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# THE EFFECT OF LONG SKIN SOAKING IN THE CALCIUM SOLUTION ON THE QUALITY OF RAMBAK CRACKERS FROM BUFFALO SKIN

**Chairil A.[1]*, Irhami[1], Umar H.A.[1], Irmayanti[2]**
[1] Politeknik Indonesia Venezuela, Aceh Besar, Indonesia
[2] Universitas Serambi Mekkah, Banda Aceh, Indonesia

**Keywords:** *calcification process, volume expansion, soaking time, slaughtering products, yield*

***Abstract***
*Buffalo skin is an underutilized by-product of buffalo slaughter. It is perishable and if it is not processed immediately, it will rot. One of the applications of buffalo skin is processing into skin crackers. The present research was aimed at determining the best duration of buffalo skin soaking in the lime solution with regard to its effect on quality of rambak from buffalo skin. The study used a completely randomized design (CRD) with a factor of treatment time, which consisted of four levels, i.e. A = 76 hours, B = 86 hours, C = 96 hours, D = 106 hours. Each treatment was performed with five replicates, so that 20 samples were obtained. The data were analyzed using the statistical analysis of variance (ANOVA). Parameters observed were the water content, yield, volume expansion, and organoleptic characteristics such as taste, aroma, color, and texture. The results show that different soaking duration (76 hours, 86 hours, 96 hours, and 106 hours) did not have a significant effect on yield, taste, aroma, color, and texture, but significantly affected the volume expansion and water content in rambak from buffalo skin. The best result was achieved with soaking duration of 106 hours; the rambak was characterized by the following parameters: water content 10.83%, yield 57.87%, volume expansion 76.66%, color score 3.51, taste score 3.61, aroma score 3.63 and texture score 3.30.*

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## Introduction

The skin, the outermost layer of the body in cattle, is a by-product of slaughtering livestock and is obtained after an animal dies and is skinned. The skin of large and small livestock, be it cows, buffaloes, sheep, or goats, has a strong tissue structure, so that it can be used for food and non-food purposes [1]. Skin that has just been removed from the animal's body is called fresh rawhide. This skin is easily damaged when exposed to chemicals, such as strong acids, and strong bases, or microorganisms. The average chemical composition of fresh skin is 64% water, 33% protein, 2% fat, 0.2% minerals, and 0.8% other substances [2]. Fresh skin from livestock slaughter can be directly tanned or further processed, but not all skin becomes the raw material for the tanning industry. The skin that cannot be used in tanning can be directly processed in the form of food products such as rambak crackers.

Crackers are a type of snacks that undergo volume expansion to form a porous product and have a puffed appearance during frying [2], while skin crackers are a by-product of processed animal skins. The raw material for making crackers is fresh skin. Fresh skin intended for producing skin crackers should be thick skin separated from fat and meat [3]. Cracker processing can be done by frying, sand roasting [4], and using a microwave [5].

One of the stages in the manufacture of rambak crackers is the calcification process, which will affect the chemical quality, especially the water and protein content of crackers. Skin that undergoes calcification will have the low water content due to the presence of $Ca^{++}$ ions that enter the tissue so that the cell wall becomes sturdy and water can be pulled out of the cell tissue [6]. Soaking in the 0.15% lime solution for 15 min allowed achieving the expected quality [7]. A higher concentration of the lime solution and longer soaking will lead to high-quality crackers.

Liming greatly influences quality of produced skin crackers. The purpose of the liming process is to remove globular proteins as well as to swell the skin so as to facilitate the subsequent process, especially to improve the physical, chemical and organoleptic qualities of skin crackers [8].

The length of calcification will affect the chemical, physical and organoleptic quality of the resulting skin rambak crackers. The longer the calcification process, the better the process of removing globular proteins and the hair. The calcification process will result in some fat being turned into calcium soap that is insoluble in water, so it will be difficult for water to be absorbed into the skin and this can increase the enlarging capacity of the resulting buffalo skin rambak crackers [9].

