

## BUKTI KORESPONDENSI

**Judul Artikel:**

Effects of different soaking time using calcium chloride extracted from eggshell on physicochemical and organoleptic properties of sweet potato chips

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**Penulis:**

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1	Bukti artikel yang di-submit	17 September 2019
2	Bukti konfirmasi review dan hasil review	17 September 2022
3	Bukti konfirmasi submit revisi artikel dan artikel yang di-resubmit	25 September 2019
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1. Bukti artikel yang di-submit  
17 September 2019

# Effects of different soaking time using calcium chloride extracted from eggshell on physicochemical and organoleptic properties of sweet potato chips

**Abstract.** The aims of this research are to investigate the effects of different soaking times using  $\text{CaCl}_2$  on the physicochemical and organoleptic properties of sweet potato chips. The concentration of  $\text{CaCl}_2$  was 0.5%. Meanwhile the soaking times were 5; 10; 15; 20; 25; and 30 minutes. From the result, the moisture content of sweet potato chips were decreased (6.39% - 2.57%) with the longer soaking time. On the other hand, the ash contents were rise up to 2.27% in 30 minutes of soaking. The hardness of sweet potato chips were reached the lower level (477 gf) on 15 minutes of soaking time, more than 15 minutes, the hardness were rise. The crispness of sweet potato chip reached its optimum level (1.4457 gf) on 15 minutes of soaking time. The longer soaking time were preferred by the panelist. Meanwhile there was no significant difference on the taste. For the aftertaste, the 15 minutes time soaking time had the highest score (4.22).

## 1. Introduction

Chips is one of popular snacks consumed by any age groups from children to elderly. Among several kinds, potato is the most common commodity used to produce chips. Numerous number of research have already been published for potato chips production starting from the postharvest treatment [1] to the packing of potato chips to avoid the quality decrease of chips [2]. However, in the case of Indonesia, potato chips could not be produced widely due to the limited stock of potato as raw material and also the variety of potato grown in Indonesia is mostly for table potato therefore could not be used in chips production.

Meanwhile, even though planted widely in Indonesia, sweet potato is not familiarly utilized to produce chips. Boiled is the most common method to consume sweet potato, while mashed sweet potato is also common to be used as ingredients for several traditional cake and sweets. The main problem for such products is the short shelf life. It means that sweet potato should be processed within one day to yield a products which usually only have one or two days of shelf life. This resulted to the loss of sweet potato in postharvest and marketing storages level due to the limitation of use [3]. Moreover, the longer storage time can decrease the quality as well as leads to the decaying process of sweet potato [4].

In order to lower the loss of sweet potato after harvest, sweet potato can be processed to become chips by slicing the sweet potato and frying in a high and constant temperature [5]. As snack, the most important characteristic of chips is the crispness. Crispness is the sensation of crisp perceived by mouth and ears in the same time. The usual problem of chips characteristic including sweet potato chips is the hard texture after frying. Numbers of methods have been developed to increase the crispness of chips. One of the methods is soaking the chips in calcium solution [6]. Calcium has long been known to play a key role in mantaining the cell wall integrity of food product, thus responsible for the firmness and chrispness of several food products [7]. Calcium in the native form is always bond with minerals or other elements. In eggshell, most calcium is in the form of calcium carbonate. By extraction process using acid such as hydrochloric acid, calcium from eggshell could be utilized in the form of calcium chloride. Research reported on the optimization of extraction of eggshell using hydrochloric acid as solvent in various concentration and extraction time [8]. Calcium can also be

obtained from the eggshell in the form of calcium chloride by extracting the powdered eggshell using hydrochloric acids. Eggshell from chicken or duck are rich of calcium in the form of calcium carbonate. By reacting using hydrochloric acid after cleaning and membrane separation, powdered calcium chloride will be obtained and can be used and applied in food products. The aims of this research are to investigate the effects of different soaking times using calcium chloride from eggshell on the physicochemical and organoleptic properties of sweet potato chips.

## **2. Materials and Methods**

Yellow fleshed sweet potato was collected from farmer in Malang district East Java province. Meanwhile chicken eggshell were collected from traditional market, traditional food street vendors, and bakery shop in Surabaya, East Java province. Meanwhile, Hydrochloric acid (HCl) (Merck, Germany) was used for extraction of eggshell, aquadest used for analytical procedure were obtained from Food Analysis laboratory, Department of Food Technology, Widya Mandala Catholic University Surabaya. Meanwhile, equipment used for chips processing were slicer, digital balance (Mettler Toledo), deep fryer, hot plate, centrifuge, and glassware.

### *2.1 Calcium extraction from eggshell*

Extraction of Calcium chloride from eggshell was done according to previously published method [fsgf]. The principle of this procedure based on the reaction between calcium carbonate ( $\text{CaCO}_3$ ) contained in the eggshell with HCl solution and yield calcium chloride. In brief, 25 mL of 2.5% HCl solution were poured beaker glass containing 1 grams of eggshell. The mixtures were stirred occasionally. The end of the reaction observed when there was no air bubbles found. The mixtures were then heated  $115^\circ\text{C}$  to evaporate the solution. Further drying process were done using cooking pan until all of the liquid were completely evaporated. The dried white powder obtained is the  $\text{CaCl}_2$ .

### *2.2 Sweet potato chips processing*

The skin of sweet potato sorted for chips production were peeled and removed. After that, to wash the peeled sweet potato, clean tap water was used. Then the sweet potato was immediately placed in trays until completely dry. Sweet potato was then sliced approximately 2 mm width using commercial slicer. The sliced sweet potato was then soaked in calcium chloride solution. In this research, commercial  $\text{CaCl}_2$  and eggshell extracted  $\text{CaCl}_2$  were used. The concentration of  $\text{CaCl}_2$  soaking solution was 0.50%. The soaking time treatment of sliced sweet potato were 5, 10, 15, 20, 25, and minutes. After soaking, the sliced sweet potato was then fried using deep fryer at  $150^\circ\text{C}$  for 3.5 minute. Then, the fried sweet potato were placed in spinner to remove the oil, cooled in the room temperature and immediately stored in a closed container until further analysis.

### *2.3 Moisture content analysis*

Thermogravimetric method was used to measure the moisture content of sweet potato chips. In brief, 1 grams of calcium chloride extracted from eggshell were placed in a bottles and weigh. After that, the bottles were placed in the oven with  $110^\circ\text{C}$ . Then, the bottles were weighed periodically until the constant weight was obtained.

### *2.4 Ash content*

Measurement of ash content of sweet potato chips was done according to AOAC method. Briefly, 1 grams of sample was placed in porcelain crush. The crush was then placed in muffle furnace. In order to completely process the sample to obtain the ash content, the temperature of muffle furnace was set to  $550^\circ\text{C}$ . Then, the crush was weighed periodically until the constant weight was obtained.

