Food Research 6 (2) : 413 - 422 (April 2022)
Journal homepage: https://www.myfoodresearch.com

FOOD RESEARCH

FULL PAPER

The effect of the addition of chicken feet flour to crispy corn on energy density and nutritional quality

*Hadi, N.S., Yulianingsih, E., Labatjo, R., Setiawan, D.I., Domili, I., Anasiru, M.A., Arbie, F.Y., Goi, M., Amalia, M.R. and Misnati, M.

Department of Nutrition, Gorontalo Polytechnic of Health of Ministry of Health, Tamalate Street, Kota Timur District, Gorontalo City, Indonesia, 96135

Article history:
Received: 14 June 2021
Received in revised form: 27 July 2021
Accepted: 18 October 2021
Available Online: 25 April 2022

Keywords:
Chicken feet flour,
Corn starch,
Crispy corn,
Nutritional values

DOI:
https://doi.org/10.26656/fr.2017.6(2).426

Abstract

Maize contains several essential nutrients that are well-known for their contribution to food studies. This crop is an alternative carbohydrate source. Considering the increase in maize production and health advantages, it is the right decision to utilize the crop as an ingredient of snacks, such as crispy maize. Chicken feet are rich in collagen and protein. Despite the unpopularity, chicken feet contain nutrition that helps the growth and development of children. The present study was devoted to analyze the nutrient content of crispy corn. Relying on an experimental method, the treatment was done by substituting chicken feet flour on crispy corn; it consisted of five treatment levels with three replications. The quality of the crispy corn with chicken feet flour was assessed objectively in a laboratory by doing some analytical methods, including proximate analysis, energy analysis, calcium analysis, dietary fibre analysis, and iron analysis. Data analysis procedures were carried out to examine the effect of chicken feet flour on the snack's chemical quality. This process involved the ANOVA test and LSD test. The results showed that the addition of chicken feet flour enhanced the nutritional value of the crispy corn product; this is seen in the rise in the content of energy, protein, fat, water, and ash. The most recommended formula is F3, the crispy corn with 45 g of chicken feet flour.

1. Introduction

Nutrition issues among adolescences are detrimental to several public health aspects, this leads to some concerns, such as poor concentration skills, low birth weight, and poor health qualities. Some examples of nutrient deficiencies are anaemia and being underweight. These health problems lead to low productivity and cognitive declines, which later cause other serious issues such as hindering national development targets (Badan Perencanaan Pembangunan Nasional, 2009). Adequate nutrient intake is essential for adolescent growth considering many physical activities that many teenagers spend. An imbalanced diet (such as calorie deficiency) results in deficiency that is detrimental to the growth of adolescences (Notoatmodjo, 2003).

One of the nutritional needs of adolescents is minerals for growth and development. At the peak of growth, adolescents need calcium, iron, zinc, magnesium, and nitrogen two times more than other periods (Ambarita *et al*., 2018). The nutritional quality of food can be improved by consuming a variety of foods.

Maize is a cereal plant containing fibre that has been extensively studied for its potential content of functional food elements (Suarni, 2009). The cereal plant has dietary fibre with a relatively low glycemic index compared to rice. This crop is an alternative carbohydrate source. The nutrient contents of 100 g of maize include 361 kcal energy, 74.4 g of carbohydrate, 8.7 g of protein, 4.5 g fat, 9 mg of calcium, and 380 mg of phosphorus (Direktorat Jenderal Kesehatan Masyarakat, 2018). Another plus point of maize is that the crop is one of the most abundantly produced food sources. According to the data by Statistics Indonesia in Gorontalo province (2017), maize production has continued to soar in recent years. The crop production in 2015 was 643,512 tons; the number increased to 911,350 and 1,477,207 in 2016 and 2017, respectively. Considering the increase in the production and health benefits of maize, it is the right decision to utilize the crop as the main ingredient of snack products that are easily accessible, in this case, crispy maize snacks.

Corn starch is the flour processed from dried corn. Using corn starch is recommended because the flour lasts the longest, is mixable, contains nutrients (fortification),

*Corresponding author.
Email: *novianswasonohadi@gmail.com*

eISSN: 2550-2166 /
Published by Rynnye Lyan Resources

and can easily be processed into other food products. Yellow maize and white maize can serve as the ingredient of corn starch; the only difference between using these two types of maize is the flour colour. The process of making corn starch applied by the cooks determines the quality of the product. Poor handling and hygiene contribute to the low quality and contamination of the maize-based products (Arief *et al.*, 2014).

A study by Pratiwi, conducted in Mojolaban district, Sukoharjo regency, reports a correlation between protein content and haemoglobin level. Animal protein can help the absorption of dietary iron in the human body. Low protein intake leads to poor iron absorption, this condition is the cause of anaemia or a low count in haemoglobin level (Pratiwi, 2017). Chicken feet are one of the edible chicken parts that people in Gorontalo do not commonly consume but rich in collagen and protein. The general public is not aware of the benefits of processing chicken feet, which can be used as flour as an alternative to food diversity (Hadi *et al.*, 2020).

Protein is central to dietary iron transportation. Low protein intake hinders the transportation of the nutrient and, in turn, provokes iron deficiency (Almatsier, 2010). Chicken feet contain more protein than fat and carbohydrate. The content of protein in 100 g of chicken feet is 19.8 g. Protein is a healthy nutrient that helps the growth and development of children. As many as 30% of the total protein in humans is collagen. Collagen is a type of protein mostly found in connective tissues. Many have used collagen as an additive in several industries, such as the food, pharmacy, cosmetics, and photography (Hartati and Kurniasari, 2010).

