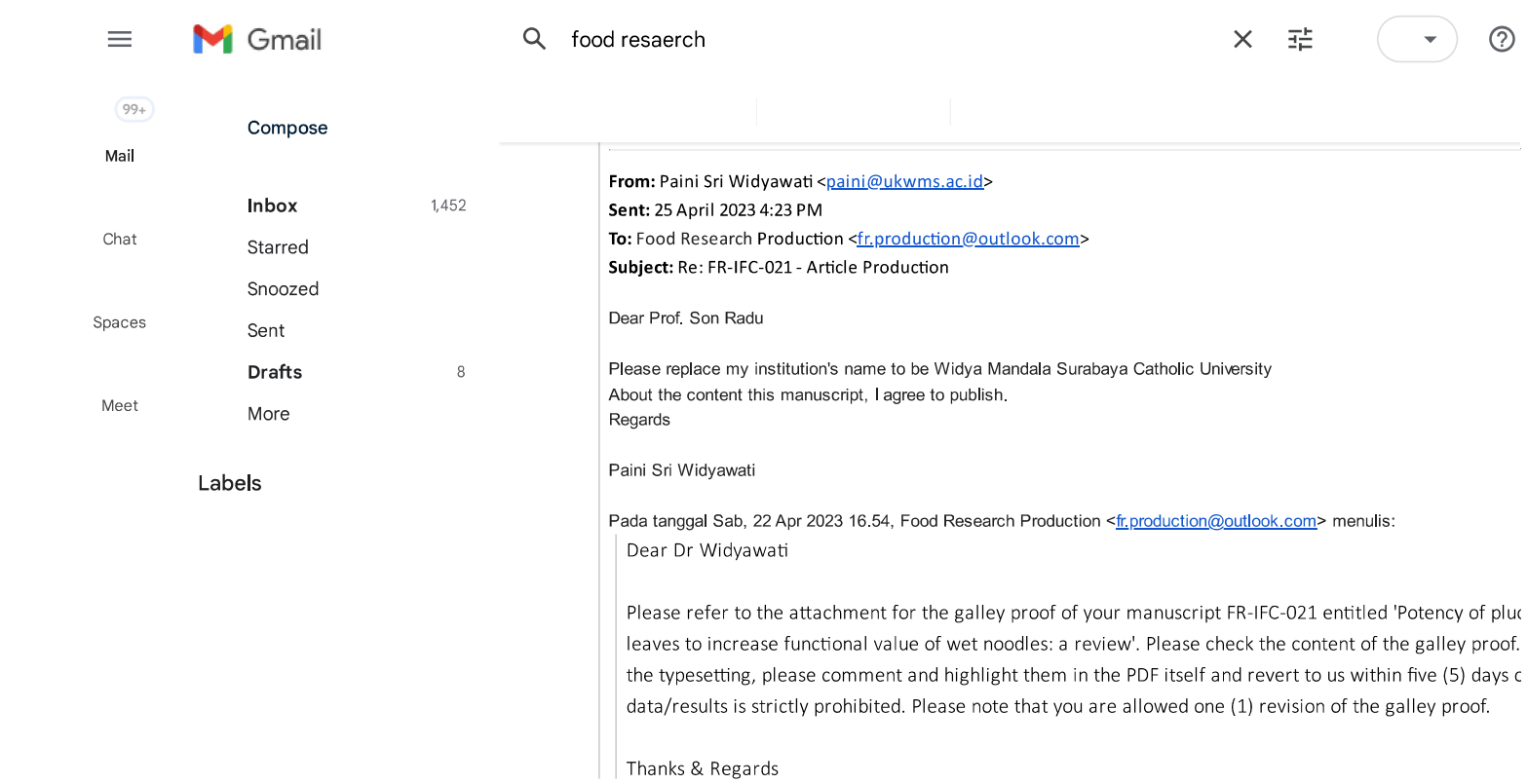

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