Study of making Potato Chips local kalosi variety with pre-treatment

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Abstract. Potato chips are a snack that is loved by the people. The purpose of this study was to examine the making of kalosi potato chips with some immersion treatment of Kalosi potato chips. The study was conducted at the Postharvest Laboratory of AIAT South Sulawesi from June to December 2017. The design of the RAL trial with 3 replications with 6 immersion treatments namely in water, Ca(OH)2 0.5% solution, Ca(OH)2 1%, Na2S2O5 0.5%, Na2S2O5 1%, CaCl2 0.5% and CaCl2 1%. The results showed that the chemical characteristics were significantly different between all immersion treatments. While the organoleptic characteristics were not significantly different from all treatments. The best treatment and fulfilling SNI requirements were local potato chips of Kalosi varieties which were soaked in 1% CaCl2 solution with a yield of 21.39%; the moisture content of 1.61%, fiber 3.71%, fat 13.71%, starch 33.67%, ash 2.46%, and the level of organoleptic of color, aroma, texture and overall acceptance with scores very like.

1. Introduction

Potatoes are one of the commodities that have the potential to be developed as a source of carbohydrates to support food diversification programs, increase farmers' incomes, non-oil export commodities, and processed industrial raw materials. Although potatoes are not a staple food for the people of Indonesia, but consumers tend to increase from year to year because the number of products is increasing, the standard of living of the community increases.

According to Samadi (2007), every 100 grams of potatoes contains 347 calories, with a protein content of 0.3 g, 0.1 g fat, carbohydrate 85.6 g, calcium 20 mg, phosphorus 30 mg, iron 0.5 mg, and vitamin B 0.04 mg [1]. Based on the calorie production, the food value of potatoes is higher when compared to cereals or other foodstuffs [2].

One of the potato producing regions in South Sulawesi is Enrekang Regency. This area has been designated as a producer of Kalosi Potatoes, which is a local variety of Enrekang since decades ago its taste has been recognized. It is now a matter of pride for the Enrekang farmers because it has been established as a patent from Bumi Massenrempulu. The potato commodity produced by Enrekang Regency is one of the best potato commodities in the country. As for the Kalosi Potato Production in Enrekang in 2016 reached 250 Kwintal, and the region with the highest production was the Anggeraja District [3].

So far, Kalosi potatoes are processed into traditional cakes and become special cakes at official events in the South Sulawesi region. In this activity, we will try to process the local potato varieties of Kalosi into snacks or snacks that are preferred by Indonesian people, namely potato chips.
Potatoes can be processed into a variety of food products, including potato chips. Processing potatoes into chips is a post-harvest stage taken to develop product diversification and increase added value. In Indonesia, two types of processed potato products that show an increasingly popular trend in consumption patterns are french fries and potato chips [4].

There are several factors that affect the quality of potato chips, including soaking and varieties or types of potatoes. Soaking with hot water activates and destroys enzymes so that browning reactions can be prevented, and the color of chips becomes bright. Good potato chips come from potato tubers that have low water and sugar content and high starch content. The too high water content will produce potato chips with a less crispy texture. High sugar levels in potatoes will reduce the quality of potato chips, especially the color because it will accelerate the Maillard browning reaction between reducing sugars with primary amine groups to produce melanoidin compounds that produce brown and undesirable products in making potato chips. Low starch content will produce potato chips with a less crispy texture [5].

One method that is used to get potato chips with a crispy texture even though using a type of potato with low starch content and high water content is by soaking in calcium (Ca). Immersion is a food processing stage which plays an important role in the quality of food produced. The immersion treatment is intended to maintain the texture. Changes in texture to food in the soft food during storage and processing using heat can occur because of changes in the nature of cell permeability, changes in pectin, and the influence of sugar [6]. This hard to soft change can be prevented by soaking in a solution of calcium salts because calcium reacts with the carboxyl group from pectin.