Similar to maize, chicken feet can serve as an additional ingredient for many food products, such as *kastengel* (cheese cookies), *dawet* (Indonesian sweet drink), and cracker (Shobikhah, 2014). In other words, processing maize and chicken feet flour into a nutritious food product, such as crispy maize, is possible. Based on the above background, the research problem statements are how are the nutrition content (proximate test on the crude fibre, calcium, and iron) and the energy density of crispy corn snacks with chicken feed flour as the ingredient.

In outline, this research consisted of two research objectives, general objectives and specific objectives. The general objective was to identify the energy density in crispy corn with chicken feed flour as the ingredient. Further, the specific objectives are to analyze the energy, carbohydrate, protein, fat, water, ash, calcium, fibre, iron (Fe) contents in crispy corn with chicken feed flour.

In theoretical significances, this research is expected to provide information regarding the use of chicken feet flour in crispy corn snacks and the effect of adding the flour to the energy density in the snack. It is expected to contribute to expanding the literature of relevant studies. In applicative significances, this research is expected to disseminate the use of the chicken feet flour as an alternative of healthy food ingredient that contributes to anemia treatments.

2. Materials and methods

2.1 Research design

This research was aimed to identify the effect of chicken feet flour on the physical quality, energy density, and nutritional content of crispy corn. This research relied on the experimental method. The treatment revolved around the substitution of chicken feet flour in crispy corn, there were five treatments and three replications.

Steps in determining nutritional values involved tests of water content and ash content. The carbohydrate and protein content was identified using the titrimetric method and titration method, respectively. The two tests are based on the standard of SNI 01-2973-1992. Furthermore, gravimetric analysis was applied to examine the fat content. Furthermore, crispy corn is a relatively new type of thin cookie made from maize or corn. This snack is based on crispy almond products. Moreover, corn starch is made from finely ground maize kernels, which have been dried for 21 hrs prior to proceeding to the grinding process and sieving using mesh ten stainless steel woven. The chicken feet were boiled for two hours and then roasted in an oven for 2 × 24 hrs at 70°C. Grind the roasted feet using a blender before sieving using mesh ten stainless steel woven.

2.2 Site and time of research

This research was conducted from March to May 2019 at the food laboratory (Laboratorium Penyelenggaraan Makanan); processes in making corn starch, chicken feet flour, and crispy corn took place in a laboratory. The research was also conducted at the Nutrition Laboratory of the Center for Food and Nutrient Studies, Universitas Gadjah Mada, Yogyakarta. The classification of maize and chicken feet was conducted at the Biology Laboratory of Universitas Gadjah Mada, Yogyakarta.

2.3 Experiment procedures

The experiment of the present work involved several treatments with different percentages of chicken feet flour, namely 0%, 15%, 30%, 45%, and 60%. Steps of the experiment include preparation, experiment, and finalization.

The first procedure was the preparation step to ensure that all experiment process runs smoothly. Below are the details of the preparation step. The objective of this step is to ensure that all materials are ready to use. The fresh sweet maize (yellow-coloured) of Bonanza varieties was bought from Pasar Sentral, a traditional market in Gorontalo. The chicken feet were also bought from the same market, from selected fresh broilers (maximum 24 hrs after slaughtered). The experiment of the present work involved several treatments with different percentages of chicken feet flour, namely 0%, 15%, 30%, 45%, and 60%. Table 1 below displays the ingredient/composition of crispy corn with chicken feet flour. All appliances used in this experiment are in good condition and hygienic.

Table 1. Ingredient/composition of crispy corn with chicken feet flour.

Ingredient	Formula (g)				
	F0	F1	F2	F3	F4
Wheat flour	100	85	70	55	40
Chicken feet flour	-	15	30	45	60
Corn starch	30	30	30	30	30
Egg white	90	90	90	90	90
Milk powder	7	7	7	7	7
Margarine	80	80	80	80	80
Powdered sugar	40	40	40	40	40
Salt	5	5	5	5	5
Baking powder	5	5	5	5	5
Grated cheese	90	90	90	90	90

The experiment processes were applied to all experiment groups with different variables simultaneously to ensure the characteristics of the experiment results. The sweet maize was odourless and in fresh condition (no moulds). The wheat flour contains 8% to 9% protein content as it has a lower leavening agent and water absorption capacity. The selected wheat flour is of good quality.

Furthermore, the washed chicken feet are boiled, blended, dried, and sifted until they become flour. The eggs are fresh and in medium sizes. Further, the experiment used fresh spices. All appliances and equipment are in good condition before being used in making the crispy corn with chicken feet flour. This is to prevent chemical reactions due to rusted parts, moulds, and bacteria.

The maize and chicken feet were divided into five different weights based on the research variables. Such a process requires a normal and properly-functioned digital scale. The first step was to ensure that the scale is in good condition. The ingredients are measured in grams.

Ingredients for the standard recipe involved 100 g low-protein wheat flour, 30 g corn starch, 90 g egg white, 7 g milk powder, 80 g margarine, 40 g powdered sugar, 5 g salt, 5 g baking powder and 90 g grated cheese. Cooking processes were as follows. First, powdered sugar was sifted and mixed with margarine until homogenized. Second, egg white was added and beat until foamy. Third, the baking powder was added. Fourth, milk powder was poured and mixed until homogenized. Fifth, a pinch of salt was added. Sixth corn starch and wheat flour were added and the dough was well mixed. Seventh, a round egg pan was buttered with the margarine before the dough was added and flatten. The grated cheese was poured in after and cooked at a low temperature for less than 3 mins.

