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Effect of salt immersion, slaked lime immersion, and freezing on proximate and sensory of pineapple chip processed with vacuum frying

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Abstract. In this study, the effect of immersion of fresh pineapple in salt (NaCl) solution and slaked lime ($Ca(OH)_2$) solution on quality and sensory of pineapple chip were investigated. A comparison of the freezing effect in each pre-treatment was also studied to decide the suitable recommendation of pineapple chip processing technology for Micro, Small and Medium Enterprises. The fresh pineapple slices were subjected to 1% w/v of salt solution and slaked lime solution for 30 minutes. To study the effect of freezing, the samples were frozen at -18°C for 24 hours. All samples were fried using a vacuum fryer at 70°C and 60 mmHg for 70 minutes. The study showed that immersion in salt solution resulting in the highest moisture and ash content (5.31±0.75% and 2.03±0.23%, respectively) while immersion in slaked lime solution gave the highest fat content (23.43±0.89%). The freezing caused lower moisture and fat content but higher ash content in all treatments without significant differences ($p \leq 0.05$). In sensory evaluation, immersion in salt solution resulting the highest likeability in taste, texture and overall acceptance with 5-scale hedonic test (4.10±0.85, 4.00±1.12, and 4.00±0.92, respectively) while freezing resulted in significantly ($p \leq 0.05$) lower likeability in overall acceptance compared to the non-freezing treatment except for the immersion in a slaked lime solution.

1. Introduction

The pineapple (*Ananas comosus*) is widely known as a healthy fruit due to the high fiber content and has desirable taste. The pineapple is rich in minerals needed by the human body, such as potassium, chlorine, sodium, phosphorus, magnesium, sulfur, calcium, iron, and iodine. Vitamins contained in pineapples are vitamins A, B, C, and E. The presence of bromelain iron in raw pineapple extract made pineapple a good anti-inflammatory [1]. However, fresh pineapple has a short shelf life that lasts only about 4-6 days [2]. One effort that can be made to overcome this problem is to process it into another form, i.e., pineapple chip.

The pineapple chips were produced using vacuum frying technology. Vacuum frying was done at lower temperatures can help in color, flavor, and nutritional quality preservation [3]. Presently, many health-conscious consumers prefer low-fat foods. Many studies reported that vacuum fried products had lower oil content than traditionally fried products. Vacuum frying has been reported to delay the deterioration of frying oil quality. For instance, free fatty acid, p-anisidine value, and total polar compound in sunflower oil used in vacuum and atmospheric frying were compared [4]. Frying temperatures in vacuum frying have been reported to have significant effects on the moisture content of vacuum fried pineapple chips. The frying time inserted more influence on color changes of vacuum fried pineapple chips than the frying temperature [5].

In addition to extending shelf life and improving product quality, the purposes of product processing of pineapple are to improve the aroma, color, shape, and texture of food. The use of various materials has been used to improve the quality of a product, such as the use of salt and slaked lime. Based on the organoleptic test, immersion in 0-2% $CaCl_2$ solution affects color and crispness changed during storage of coconut chips [6]. NaCl immersion was reported can significantly reduce oil uptake from 0.13 to 0.10 g oil/g dry matter and increased the measured texture parameters on potato chips [7]. Freezing is another pre-treatment that can produce a crispy fruit chip. Freezing apple at − 30°C overnight produce a porous sponge-like matrix in apple chips [8]. Thus, this study was undertaken to compare the effect of salt and slaked lime immersion as well as freezing on the quality and sensory of pineapple chip processed with vacuum frying in order to decide the suitable recommendation of pineapple chip processing technology for Micro, Small and Medium Enterprises.

2. Materials and methods

2.1. Materials
Pineapple, obtained from the local farmer in North Pontianak District, West Kalimantan, was selected based on the same degree of maturity (25% yellow and 75% green). Salt (99% of NaCl) was purchased from a local mini-market, and slaked lime ($Ca(OH)_2$) was purchased from local groceries.

2.2. Sample preparation
The fruit was peeled and sliced using a knife into 4-5 mm thickness as the samples for the experiment. The core was removed using a hollow stainless steel pipe with a 25 mm diameter. The sliced samples were then subjected to further processes.