### *2.5 Crispness of chips*

Crispness of chips was analysed using Texture Profile Analyser equipment, which will measure the texture using cylinder probe for chips sample

### *2.6 Organoleptic properties*

The organoleptic properties were assessed by hedonic scale test range from 7 to 1 scale consists of (7) like extremely, (6) like very much, (5) like, (4) neither like nor dislike, (3) dislike, (2) dislike very much, (1) dislike extremely. 120 untrained panellists of Widya Mandala Catholic University students were asked to provide their preference on the taste, texture, and aftertaste of chips with different soaking time in  $\text{CaCl}_2$  solution.

### 2.7 Statistical analysis

This research was conducted using Randomized Complete Block Design with one factor and five replications. Data obtained were analysed using ANAVA on 5% of alpha. For significance difference analysis, DMRT (*Duncan Multiple Range Test*) were applied. For statistical analysis, SPSS ver. 16 software was used.

## 3. Result and Discussion

The potency of processing eggshell to become other products is promising. This condition is supported by the large quantity of eggshell as waste of industries, small scale enterprises, and also household. Eggshell is usually processed as craft for decoration. Meanwhile, reports indicated that eggshell contain more than 80% of calcium in the form of calcium carbonate [9]. Therefore, the calcium can potentially be extracted and used as ingredient in food and other industries.

In this research, the calcium of eggshell was extracted using HCl to yield calcium chloride. The calcium chloride was then used to soak the sweet potato slices before fried to produce sweet potato chips. The moisture contents, ash contents, hardness, and crispness, as well as organoleptic properties were measured to examine the effects of different soaking time in calcium chloride solution on such parameters of sweet potato chips.

Moisture content is an important parameter of chips quality. It describe the amount of water contain in the product, which usually expressed in percentage. Especially in chips, the moisture content will affect the quality parameters because it is playing an important role in the crispness and also the shelf life of chips [10]. The data of moisture content of chips treated with different soaking time in calcium chloride can be seen in Figure 1. Calcium chloride has known as material with hygroscopic characteristic thus can react and bond easily with water [11].  $\text{CaCl}_2$  are often found in their native state to have bond with water. The moisture content of sweet potato chips product is not directly affected by  $\text{CaCl}_2$ . Nevertheless, soaking sweet potato slices in  $\text{CaCl}_2$  solution will lead to the formation of calcium pectate in the product [12]. Sweet potato having pectin content, the availability of calcium from the soaking process will result in the  $\text{Ca}^{2+}$  ion that bonding with pectinic acid in sweet potato. Thus create a crosslinking formation among  $\text{Ca}^{2+}$  ion known as calcium pectate an insoluble substance [13]. Calcium pectate is playing a crucial role in the crispness of sweet potato chips. The mechanism of calcium pectate in affecting the crispness of sweet potato chips is that the crosslinking will attract the water to bond with. Therefore, water molecules will penetrate the wall and the matrix of sweet potato slices. When the slices were fried, the water molecules will evaporated leaving space inside the chips resulted in low water content as well as increase of the crispness of the chips [14].

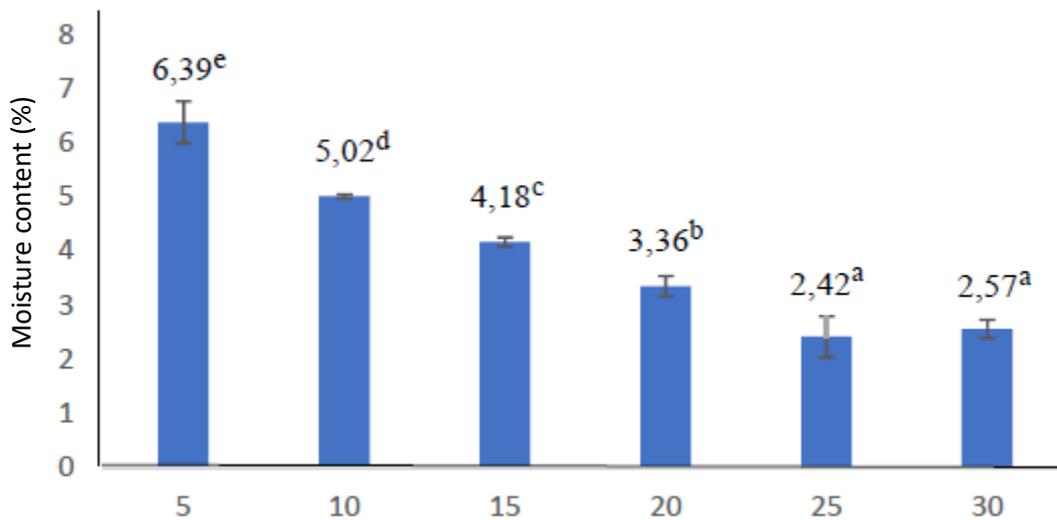


Figure 1. The moisture content of sweet potato chips

Figure 1 revealed that the increase of soaking time resulted in the decrease of moisture content. This could be due to the more time was available for calcium to penetrate in the matrix of sweet potato slice. Thus, more calcium pectate was formed. With the higher calcium pectate formed, it can bond higher number of water molecules. While, when it fried, it can evaporate a lot of water. Therefore the moisture contents of sweet potato chips are decreased. From the result, it can be postulated that  $\text{CaCl}_2$  from eggshell can be used as substitute to the commercial  $\text{CaCl}_2$ . The results also shows that by soaking the sweet potato slices at least for 10 minutes, the moisture content of the product can fulfil the standard requirement by Indonesian Standardization Agency for chips products which is 6%. Meanwhile the ash content of sweet potato chips were increase in line with the increase of soaking time (Figure 2).