After the cooking process in the oven was completed, the chicken feet were left to cool down at room temperature. The environment was ensured to be cleaned throughout the process. Other than ensuring the quality of the product, the purpose of packaging is to prevent microorganism contamination and store the product. The crispy corn packaging was air-tight. Following the packaging process is the labelling of each product based on the code of the sample. The label contains the product name, composition, and expiration date. Quality assessment was performed at the laboratory after the labelling step.

2.4 Data analysis

Analysis processes on the effect of mixing chicken feet flour into the crispy corn dough were performed objectively. The quality of the crispy corn with chicken feet flour was assessed objectively in a laboratory. This is aimed at identifying the content of nutrients in crispy corn with chicken feet flour. All data were analyzed to identify the effect of adding chicken feet flour on the chemical qualities of crispy corn products. The ANOVA test at the significance level of 95% was performed using computer software. This test was followed by the LSD (least significant difference) test.

2.4.1 Water content analysis

For the water content analysis (AOAC, 2005), aluminium cups were dried in an oven at 100°C for 15 mins, the cups were then cooled down in a desiccator for 10 mins. An experiment scale was used in measuring the weight of the cups (a gram). The sample, weighing 4 to 5 g, was measured using the scale (b gram). Furthermore, the cups were dried in an oven at 100-105°C for at least 6 hrs before proceeding to the cooling down process in the desiccator, the cups were measured for the second time in the scale (c gram). They were then cooled down for 15 -30 mins, and the weighing process was repeated. The sample drying was repeated until the weight was relatively constant (particularly if the difference of the dry sample was 0.0003 g).

$$\text{Water content (\% dry base)} = \frac{b-(c-a) \times 100\%}{c-a}$$

Where a = weight of empty cup (g), b = weight of sample (g) and c = weight of sample + weight of cup after drying (g)

2.4.2 Protein content analysis

For the protein content analysis (AOAC, 2005), as many as 0.1 g of sample was put into a 100 mL Kjeldahl flask with 2.0 g of K_2SO_4, 40 mg of HgO, and 2.5 mL of concentrated H_2SO_4. The sample was digested until it became transparent in colour and left to cool. The content of the flask was moved to the distillation equipment. The flask was washed 5 to 6 times with 1-2 mL water. Before the distillation process, 8-10 mL of concentrated NaOH-Na was added until the sample turned blackish-brown. The distillation results were moved to an Erlenmeyer flask containing 5 mL of H_3BO_3 and two drops of indicator (a mix of two ratios of 0.2% red methyl in alcohol and one ratio of blue methylene 0.2% in alcohol) and were titrated using HCl 0.02 N that had been standardized until the colour turned from green to grey.

$$\%\ n = \frac{(\text{mL sample} - \text{mL blank})}{\text{dry base sample weight (mg)}} \times \text{NHCl} \times 14.007 \times 100\%$$

$$\text{Protein Content} = \%\ \text{N} \times \text{conversion factor}$$

2.4.3 Ash content analysis

For the analysis of ash content (AOAC 2005), the ash content was measured using a laboratory furnace. The porcelain cups were heated in an oven and the cups were cooled down in a desiccator before weighing. The sample weighing 2.0 g to 3.0 g was moved to the porcelain cups and then heated in an oven for 30 mins. Furthermore, the sample was heated in the furnace at 600°C for four to five days, later cooled in the desiccator and weighed. The drying process was repeated until the weight was relatively constant (particularly if the difference of the dry sample was ≤ 0.0003 g).

$$\%\ \text{ash content} = \frac{\text{ash weight}}{\text{sample weight}} \times 100\ \%$$

2.4.4 Fat content analysis

For the analysis of fat content (AOAC 2005), the fat flask used in the soxhlet extractor was dried in an oven and weighed after being cooled in a desiccator. As much as 2 g of sample was weighed in a beaker glass with an added 30 mL of 25%, 20 mL of water, and boiling chips. A watch glass was used to cover the beaker and heated for 15 mins. The sample was filtered with a filter paper at a high temperature and washed for the second time using hot water to prevent the acid reaction. The filter paper previously used and its content was dried at 100-105°C. The filter paper was inserted into the lab wrapping, which has its tips covered with cotton resulting in a tube-shaped form. The tube was extracted using hexane for two to three hours at 80°C. Following the process was heating of the flask containing the fat in an oven at 100 to 105°C, later it was left to cool in a desiccator before weighing.

$$\%\ \text{fat} = \frac{(\text{fat weight} + \text{flask}) - \text{flask weight}}{\text{sample weight}} \times 100\ \%$$

2.4.5 Carbohydrate content analysis

Furthermore, the formula to count the Carbohydrate content analysis (by difference) is the percentage of carbohydrate = 100 % - % (protein content + fat + water + ash).

2.4.6 Dietary fibre content analysis

The AOAC (2005) was applied to examine dietary fibre content, the method relied on the principle of fat extraction principle, hydrolysis, and starch separation using the amylase and amyloglucosidase enzymes. The protease enzyme was used in the hydrolysis and protein separation process.