Soaking in a solution of betel lime causes the texture to become hard, reducing the taste of sepah, bitter and distorted tastes [7]. Calcium can enhance the hardness of the gel due to the presence of calcium bonds with the carboxyl group through the calcium bridge. The whole potato tuber contains 1.55% methoxyl in every 100 grams of potato tubers. Pectin with low methoxyl lower than 7% can form a gel if there are two valent metal ions. Calcium, which has two valencies, will bind crossing between the two carboxyl groups in pectin. If these bonds are present in large numbers, calcium pectate tissues will form. Calcium salt solution in the material will form calcium pectate, which is insoluble in water [6].

The advantage of using lime Ca(OH)$_2$ solution in soaking food is that lime, which is a strong electrolyte, will dissolve easily in water, and Ca ions will be easily absorbed in the tissue material. In addition, Ca(OH)$_2$ can also prevent the non-enzymatic browning process caused by Ca ions against amino acids. Non-enzymatic browning reactions generally occur when we add or dry food. The brown color will arise due to the reaction between sugar and protein or amino acids [8]. Ca(OH)$_2$ is a strong electrolyte that dissolves easily in water. Ion Ca$^{2+}$ will be easily absorbed into the tissue so that it can strengthen the cell wall. Ca(OH)$_2$ includes a firming agent for fruits and vegetables. Ca$^{2+}$ ions will form Ca-pectate and pectin. Calcium salts that can be used besides Ca(OH)$_2$ are Ca-lactate, Ca-citrate, and Ca-chloride. Calcium ions can also strengthen texture and prevent enzymatic browning because calcium ions react with amino acids, thereby inhibiting browning reactions [8].

In making chips, calcium pectate formation will help increase porosity, thereby increasing its crispness. However, the use of high Ca concentrations results in a high amount of calcium pectate interactions, so the texture of the product becomes hard. At high solution pH, Ca(OH)$_2$ will ionize into Ca$^{2+}$ and OH- form cross bonds with starch. Ca$^{2+}$ interactions will stabilize the starch granule walls so that the starch granules are harder and stronger [9].

The aim of this study was to look at the effect of soaking with several types of solutions on the quality of local potato chips Kalosi.

2. Materials and methods

2.1 Materials

Potato variety of local Kalosi is harvested when they are ripe commercially in Anggeraja District, Enrekang Regency, South Sulawesi. After it is dry enough, potatoes are transported from the farmer's
area to the Agricultural Technology Assessment laboratory (BPTP), and the further selection and grading are carried out to select uniform potatoes per kg and free of pests and diseases. This activity was carried out from January to December 2017. Potatoes were taken from farmers in Anggeraja District, Enrekang Regency, and processed in the Post Harvest Laboratory of AIAT South Sulawesi after that analyzed at the Laboratory of the Faculty of Pharmacy, University of Hasanuddin.

The materials used in this study were local potato variety of Kalosi, lime (Ca(OH)\(_2\)), Sodium metabisulfite (Na\(_2\)S\(_2\)O\(_5\)), CaCl\(_2\), water, cooking oil, distilled water, chemical analyzers, packaging, and tissue.

The equipment used consists of a knife, slicer, deep fryer, chemical analysis equipment, digital scales, filters, plastic trays, aluminum foil packaging, basins, spoons, label paper, and sealer.

2.2 Procedure
Selected good potato tubers (not rotten or deformed), washed clean of dirt attached, then peeled. Potato tubers that have been peeled weighed and cut using a slicer. Potato chips were immediately soaked according to the treatment that was tried, i.e., soaked in a solution of betel lime Ca(OH)\(_2\) 0.5% and 1%, soaked in a solution of sodium metabisulfite (Na\(_2\)S\(_2\)O\(_5\)) 0.5 and 1%, immersed in 0.5 and 1% CaCl\(_2\), and soaked in water as a control. The immersion process is carried out for 30 minutes then blanching in hot water for 5-10 minutes to activate the enzyme. After that, the potato pieces are removed and drained, then fried at ±180°C for ±15 minutes, depending on the amount to be fried. The temperature of 180°C is the most suitable temperature for use in frying chips. A good frying temperature is 163 - 196°C [10]. Fried products are drained, cooled, and packaged. Potato chips are ready to be analyzed for chemical and organoleptic quality.

