Comparison of Chemical Characteristics of Various Commercial Animal Skin Crackers

by Siti Susanti

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Comparison of Chemical Characteristics of Various Commercial Animal Skin Crackers

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Abstract: This study aims to compare the data on chemical characteristics (protein content, fat, ash, moisture, Free Fatty Acid (FFA), Thiobarbituric Acid (TBA), and total energy) of commercial skin crackers made from various kinds of animal skin. Four categories of commercial animal skin crackers from the same producer were assigned as treatments, including cowhide crackers, buffalo askin crackers, fish skin crackers, and chicken skin crackers. The data showed that the type of animal skin as the raw material for crackers had a significant effect on the levels of protein, fat, ash, free fatty acid value, and total energy of the final product. However, the type of animal skin did not significantly affect of moisture content of the product. The highest protein content was shown in cowhide crackers and buffalo skin crackers, where cowhide crackers also showed the lowest fat content and free fatty acid value but high ash content ($p<0.05$). Descriptively, the thiobarbituric acid value of cowhide crackers is also low. Meanwhile, the highest total energy was owned by chicken skin crackers ($p<0.05$). Thus, among commercial animal skin crackers products, cowhide crackers have the best chemical characteristics because they contain higher protein and ash with a lower fat content, free fatty acid value, thiobarbituric acid value, and total energy so they can be recommended as a quality.

Keywords: Animal, Chemical Characteristics, Commercial, Nutrition, Skin Crackers, Cowhide, Chicken, Fish, Buffalo

Introduction

Crackers are snacks that undergo volume expansion, become porous, and have a low density during the frying process (Rosiani *et al*., 2015). Crackers are very popular with the Indonesian people as a complement to dishes, as a substitute for side dishes, or also as a snack. Generally, crackers are often made from foodstuffs that contain starch, such as tapioca flour, sago flour, or other flours that are given the addition of spices or even a mixture of meat and shrimp (Ramesh *et al*., 2018). However, crackers can also be produced from the use of animal skins, which are commonly called skin crackers. There are various types of skin crackers depending on the skin raw materials used, such as cowhide crackers, buffalo skin crackers, fish skin crackers, chicken skin crackers, and other commercial animal skin crackers. Animal skin is used as a raw material for crackers because, from a nutritional aspect, it still contains high nutrients such as protein, fat, carbohydrates, and moisture (Amertaningtyas *et al*., 2010). In addition to their nutritional content, skin crackers have a crunchy texture, and a savory and distinctive taste so people are very fond of skin crackers both as a snack and as a side dish (Kurniawan *et al*., 2020). Although skin crackers are processed from the skin, which is a by-product of cattle, as a food product, they must adhere to quality standards, especially those related to chemical or nutritional content, as a condition to increase consumer trust and satisfaction (Verbeke *et al*., 2007). However, many commercial animal skin crackers products do not provide information about their contents, so they are often questioned. The chemical characteristics of many commercial animal skin crackers of course depend on animal skins as raw materials, so in this study, an evaluation of the chemical characteristics (protein, fat, ash, moisture, free fatty acid values, thiobarbituric acid values, and total energy) was carried out on various commercial animal skin cracker products, namely cowhide crackers, buffalo skin crackers, fish skin crackers, and chicken skin crackers. The data obtained will be taken into consideration in providing recommendations to the public regarding the types of quality animal skin crackers in terms of nutrition and health aspects.

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Materials and Methods

Sample Preparation

The samples are commercial animal skin cracker products which consist of 4 categories based on the type of animal skin as a raw material. The four categories include cowhide crackers, buffalo skin crackers, fish skin crackers, and chicken skin crackers obtained from Pandawa Small and Medium Enterprises (SMEs) in Pemalang Regency. For each category, it is set to have 5 repetitions to run 20 experimental units, namely testing several parameters related to the chemical characteristics of the product (contents of protein, fat, moisture, ash, free fatty acid values, thiobarbituric acid values, and total energy). The sample was then prepared by crushing it into smaller pieces, putting it in a plastic sample, and labeling it for further analysis in the food laboratory.

