# The Utilization of Chicken Bone Flour as a Source of Calcium in Cookies Making

**Melanie Cornelia[*) ] and Dhanny Prasetya Gozali**

Department of Food Technology, Faculty of Science and Technology, Pelita Harapan University
UPH Tower, B Building, Karawaci, Tangerang 15811
Telp/Fax. (021)5460901/(021)5460910

[*) ]Coresponding author: melanie.cornelia@uph.edu

## Abstract

*Chicken bone contained high calcium, but that utilization was very limited and mostly as a waste. Calcium was needed for humans, especially who were in period of growth. The purpose of this research was to utilize chicken bone flour as a source of calcium in cookies making. Cookies were food products that often consumed by people in Indonesia because easy to make and have a longer shelf life. The initial phase of this research was to find the best process of chicken bone flour from broiler chicken bone and kampong chicken bone as raw materials. The best chicken bone flour have high calcium content of 18061.12 mg/100 g, low fat content 13.79% and yield 34.63%. The formulation of cookies making were trial to add 0, 5, 10, 15, and 20% of chicken bone flour into cookies. From scoring and hedonic test by panelists, cookies were made with additional 5% of chicken bone flour was more preferable. So the best formulation was cookies which has calcium content 464.03 mg/100 g, 26.58% fat, and hardness 1372.03 g/cm². These cookies have characteristics and nutrients better than the cookies control.*

## INTRODUCTION

Chicken consumption in Indonesia was 4.472 kg per capita per year in 2014 (Badan Pusat Statistik, 2015). Chicken bone was a waste that its utilization still limited, which was only used as a mixture of fertilizer, broth, and pet food. Chicken bone contained nutrients that were beneficial to human growth, such as calcium, phosphor, and amino acids. These nutrient could be used to increase nutrients of food products. Calcium served as a nutrient for growth, development of motoric nervous function to be more optimal, bone growth, and teeth. Deficiency of calcium could cause disorder of bone and teeth growth, osteoporosis, and osteomalacia. Recommended Dietary Allowance of calcium for men and women aged 19-50 years is 1000 mg/day (Kotecki, 2011). So, increased calcium intake needs to be done in order to minimize the risk of bone loss. It could be done by adding calcium-containing materials into food products that were often consumed by the people in Indonesia. The addition of chicken bone into food products by milling chicken bone to flour which were used as raw material for example in cookies making. Cookies were food products that were often consumed by people in Indonesia because easy to make, has a crunchy texture, and has specific aroma. The consumption of cookies in Indonesia is 0.4 kg per capita per year (Subagjo, 2007). The addition of chicken bone flour in the production of cookies was

expected to increase the nutritional value of the cookies (especially the calcium content), so the cookies has more value and useful for consumption by the people of Indonesia. The purpose of this research was to get the best condition in making chicken bone flour that had high calcium content, and used it that as a source of calcium in making cookies.

## RESEARCH METHOD
### Materials and Equipments
The material used in the making of chicken bone flour was the bone of broiler chicken (*gallus domesticus*) 2 months old  and the bone of kampong chicken (*gallus gallus*) 8 months old  bought from market "paramount" Tangerang, wheat flour Boga Sari "Kunci Biru", butter "Blue Band", refined sugar, chicken egg, salt, and vanilli.

The materials used for the analysis were $K_2SO_4$, selenium, HCl solution, NaOH solution, $H_2SO_4$ solution, and boric acid solution.

The equipments used were knife, pressure cooker, cabinet dryer, dry blender, thermometer, table balance, Tyler sieve, mixer, oven, and baking sheet. The equipments used for analysis were volumetric glassware, desiccator, Kjeldahl apparatus, water heater, soxhlet, chromameter, and texture analyzer.

### Preliminary Research
Chicken bone was processed into chicken bone flour. Sequentially the bone was cleaned, cut (size 5-6 cm), boiled in pressure cooker (100°C, 1 hour), water drained, separation of meat from the bone, the bone was cut with knife (size 1 cm), weighing (weight as raw material), dried in 2 types of dryer (cabinet dryer 60°C, 24 hours, oven drying 60°C, 24 hours, milled with disc mill, dried blending, and sieved up to 60 mesh.

### Main Research
This cookies making used chicken bone flour as source of calcium. The addition of chicken bone flour concentration was 0, 5, 10, 15, and 20%. The process of cookies making was: weighing of butter, egg, and refined sugar, stirred with mixer (medium speed) to homogeneous, addition of salt and vanilli, stirred with mixer (low speed) to homogeneous, addition of wheat flour and chicken bone flour, mixed to homogeneous, molded on a baking sheet, roasted at a temperature of 170°C for 15 minutes. The cookies formulation form can be seen in Table 1.