2.3 Observation parameters
The parameters observed include yield, chemical aspects [11], which include moisture, ash, starch, fat, and crude fiber. Sensory aspects include texture, aroma, colour, flavor and likeness value performed by the scoring method (1 = very disliked, 2 = dislike, 3 = somewhat like, 4 = like, 5 = very like and 6 = really like it) [12].

The yield of potato chips is a percentage ratio between the weight of potato chips that have been fried (ready for consumption) with the weight of potatoes that have not been peeled.

2.4 Experimental design
The experimental design used in this study was a completely randomized design (CRD) and 3 replications with immersion treatment as follows:
   a. Water/control
   b. Lime (CaOH\(_2\)) 0.5%.
   c. Lime (CaOH\(_2\)) 1%.
   d. Natrium metabisulfit (Na\(_2\)S\(_2\)O\(_5\)) 0.5%.
   e. Natrium metabisulfit (Na\(_2\)S\(_2\)O\(_5\)) 1%.
   f. CaCl\(_2\) 0.5%.
   g. CaCl\(_2\) 1%.

The collected data are tabulated, analyzed with ANOVA analysis of analysis (Analysis of variance), and if the real F test is forwarded to the DMRT (Duncan Multiple Range Test) multiple tests.

3. Result and discussion

3.1 Effect of type of immersion on the yield of potato chips
The results of statistical tests it was known that the type of immersion significantly affected the yield of local potato chips of Kalosi. The yield of potato chips can be seen in Table 1.
Table 1. Characteristics of yields of potato chips some soaking treatment.

| Treatment       | yield (%)   |
|-----------------|-------------|
| Control         | 25.39 ±3.51 a |
| CaCl$_2$ 0.5%   | 21.15 ±0.28 bcd |
| CaCl$_2$ 1%     | 21.39 ±0.23 bcd |
| Na$_2$S$_2$O$_5$ 0.5% | 22.77 ±0.69 bc |
| Na$_2$S$_2$O$_5$ 1% | 23.53 ±0.09 ab |
| Ca(OH)$_2$ 0.5% | 19.85 ±0.83 d |
| Ca(OH)$_2$ 1%   | 20.85 ±0.06 cd |

Note: Numbers followed by the same letter in the same column are not significantly different in Duncan's multiple range test $\alpha = 0.05$.

The highest yield of potato chips was the immersion treatment with control (25.39%) and was not different from the soaking treatment with Na$_2$S$_2$O$_5$ 1% (23.53%). This was presumably due to the absence of starch damage in the immersion treatment with plain water and Na$_2$S$_2$O$_5$ 1%. Starch differences can cause different yields [13].

3.2 Effect of type of immersion on proximate levels of potato chips

From the results of statistical tests, it was found that the type of immersion significantly affected the water content, ash content, starch content, fat content, and the fiber content of local potato chips of Kalosi. Chemical analysis of potato chips can be seen in Table 2.

Table 2. The chemical characteristics of potato chips are some immersion treatments.

| Treatment       | Moisture (%) | Ash (%) | Starch (%) | Fat (%)  | Fiber (%) |
|-----------------|--------------|---------|------------|----------|-----------|
| Control         | 3.00 ±0.00 b | 2.05 ±0.01 e | 23.93 ±0.01 f | 13.93 ±0.01 d | 3.24 ±0.01 e |
| CaCl$_2$ 0.5%   | 1.31 ±0.01 f | 2.28 ±0.01 f | 30.79 ±0.01 c | 14.96 ±0.01 c | 2.73 ±0.01 g |
| CaCl$_2$ 1%     | 1.61 ±0.01 d | 2.46 ±0.01 e | 33.67 ±0.01 b | 13.71 ±0.01 e | 3.71 ±0.01 b |
| Na$_2$S$_2$O$_5$ 0.5% | 2.05 ±0.01 d  | 2.67 ±0.01 d | 26.95 ±0.01 c | 15.80 ±0.01 a | 3.36 ±0.01 d |
| Na$_2$S$_2$O$_5$ 1% | 1.06 ±0.01 g | 2.85 ±0.01 b | 21.84 ±0.01 g | 15.82 ±0.01 a | 3.61 ±0.01 c |
| Ca(OH)$_2$ 0.5% | 1.41 ±0.01 e | 2.72 ±0.01 f | 30.02 ±0.01 d | 15.61 ±0.01 b | 3.15 ±0.01 f |
| Ca(OH)$_2$ 1%   | 3.52 ±0.01 a | 2.92 ±0.01 a | 34.72 ±0.00 a | 10.92 ±0.01 f | 3.97 ±0.01 a |