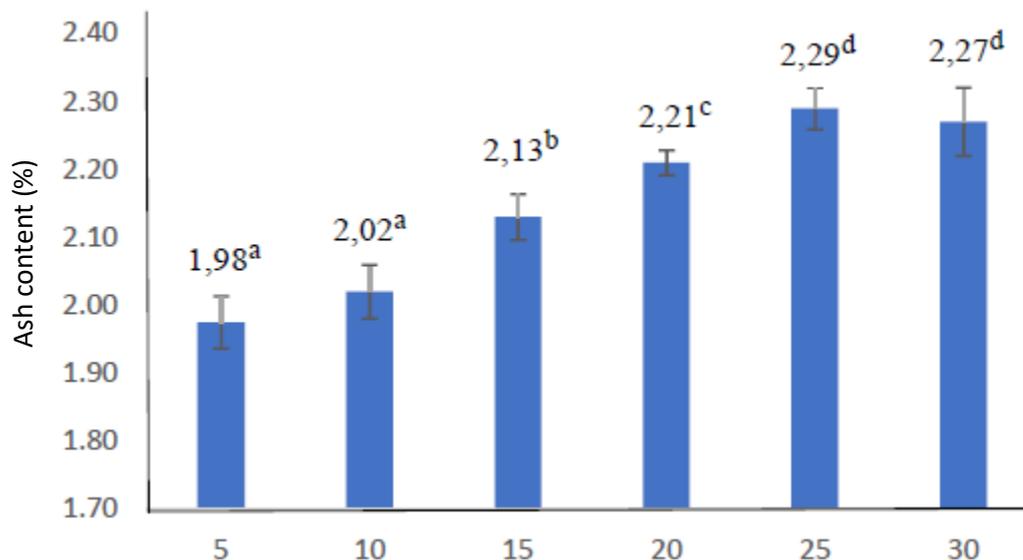


Figure 2. The ash content of sweet potato chips

The ash content in food sample shows the amount of minerals available in food products. The increase of ash content affected by longer soaking time could be due to the sufficient time available for calcium to penetrate to the cell wall and inside the matrix of sweet potato slices. Calcium will then bond with

water, creating crosslinking network thus in the same time trapping the calcium inside the sweet potato slice and remain inside the chips after the frying process.

Crispness of the sweet potato chips was measured using texture analyser. The results are presented in Figure 3. The result indicates that the soaking time will affect the crispness of chips. From Figure 3, it can be seen that soaking the sweet potato slices until 15 minutes will increase the crispness of chips. This could be due to the optimum time needed for calcium to diffuse to the matrix of sweet potato and creating networking bond with other calcium and also with water [15]. The more water attracted to the calcium ion, resulted in the increase of water penetrate inside the cell wall and creating microstructures hole which filled with water. When the slice was fried, the water molecules evaporate leaving microstructure holes and thin layers of wall resulted in the increase of crispness value of sweet potato chips. Meanwhile, there is no significant difference observed at the 20 minutes of soaking time. On the other hand, soaking the sweet potato slices for 25 and 30 minutes leads to the decrease of crispness. This could be due to the more calcium penetrate to the cell wall will result in the higher formation of calcium pectate. The more calcium pectate formed affected the texture of chips to become rigid which decrease the crispness of the sweet potato chips [16].

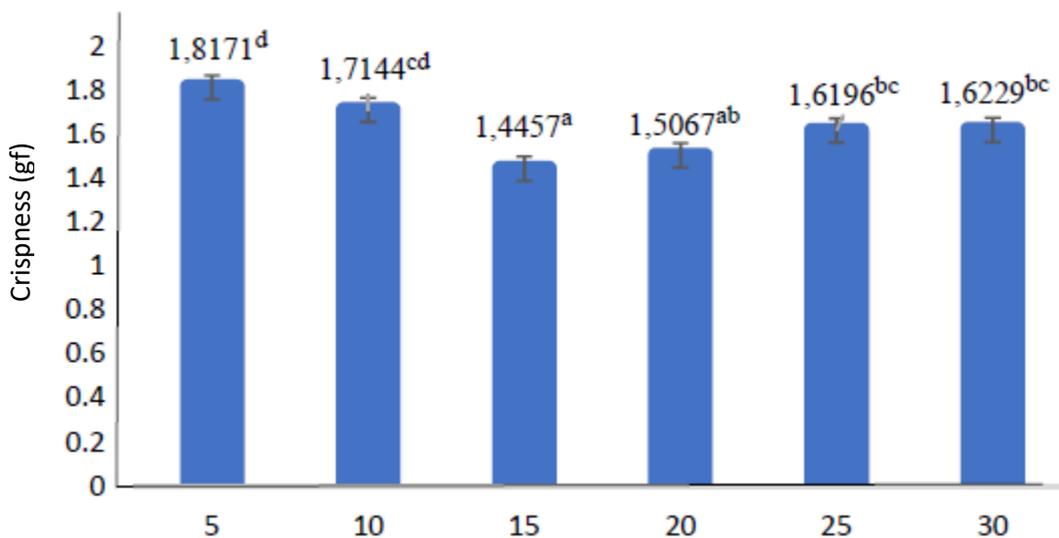


Figure 3. Crispness value of sweet potato chips

The organoleptic test using hedonic scale revealed that from the texture preference, the soaking time at least 20 minutes were chosen by the panellist. The score is between neutral to like the texture of sweet potato chips. This could be due to the increase of crispness of sweet potato chips therefore preferred by the panellists. Meanwhile, there were no significant differences on taste preferred by panellists. The range is between neutral to like. On the other hand, for the aftertaste preference test, the soaking time more than 15 minutes were not preferred by panellists. The range is between dislike and neutral. This could be due to the more calcium chloride in sweet potato chips, resulted in the bitter aftertaste due to the calcium content.

#### 4. Conclusion

Eggshell is the potential source to produce calcium chloride ( $\text{CaCl}_2$ ), Calcium chloride can be applied as soaking agent in sweet potato chips production. The increase of soaking time leads to the decrease of moisture content, increase of ash content. The maximum crispness value of sweet potato chips is with 15 minutes of soaking time. Meanwhile for organoleptic test, soaking the sweet potato slices at least 15 minutes were preferred by panellists. However there were no significant differences observed for taste parameter. While for aftertaste, maximum soaking time of 15 minutes was preferred by panellists for aftertaste.