Chemical Product Testing Parameters

Determination of Protein Content

Protein content testing was carried out using the Kjeldahl method (Safitri *et al*., 2019). The principle of this method is the total amount of nitrogen produced from the oxidation of carbonaceous materials, which is converted into ammonia. The 0.5-gram sample that has been pulverized is put into a destruction flask. The next step is to add 10 mL of concentrated H_2SO_4 and selenium. Sample destruction was carried out for 1 h until the solution became clear. The sample was then allowed to stand until it reached room temperature then added 100 ml of distilled water and 40 mL of 45% NaOH then distilled. The distillate was accommodated in an Erlenmeyer flask containing a mixture of 10 mL of 4% $H3BO_3$ and 2 drops of the MRMB indicator until the distillate volume reached 40 mL. The distillate was then titrated using 0.1 N HCl until it turned purple. The protein content is calculated using the following formula:

$$Protien\ content = \frac{(VA - VB)HCL \times N\ HCL \times 14 \times 6{,}25}{W \times 1000}$$

where:

VA = Ml of HCl for sample titration
VB = Ml HCl for Blanko titration
N = Normality of HCl
W = Sample weight (g)
14 = The atomic weight of nitrogen
6,25 = A protein conversion factor

Determination of Fat Content

The fat content test was carried out using the Soxhlet method (Akbar *et al*., 2017). Samples of 0.5 grams were wrapped using filter paper that had been oven-baked for 1 h as weight A. The wrapped samples were then baked in an oven for 4 hats at 105°C, then put in a desiccator for15 min, and weighed. The sample was reheated in the oven for 1 h, then put into a desiccator at 15 and weighed as weight B. The next step was that the sample was put into the Sox let flask then, then 150 mL of n-hexane solvent was added into the Soxhlet flask. Extraction was carried out for 6 h. The fat flask containing the extracted fat was then dried using an oven at 105°C for 1 h. The dried sample was then cooled in a desiccator for 20 min and weighed as weight C. Fat content was calculated using the following formula:

$$Fat\ content = \frac{Weight\ B - Weight\ C}{Weight\ A} \times 100\%$$

where:

A = Represents the sample weight
B = Denotes the sample weight after the oven
C = The sample weight after soxhlet

Determination of Moisture Content

The moisture content test was carried out using the drying method in the oven. This method is based on the difference in sample weight before and after being dried in an oven at 105°C until it reaches a constant weight. The water content is calculated using the following formula:

$$Moisture\ content = \frac{Weight\ B - (Weight\ C - Weight\ A)}{Weight\ B} \times 100\%$$

where:

A = The weight of the empty porcelain after being in the oven
B = Denotes the sample weight
C = The porcelain weight plus the sample after the oven

Determination of Ash Content

Ash content testing was carried out using the gravimetric method (Toruan *et al*., 2019). A porcelain dish that has been in the oven and cooled in a desiccator is weighed as the weight of *A*. A sample of 1 gram is put into a porcelain dish whose weight is known as the weight of *B*. Then the sample is put into the furnace for 4 h at a temperature of 550°C until it becomes ash. The sample that has turned into ash is put into a desiccator for 15 min and then weighed as a C weight. The ash content can be calculated using the following formula:

$$Ash\ content = \frac{Wieght\ C - Weight\ A}{Wieght\ B} \times 100\%$$

where:

A = Porcelain weight
B = Denotes the sample weight
C = Stands for porcelain weight plus ash

Determination of Free Fatty Acid (FFA) Content

Testing the value of Free Fatty Acid (FFA) on this skin cracker using the titration method (Rusdianasari *et al*., 2019). A sample of 3 grams was added to 30 mL of 95% ethanol solution, after which it was heated at 40°C. The cooled sample was then added with 3 drops of phenolphthalein indicator. The sample is then titrated using 0.1 N NaOH until it changes color to pink. The amount of NaOH used was recorded and the FFA value was calculated using the formula. The FFA value can be calculated by the following formula:

$$FFA\ Value = \frac{(MW \times V\ NaOH \times N\ NaOH)}{1000 \times m\ sample} \times 100\%$$

where:
MW = Fatty acid molecular weight (from coconut oil as lauric acid = 200)
V NaOH = The volume of NaOH required for titration
N NaOH = The concentration of NaOH
M sample = The weight of the sample