2.3. Pre-treatments and frying
The effect of pre-treatment and freezing on the quality and sensory of pineapple chip were investigated. Pre-treatment was applied by immersing the samples into salt and slaked lime solution. The control sample was vacuum fried without pre-treatment or freezing. One kilogram (1 kg) of the sample was immersed in 1% w/v salt solution and slaked lime solution for 30 minutes. The freezing was done at -18°C for 24 hours. The samples were vacuum fried at 70°C, 60 mmHg for 70 minutes. The chips were rinsed using a spinner, then packed in the aluminium foil bag and stored at 4°C in a refrigerator for further analysis.

2.4. Proximate analysis
Proximate analysis of moisture, fat, and ash contents were determined according to Seweh *et al.* (2016) with modification [9]. Moisture content was calculated from weight loss of 3 g sample of pineapple chip. The chip was dried in an oven at 105°C overnight, cooled in a desiccator and weighed. Ash content was determined using the samples from the moisture content determination. The samples were put into crucible porcelain of known weight. The crucible was placed inside a muffle furnace at 300°C for one hour continued at 600°C for two more hours. The crucible was taken out, cooled in a desiccator and weighed. Fat content was determined using Soxhlet extraction. Extracted fat was weighted, and fat content was calculated.

2.5. Sensory analysis
Sensory analysis was conducted to assess consumer acceptability. Thirty untrained panelists were used for evaluation with a 5-point hedonic scale, where 1- dislike extremely; 2- dislike slightly; 3- neither like nor dislike; 4- like slightly and 5- like extremely.

2.6. Statistical Analysis
All experiments were carried on in triplicates. One-way analysis of variance (ANOVA) was performed for analyzing data. LSD post hoc was used to compare mean values and statistical significance was expressed at 95% confident interval.

3. Results and discussion

3.1. Effect of salt and slaked lime immersion on proximate of pineapple chips
From Table 1, it is shown that the moisture content of pineapple chips with control treatment is 4.36±0.65, with a salt solution is 5.31±0.75, and a slaked lime solution is 5.08±0.93. Moisture content in food is one of the factors that influence enzyme, microbial, chemical activity and reactions. Non-enzymatic, causing changes in organoleptic properties, appearance, texture, taste and nutritional value. Analysis of variant showed that the pre-treatment has no significant effect on the moisture content of the pineapple chips produced. The moisture value of the chips without pre-treatment (control) meets the Indonesian National Standard (SNI) quality on chips (SNI 01-4304-1996) which is 5% Max, while the other pretreated sample produced chips which moisture content is a little higher than the standard allowed.

Table 1. Quality parameters of pineapple chips processed with different pre-treatments.

Pre-treatment	Quality Parameters		
	Moisture (%)	Ash (%)	Fat (%)
Control	$4.36{\pm}0{,}65^{a}$	$1.49{\pm}0.14^{a}$	$18.99{\pm}0.67^{a}$
Salt solution	$5.31{\pm}0.75^{a}$	$2.03{\pm}0.23^{b}$	$19.93{\pm}2.33^{a}$
Slaked lime solution	$5.08{\pm}0.93^{a}$	$1.91{\pm}0.30^{ab}$	$23.43{\pm}0.89^{b}$

$^{a\text{–}b}$ Means followed by different superscript alphabets in each column are significantly different (P < 0.05).

For the ash content, the highest value was obtained with salt solution pre-treatment, which is 2.03±0.23, followed by the slaked lime solution pre-treatment with a value of 1.91±0.30, and the lowest was the control with a value of 1.49±0.14. The pre-treatment with salt solution had a significant effect compared with the control but did not have a significant effect compared with the slaked lime solution pre-treatment. This is presumably because the salt solution caused the accumulation of sodium and chloride minerals in the samples, resulting in a buildup of inorganic residue that enters the pineapple and cause the ash content of pineapple chips to increase. Desniar, *et al.* (2009), stated that salt contains minerals such as sodium and chloride [10]. In addition, there is an osmosis process where the hygroscopic salt solution will absorb and remove water from the pineapple flesh and then some of the solids in the salt solution will enter the pineapple flesh through the diffusion process.

The fat content of the chips with the slaked lime solution pre-treatment had the highest value (23.43±0.89), followed by the salt solution pre-treatment (19.93±2.33), and the lowest was the control (18.99± 0.67). Pre-treatment with slaked lime solution had a significant effect on fat content compared to the pre-treatment with salt solution and control. From the three types of treatment, the fat content value is in the range of 18-23%, which is still in accordance with the SNI 01-4304-1996. This is due to the fact that when the frying is finished and enters the draining stage, there is no excessive accumulation of pineapple chips.