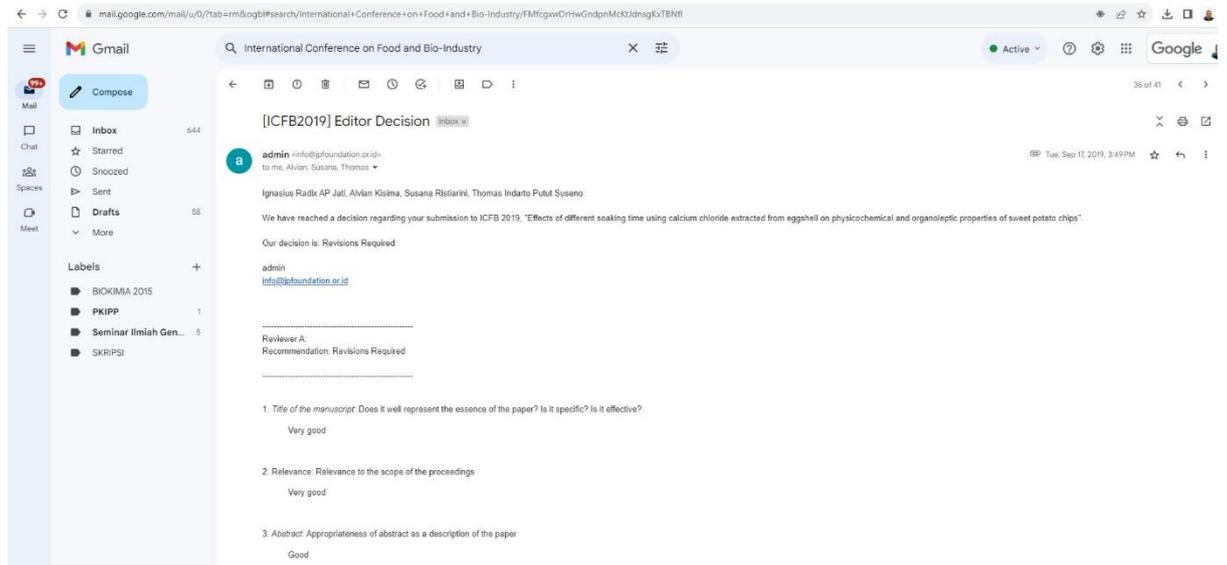
## Acknowledgement

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## 2. Bukti konfirmasi review dan hasil review 17 September 2019



The screenshot shows a Gmail interface with a search bar at the top containing the text "International Conference on Food and Bio-Industry". The left sidebar displays the Gmail navigation menu, including "Compose", "Inbox" (644), "Starred", "Sncoozed", "Sent", "Drafts" (58), and "More". Below the navigation menu, there are labels for "BIOKIMIA 2015", "PKIPP", "Seminar Ilmiah Gen..." (5), and "SKRIPSI".

The main content area shows an email from "admin" (info@igfoundation.or.id) to "me, Alvin, Susana, Thomas". The email subject is "[ICFB2019] Editor Decision". The body of the email reads:

Ignasius Radix AP Jati, Alvin Kisma, Susana Ristiarini, Thomas Indarto Putut Suseno

We have reached a decision regarding your submission to ICFB 2019, "Effects of different soaking time using calcium chloride extracted from eggshell on physicochemical and organoleptic properties of sweet potato chips".

Our decision is: **Revisions Required**

admin  
[info@igfoundation.or.id](mailto:info@igfoundation.or.id)

Reviewer A:  
Recommendation: **Revisions Required**

1. Title of the manuscript: Does it well represent the essence of the paper? Is it specific? Is it effective?  
Very good

2. Relevance: Relevance to the scope of the proceedings  
Very good

3. Abstract: Appropriateness of abstract as a description of the paper  
Good

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**Abstract.** The aims of this research are to investigate the effects of different soaking times using  $\text{CaCl}_2$  on the physicochemical and organoleptic properties of sweet potato chips. The concentration of  $\text{CaCl}_2$  was 0.5%. Meanwhile the soaking times were 5; 10; 15; 20; 25; and 30 minutes. From the result, the moisture content of sweet potato chips were decreased (6.39% - 2.57%) with the longer soaking time. On the other hand, the ash contents were rise up to 2.27% in 30 minutes of soaking. The hardness of sweet potato chips were reached the lower level (477 gf) on 15 minutes of soaking time, more than 15 minutes, the hardness were rise. The crispness of sweet potato chip reached its optimum level (1.4457 gf) on 15 minutes of soaking time. The longer soaking time were preferred by the panelist. Meanwhile there was no significant difference on the taste. For the aftertaste, the 15 minutes time soaking time had the highest score (4.22).

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## 1. Introduction

Chips is one of popular snacks consumed by any age groups from children to elderly. Among several kinds, potato is the most common commodity used to produce chips. Numerous number of research have already been published for potato chips production starting from the postharvest treatment [1] to the packing of potato chips to avoid the quality decrease of chips [2]. However, in the case of Indonesia, potato chips could not be produced widely due to the limited stock of potato as raw material and also the variety of potato grown in Indonesia is mostly for table potato therefore could not be used in chips production.

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In order to lower the loss of sweet potato after harvest, sweet potato can be processed to become chips by slicing the sweet potato and frying in a high and constant temperature [5]. As snack, the most important characteristic of chips is the crispness. Crispness is the sensation of crisp perceived by mouth and ears in the same time. The usual problem of chips characteristic including sweet potato chips is the hard texture after frying. Numbers of methods have been developed to increase the crispness of chips. One of the methods is soaking the chips in calcium solution [6]. Calcium has long been known to play a key role in maintaining the cell wall integrity of food product, thus responsible for the firmness and chrispness of several food products [7]. Calcium in the native form is always bond with minerals or other elements. In eggshell, most calcium is in the form of calcium carbonate. By extraction process using acid such as hydrochloric acid, calcium from eggshell could be utilized in the form of calcium chloride. Research reported on the optimization of extraction of eggshell using hydrochloric acid as solvent in various concentration and extraction time [8]. Calcium can also be

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## 2. Materials and Methods

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### 2.3 Moisture content analysis

Thermogravimetric method was used to measure the moisture content of sweet potato chips. In brief, 1 grams of calcium chloride extracted from eggshell were placed in a bottles and weigh. After that, the bottles were placed in the oven with  $110^\circ\text{C}$ . Then, the bottles were weighed periodically until the constant weight was obtained.

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### 2.4 Ash content

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### 2.7 Statistical analysis

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## 3. Result and Discussion

The potency of processing eggshell to become other products is promising. This condition is supported by the large quantity of eggshell as waste of industries, small scale enterprises, and also household. Eggshell is usually processed as craft for decoration. Meanwhile, reports indicated that eggshell contain more than 80% of calcium in the form of calcium carbonate [9]. Therefore, the calcium can potentially be extracted and used as ingredient in food and other industries.