Note: Numbers followed by the same letter in the same column are not significantly different in Duncan's multiple range test $\alpha = 0.05$.

3.2.1 Moisture. The highest moisture was potato chips soaked with 1% Ca(OH)$_2$ (3.52%) and immersion in control (3.00%) while the lowest moisture was potato chips soaked with 0.5% CaCl$_2$ (1.31%) and significantly different from other treatments. This water content was lower than the results of Istiningsh (2005) research, which moisture as 4.59%. So that the treatment that meets the quality requirements of potato chips according to SNI 01-4031-1996 is a maximum water content of 3%, namely immersion treatment in CaCl$_2$ 0.5% (1.31%), CaCl$_2$ 1% (1.61%), Na$_2$S$_2$O$_5$ 0.5% (2.05%) and Na$_2$S$_2$O$_5$ 1% (1.06%). The high moisture in the immersion treatment of Ca(OH)$_2$ 1% is due to the high element of Calcium in Ca(OH)$_2$ 1%, which absorbs water when immersing [16]. While the results
of Nagara's research (2016), the average moisture content of potato chips was 7.41%. Water content contained in potato chips will affect the shelf life of potato chips [17].

3.2.2 Ash. The results of the analysis of variance on ash content showed that the immersion treatment before frying significantly affected the levels of potato chip ash. The average value of the ash of potato chips can be seen in Table 2. SNI 01-4031-1996 regarding quality requirements of potato chips requires maximum ash content of potato chips is 3%. Based on these requirements, the potato chips produced in all treatments meet the quality requirements because the ash content is less than 3%.

3.2.3 Starch. The levels of potato chip starch from several immersion treatments can be seen in Table 2. The levels of potato chips in the Kalosi variety range from 21.84% - 34.72%. The highest levels of starch were respectively immersion treatment in Ca(OH)$_2$ 1% (34.72%), CaCl$_2$ 1% (33.67%), CaCl$_2$ 0.5% (30.79%), Ca(OH)$_2$ 0.5% (30.02%), Na$_2$SO$_3$ 0.5% (26.95%), control (23.93%), and Na$_2$SO$_3$ 1% (21.84%). Starch differences can cause different yields [13].

This is in accordance with the recommendations of Siswaoputanto (1989) [18] and the working procedure of potato chips from Asgar et al. (2010) [14]. During the frying process, there is a big change in the potato tissue. Loss of water from potatoes during frying causes starch and non-starch levels in potatoes to increase [19].

3.2.4 Fat. Fat content ranges from 10.92 - 15.82%, the highest fat content is the immersion treatment in 1% Na$_2$SO$_3$ solution (15.82%) and not significantly different from 0.5% Na$_2$SO$_3$ (15.80%). While the lowest fat content is immersion treatment in 1% Ca(OH)$_2$ (10.92%) solution and significantly different from other treatments. Immersion in Ca(OH)$_2$ will result in the formation of a bond between calcium and pectin in potato tissue. This bond causes the potato to have a stronger texture structure as a result of the formation of a hard-formed texture. The hard texture can inhibit the process of evaporation of water during frying so that the water that evaporates slightly accelerates the formation of crusts, consequently the amount of oil absorbed by the material is also low. According to Ketaren (1986), during the frying process, the oil enters the crust and fills the space that was initially filled with water [6].