Based on this background, further studies are needed for the manufacture of skin rambak crackers in the long process of skin immersion in the lime solution to produce high-quality skin rambak crackers.

## Materials and Methods

A part of the buffalo skin used for preparation of crackers was belly, and the selected parts of the skin were intact/not torn, not injured/bruised, without black spots on the skin surface. This skin was dried using a temperature of 60 °C, which is expected to be sufficient to inhibit the microbial growth. The dry skin containing 2.31% — 2.84% of water was obtained after drying.

In this study, the skin from Simeulue buffalo and calcium oxide obtained from Lambaro's traditional market, Aceh Besar, were used. Ingredients used were cooking oil, water, garlic and salt. The tools used in this study were cork, winnower, knife, pan, cutting board, stove, tarpaulin, fried spoon, oil sieve, scales, bucket, porcelain cup, oven, and desiccator.

*Research Procedures*

The stages of the process of making buffalo skin rambak crackers were as follows:

1. Soaking in water
   Skin soaking was done with clean water for two hours.
2. Calcification
   Skin that underwent soaking in water, was then put in a solution of lime (0.4 kg of lime in 5 L of water for 1 kg of skin). The treatment length was 76 hours, 86 hours, 96 hours, and 106 hours. Stirring was done every five hours.
3. Removal of lime and the hair
   Removal of lime was done by washing the skin using clean water (five liters for each treatment) repeated five times. The hair was removed by scraping using a knife.
4. Boiling
   Boiling of the skin was done in boiling water at a temperature of 90 °C for two hours. Then it was winded.
5. Grinding
   Skin was ground to a size of 3 × 2 cm.
6. Drying I
   Drying was done in sunlight for one day.
7. Seasoning by soaking
   Crackers from drying I were soaked in a seasoning solution (salt 2% and garlic 5%).
8. Drying II
   Second drying was done in sunlight for 2–3 days (until dry).
9. Frying
   Frying I: crackers were put in a frying pan at a temperature of 80 °C for 5 min and watered in a tub for one day. Frying II (temperature 80 °C for 10 min) and frying III (temperature 160 °C until crackers expand perfectly) were performed afterwards.

*Research Methods*

This study used a factorial complete randomized design (CRD) with a length of calcification consisting of four treatment standards namely A = 76 hours, B = 86 hours, C = 96 hours and D = 106 hours. Each treatment was carried out in five replicates so that 20 samples were obtained.

*Analysis Methods*

The parameters analyzed included the water content, yield, volume expansion and organoleptic characteristics. To determine the water content, a sample was put into a porcelain dish and dried in an oven for two hours at 110 °C; after drying, the sample was placed in a desiccator and the final weight was measured [10]. The yield determination was carried out by comparing the percentage of crackers produced per unit of skin used [11]. The volume expansion was determined by the ratio of the volume of raw crackers to the volume of fried crackers [12]. For determination of organoleptic characteristics (color, taste, aroma, and texture), the 5-point hedonic scale was used, where: 1 = dislike very much; 2 = dislike; 3 = like slightly; 4 = like; and 5 = like very much. Organoleptic analysis was performed by panelists recruited and trained to carry out specific tasks of organoleptic evaluation [13]. All data presented in the study were analyzed using analysis of variance (ANOVA) with SPSS2010 software. If the results of ANOVA showed a difference in treatment, analysis was continued with the smallest real difference test with a level of 5%.

## Results and Discussion

*Water content*

The water content is an amount of water contained in the material expressed in the percent. The water content is one of the very important characteristics of food, because water can affect the appearance, texture, and taste of food. The water content in food also determines the freshness and durability of foodstuffs. When the water content is high, it is easy for bacteria, mold, and yeast to multiply, so that there will be changes in food [14].

The water content of the resulting skin crackers ranged from 10.96% to 11.36% with an overall average value of 11.16%. The results of the analysis of variance show that the long treatment by skin immersion in the calcium solution did not have a noticeable effect ($P > 0.05$) on the water content of buffalo skin crackers produced.