Determination of Thiobarbituric Acid (TBA) Content

Testing the value of Thiobarbituric Acid (TBA) was carried out with a sample of 3 grams inserted into a distillation tube with the addition of 98.5 mL of distilled water. In the next step, 1.5 mL of 4 N HCl was added until the pH reached 1.5. Then, boiling stone and an anti-foaming agent were added. The solution was then heated for 10 min until 50 mL of distillate was obtained. The distillate mixture was then stirred and 5 mL of the pipette was transferred into a closed test tube. In the next step, 5 mL of thiobarbituric acid reagent was added and heated for 35 min. After that, the solution was cooled and the absorbance was measured with a wavelength of 528 nm (D) and the blank solution was the zero point. The calculation of the TBA value can be done with the following formula (Christie *et al*., 2016):

$$TBA\ Value = \frac{7{,}8 \times D \times 3}{sample\ weigh(g)}$$

Determination of Total Energy

Calculation of the energy value can be done using the Atwater factor, which is converted through the carbohydrate, fat, and protein content contained (Perrin *et al*., 2020). Calculation of the energy value can be done with the Equation.

Total Energy/100 g = (4 × carbohydrate) + (4 × protein) + (9 × fat)

Statistical Analysis

The data obtained from the test results of chemical characteristics, including the levels of protein, fat, water, ash, Free Fatty Acid (FFA), and total energy were analyzed by the ANOVA method using SPSS 26.0 with a significance level of $p = 0.05$ and the data from the Thiobarbituric Acid (TBA) value test results will be analyzed descriptively using Microsoft Excel 19 for Windows.

Results

This study attempts to evaluate the chemical characteristics of various skin cracker products on the market. Although in general, the quality of taste and texture of all skin crackers is almost the same, chemicals still need a more in-depth study considering the raw materials used in the production process come from different sources. Table 1 shows that the raw material for skin crackers from various animals has a significant effect on the chemical characteristics of commercial animal skin crackers products ($p<0.05$).

The highest protein content was found in cowhide crackers (56.79%) and buffalo skin (51.45%). This result is lower than Nadia's (2005) study which states that the protein content of buffalo skin crackers was not much different from that of cowhide crackers with levels ranging from 63.90 to 64.71%.

The fat content of animal skin crackers Table 1 shows that the raw material for skin crackers from various animals has a significant effect on the fat content of the product ($p<0.05$), the highest fat content is shown in chicken skin crackers (45.53%). This is comparable to Hermanto *et al*. (2008) research which states that chicken has a relatively higher fat content when compared to beef fat. The difference in fat content is because each species naturally has a different fat content.

The moisture content of animal skin crackers Table 1 showed that the raw material for skin crackers from various animals had no significant effect on the moisture content of the product ($p>0.05$). Fish skin crackers are skin crackers with the highest water content (2.21%), while beef skin crackers have the lowest water content (1.79%) compared to the other four types of skin crackers. The moisture content of each skin cracker has met the requirements of skin crackers. Based on the Indonesian National Standard 01-4308-1996 regarding skin crackers, the maximum moisture content of skin crackers is 6%. The amount of moisture contained in the skin crackers is very important because the water content will affect the texture, taste, and shelf life of a product.

The ash content of animal skin crackers Table 1 showed that the raw material for skin crackers from various animals had a significant effect on the ash content of the product ($p<0.05$). The highest ash content was shown in fish skin crackers (4.14%). The high ash content in fish skin crackers indicates that fish skin crackers have a higher mineral content.

The value of free Fatty Acid (FFA) of animal skin crackers Table 1 indicates that the raw material for skin crackers from various animals has a significant effect on the free fatty acid value of the product ($p<0.05$). The highest free fatty acid value was shown in fish skin crackers (2.24%) and the lowest free fatty acid value was shown in beef skin crackers (0.41%). The free fatty acid value of skin crackers that meet SNI 01-4308-1996 skin crackers are cowhide crackers, while buffalo skin crackers, fish skin crackers, and chicken skin crackers did not meet the quality requirements for the free fatty acid content of skin crackers. This is per the Indonesian National Standard 01-4308-1996 regarding skin crackers the quality requirement for free fatty acids or free fatty acids is a maximum of 0.5%.