Table 1.  Formulation of cookies

| Materials | Formulation |
| --- | --- |
| Wheat flour | 200 g |
| Chicken bone flour | (0, 5, 10, 15, 20) % |
| Butter | 135 g |
| Refined sugar | 100 g |
| Chicken egg | 50 g |
| Salt | 1 g |
| Vanilli | 0.2 g |

Source: Modification of Priyono. (2008)

## RESULTS AND DISCUSSION
### Moisture of Chicken Bone
The analysis results of moisture in broiler chicken bone were 63.79±0.78% and kampong chicken bone were 62.84±0.22%. Water content in the chicken bone was affected by the boiling process.

### Yield of Chicken Bone Flour
The chicken bone flour mass was obtained after sieving 60 mesh. Yield for broiler chicken bone was 34.26±1.68% and kampong chicken bone was 34.68±0.87%.

### Moisture of Chicken Bone Flour
Flour generally have low water content, so it has a long shelf life. High water content causes harm to the flour. According to Latief (2006), good water content of bone flour is 6.6%. The lowest water content obtained from this research results was drying flour used cabinet dryer (4.84±0.23%) while oven 5.86±0.13%.

### Density of Chicken Bone Flour
Density was one of the parameters in powdered product. The higher the density of the flour the more dense the product when put into a volume. The highest density was 0.60±0.02 g/ml for kampong chicken bone flour and 0.57±0.00 g/ml for broiler chicken bone flour.

### Water Absorption of Chicken Bone Flour
Water absorption was the ability of the flour to absorb water. High water absorption will retain more and more particles of material which then caused the rising water content in the flour to the saturation limit where water could no longer be absorbed. It could be seen there were significant differences in the water absorption capacity of broiler chicken bone and kampung chicken bone flour. Broiler chicken bone flour had water absorption 175.30±2.04% and kampong chicken bone flour 139.15±1.64%.

### Fat Content of Chicken Bone Flour
According to Rosalin (2006), chicken bone flour fat content was 14.48%. There were significant differences between different drying treatments and bone types. Treatment of kampong chicken bone and cabinet dryer produces the lowest fat content. The higher the fat content, the product will be faster rancid and lower quality of the product. The fat content of kampong chicken bone with cabinet drying treatment had the lowest fat content was 14.59±1.10%, while broiler chicken bone was 16.03±0.61%.

### Protein Content of Chicken Bone Flour
According to Rosalin (2006), broiler chicken bone flour has protein 59.02%. From the results of the research there was a significant difference between the drying treatment and the type of bone used. Protein content ranged from 44.66±1.72% to 47.88±0.97%. Protein content obtained from research low may be

due to long of boiling time when pressure cooking was done so that protein denaturation.

**Degree of Whiteness of Chicken Bone Flour**

Degree of Whiteness determines the quality of flour. The higher the degree of whiteness it will be the white of the flour. From the results found a significant difference between the drying treatment and the type of bone used. The result of flour which has the highest degree of whiteness was kampong chicken bone flour with cabinet drying 49.47±0.52%, while broiler chicken bone was 42.65±0.34%. According to Sudarmadji *et al.* (2003), the degree of whiteness on the flour is influenced by the protein content contained in the raw material in the manufacture of the product. The degree of white is also affected by the color of brown bone marrow.
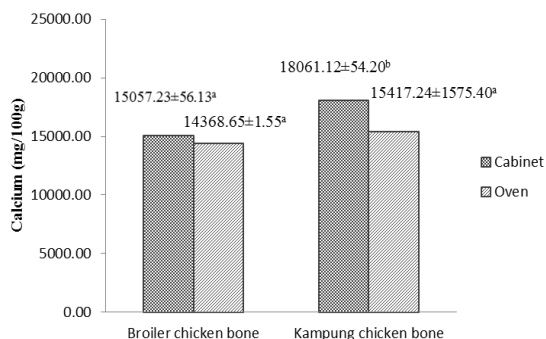
**Ash Content of Chicken Bone Flour**

Ash content indicated all of minerals (including calcium, magnesium, phosphate, and carbonate) contained in the substance and undergoes by the process of furnace, calculated as ash content. The higher of ash content obtained indicate the higher the calcium content contained in chicken bone flour. Based on the results of research conducted there was a significant difference between the drying treatment and the type of chicken bone used. The highest ash content obtained from kampung chicken bone flour with cabinet drying was 31.50±0.97% while broiler chicken bone was 27.05±2.16%.

**Carbohydrate Content of Chicken Bone Flour**

Carbohydrate content were calculated using the method "by difference". There was a significant difference in carbohydrate content between cabinet drying and oven drying. Cabinet drying had carbohydrate 3.14±1.44%, while carbohydrate content using oven drying had 4.27±2.81%. Low carbohydrate content obtained due to the higher of other content such as moisture, fat, protein and ash content.