**Table 1. Effect of skin immersion in the calcium solution on the water content of buffalo skin crackers**

| Length of calcification (hours) | Water content (%) |
|---|---|
| A = 76 | $11.04 \pm 0.03^{ns}$ |
| B = 86 | $11.26 \pm 0.06^{ns}$ |
| C = 96 | $11.36 \pm 0.10^{ns}$ |
| D = 106 | $10.96 \pm 0.17^{ns}$ |

**Note: ns = not significant**

Table 1 shows that the highest water content (11.36%) was found in the sample that underwent treatment by skin immersion in the calcium solution for 96 hours, while the lowest water content (10.96%) was in the sample subjected to skin immersion in the calcium solution for 106 hours. This is because the length of skin immersion in the lime solution can enlarge the pores on the skin, so that the water contained in the skin can come out and the water content of the skin will decrease. In the frying process, there will be evaporation of bound water due to an increase in temperature, so air cavities in fried crackers will be formed [15].

From the results of the study, it is clear that there are differences in the water content whereby not all treatments by skin immersion in the calcium solution for a relatively long time resulted in the low water content. It can be seen from Table 1 that skin immersion in the calcium solution with a 96-hour soaking duration led to a higher water content than skin immersion in the calcium solution for 76 hours and 86 hours. It is assumed that unequal levels of skin thickness may cause fluctuations in the water content in the skin. This is confirmed by the opinion of [9], who stated that the water content in each part of the skin is not the same.

An effect of liming time on rambak quality parameters was also observed by other researchers. In [16] Widati et al. compared four treatments with liming duration of 24, 48, 72 and 96 hours and found that the best result was achieved when using 96-hour treatment. The rambak crackers had the protein content 6.10%, water content 0.11%, calcium content 1.88%, volume expansion ratio 372.12%, crispness score 5.38 and taste score 6.89 [16].

The water content of crackers decreases from the beginning to the end of the drying process. One of the studies on drying skin crackers reports that during the 30-hour drying stage, the cracker moisture content dropped from 63.4% to around 10–20% [17]. However, the moisture content during storage is affected by the length of storage. An increase in the water content causes a decrease in crispness of crackers [18].

*Yield*

Yield is a percentage of products obtained from the comparison of the initial weight and final weight of the material. The yield of buffalo skin crackers was determined by weighing the final product and comparing the obtained weight to the weight of the initial product before the process.

The resulting yield value ranged from 57.87% to 61.23%. The average overall yield value was 59.56%. The results of the analysis of variance show that the long treatment by skin immersion in the calcium solution did not have a noticeable effect ($P > 0.05$) on the yield value of buffalo skin crackers produced. The small yield of skin crackers was affected by cell, tissue and structure types. It is worth noting that each part of the skin has different types of cells, tissues and structures.

**Table 2. Effect of skin immersion in the calcium solution on the yield of buffalo skin crackers**

| Length of calcification (hours) | Yield (%) |
|---|---|
| A = 76 | 60.49 ± 1.22$^{ns}$ |
| B = 86 | 61.23 ± 2.79$^{ns}$ |
| C = 96 | 58.64 ± 0.10$^{ns}$ |
| D = 106 | 57.87 ± 0.95$^{ns}$ |

**Note: ns = not significant**

This corresponds to [19], which states that one of the factors that influence the yield of skin crackers is the skin structure or the part of the skin itself, where each layer has the specific structure. The skin structure can be loose, dense, thick, thin, so it could affect the small yield produced.

*Volume expansion*

Volume expansion of crackers is one of the most important factors for cracker quality because it determines consumer acceptance [20]. Basically the phenomenon of cracker volume expansion is caused by the pressure of steam formed from heating the water in the material so that it urges the structure of the material to form an expanding product. The enlarging capacity of skin crackers ranged from 33.33% to 83.33%. The overall average volume expansion of crackers was 63.33%. The results of the analysis of variance for volume expansion in buffalo skin crackers show that the length of skin immersion in the lime solution had a very real effect ($P < 0.01$) on the enlarging capacity of buffalo skin crackers produced.