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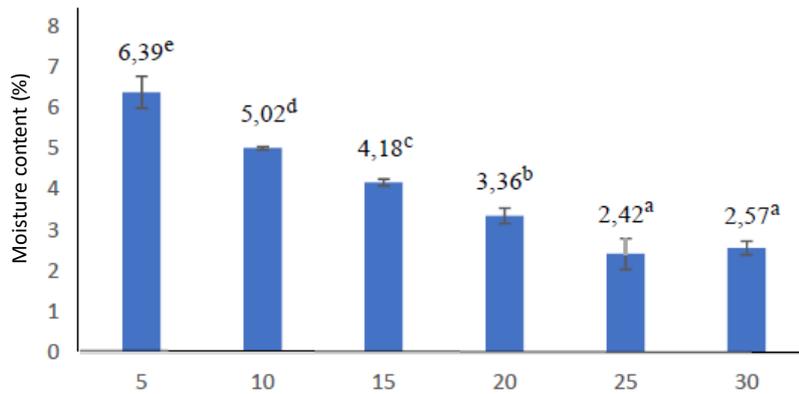


Figure 1. The moisture content of sweet potato chips

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Figure 1 revealed that the increase of soaking time resulted in the decrease of moisture content. This could be due to the more time was available for calcium to penetrate in the matrix of sweet potato slice. Thus, more calcium pectate was formed. With the higher calcium pectate formed, it can bond higher number of water molecules. While, when it fried, it can evaporate a lot of water. Therefore the moisture contents of sweet potato chips are decreased. From the result, it can be postulated that  $\text{CaCl}_2$  from eggshell can be used as substitute to the commercial  $\text{CaCl}_2$ . The results also shows that by soaking the sweet potato slices at least for 10 minutes, the moisture content of the product can fulfil the standard requirement by Indonesian Standardization Agency for chips products which is 6%. Meanwhile the ash content of sweet potato chips were increase in line with the increase of soaking time (Figure 2).

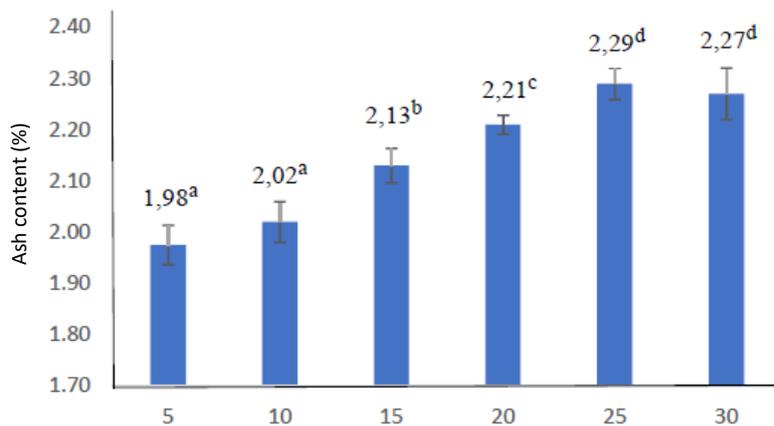


Figure 2. The ash content of sweet potato chips

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The ash content in food sample shows the amount of minerals available in food products. The increase of ash content affected by longer soaking time could be due to the sufficient time available for calcium to penetrate to the cell wall and inside the matrix of sweet potato slices. Calcium will then bond with

water, creating crosslinking network thus in the same time trapping the calcium inside the sweet potato slice and remain inside the chips after the frying process.

Crispness of the sweet potato chips was measured using texture analyser. The results are presented in Figure 3. The result indicates that the soaking time will affect the crispness of chips. From Figure 3, it can be seen that soaking the sweet potato slices until 15 minutes will increase the crispness of chips. This could be due to the optimum time needed for calcium to diffuse to the matrix of sweet potato and creating networking bond with other calcium and also with water [15]. The more water attracted to the calcium ion, resulted in the increase of water penetrate inside the cell wall and creating microstructures hole which filled with water. When the slice was fried, the water molecules evaporate leaving microstructure holes and thin layers of wall resulted in the increase of crispness value of sweet potato chips. Meanwhile, there is no significant difference observed at the 20 minutes of soaking time. On the other hand, soaking the sweet potato slices for 25 and 30 minutes leads to the decrease of crispness. This could be due to the more calcium penetrate to the cell wall will result in the higher formation of calcium pectate. The more calcium pectate formed affected the texture of chips to become rigid which decrease the crispness of the sweet potato chips [16].

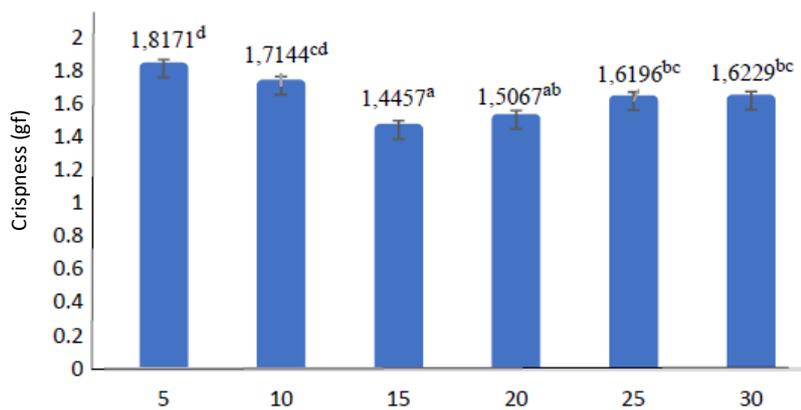


Figure 3. Crispness value of sweet potato chips

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The organoleptic test using hedonic scale revealed that from the texture preference, the soaking time at least 20 minutes were chosen by the panellist. The score is between neutral to like the texture of sweet potato chips. This could be due to the increase of crispness of sweet potato chips therefore preferred by the panellists. Meanwhile, there were no significant differences on taste preferred by panellists. The range is between neutral to like. On the other hand, for the aftertaste preference test, the soaking time more than 15 minutes were not preferred by panellists. The range is between dislike and neutral. This could be due to the more calcium chloride in sweet potato chips, resulted in the bitter aftertaste due to the calcium content.

#### 4. Conclusion

Eggshell is the potential source to produce calcium chloride ( $\text{CaCl}_2$ ), Calcium chloride can be applied as soaking agent in sweet potato chips production. The increase of soaking time leads to the decrease of moisture content, increase of ash content. The maximum crispness value of sweet potato chips is with 15 minutes of soaking time. Meanwhile for organoleptic test, soaking the sweet potato slices at least 15 minutes were preferred by panellists. However there were no significant differences observed for taste parameter. While for aftertaste, maximum soaking time of 15 minutes was preferred by panellists for aftertaste.