2.4.7 Calcium content analysis

For the *analysis of calcium content,* equipment for the process of analyzing calcium content involved a KERN ABJ-NM/ABSN scale (Kern and Sohn GmbH, Balingen, Germany), burette, stative, Erlenmeyer flask, and volumetric pipette (Taufik *et al*., 2018).

$$\text{Calcium Content (mg/100 mL)} = \frac{M \times V_1 \times 40.8 \times 100}{V_2}$$

Where M = Molarity NA_2EDTA (M), V_1 = Volume NA_2EDTA (mL), and V_2 = Sample volume (mL)

2.4.8 Fe content analysis

The Fe analysis relied on the permanganometric titration method (a quantitative, volumetric test) with a series of laboratory experiments (Qamairah and Yanti, 2018).

$$\text{Fe Content} = \frac{Vt \times Nt \times 28 \times FP \times 100\%}{W \times 0.1}$$

Where Vt = Titrant volume, Nt = concentration of KMnO4 from the results the standardized N, 28 = equality of 1 mL KMnO4 0.1 n = 28 mg Fe, FP = Dilution factor, N = Sample weight (mg)

eISSN: 2550-2166

2.4.9 Energy content analysis

As for energy content analysis, a bomb calorimeter was used in this process (Direktorat Jenderal Kesehatan Masyarakat, 2018).

3. Results and discussion

3.1 Water content

The average water content in the crispy corn product ranges from 2.07 to 3.05 (Figure 1). Figure 1 indicates that the higher the addition of chicken feet flour, the higher the water content in crispy corn will be. The results of the ANOVA test reported no significant difference (0.067 > 0.05) in the water content in all treatment processes. The highest water content is in the sample with 60 g of chicken feet flour. The crispy corn with 15 g of chicken feet flour has the lowest water content at 2.17%. The high water content contained in chicken feet flour can be caused by the presence of water bound to bone meal protein which is difficult to remove during drying (Novidahlia *et al*., 2011).

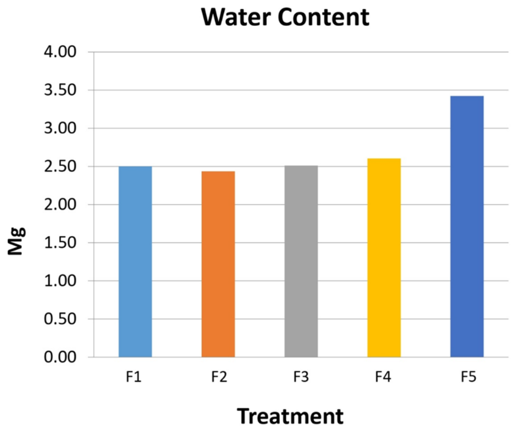

Figure 1. The average water content in crispy corn

Table 2. LSD test on intergroup water content after intervention.

Post Hoc Test	Mean Difference	P-value
F0 vs F4	-0.92	0.019
F1 vs F4	-0.99	0.014
F2 vs F4	-0.91	0.020
F3 vs F4	-0.82	0.033

P-value <0.05 indicates significant difference.

Similar research explains that water moves from high pressure to low pressure after the heating process, but not all of the water is removed and evaporates, making the biscuits contain a low amount of water. In addition, radiant heat is emitted by an object in the form of a limited set of energy (Novidahlia *et al*., 2011). This is in accordance with the research that describes the movement of radiant heat in space, such as the propagation of light, which a wave theory can describe. If the radiation wave encounters another object, the energy is absorbed. The LSD test results have been provided in Table 2.

3.2 Ash content

The average ash content in the crispy corn product ranges from 1.54 to 6.14 (Figure 2). Figure 2 indicates that the higher the addition of chicken feet flour, the higher the ash content in crispy corn will be. The results of the ANOVA test revealed a significant difference (0.00 > 0.05) in the ash content in all treatment processes. The highest ash content is in the sample with 60 g of chicken feet flour. The crispy corn with an additional 15 g of chicken feet flour has the lowest ash content at 1.54%.

Ash is the leftover of food or organic materials after they have been burned. The content and composition of dietary ash depend on the ingredients and the burning process is related to the mineral content. The ash content in food signifies the inorganic mineral content. According to Sundari, Almasyhuri, and Lamid (2015), ash content is the remaining food that has been burned at temperature ranging from 500° to 800°C. The LSD test results have been provided in Table 3.

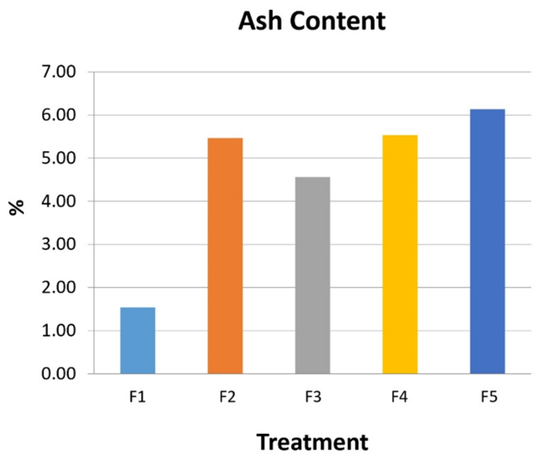

Figure 2. The average ash content in crispy corn

Table 3. LSD test on intergroup ash content after intervention.

Post Hoc Test	Mean Difference	P-value
F0 vs F1	-3.927	0.000
F0 vs F2	-3.020	0.000
F0 vs F3	-3.993	0.000
F0 vs F4	-4.597	0.000
F1 vs F2	0.907	0.160
F2 vs F3	-0.973	0.110
F2 vs F4	-1.577	0.000

P-value <0.05 indicates significant difference.