The highest value of Thiobarbituric Acid (TBA) for skin crackers was found in chicken skin crackers (1.97 mg malonaldehyde/kg) and beef skin crackers with the lowest TBA values (0.96 mg malonaldehyde/kg). The thiobarbituric acid value for each skin cracker did not indicate any rancidity. This is per the opinion of Günşen *et al.* (2011), which states that a product is said to be not rancid if it has a thiobarbituric acid value of less than 3 mg malonaldehyde/kg. Chicken skin crackers have the highest thiobarbituric acid value compared to other animal skin crackers with a value of 1.97 mg malonaldehyde/kg. This may be due to the effect of high-fat content on chicken skin crackers.

The total energy of animal skin crackers Fig. 1 shows that the raw material for skin crackers from various animals has a significant effect on the total energy of the product ($p<0.05$). The total energy of chicken skin crackers (578.10 kcal) has the highest energy value compared to the total energy value of other types of skin crackers. While the lowest energy value was found in cowhide crackers (437.15 kcal) because cowhide crackers also had the lowest fat content when compared to buffalo skin crackers and fish skin crackers. This is per the opinion of Br Silaban and Srimariana (2013), which states that the energy value of a food ingredient is strongly influenced by the levels of fat, protein, and carbohydrates produced, so the higher the fat content in skin crackers, the higher the energy value. This is also supported by Zuhra *et al.* (2012) who state that the largest source of energy and is considered more effective when compared to carbohydrates is fat, because fat produces 9 kcal of energy per one gram, while carbohydrates in one gram only produce 4 kcal of energy.

Table 1: Comparison of the chemical characteristics of various commercial animal skin crackers products

	Product category			
	Cowhide crackers	Buffalo skin crackers	Fish skin crackers	Chicken skin crackers
Crude protein content (%)	56.79 ± 2.84^{c}	51.45 ± 7.77^{bc}	48.00 ± 1.89^{ab}	42.09 ± 6.16^{a}
Fat content (%)	23.33 ± 1.44^{a}	33.05 ± 0.57^{b}	35.13 ± 1.77^{c}	45.53 ± 1.80^{d}
Moisture content (%)	1.79 ± 0.55	1.95 ± 0.68	2.21 ± 0.63	2.15 ± 1.17
Ash content (%)	3.96 ± 0.19^{a}	1.25 ± 0.93^{b}	4.14 ± 0.17^{b}	3.91 ± 1.68^{b}
Free fatty Acid value (%)	0.41 ± 0.87^{a}	0.75 ± 0.36^{a}	2.24 ± 0.50^{b}	1.79 ± 0.69^{b}
Thiobarbituric Acid	0.96	1.43		1.75
value (mg molanoldehyde/kg)	1.97			

a-d Value with different superscript within a line are significantly different (p<0,05). Thiobarbituric Acid (TBA) values were analyzed descriptively

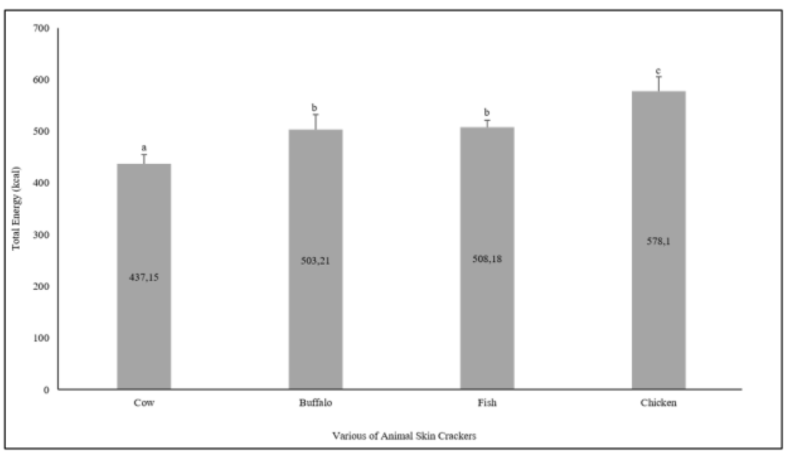

Fig. 1: Comparison of Total Energy of Various Commercial Animal Skin Crackers a-c. Value with different superscripts within a bar are significantly different (p<0,05)

