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

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Abstract. The aims of this research were to investigate the effects of different soaking times using $CaCl_2$ on the physicochemical and organoleptic properties of sweet potato chips. The concentration of $CaCl_2$ 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 was decreased (6.39% - 2.57%) with the longer soaking time. On the other hand, the ash contents were risen up to 2.27% in 30 minutes of soaking. The hardness of sweet potato chips was reached the lower level (477 gf) on 15 minutes of soaking time, more than 15 minutes, the hardness was rise. The crispness of sweet potato chips reached its optimum level (1.4457 gf) on 15 minutes of soaking time. The longer soaking time was preferred by the panelist. Meanwhile, there was no significant difference in the taste. For the aftertaste, the 15 minutes time soaking time had the highest score (4.22). Based on the result, $CaCl_2$ extracted from eggshell could be potentially applied for food processing.

1. Introduction

Chips are one of the popular snacks consumed by any age group from children to the elderly. Among several kinds, potato is the most common commodity used to produce chips. Some research has 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, it 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 the mashed sweet potato is also common to be used as ingredients for several traditional cake and sweets. The main problem with such products is the short shelf life. It means that sweet potato should be processed within one day to yield products that usually only have one or two days of shelf life. This resulted in 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 lead 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 a snack, the most important characteristic of chips is the crispness. Crispness is the sensation of crisp perceived by

mouth and ears at 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 crispiness 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 products, thus responsible for the firmness and crispness of several food products [7]. Calcium in the native form is always bond with minerals or other elements. In an eggshell, most calcium is in the form of calcium carbonate. By extraction process using an acid such as hydrochloric acid, calcium from eggshell could be utilized in the form of calcium chloride. The research reported on the optimization of the extraction of eggshell using hydrochloric acid as a 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 hydrochloride acids. Eggshellfrom chicken or duck is rich with 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 farmers in Malang district East Java province. Meanwhile, chicken eggshell was collected from the traditional market, traditional food street vendors, and bakery shop in Surabaya, East Java province. Meanwhile, Hydrochloride acid (HCl)(Merck, Germany) was used for extraction of eggshell, aquadest used for the analytical procedure were obtained from Food Analysis Laboratory, Department of Food Technology, Widya Mandala Catholic University of Surabaya. Meanwhile, equipment used for chips processing was slicer, digital balance (Mettler Toledo), deep fryer, hot plate, centrifuge, and glassware.

2.1. Calcium extraction from eggshell

The extraction of Calcium chloride from eggshell was done according to a previously published method [9]. The principle of this procedure based on the reaction between calcium carbonate (CaCO3) contained in the eggshell with HCl solution and yield calcium chloride. In brief, 25 mL of 2.5% HCl solution was poured beaker glass containing 1 gram of eggshell. The mixtures were stirred occasionally. The end of the reaction observed when there were no air bubbles found. The mixtures were then heated 115ºC to evaporate the solution. The further drying process was done using a cooking pan until all of the liquid was completely evaporated. The dried white powder obtained is the $CaCl_2$.

2.2. Sweet potato chips processing

The skin of sweet potato sorted for chips production was 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. The sweet potato was then sliced approximately 2 mm wide using a commercial slicer. The sliced sweet potato was then soaked in calcium chloride solution. In this research, commercial $CaCl_2$ and eggshell extracted $CaCl_2$ were used. The concentration of $CaCl_2$ 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 150ºC for 3.5 minutes. Then, the fried sweet potato was placed in the 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

The thermogravimetric method was used to measure the moisture content of sweet potato chips according to a previously published method [10]. In brief, 1 gram of calcium chloride extracted from eggshell was placed in a bottle and weighed. After that, the bottles were placed in the oven with 110ºC. 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 gram of sample was placed in a porcelain crush. The crush was then placed in a muffle furnace. In order to completely process the sample to obtain the ash content, the temperature of the muffle furnace was set to 550ºC. Then, the crush was weighed periodically until the constant weight was obtained.

2.5. *Crispness of chips*

The crispness of chips was analyzed using texture profile analyzer 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. A total of 120 untrained panelists of Widya Mandala Catholic University students was asked to provide their preference on the taste, texture, and aftertaste of chips with different soaking time in $CaCl_2$ solution.

2.7. *Statistical analysis*

This research was conducted using a randomized complete block design with one factor and five replications. Data obtained were analyzed using ANOVA on5% of alpha. For significance difference analysis, DMRT (*Duncan Multiple Range Test*) was applied. For statistical analysis, SPPS ver. 16 software was used.