3.3 Protein content

The average protein content in the crispy corn product ranges from 10.43% to 25.54% (Figure 3). Figure 3 indicates that the higher the addition of chicken feet flour, the higher the ash content in crispy corn. The results of the ANOVA test revealed a significant difference (0.00 > 0.05) in the ash content in all treatment processes. The highest protein content is in the sample with 60 g of chicken feet flour, while the lowest protein content in crispy corn with chicken feet flour measures at 10.43%.

Proteins are composed of hydrogen, oxygen, and nitrogen carbon atoms and are essential to forming new tissues and maintaining existing tissue, regulating the balance of tissue and blood vessels, and serving as an enzyme and a medium of transportation and storage (Warsito *et al*., 2015). Another study explained that the greater the substitution of food with high protein, the higher the protein content. The texture of the product becomes denser because the protein will bind strongly and cover the fat to form an emulsion. (Hasanah *et al*., 2020). The LSD test results have been provided in Table 4.

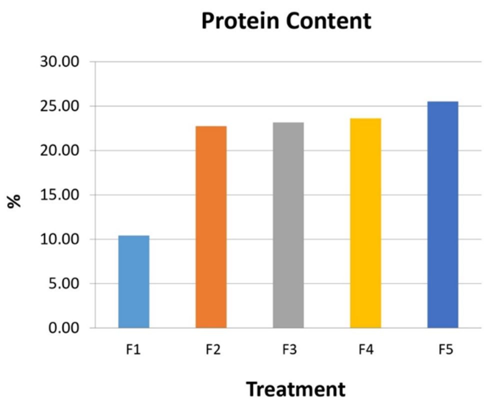

Figure 3. The average protein content in crispy corn

Table 4. LSD test on intergroup protein content after intervention.

Post Hoc Test	Mean Difference	P-value
F0 vs F1	-12.327	0.000
F0 vs F2	-12.753	0.000
F0 vs F3	-13.207	0.000
F0 vs F4	-15.110	0.000
F1 vs F4	-2.783	0.000
F2 vs F4	-2.357	0.010
F3 vs F4	-1.903	0.030

P-value <0.05 indicates significant difference.

3.4 Fat content

The average fat content in the crispy corn product ranges from 18.59% to 21.52% (Figure 4). Figure 4 indicates that the higher the addition of chicken feet flour, the higher the fat content in crispy corn will be. The results of the ANOVA test revealed a significant difference (0.01 > 0.05) in the fat content in all treatment processes. The highest fat content is in the sample with 60 g of chicken feet flour while the lowest fat content in crispy corn with chicken feet flour measures at 18.59%.

Generally, the fat content will decrease after going through boiling or steaming. This decrease occurs because of the damage to the structure of the fat due to the use of high temperatures. Fat is a better energy source compared to carbohydrates and protein. Fat becomes liquid at room temperature due to the content of large unsaturated fatty acids, resulting in a low melting point (Warsito *et al*., 2015). The LSD test results have been provided in Table 5.

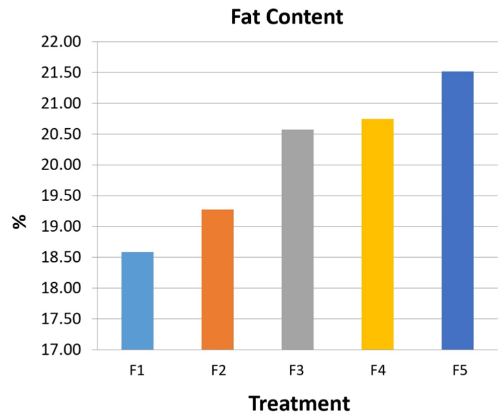

Figure 4. The average fat content in crispy corn

Table 5. LSD test on intergroup fat content after intervention.

Post Hoc Test	Mean Difference	P-value
P0 vs P2	-1.987	0.017
P0 vs P3	-2.160	0.011
P0 vs P4	-2.933	0.002
P1 vs P4	-2.243	0.090

P-value <0.05 indicates significant difference.

3.5 Carbohydrate content

The average carbohydrate content in the crispy corn product ranges from 42.42% to 65.47% (Figure 5). Figure 5 indicates that the higher the addition of chicken feet flour, the lower the carbohydrate content in crispy corn. The results of the ANOVA test revealed a significant difference (0.00 > 0.05) in the carbohydrate content in all treatment processes. Crispy corn with no addition of chicken flour has the highest carbohydrate content. The crispy corn with an additional 60 g of chicken feet flour has the lowest fat content at 42.42%. The LSD test results have been provided in Table 6.

The value of carbohydrate content in all treatments produced meets the standard of carbohydrate content set by BSN (1992), a minimum of 70%. The carbohydrate content of some commercial biscuits and crackers ranges from 56.8-74.6%. Measurement of several proximate profiles, the carbohydrate content of biscuits, is often needed to ensure that the chicken claw flour tested complies with applicable food regulations. (Hasanah *et al*., 2020). Carbohydrates can break down into simpler compounds. The decomposition products include glucose, sugar phosphate, pyruvic acid, and lactic acid.

The occurred reduction in water content can affect the measurement of carbohydrate values, same as other proximate levels. Both of these results explain the increase and decrease in the carbohydrate value of the biscuits tested.