3.2. Effect of freezing on proximate of pineapple chips

Figure 1 shows that the fat content produced from the three types of treatment, both frozen and without freezing, is in the range of 17-24%, which is still in accordance with the SNI 01-4304-1996 (maximum of 25%). The freezing has no significant effect on three types of treatment on the fat content. The fat content of the chips is influenced by the fat content of the cooking oil used and the thickness of the product during draining.

The freezing also did not have a significant effect on the moisture content for all treatments. Moisture content and water activity are always related. The smaller the moisture content, the smaller the water activity. This result was similar to the previous report by Hariono B *et al.* (2018), that freezing did not have a significant effect on the water content as well as fat content [11].

As displayed in Figure 1, freezing significantly affect the ash content of the sample pretreated with a salt solution. This is due to the accumulation of sodium and chloride content in the material (pineapple meat). The result in accordance with the previous report by Raji A O *et al.* (2016) that minerals inside the sample were retained more with freezing treatment [12].

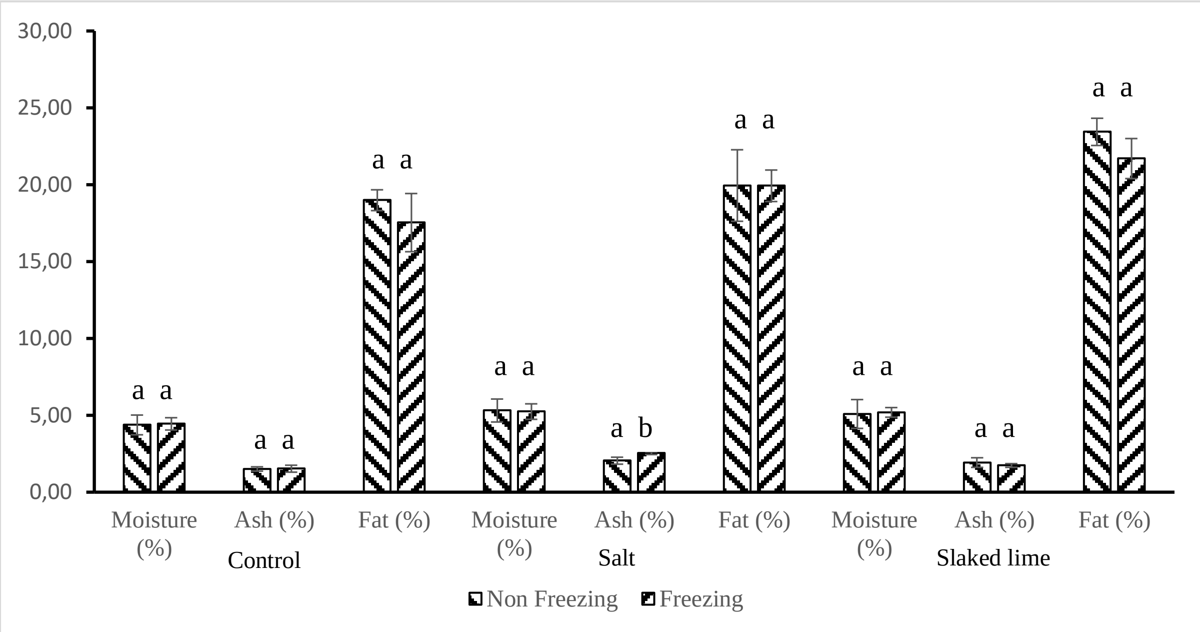

Figure 1. Quality parameters of pineapple chips processed with freezing and without freezing. Different alphabet indicates significantly different (P < 0.05).

3.3. Effect of salt and slaked lime immersion on sensory of pineapple chips

Organoleptic testing was carried out using the hedonic test involving sensory parameters of taste, texture and overall. The sensory score was presented in table 2.

Table 2. Sensory score of pineapple chips processed with different pre-treatments.

Pre-treatment	Sensory Parameters		
	Taste	Texture	Overall Acceptance
Control	3.75 ± 1.07^{a}	3.55 ± 1.15^{ab}	3.85 ± 0.88^{a}
NaCl Solution	4.10 ± 0.85^{a}	4.00 ± 1.12^{b}	4.00 ± 0.92^{a}
Slaked lime solution	4.00 ± 0.86^{a}	3.45 ± 1.19^{a}	3.75 ± 0.91^{a}

$^{a–b}$ Means followed by different superscript alphabets in each column are significantly different (P < 0.05)

As presented in table 2, the analysis of variance (ANOVA) showed that the pre-treatment of pineapples has no significant effect on the taste and overall acceptance of the pineapple chips produced ($p>0.05$), while in texture immersion in slaked lime solution showed significantly lower score compared to immersion in the salt solution.