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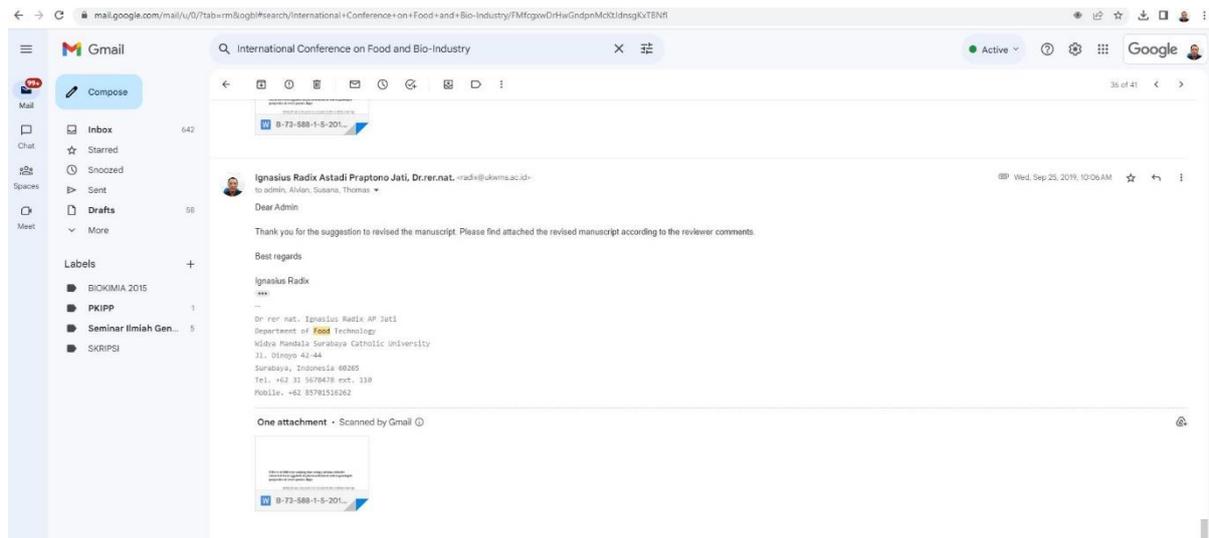
### Acknowledgement

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3. Bukti konfirmasi submit revisi artikel dan artikel yang di-resubmit  
25 September 2019



# Effects of different soaking time using calcium chloride extracted from eggshell on physicochemical and organoleptic properties of sweet potato chips

**Abstract.** The aims of this research were to investigate the effects of different soaking times using  $\text{CaCl}_2$  on the physicochemical and organoleptic properties of sweet potato chips. The concentration of  $\text{CaCl}_2$  was 0.5%. Meanwhile the soaking times were 5; 10; 15; 20; 25; and 30 minutes. The result showed that, the moisture content of sweet potato chips were decreased (6.39% - 2.57%) with the longer soaking time. On the other hand, the ash contents were rise up to 2.27% in 30 minutes of soaking. The hardness of sweet potato chips were reached the lower level (477 gf) on 15 minutes of soaking time, more than 15 minutes, the hardness were rise. The crispness of sweet potato chip reached its optimum level (1.4457 gf) on 15 minutes of soaking time. The longer soaking time were preferred by the panelist. Meanwhile there was no significant difference on the taste. For the aftertaste, the 15 minutes time soaking time had the highest score (4.22). Based on the result,  $\text{CaCl}_2$  extracted from eggshell could be potentially applied for food processing.

## 1. Introduction

Chips is one of popular snacks consumed by any age groups from children to elderly. Among several kinds, potato is the most common commodity used to produce chips. Numerous number of research have already been published for potato chips production starting from the postharvest treatment [1] to the packing of potato chips to avoid the quality decrease of chips [2]. However, in the case of Indonesia, potato chips could not be produced widely due to the limited stock of potato as raw material and also the variety of potato grown in Indonesia is mostly for table potato therefore could not be used in chips production.

Even though planted widely in Indonesia, sweet potato is not familiarly utilized to produce chips. Boiled is the most common method to consume sweet potato, while mashed sweet potato is also common to be used as ingredients for several traditional cake and sweets. The main problem for such products is the short shelf life. It means that sweet potato should be processed within one day to yield a products which usually only have one or two days of shelf life. This resulted to the loss of sweet potato in postharvest and marketing storages level due to the limitation of use [3]. Moreover, the longer storage time can decrease the quality as well as leads to the decaying process of sweet potato [4].

In order to lower the loss of sweet potato after harvest, sweet potato can be processed to become chips by slicing the sweet potato and frying in a high and constant temperature [5]. As snack, the most important characteristic of chips is the crispness. Crispness is the sensation of crisp perceived by mouth and ears in the same time. The usual problem of chips characteristic including sweet potato chips is the hard texture after frying. Numbers of methods have been developed to increase the crispness of chips. One of the methods is soaking the chips in calcium solution [6]. Calcium has long been known to play a key role in mantaining the cell wall integrity of food product, thus responsible for the firmness and chrispness of several food products [7]. Calcium in the native form is always bond with minerals or other elements. In eggshell, most calcium is in the form of calcium carbonate. By extraction process using acid such as hydrochloric acid, calcium from eggshell could be utilized in the form of calcium chloride. Research reported on the optimization of extraction of eggshell using hydrochloric acid as solvent in various concentration and extraction time [8]. Calcium can also be

obtained from the eggshell in the form of calcium chloride by extracting the powdered eggshell using hydrochloric acids. Eggshell from chicken or duck are rich of calcium in the form of calcium carbonate. By reacting using hydrochloric acid after cleaning and membrane separation, powdered calcium chloride will be obtained and can be used and applied in food products. The aims of this research were to investigate the effects of different soaking times using calcium chloride from eggshell on the physicochemical and organoleptic properties of sweet potato chips.

## **2. Materials and Methods**

Yellow fleshed sweet potato was collected from farmer in Malang district East Java province. Meanwhile chicken eggshell were collected from traditional market, traditional food street vendors, and bakery shop in Surabaya, East Java province. Meanwhile, Hydrochloric acid (HCl) (Merck, Germany) was used for extraction of eggshell, aquadest used for analytical procedure were obtained from Food Analysis laboratory, Department of Food Technology, Widya Mandala Catholic University Surabaya. Meanwhile, equipment used for chips processing were slicer, digital balance (Mettler Toledo), deep fryer, hot plate, centrifuge, and glassware.

### *2.1 Calcium extraction from eggshell*

Extraction of Calcium chloride from eggshell was done according to previously published method [9]. The principle of this procedure based on the reaction between calcium carbonate ( $\text{CaCO}_3$ ) contained in the eggshell with HCl solution and yield calcium chloride. In brief, 25 mL of 2.5% HCl solution were poured beaker glass containing 1 grams of eggshell. The mixtures were stirred occasionally. The end of the reaction observed when there was no air bubbles found. The mixtures were then heated  $115^\circ\text{C}$  to evaporate the solution. Further drying process were done using cooking pan until all of the liquid were completely evaporated. The dried white powder obtained is the  $\text{CaCl}_2$ .