Discussion

The quality of crackers is generally determined by the raw materials used in the production process. The variety of raw materials for making crackers produces various types of cracker products that are known in the market, including sticky rice crackers, skin crackers, cassava crackers, rice crackers, etc. As the name implies, leather crackers are one of the cracker products made from various kinds of livestock skins such as cows, buffalo, fish, and chicken skins. Each type of animal skin certainly has a chemical composition that varies depending on the species and how it is managed as livestock, especially the type of feed given (Suryanto *et al*., 2017). Based on the results obtained. It is known that various commercial animal skin crackers products have different characteristics.

The difference in protein content of skin crackers is due to the different protein content of animal skin raw materials used so that which affects the protein content of the product. According to Lessu *et al*. (2019) stated that differences in protein content can be caused by processing treatment, type of feed, and differences in water content of each food ingredient. The processing of skin crackers also greatly affects the protein content of the crackers produced, such as the drying and frying process which affects the decrease in protein content. This is following the opinion of Zhou *et al*. (2020) who state that the frying process using hot temperatures has beneficial and detrimental effects, one of the adverse effects is protein denaturation. During frying, the water contained in the tissue will evaporate out and make the amount of dissolved protein more and more. According to Naffa *et al*. (2020), The protein contained in the skin is mostly collagen. Collagen is one of the proteins with the longest and fibrous structure. Lin *et al*. (2010) stated that collagen is very difficult to digest, thus the protein contained in skin crackers when consumed is not absorbed by the body and will be excreted.

The high-fat content in chicken skin crackers is caused because the poultry skin layer has a lot of fat woven. This is following the opinion of Rakhmawati and Sulistyoningsih (2019) who stated that the fat content in chicken meat is relatively less when compared to the fat content in chicken skin because the fat in chicken is more spread under the skin than under the meat. In addition to chicken skin crackers, fish skin crackers also have a relatively higher fat content than cowhide crackers and buffalo skin crackers. The high-fat content in chicken skin crackers and fish skin crackers can also be influenced by the type of feed. Chicken and fish feed are usually a pellet feed consisting of carbohydrates and fats, thereby affecting the fat content in the animal's body. This is following Von Schaumburg *et al*. (2019) who state that the fat content in the animal's body is obtained from the excess energy consumed, so the higher the energy content consumed will increase the fat content in the body. The process of frying crackers also affects the increase in fat content of skin crackers because during the frying process the oil will be trapped in the pores of the crackers. Differences in fat content in skin crackers are also influenced by other aspects such as the thickness of the skin crackers, the drying method used before frying, and the draining process. This is following Martínez-Pineda *et al*. (2021) opinion which states that the processing method will affect the fat content produced such as the draining time after frying because it will affect the absorption of oil and other factors such as the initial water content of the product, the thickness of the slices and the quality of the oil used for frying. According to Nurainy *et al*. (2013), the increase in fat content is caused by the oil filling the space left by the evaporating water, so that the measured fat content in the skin crackers is counted as oil absorbed during frying.

Following to the opinion of Widati and Mustakim (2007) who states that the low water content in the product will increase the crispness of the skin crackers. Where the water that comes out of the ingredients during the frying process will form a space so that the crackers will expand to a certain level and cause the crackers to become crispier. Where the water that comes out of the ingredients during the frying process will form a space so that the crackers will expand to a certain level and cause the crackers to become crispier. The low water content contained in the skin crackers also affects the shelf life of these crackers and is related to product quality. This is following the opinion of Tay *et al*. (2022) which states that the decrease in product quality is strongly influenced by the water content in the product, this is because water activity can help microbial growth activity and chemical reactions of food ingredients that cause the product to experience a decrease in quality and shorten the shelf life.