Carbohydrate is the primary calorie source, which is central to determining the characteristics of food, including taste, texture, and colour. Carbohydrates are composed of carbon and polyhydroxy aldehyde or ketones (Warsito *et al*., 2015).

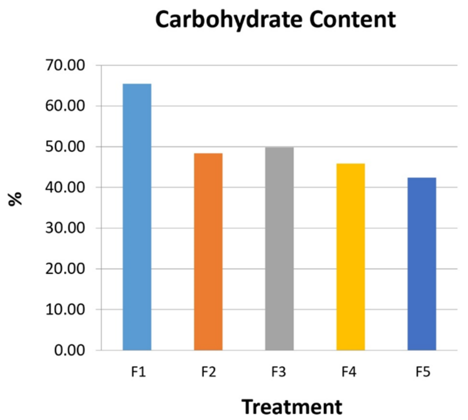

Figure 5. The average carbohydrate content in crispy corn

Table 6. LSD test on intergroup carbohydrate content after intervention.

Post Hoc Test	Mean Difference	P-value
F0 vs F1	17.073	0.000
F0 vs F2	15.640	0.000
F0 vs F3	19.587	0.000
F0 vs F4	23.043	0.000
F1 vs F4	5.970	0.010
F2 vs F4	7.403	0.003

P-value <0.05 indicates significant difference.

3.6 Fibre content

The average fibre content in the crispy corn product ranges from 0.28% to 0.67% (Figure 6). Figure 6 indicates that the higher the addition of chicken feet flour, the lower the fibre content in crispy corn. The results of the ANOVA test revealed a significant difference (0.019 > 0.05) in the fibre content in all treatment processes. Crispy corn with no addition of chicken flour has the highest fibre content. The crispy corn with an additional 45 g of chicken feet flour has the lowest fibre content at 0.28%. Fibre stimulates peristaltic motion and absorbs more water to the colon, thus allowing stools to pass smoothly and preventing constipation (Furkon, 2014). The LSD test results have been provided in Table 7.

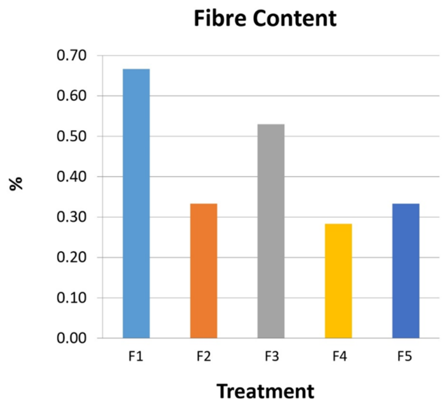

Figure 6. The average fibre content in crispy corn

Table 7. LSD test on intergroup dietary fibre after intervention.

Post Hoc Test	Mean Difference	P-value
F0 vs F1	0.333	0.009
F0 vs F3	0.383	0.004
F0 vs F4	0.333	0.009
F2 vs F3	0.247	0.039

P-value <0.05 indicates significant difference.

3.7 Calcium content

The average calcium content in the crispy corn product ranges from 0.75% to 1.95% (Figure 7). Figure 7 indicates that the higher the addition of chicken feet flour, the higher the calcium content in crispy corn. The results of the ANOVA test revealed a significant difference (0.00 > 0.05) in the fibre content in all treatment processes. Crispy corn with the addition of 60 g of chicken flour has the highest calcium content, and the lowest fat content in crispy corn with no chicken feet flour measures at 0.75%.

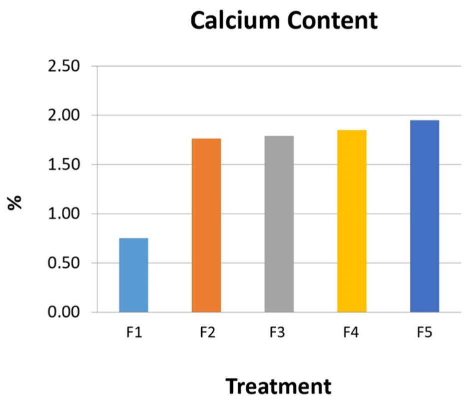

Figure 7. The average calcium content in crispy corn

The results show that the higher substitution of chicken feet flour on crispy corn resulted in a decrease in calcium levels. Theoretically, the higher the substitution of chicken feet flour on crispy corn substituted with 60% chicken feet flour will increase the calcium content. This is due to the possibility that the crispy corn contains a lower water content than other cookies because the free water released is higher. (Rahmawati and Rustanti, 2013). The LSD test results have been provided in Table 8.

Table 8. LSD test on intergroup calcium content after intervention.

Post Hoc Test	Mean Difference	P-value
F0 vs F1	-1.010	0.000
F0 vs F2	-1.037	0.000
F0 vs F3	-1.097	0.000
F0 vs F4	-1.197	0.000
F1 vs F3	-0.087	0.000
F1 vs F4	-0.187	0.000
F2 vs F3	-0.060	0.001
F2 vs F4	-0.160	0.000
F3 vs F4	-0.100	0.000

P-value <0.05 indicates significant difference.

Consuming food rich in calcium helps the development of bone (through phosphor) and tooth enamel (through the calcification process) and improves muscle contraction (with protein interaction). Food high in calcium plays a significant role in blood clotting by stimulating the release of thromboplastin from blood platelet when a person is injured (Furkon, 2014).