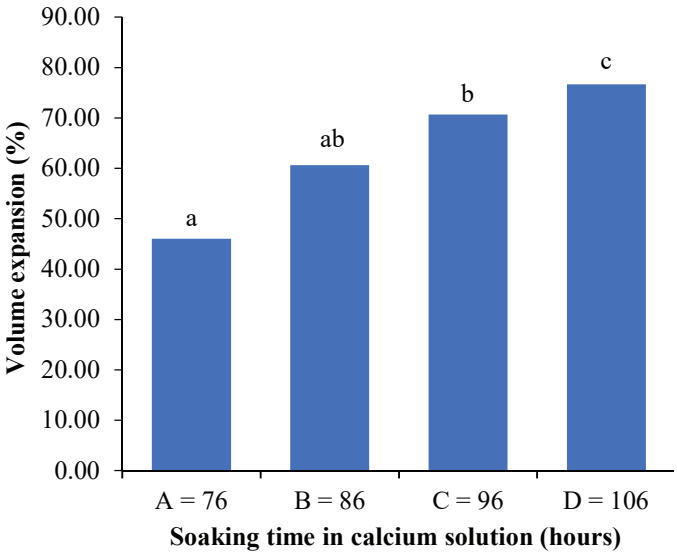


**Figure 1.** Influence of skin immersion in the calcium solution on the volume expansion of buffalo skin crackers. The letters indicate a significant difference ($P < 0.01$) between treatments

Figure 1 demonstrates that the highest volume expansion (76.66%) was obtained when using the long treatment by skin immersion in the lime solution for 106 hours, the lowest volume expansion (46.00%) was in the sample subjected to this treatment for 76 hours, while the samples treated for 86 hours and 96 hours occupied the intermediate position (60.66% and 70.66%, respectively). The results of the study

show a real effect of the length of skin immersion in the lime solution. The longer the soaking of the skin in the lime solution, the higher the value of the resulting volume expansion. It is assumed that long immersion of the skin in the lime solution can remove water contained in the buffalo skin so that the resulting skin crackers will expand more easily. When crackers expand, cavities will be formed in them. The more cavities formed, the more tenuous the structure, so it will be easier to break them. Thus, the higher the enlarging capacity of rambak crackers, the higher crispness. The mechanism of cracker development resides in the release of water trapped in the gel during calcification [21].

The frying process at high temperature also influenced the quality of the skin crackers in this research. Choe and Min [22] noted that frying is the process of cooking food ingredients using hot fat or oil at high temperatures. Deep frying leads to changes in stability and quality, taste, color and texture of fried food and the nutritional value of fried food [22].

The frying process causes the crackers to expand/develop. The cracker development is caused by the formation of air cavities because of the evaporation of water bound to the cracker structure due to the influence of frying temperature. At the time of boiling the skin, the water will be bound in the collagen protein forming a gel with a very strong bond so that at the time of drying it is difficult to evaporate it, but it can be removed at the time of frying due to the use of high temperatures [23]. The amount of water absorbed during cooking plays a role in conversion collagen into gelatin, and affects the level of the development and crispness of the rambak crackers produced [16].

*Organoleptic test*

The organoleptic test is also called the sensory test because it is based on sensory stimulation of the five senses such as sight, smell, touch, taste and hearing [24]. The purpose of the hedonic test or the test of preference is to find out the panelists' response to sensory quality characteristics, for example, color, taste, aroma, and texture [13]. Sometimes, the organoleptic test can be more dependent on a type and specifications of ingredients / food products.