The oil that is absorbed will affect the taste and distinctive taste of the product's crispness. On the other hand, it has a negative impact on the product because of the appearance of oily chips. This appearance will reduce the level of consumer acceptance. In addition, high oil absorption can cause the product to become rancid if stored for a long time [20]. Potato chips with lime soaking have the lowest fat content compared to others. These results are in accordance with the previous report [21], it was reported that the low amount of oil absorption was caused by the formation of covalent relationships in the film during heating. The raw material of potato chips also affects oil absorption by slicing during frying. Potato flour has the highest oil absorption capacity [22].

3.2.5 Fiber. Levels of the crude fiber of potato chips range from 2.73 - 3.97% (Table 2). The highest levels of fiber were respectively immersion treatment with Ca(OH)$_2$ 1% (3.97%), CaCl$_2$ 1% (3.71%), Na$_2$SO$_3$ 1% (3.61%), Na$_2$SO$_3$ 0.5% (3.36%), control (3.24%), Ca(OH)$_2$ 0.5% (3.15%) and CaCl$_2$ 0.5% (2.73%). Cellulose is a type of dietary fiber and is present in vegetables as one of the main elements [23]. High fiber content makes the combustion process slower. That is, energy from calories is used more slowly and efficiently than other low-fiber carbohydrates [24].

The term food fiber must be distinguished from the term coarse fiber that is commonly used in the proximate analysis of food. Crude fiber is part of food that cannot be hydrolyzed by chemicals that are used to determine levels of crude fiber, namely sulfuric acid (H$_2$SO$_4$) and Sodium Hydroxide (NaOH), while food fiber is part of food that cannot be hydrolyzed digestive enzymes. Therefore the value of crude fiber is lower than that of dietary fiber because sulfuric acid and sodium hydroxide have a greater ability to hydrolyze food components than digestive enzymes [25].
The fiber in potato tissue increases during heating due to the loss of non-fiber substance [26]. Golubowska (2005) [19] reports that a high percentage of cellulose in dry matter from french fries is possible due to leaching from fractions that dissolve from the tissue during the frying process and another reason is the formation of resistant starch. The fat contained in potato frying oil reduces the amount of starch that can be digested in vitro and significantly increases resistant starch and water-soluble dietary fiber, including cellulose, hemicellulose, and lignin. Frying in oil can increase the content of non-starch or fiber polysaccharides [27].

### 3.3 Effect of type of immersion on organoleptic characteristics of potato chips

Organoleptic testing was carried out on the condition of potato chips, including odor, taste, color, and texture (crispness), according to SNI 01-4031-1996 Potato Chips. The organoleptic characteristics of potato chips with some immersion treatments can be seen in Table 3.

| Treatment  | Colour   | Flavor   | Texture | Overall acceptance |
|------------|----------|----------|---------|--------------------|
| Control    | 5.10±0.91a | 4.85±0.97a | 4.85±1.20a | 5.25±1.09a         |
| CaCl₂ 0.5% | 5.05±0.37a | 5.15±1.03a | 5.15±0.85a | 5.10±1.02a         |
| CaCl₂ 1%   | 5.00±0.62a | 4.95±0.83a | 5.15±0.91a | 4.85±0.94a         |
| Na₂S₂O₅ 0.5%| 5.05±0.64a | 4.95±0.96a | 4.90±0.70a | 4.80±0.67a         |
| Na₂S₂O₅ 1% | 5.20±0.79a | 4.95±0.60a | 5.20±0.42a | 4.95±0.83a         |
| Ca(OH)₂ 0.5%| 5.45±0.55a | 5.00±0.47a | 4.90±0.99a | 5.15±0.67a         |
| Ca(OH)₂ 1% | 5.20±0.75a | 5.00±0.58a | 4.75±1.09a | 5.00±0.91a         |

Note: Numbers followed by the same letter in the same column are not significantly different in Duncan's multiple range test α = 0.05.