3.8 Iron (Fe) content

The average iron content in the crispy corn product ranges from 6.44% to 8.21% (Figure 8). Figure 8 indicates that the higher the addition of chicken feet flour, the higher the iron content in crispy corn compared to crispy corn with chicken feet flour substitution at the lowest (15%). The results of the ANOVA test revealed a significant difference (0.00 > 0.05) in the iron content in all treatment processes. Crispy corn with no addition of chicken flour has the highest iron content. The crispy corn with an additional 15 g of chicken feet flour has the lowest iron content at 6.44 mg per 100 g. The LSD test results have been provided in Table 9.

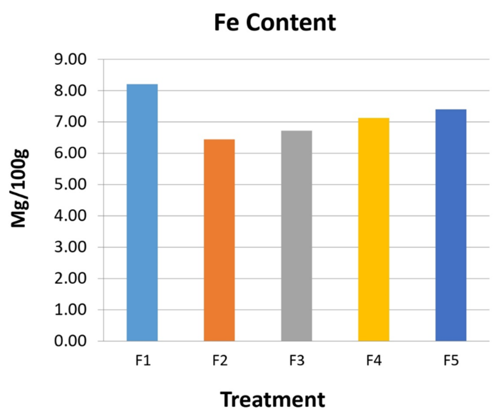

Figure 8. The average iron content in crispy corn

Iron is central to the production of haemoglobin, specifically the protein that transports the oxygen to body cells. Moreover, iron helps maintain the availability of oxygen supply for muscle contraction. Iron assists the electron transfer process by the protein when the cells use energy as a part of metabolism (Furkon, 2014).

Table 9. LSD test on intergroup Fe content after intervention.

Post Hoc Test	Mean Difference	P-value
F0 vs F1	1.763	0.000
F0 vs F2	1.487	0.000
F0 vs F3	1.077	0.000
F0 vs F4	0.807	0.000
F1 vs F3	-0.687	0.003
F1 vs F4	-0.957	0.000
F2 vs F3	-0.410	0.043
F2 vs F4	-0.680	0.003

P-value <0.05 indicates significant difference.

3.9 Energy

The average energy content in the crispy corn product ranges from 49.69 to 55.64 kcal (Figure 9). Figure 9 indicates that the higher the addition of chicken feet flour, the lower the energy content in crispy corn. The results of the ANOVA test revealed a significant difference (0.00 > 0.05) in the energy content in all treatment processes. Crispy corn with 30 g of chicken feet flour has the highest energy content and the lowest fat content in crispy corn with no chicken feet flour measures at 49.69 cal. The LSD test results have been provided in Table 10.

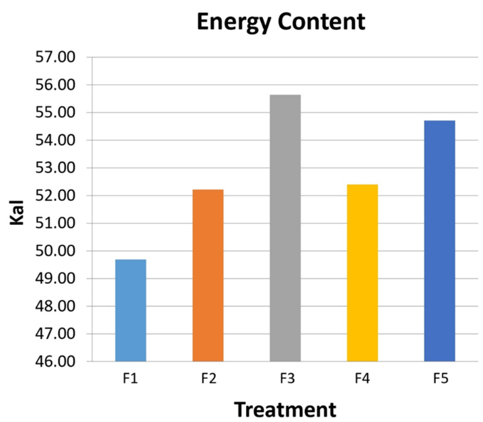

Figure 9. The average energy content in crispy corn

Table 10. LSD test on intergroup energy content after intervention.

Post Hoc Test	Mean Difference	P-value
F0 vs F1	-2.530	0.012
F0 vs F2	-5.953	0.000
F0 vs F3	-2.713	0.008
F0 vs F4	-5.027	0.000
F1 vs F2	-3.423	0.002
F1 vs F4	-2.497	0.013
F2 vs F3	3.240	0.003
F3 vs F4	-2.313	0.019

P-value <0.05 indicates significant difference.

Energy is essential to perform all activities. Human energy supplies come from consuming food containing carbohydrates and fat. Energy is released in the process of food burning. Measuring energy expenditure helps identify the food intake needed to produce sufficient energy (Soediaoetama, 2000).

4. Conclusion

Crispy corn snack with chicken feet flour substitution has resulted in a significant increase in the energy content, protein content, fat content, ash content, and calcium content compared to crispy corn snack without chicken feet flour substitution. Moreover, crispy corn snacks with higher substitution of chicken feet flour also experienced a significant increase in iron (Fe) content compared to the lowest substitution of chicken feet flour. On the other hand, crispy corn with chicken feet flour substitution experienced a significant drop in carbohydrate content and fibre content compared to the snack without chicken feet flour substitution. All in all, the substitution of 45 g of chicken feet flour can be used as an alternative in making crispy corn. It is one of the healthy snacks from local food modifications in overcoming nutritional problems as the content of energy, protein, fat, calcium, and iron is quite high compared to other substitution formulas.

It is of paramount importance to further examine the acceptability (through organoleptic tests) and food safety (microbiology tests) to increase the acceptability of people regarding the crispy corn product. Examining the addition of other micro-nutrients capable of improving nutrient quality treatment is also necessary. The packaging stage can affect the shelf life of crispy corn products. Products packaged in air-tight containers are more durable and crunchy than products exposed to the open air.

Conflict of interest

The authors declare no conflict of interest.

References

Almatsier, S. (2010). Prinsip dasar ilmu gizi. 9th ed. Jakarta, Indonesia: PT Gramedia Pustaka Utama. [In Bahasa Indonesia].