### *2.2 Sweet potato chips processing*

The skin of sweet potato sorted for chips production were peeled and removed. After that, to wash the peeled sweet potato, clean tap water was used. Then the sweet potato was immediately placed in trays until completely dry. Sweet potato was then sliced approximately 2 mm width using commercial slicer. The sliced sweet potato was then soaked in calcium chloride solution. In this research, commercial  $\text{CaCl}_2$  and eggshell extracted  $\text{CaCl}_2$  were used. The concentration of  $\text{CaCl}_2$  soaking solution was 0.50%. The soaking time treatment of sliced sweet potato were 5, 10, 15, 20, 25, and minutes. After soaking, the sliced sweet potato was then fried using deep fryer at  $150^\circ\text{C}$  for 3.5 minute. Then, the fried sweet potato were placed in spinner to remove the oil, cooled in the room temperature and immediately stored in a closed container until further analysis.

### *2.3 Moisture content analysis*

Thermogravimetric method was used to measure the moisture content of sweet potato chips according to previously published method [10]. In brief, 1 grams of calcium chloride extracted from eggshell were placed in a bottles and weigh. After that, the bottles were placed in the oven with  $110^\circ\text{C}$ . Then, the bottles were weighed periodically until the constant weight was obtained.

### *2.4 Ash content*

Measurement of ash content of sweet potato chips was done according to Mortensen et al. (1989) [11]. Briefly, 1 grams of sample was placed in porcelain crush. The crush was then placed in muffle furnace. In order to completely process the sample to obtain the ash content, the temperature of muffle furnace was set to  $550^\circ\text{C}$ . Then, the crush was weighed periodically until the constant weight was obtained.

### *2.5 Crispness of chips*

Crispness of chips was analysed using Texture Profile Analyser equipment [12], which will measure the texture using cylinder probe for chips sample

## 2.6 Organoleptic properties

The organoleptic properties were assessed by hedonic scale test [13] range from 7 to 1 scale consists of (7) like extremely, (6) like very much, (5) like, (4) neither like nor dislike, (3) dislike, (2) dislike very much, (1) dislike extremely. 120 untrained panellists of Widya Mandala Catholic University students were asked to provide their preference on the taste, texture, and aftertaste of chips with different soaking time in  $\text{CaCl}_2$  solution.

## 2.7 Statistical analysis

This research was conducted using Randomized Complete Block Design with one factor and five replications. Data obtained were analysed using ANOVA on 5% of alpha. For significance difference analysis, DMRT (*Duncan Multiple Range Test*) were applied. For statistical analysis, SPSS ver. 16 software was used.

## 3. Result and Discussion

In this research, the calcium of eggshell was extracted using HCl to yield calcium chloride. The calcium chloride was then used to soak the sweet potato slices before fried to produce sweet potato chips. The moisture contents, ash contents, hardness, and crispness, as well as organoleptic properties were measured to examine the effects of different soaking time in calcium chloride solution on such parameters of sweet potato chips.

Moisture content is an important parameter of chips quality. It describe the amount of water contain in the product, which usually expressed in percentage. Especially in chips, the moisture content will affect the quality parameters because it is playing an important role in the crispness and also the shelf life of chips [14]. The data of moisture content of chips treated with different soaking time in calcium chloride can be seen in Figure 1. Calcium chloride has known as material with hygroscopic characteristic thus can react and bond easily with water [15].  $\text{CaCl}_2$  are often found in their native state to have bond with water. The moisture content of sweet potato chips product was not directly affected by  $\text{CaCl}_2$ . Nevertheless, soaking sweet potato slices in  $\text{CaCl}_2$  solution will lead to the formation of calcium pectate in the product [16]. Sweet potato having pectin content, the availability of calcium from the soaking process will result in the  $\text{Ca}^{2+}$  ion that bond with pectinic acid in sweet potato. Thus create a cross linking formation among  $\text{Ca}^{2+}$  ion known as calcium pectate an insoluble substance [17]. Calcium pectate is playing a crucial role in the crispness of sweet potato chips. The mechanism of calcium pectate in affecting the crispness of sweet potato chips is that the crosslinking will attract the water to bond with. Therefore, water molecules will penetrate the wall and the matrix of sweet potato slices. When the slices were fried, the water molecules will evaporated leaving space inside the chips resulted in low water content as well as increase of the crispness of the chips [18].

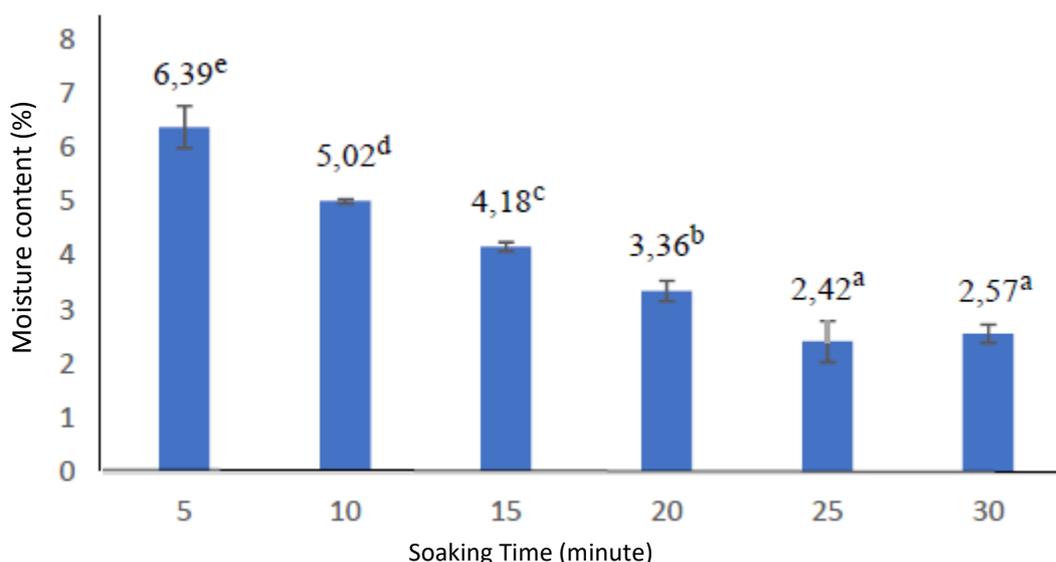


Figure 1. The moisture content of sweet potato chips

Figure 1 revealed that the increase of soaking time resulted in the decrease of moisture content. This could be due to the more time was available for calcium to penetrate in the matrix of sweet potato slice. Thus, more calcium pectate was formed. With the higher calcium pectate formed, it can bond higher number of water molecules. While, when it fried, it can evaporate a lot of water. Therefore the moisture contents of sweet potato chips were decreased. From the result, it can be postulated that CaCl<sub>2</sub> from eggshell can be used as substitute to the commercial CaCl<sub>2</sub>. The results also shows that by soaking the sweet potato slices at least for 10 minutes, the moisture content of the product was able to fulfil the standard requirement by Indonesian Standardization Agency for chips products which is 6%. Meanwhile the ash content of sweet potato chips were increase in line with the increase of soaking time (Figure 2).