3. Results and discussions

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 describes the amount of water contains 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 the moisture content of chips treated with different soaking time in calcium chloride can be seen in figure 1. Calcium chloride has known as a material with hygroscopic characteristics, thus can react and bond easily with water [15]. $CaCl_2$ are often found in their native state to have a bond with water. The moisture content of sweet potato chips products was not directly affected by $CaCl_2$. Nevertheless, soaking sweet potato slices in CaCl2 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 Ca^{2+} ion that bond with pectinic acidin sweet potato. Thus create a crosslinking formation among 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 be evaporated leaving space inside the chips resulted in low water content as well as the increase of the crispness of the chips [18].

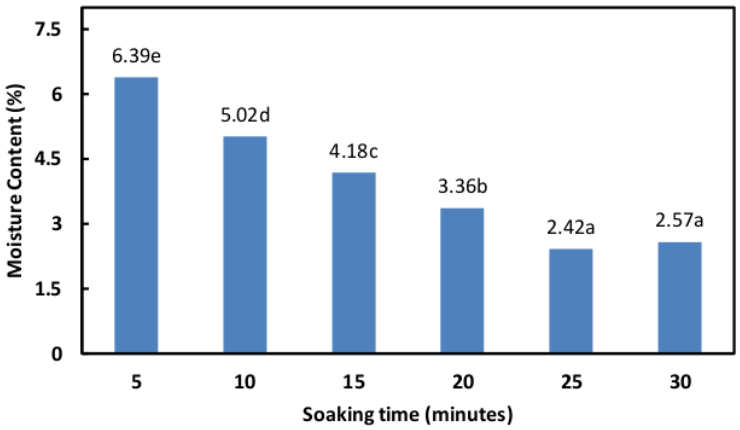

Figure 1. The moisture content of sweet potato chips.

Figure 1 reveals 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 bound 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 CaCl2 from eggshell can be used as substitute to the commercial CaCl2. 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).

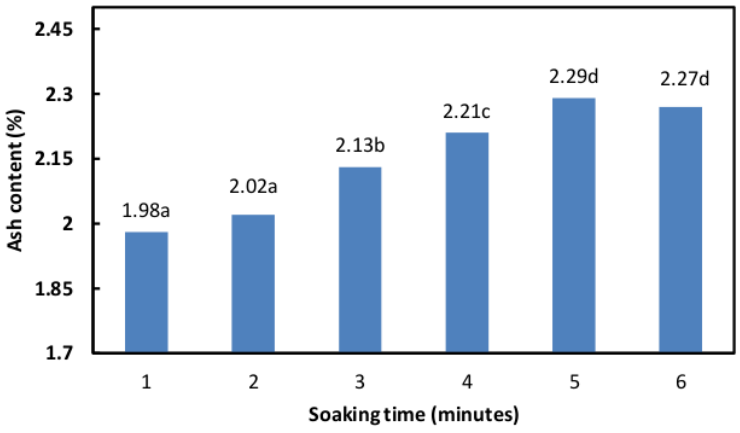

Figure 2. The ash content of sweet potato chips.

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].

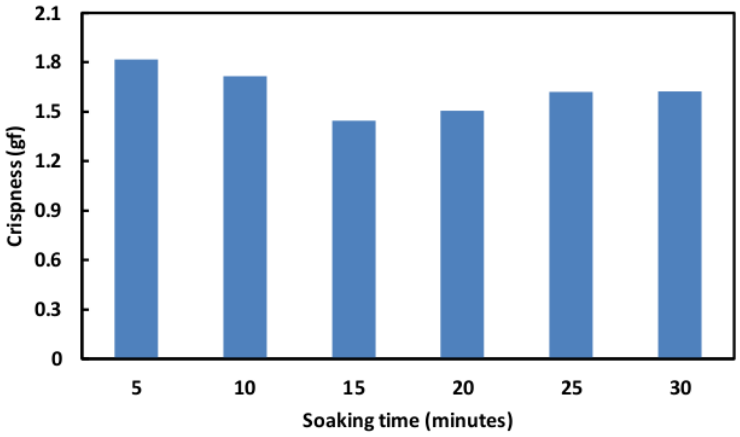

Figure 3. Crispness value of sweet potato chips.

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 inthe bitter aftertaste due to the calcium content.

4. Conclusion

Eggshell is the potential source to produce calcium chloride ($CaCl_2$), Calcium chloride can be applied as soaking agent in sweet potato chips production. The increase of soaking time was leads to the decreased of moisture content and increased of ash content. The maximum crispness value of sweet potato chips was 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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