following the opinion of Eggleston *et al*. (2022) which states that the ash content of a material indicates the mineral content present in the food material and indicates the purity and cleanliness of the resulting material. The high ash content in fish crackers can also be caused by the mineral components in the collagen that are still present until the ashing process. According to Agustina *et al*. (2017) ash content is influenced by several factors such as species, species age, sex, environment, and type of feed. The high and low ash content of the product can be influenced by the processing process. When making crackers the skin will go through a boiling process using high temperatures and drying to remove water, with reduced water content it will leave a residue on the material so that the ash content increases. This is per the opinion of Diachanty and Nurjanah (2017) who states that a decrease in the water content in food will cause a concentration of the remaining material, namely minerals, where the more mineral content of a food ingredient, the higher the ash content produced.

The high value of free fatty acid in fish skin crackers, chicken skin crackers, and buffalo skin crackers indicates that each of these skin crackers has decreased in quality. This is per the opinion of Prasetyo (2018), who states that the levels of Free Fatty Acids (FFA) in foods indicate the level of damage to foods due to the breakdown of triglycerides into other compounds such as free fatty acids. The high and low levels of free fatty acid in each skin cracker are also influenced by the time of production until the product is consumed because the longer storage will increase the free fatty acid value of the skin crackers. This is per the opinion of Vicentini-Polette *et al*. (2021) which states that free fatty acid will be formed during the storage process, where during storage the oil and fat content of the skin crackers undergo an oxidation reaction to form components such as aldehydes, ketones, and free fatty acids, thereby causing rancidity in the product.

The difference in free fatty acids in skin crackers can also be influenced by the quality of the cooking oil used when frying. If the frying process uses good quality cooking oil, the frying product will also be of good quality. If the quality of the frying oil is low, it will produce low-quality products. According to Nurhasnawati *et al*. (2015), cooking oil that has been used repeatedly has a high level of damage because the free fatty acid content has increased, thus it will affect the fried product.

According to Azizah *et al*. (2017), in a product with a high-fat content when exposed to heat, the possibility of fat breakdown is higher, resulting in a high thiobarbituric acid value. The skin crackers themselves undergo a high-temperature frying process using cooking oil, thus the thiobarbituric acid content in foodstuffs can be affected by this process. The difference in the high and low thiobarbituric acid value for each skin cracker is also influenced by the difference in the production date of each skin cracker where the sooner the production date will affect the shelf life and quality of the crackers. This is per the opinion of Wang *et al*. (2018) which states that the longer the storage time of crackers, the higher the thiobarbituric acid value in foodstuffs. Long storage time is one of the factors that increase the thiobarbituric acid value in skin crackers, this is thought to be due to chemical and physical changes in skin crackers during storage. One of the chemical reactions that occur that can cause thiobarbituric acid values in skin crackers is caused by the use of cooking oil, where cooking oil can undergo a hydrolysis process into free fatty acids and glycerol due to mixing water with oil. In addition, damage to cooking oil is also caused by the oxidation reaction between oxygen and oil both during frying and storage.

The high energy value contained in chicken skin crackers compared to the other three types of skin crackers is influenced by the high-fat content in chicken skin crackers. This is due to the high-fat content in chicken skin crackers, which contributes to their high energy content.

Conclusion

Commercial animal skin crackers have various qualities in terms of the chemical characteristics of the product related to the type of animal skin used as the raw material. Cowhide cracker products have the best chemical characteristics among other commercial animal skin crackers products because they contain higher protein and ash with low-fat content, free fatty acid value, thiobarbituric acid value, and total energy so they can be recommended as a quality and healthy commercial food product from a nutritional point of view.

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Author's Contributions

Siti Susanti: Analyzed the data, laboratory analysis, and paper writing.

Antonius Hintono: Statically analyzed and finalized the paper.

Sri Mulyani: Laboratory analyzer.

Fadia Aini Ardi: Conducted the study and collected data writing assistant.

Fahmi Arifan: Topic idea and analyzed the data.

Ethics

This article is original and contains unpublished material. The corresponding author confirms that all of the other authors have read and approved the manuscript and no ethical issues involved.

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