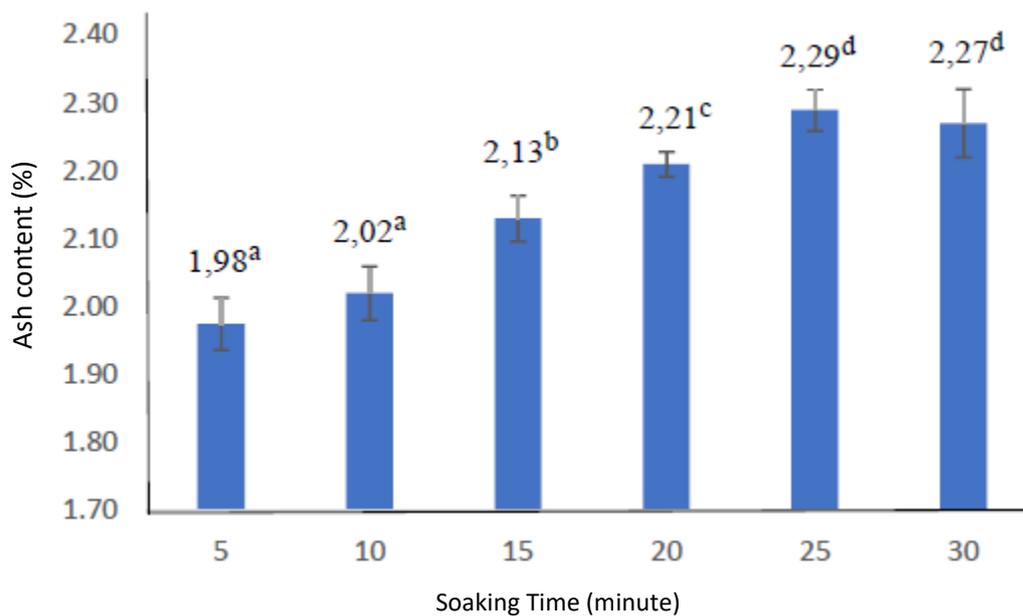


Figure 2. The ash content of sweet potato chips

The ash content in food sample shows the amount of minerals available in food products. The increase of ash content affected by longer soaking time could be due to the sufficient time available for calcium to penetrate to the cell wall and inside the matrix of sweet potato slices. Calcium will then bond with water, creating crosslinking network thus in the same time trapping the calcium inside the sweet potato slice and remain inside the chips after the frying process.

Crispness of the sweet potato chips was measured using texture analyser. The results are presented in Figure 3. The result indicated that the soaking time will affect the crispness of chips. From Figure 3, it can be seen that soaking the sweet potato slices until 15 minutes was able to increase the crispness of chips. This could be due to the optimum time needed for calcium to diffuse to the matrix of sweet potato and creating networking bond with other calcium and also with water [19]. The more water attracted to the calcium ion, resulted in the increase of water penetrate inside the cell wall and creating microstructures hole which filled with water. When the slice was fried, the water molecules evaporate leaving microstructure holes and thin layers of wall resulted in the increase of crispness value of sweet potato chips. Meanwhile, there was no significant difference observed at the 20 minutes of soaking time. On the other hand, soaking the sweet potato slices for 25 and 30 minutes leads to the decrease of crispness. This could be due to the more calcium penetrate to the cell wall resulted in the higher formation of calcium pectate. The more calcium pectate formed affected the texture of chips to become rigid which decrease the crispness of the sweet potato chips [20].

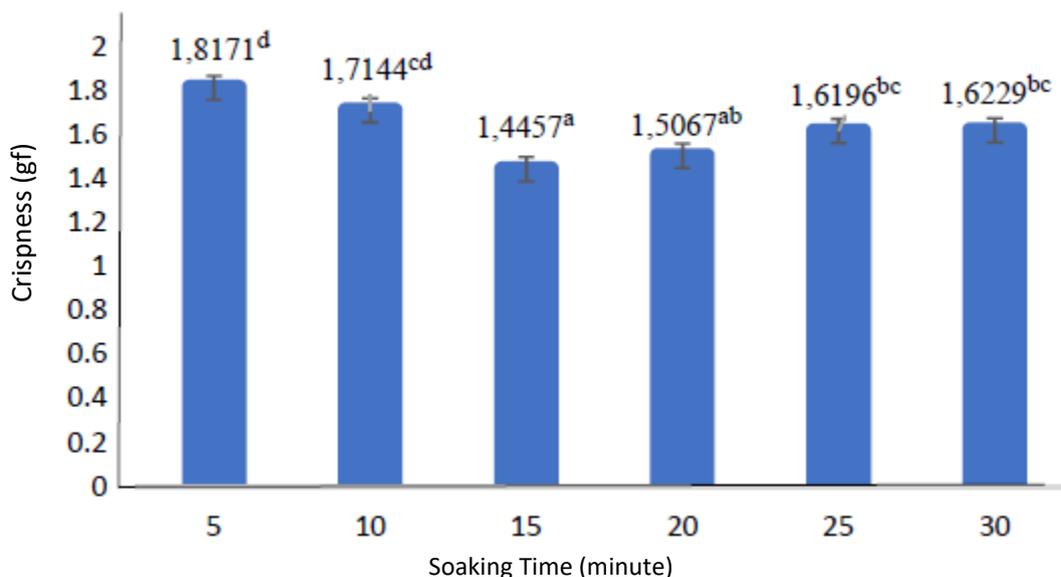


Figure 3. Crispness value of sweet potato chips

The organoleptic test using hedonic scale revealed that from the texture preference, the soaking time at least 20 minutes were chosen by the panellist. The score was between neutral to like the texture of sweet potato chips. This could be due to the increase of crispness of sweet potato chips therefore preferred by the panellists. Meanwhile, there were no significant differences on taste preferred by panellists. The range was between neutral to like. On the other hand, for the aftertaste preference test, the soaking time more than 15 minutes were not preferred by panellists. The range was between dislike and neutral. This could be due to the more calcium chloride in sweet potato chips, resulted in the bitter aftertaste due to the calcium content.

#### 4. Conclusion

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#### Acknowledgement

Author are grateful to the Ministry of Research Technology and Higher Education for the research grant on scheme Decentralisation Research, Applied Research in Higher Education 2019 (PD PTUPT 2019)

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#### 4. Bukti konfirmasi artikel diterima 3 November 2022