**Table 3. Average organoleptic scores of buffalo skin rambak crackers depending on the length of immersion in the calcium solution**

| Soaking time in calcium solution (hours) | Organoleptic scores | | | |
|---|---|---|---|---|
| | Color | Taste | Aroma | Texture |
| A = 76 | $3.52^{ns}$ | $3.47^{ns}$ | $3.44^{ns}$ | $3.51^{ns}$ |
| B = 86 | $3.55^{ns}$ | $3.55^{ns}$ | $3.51^{ns}$ | $3.38^{ns}$ |
| C = 96 | $3.57^{ns}$ | $3.53^{ns}$ | $3.59^{ns}$ | $3.41^{ns}$ |
| D = 106 | $3.51^{ns}$ | $3.61^{ns}$ | $3.63^{ns}$ | $3.30^{ns}$ |

**Note: ns = not significant.**
**Organoleptic scores: 1) dislike very much, 2) dislike, 3) like slightly, 4) like, and 5) like very much.**

The results of the organoleptic evaluation (color, taste, aroma, and texture) demonstrate that the buffalo skin rambak crackers produced using soaking in the calcium solution corresponded to the panelists' acceptance level as shown in Table 3. The panelists showed a slightly higher preference for samples soaked in the calcium solution for 96 hours with a level of acceptance between "like slightly" and "like". It can be seen from Table 3 that most of organoleptic characteristics had scores lower than 4 with the average organoleptic score of 3.5. It is possible to improve the new technology to produce skin crackers with better organoleptic characteristics. Additional formulation ingredients may be necessary.

*Color*

Consumer preference for food products is also determined by the food color. The food color is influenced by the light absorbed and reflected from the material itself and is also determined by color dimensions [25]. Color is a feature of food products that attracts the most attention of consumers and most quickly gives the impression of being liked or not. The color intensity of the crackers depends on the pigment changes that occur during ripening; the changes are determined by a type of crackers and length of ripening. The process of cooking or processing food can cause the color of foodstuffs or products to become brighter because of the loss of pigment due to the release of cell fluids [26].

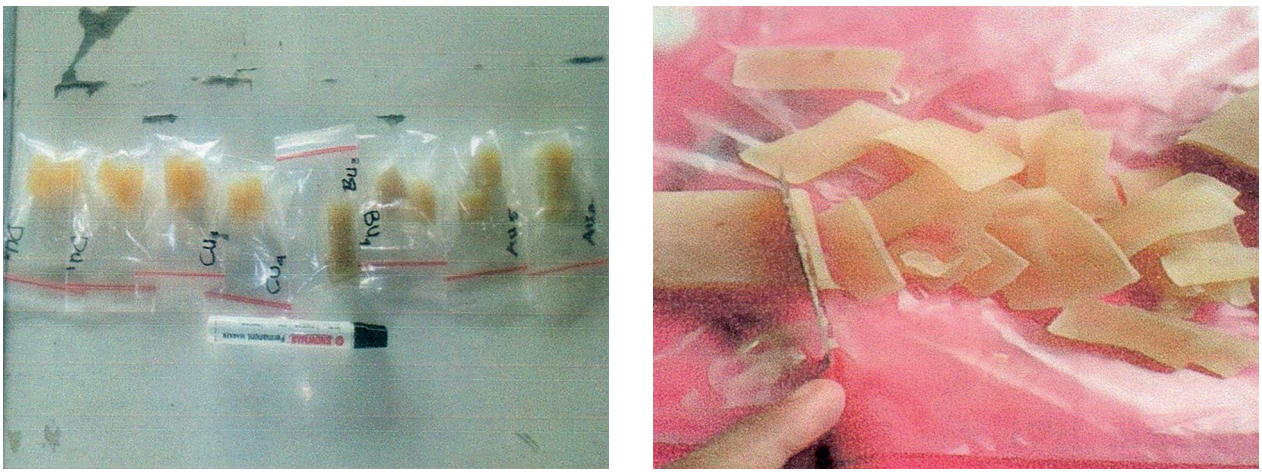

**Figure 2.** The color of rambak crackers from buffalo skin

The data from the analysis of the influence of long immersion of the buffalo skin in the lime solution on the color of the produced buffalo skin crackers show that the organoleptic scores of the color ranged from 3.51 to 3.57 with the average score equal to 3.54. The results obtained suggest that the long treatment of the buffalo skin by immersion in the lime solution had an unreal effect ($P > 0.05$) on the color of the resulting buffalo skin crackers.