Ambarita, A.T., Sudaryati, E. and Nasution, E. (2018). Pengaruh penambahan tepung ceker ayam ras terhadap daya terima dan kandungan gizi mutiara tapiona (tapioka pearl). *Jurnal Gizi, Kesehatan Reproduksi dan Epidemiologi*, 1(1), 301-316. [In Bahasa Indonesia].

Arief, R.W., Yani, A. and Dewi, F. (2014). Kajian pembuatan tepung jagung dengan proses pendahuluan, presented at National Seminar entitled Specific Agricultural Technology Innovations, Banjarbaru, 2014. Banjarbaru: BPTB Kalimantan Selatan. [In Bahasa Indonesia].

Badan Perencanaan Pembangunan Nasional. (2009). Pengembangan database pembangunan bidang kesehatan dan gizi masyarakat. Jakarta, Indonesia: Bappenas. [In Bahasa Indonesia].

Direktorat Jenderal Kesehatan Masyarakat. (2018). Tabel komposisi pangan Indonesia. Jakarta, Indonesia: Kementerian Kesehatan RI. [In Bahasa Indonesia].

Furkon, L.A. (2014). Mengenal zat gizi. In Furkon, L.A. (Eds). Ilmu Kesehatan Gizi, p. 1–53. Jakarta, Indonesia: Universitas Terbuka. [In Bahasa Indonesia].

Hadi, N.S., Labatjo, R., Setiawan, D.I., Domili, I. Rasyid, P.S. and Rahmat, A. (2020). The influence of chicken feet addition to the nutrition value and organoleptic quality of the corn nugget. *International Journal of Psychosocial Rehabilitation,* 24(9), 1313-1319.

Hartati, I. and Kurniasari, L. (2010). Kajian produksi kolagen dari limbah sisik ikan secara ekstraksi enzimatis. *Momentum*, 6(1), 33–35. [In Bahasa Indonesia].

Hasanah, U., Ulya, M. and Purwandari, U. (2020). Pengaruh penambahan tempe dan tepung tapioka terhadap karakteristik fisikokimia dan hedonik nugget nangka muda (Artocarpus heterophyllus LMK). *Jurnal Pangan dan Agroindustri*, 8(3), 154-162. https://doi.org/10.21776/ub.jpa.2020.008.03.5

Notoatmodjo, S. (2003). Pendidikan dan perilaku kesehatan. Jakarta, Indonesia: Rineka Cipta. [In Bahasa Indonesia].

Novidahlia, N., Mardiah, M. and Sarifudin A. (2011). Dry noodle making by chicken metatarsal meal addition. *Jurnal Pertanian,* 2(2), 103-109.

Pratiwi, I.Y. (2017). Hubungan asupan protein dan status gizi dengan kadar hemoglobin ibu hamil di Desa Demakan Kecamatan Mojobalan Kabupaten Sukoharjo. Surakarta, Indonesia: Universitas Muhammadiyah Surakarta, BSc. Thesis. [In Bahasa Indonesia].

Qamairah, N. and Yanti, R. (2018). Uji kuantitatif kadar zat besi dalam tumbuhan kelakai dan produk olahannya. *Jurnal Surya Medika,* 3(2), 32–40. https://doi.org/10.33084/jsm.v3i2.96 [In Bahasa Indonesia].

Rahmawati, H. and Rustanti, N. (2013). Pengaruh substitusi tepung tempe dan ikan teri nasi (*Stolephorus* sp.) terhadap kandungan protein, kalsium, dan organoleptik cookies. *Journal of Nutrition College,* 2(3), 382-390. https://doi.org/10.14710/jnc.v2i3.3440 [In Bahasa

Indonesia].

Shobikhah, S. (2014). Eksperimen pembuatan kastengel dengan substitusi tepung ceker ayam sebagai upaya peningkatan. Semarang, Indonesia: Universitas Negeri Semarang, BSc. Thesis. [In Bahasa Indonesia].

Soediaoetama, A.D. (2000). Ilmu gizi untuk mahasiswa dan profesi di Indonesia. 1st ed. Jakarta, Indonesia: Dian Rakyat. [In Bahasa Indonesia].

Suarni, S. (2009). Prospek pemanfaatan tepung jagung untuk kue kering (Cookies). *Jurnal Penelitian Dan Pengembangan Pertanian*, 28(2), 63–71. https://doi.org/10.21082/jp3.v28n2.2009.p63-71 [In Bahasa Indonesia].

Suarni, S. and Yasin, M. (2011). Jagung sebagai sumber pangan fungsional. *Iptek Tanaman Pangan*, 6(1), 41–56. [In Bahasa Indonesia].

Sundari, D., Almasyhuri, A. and Lamid, A. (2015). Pengaruh proses pemasakan terhadap komposisi zat gizi bahan pangan sumber protein. *Media Penelitian dan Pengembangan Kesehatan*, 25(4), 235–242. https://doi.org/10.22435/mpk.v25i4.4590.235-242 [In Bahasa Indonesia].

Taufik, M., Seveline, S. and Saputri, E.R. (2018). Validasi metode analisis kadar kalsium pada susu segar secara titrasi kompleksometri. *Agritech,* 38(2), 187–193. https://doi.org/10.22146/agritech.25459 [In Bahasa Indonesia].

Warsito, H., Rindiani, R. and Nurdyansyah, F. (2015). Ilmu bahan makanan dasar. Yogyakarta, Indonesia: Nuha Medika. [In Bahasa Indonesia].