#### 3.3.1 Colour

The results of statistical tests it is known that no immersion treatment does not significantly affect the color characteristics. The color score ranges from 5.00 - 5.45, where the highest score in the immersion treatment with Ca(OH)₂ 0.5% and not significantly different from other immersion treatments. SNI 01-4031-1996 regarding the quality requirements of potato chips requires that the color of potato chips is yellow to light brown evenly. Organoleptic test results showed that the colors of all potato chips were qualified according to the SNI 01-4031-1996 standards (Table 3). Colour is related to the reducing sugar content of the raw material, where the same type of potato is the local variety of Kalosi. During frying, the presence of high temperatures stimulates the Maillard reaction, which is the reaction between reducing sugars and proteins at high temperatures, which causes the brown color of fried products.

Colour is one of the important properties of potato chips that will affect consumer preferences. The color of potato chips is influenced by the Maillard reaction, which depends on sugar and amino acid levels in the potato slices. This process occurs during frying and is influenced by the temperature and time of the frying pan [28]. Discoloration in french fries is caused by Maillard reactions that occur during the frying process. Maillard reaction is a non-enzymatic browning reaction that occurs due to the reaction between reducing sugars and proteins at high temperatures, which causes the brown color of fried products [29].

This non-enzymatic browning reaction causes lower brightness values. Table 3 shows that the majority of panelists preferred the color of potato chips from the CaCl₂ 0.5% immersion treatment, this is in accordance with the research of Haryanti et al. (2013) [30] who reported that the concentration of CaCl₂ and type of edible coating significantly affected the color of French fries. French fries produced from a combination of Tenggo varieties with immersion in 0.5% CaCl₂ and gelatin as edible coatings as well as a combination of Tenggo varieties with immersion in 1% CaCl₂ and maltodextrin as edible coatings had a color score of 2.30 (dark yellow).
3.3.2 Flavour. Flavor or odor scores range from 4.85 to 5.15, and the highest score is the treatment of soaking with plain water but not significantly different from other treatments (Table 3). According to Mandei and Nuryadi (2017) [31], organoleptic test results showed that the smell of almost all potato chip products showed a normal odor (typical of potato chips) except the smell of chips produced by the treatment of boiling water immersion. The odor in potato chips refers to the distinctive odor of potato chips produced. The flavor component consists of volatile compounds which volatile at high temperatures so that when the potato slices are immersed in boiling water, the pores of the potato tissue open so that when fried most of the volatile compounds are more volatile and the distinctive odor of the potato is reduced [32].

In the processing process, due to the heat, there will be a maillard reaction due to the interaction between carbohydrates (reducing sugars) and proteins (amino acids) producing volatile compounds typical of fried products. Maillard's reaction through strecker degradation will produce a pleasant aroma compound due to the formation of furfural compounds and maltols. In addition to furfural compounds and maltol, strecker degradation also produces heterocyclic components resulting from the condensation of intermediate compounds such as pyrazines, pyrrolines, oxazoles, oxazoline, and thiazole [33].

3.3.3 Texture. The average texture of potato chips ranges from 4.75 - 5.20. the highest texture score of chips from the Na2S2O5 1% soaking treatment (with a score of 5.20 = very crispy) but not significantly different from other soaking treatments. The texture is difficult to measure because chips tend to soften a few minutes after frying. Therefore, after frying and draining the oil, chips are put into plastic containers. The crispness or texture of potato chips is influenced by the chemical composition of the tubers. The crunchiness is caused by differences in starch and pectin content, which affect the texture. Increasing the harvest age will increase crispness. The longer the harvest time, the crispness increases [34].

3.3.4 Overall acceptance. The overall acceptance score ranges from 4.80 - 5.25. The highest level of overall acceptance from the panelists was the treatment of soaking with control but not significantly different from the other treatments.

4. Conclusion
1. The chemical characteristics were significantly different between all treatments, while the organoleptic characteristics were not significantly different from the quality of local Kalosi potato chips.
2. The best treatment and meet the requirements set by the SNI - 1996 and high in fiber is potato chips soaked in 1% CaCl2 solution with a yield of 21.39%; the moisture content of 1.61%, fiber 3.71%, fat 13.71%, starch 33.67%, ash 2.46%, and the level of the likeness of color, aroma, texture and overall acceptance are very like.

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