The color of buffalo skin crackers can been seen in Figure 2.

Figure 2 shows that the color of the skin crackers did not differ between treatments. The color of skin crackers produced in this research tend to be bright and there was no dark color in the tested samples. Relatively the same color impression is associated with relatively the same sorting process resulting in relatively the same color changes.

*Taste*

One of the factors that play an important part in determining the final decision of consumers to accept or reject a product is taste. Even if other evaluation parameters are good, a product with bad taste will be rejected by consumers. The basic tastes include salty, sweet, bitter, and sour [27]. The great role in perceiving these basic tastes is played by taste buds on the tongue in the oral cavity. However, besides the above mentioned basic tastes, some researchers also regard other tastes such as metallic and savory as a result of perception by taste receptors [28].

In this study, the value of the panelists' liking of the taste of buffalo skin crackers ranged from 3.47 to 3.61 with the average score equal to 3.54.

The results of the analysis of variance of organoleptic scores for skin cracker taste show that the length of skin immersion in the lime solution (76, 86, 96 and 106 hours) did not have a noticeable effect ($P > 0.05$) on the organoleptic scores for taste of the resulting buffalo skin crackers.

In addition, skin crackers that were fried using oil had a distinctive flavor of fried skin crackers. The savory taste found in skin crackers can be caused by protein contained in the crackers. During the cooking process, protein will be hydrolyzed into amino acids, namely glutamic acid, which can cause delicious taste.

*Aroma*

The aroma organoleptic analysis is a sensory analysis that is usually carried out after observing the general appearance of the product. The aroma of a food product can determine the delicacy of the food. Its emergence is caused by the formation of volatile compounds. The aroma that each food emits is different. In addition, different cooking methods will lead to different aromas [29,30].

Based on the sensory test results, it has been found that buffalo skin crackers had a distinctive aroma, which was also influenced by sunlight drying. The value of panelists' liking of aroma of skin crackers ranged from 3.44 to 3.63 with the average score equal to 3.54. The highest panelists' score for aroma of skin crackers (3.63) was in the samples with a 106-hour soaking length, while the lowest score (3.44) was in the samples subjected to immersion for 76 hours.

The results of the analysis of the organoleptic properties of skin crackers demonstrate that the length of skin immersion in the lime solution (76 hours, 86 hours, 96 hours, and 106 hours) did not have a noticeable effect ($P > 0.05$) on the organoleptic scores for aroma of the resulting buffalo skin crackers. This is because skin soaking in the lime solution does not impart aroma that would be strong enough to change the aroma of the resulting skin crackers. However, the results show that the longer skin soaking in the lime solution, the higher the level of panelists' liking of aroma of buffalo skin crackers.

*Texture*

Texture is a factor that determines a product. Texture assessment aims to determine the panelist's acceptance of the level of elasticity or tenderness of a product that can be assessed using the sense of touch. Food texture testing is an attempt to find the exact texture parameters that are the quality attributes of the food in question, and then determine the most appropriate common terms in the category of parameters accompanied by additional information to state their levels [31].

The organoleptic scores for texture ranged from 3.30 to 3.51. The overall average organoleptic score of buffalo skin cracker texture was 3.40. The score for panelists' liking of the texture of buffalo skin crackers was the highest (3.51) upon using the long treatment by skin immersion in the lime solution for 76 hours, while the lowest panelists' score (3.30) was in the samples treated by skin immersion in the lime solution for 106 hours.

The results of the analysis of organoleptic scores of buffalo skin cracker texture show that the treatment with the lime solution using different calcification periods did not have a noticeable effect ($P > 0.05$) on the organoleptic scores of the texture of buffalo skin crackers. This is because long skin immersion in the lime solution can remove water contained in the skin. The skin has different connective tissues, so the skin will be easily overhauled by lime and cavities contained in the skin will be more easily opened. If the cavities in the skin have opened, then the skin will more easily expand and produce a crisp skin cracker texture, so that the resulting skin crackers will be preferred by panelists. Each panelist's perception of food product taste is different, so the rate of panelist acceptance of skin crackers was not the same. This is supported by [32], which states that all resulting skin cracker products have a level of liking that tends not to be the same for mature products.