Pineapple chips with salt immersion pre-treatment are considered as the best parameter because they have the highest score in all sensory parameters tested, which was 4.10 (like slightly) in taste, 4.00 (like slightly) in texture and overall acceptance. Salt immersion can increase the osmotic pressure, which causes the water content in pineapples to decrease so that it can improve taste and texture [13] as well as overall acceptance. Taste and texture were important parameters to determine the consumer acceptance of food products. The products with good taste and good texture would be preferable by consumers [14].

3.4. Effect of freezing on sensory of pineapple chips
As displayed in figure 2, freezing showed no significant effect on all sensory parameters in all treatments except in control, where freezing significantly affected the texture and overall acceptance ($p>0.05$). It was suspected that the control sample with freezing treatment produced the pineapple chips with a hard texture and less savory taste. Based on the resulting graph, it can be seen that the average sample with pre-treatment without freezing is the most preferred sample by the panelists.

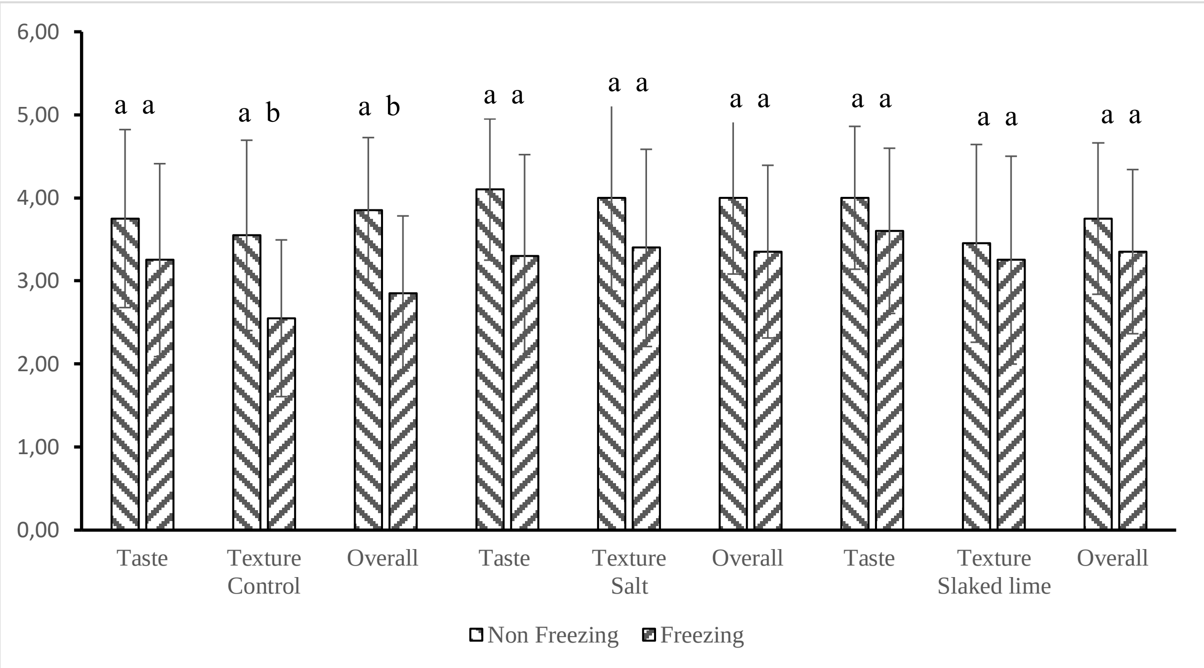

Figure 2. Sensory score of pineapple chips processed with freezing and without freezing. Different alphabet indicates significantly different ($P < 0.05$)

4. Conclusions
The study showed that pre-treatment of fresh pineapple slices by immersion in salt solution and a slaked lime solution did not affect significantly increasing the moisture content of pineapple chips. Ash content of the pineapple chips increased by immersion in a salt solution, while fat content increased by immersion in a slaked lime solution. Freezing did not significantly affect the moisture, ash and fat content of pineapple chips except when combined with the immersion in a salt solution, which produced the pineapple chips with significantly higher ash content. Pre-treatment did not

significantly affect the sensory score of pineapple chips except the texture score, where immersion in salt solution displayed significantly higher score than immersion in a slaked lime solution. On the other hand, freezing significantly affected the sensory score of the texture and overall acceptance in control samples.

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