Analysis of the chemical characteristics of various commercial animal skin cracker products indicate that the cow-

hide crackers have the best nutritional value compared to other skin crackers. Table 4 demonstrates that the highest crude protein content was in cowhide crackers (56.79%) and buffalo skin crackers (51.45%), while the lowest crude protein content (42.00%) was in the samples of chicken skin crackers [33].

**Table 4. Comparison of the chemical characteristics of various commercial animal skin cracker products [33]**

| | Product category | | | |
|---|---|---|---|---|
| | Cowhide crackers | Buffalo skin crackers | Fish skin crackers | Chicken skin crackers |
| Crude protein content | 56.79 | 51.45 | 48.00 | 42.09 |
| Fat content (%) | 23.33 | 33.05 | 35.13 | 45.53 |
| Moisture content (%) | 1.79 | 1.95 | 2.21 | 2.15 |
| Ash content (%) | 3.96 | 1.25 | 4.14 | 3.91 |
| Free fatty acid value (%) | 0.41 | 0.75 | 2.24 | 1.79 |
| Thiobarbituric acid value (mg malondialdehyde /kg) | 0.96 | 1.43 | 1.75 | 1.97 |

It can be seen from Table 4 that buffalo skin crackers have a good nutritional value and the nutritional composition of buffalo skin crackers is not much different from that of cowhide crackers.

## Conclusion

The results of the study indicate that the length of skin soaking in the calcium solution in the manufacture of buffalo skin crackers had a very real effect ($P < 0.01$) on the enlarging capacity of skin crackers and had no real effect ($P > 0.05$) on yield, organoleptic scores of color, taste, aroma, and texture. Skin immersion in the calcium solution for 106 hours led to the best skin crackers with the following characteristics: moisture content 10.83%, yield 57.87%, expansion volume 76.66%, color score 3.51, taste score 3.61, aroma score 3.63, and texture score 3.30. Although, all organoleptic characteristics had scores lower than 4, it is possible to improve the new technology with appropriate selection of ingredients to produce skin crackers acceptable to all circles of consumers.

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## AUTHOR INFORMATION

**Chairil Anwar,** Master of Science, Senior Lecturer, Head of Research and Community Service Institute, Departement of Livestock Product Technology, Politeknik Indonesia Venezuela, Jl. Bandara Sultan Iskandar Muda KM 12, Aceh Besar Regency, Province of Aceh 23372, Indonesia. Tel.: +62–821–2132–1900, E-mail: chairil.anwar@poliven.ac.id
ORCID: https://orcid.org/0000–0002–9395–8028
* corresponding author

**Irhami,** Master of Science, Lecturer, Department of Agroindustry, Politeknik Indonesia Venezuela, Jl. Bandara Sultan Iskandar Muda KM 12, Aceh Besar Regency, Province of Aceh 23372, Indonesia. Tel.: +62–812–6933–201, E-mail: irhamistp@yahoo.co.id
ORCID: https://orcid.org/0000–0003–0012–1649

**Umar H.A,** Doctor of Philosophy, Head of Programs, Department of Agroindustry, Politeknik Indonesia Venezuela, Jl. Bandara Sultan Iskandar Muda KM 12, Aceh Besar Regency, Province of Aceh 23372, Indonesia. Tel.: +62–813–6009–8028, E-mail: umarah_1977@yahoo.co.id
ORCID: https://orcid.org/0000–0002–1434–7940

**Irmayanti,** Master of Science, Lecturer, Department of Agricultural Industrial Engineering, Universitas Serambi Mekkah, Jl. T. Imum Lueng Bata, Banda Aceh City, Province of Aceh, Indonesia. Tel.: +62–812–6946–640, E-mail: irmayanti@serambimekkah.ac.id
ORCID: https://orcid.org/0000–0002–0274–8894

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All authors made an equal contribution to the work.

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