**Calcium Content of Chicken Bone Flour**



Note: Different notations between diagrams show a significant difference (p <0.05)

Figure 1. Calcium content of chicken bone flour

Calcium content became the main parameter in the selection of the best chicken bone flour. Calcium obtained in ranged from 14368±1.55 mg/100 g to

18061.12±54.20 mg/100 g. The result can be seen in Figure 1. The highest calcium was obtained from kampong chicken bone flour using cabinet drying, while broiler chicken bone was 15057.23±56.13 mg/100 g. According to Winarsih *et al.* (2012), the main composition of chicken bones are salts, especially calcium carbonate and calcium phosphate which can be used as a source of minerals such as calcium and phosphorus.

**Calcium Content Analysis (AOAC, 2005)**

Ashing at 550°C was done for 6 hours then added with 10 ml of HCl 3 N and heated for 10 minutes at 80°C. Preparation of sample solution on the volumetric flask by filtering the sample solution, then rinsed with distilled water up to 200 ml. Preparation of standard curve solutions at concentrations of 0, 2, 4, 8, 12, 16, and 20 mg/liter. The intake of 5 ml of the sample solution and each was put into a 50 ml volumetric flask was added with 10 ml of lanthanum oxide ($La_2O_3$). Readings by Atomic Absorption Spectrefotometer (AAS). Calcium content was calculated using the formula:

**Calcium Content (%)** = Fp x ([(ppm sample-ppm blanko))/(sample weight x dry sample weight)x 1/1000000 x 100%.

**Main Research**

The main research was to use the best chicken bone flour from the preliminary research in the cookies making process. The best cookies are determined based on the organoleptic test. The best cookies then will be analyzed physico-chemically.

**Organoleptic Analysis (Scoring and Hedonic Test)**
**Color scoring test of cookies**

Color was an important parameter in product acceptance by panelists. The result of color scoring test on chicken bone cookies can be seen in Figure 2.
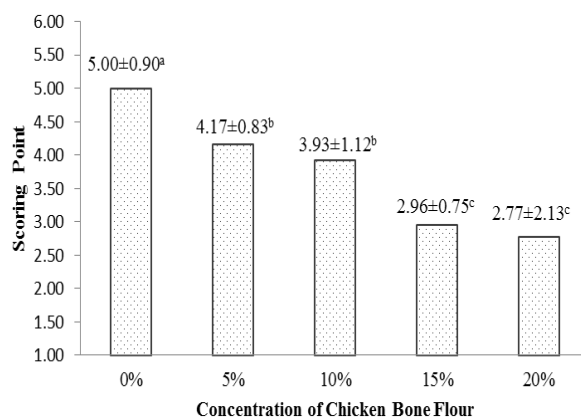


Note: Different notations between diagrams show a significant difference (p <0.05)
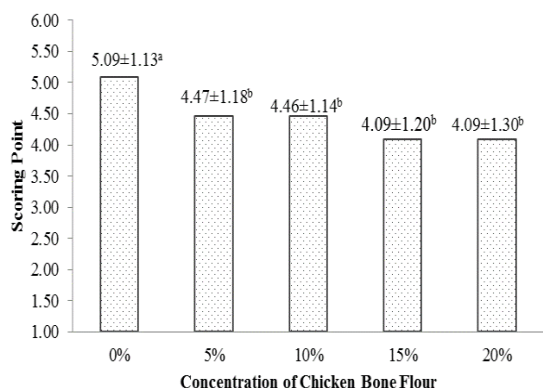
Figure 2. Cookies color scoring test

Based on the ANOVA in Figure 2, there was a significant difference (p<0.05) in cookies with addition chicken bone flour 0% and cookies with addition 20% of chicken bone flour. At 0% got

cookies with the brightest color. The higher substitution of chicken bone flour, the darker the color of the resulting cookies. This was influenced by the drying process which can cause Maillard reactions between reducing sugars and amino acids from proteins that produce brown melanoidin (Sudarmadji *et al.*, 2003).

**Aroma scoring test of cookies**

Foreign aroma was an unexpected fragrance in a food product. The results of the scoring test can be seen in Figure 3.
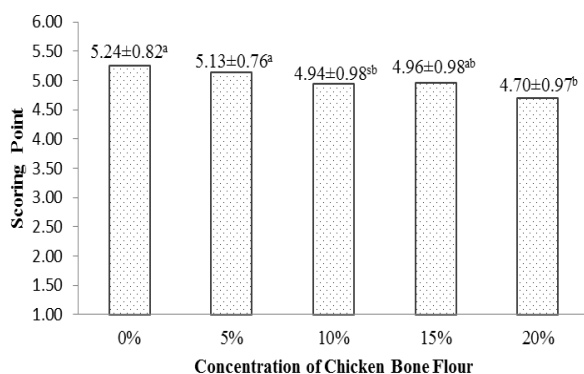


Note: Different notations between diagrams show a significant difference (p <0.05)

Figure 3. Cookies aroma scoring test

Based on the ANOVA in Figure 3, there was a significant difference (p<0.05) in cookies with addition chicken bone flour 0% and cookies with addition 5, 10, 15, and 20%. Cookies 0% have no foreign aroma, while cookies with addition 5, 10, 15, and 20% have unfavorable foreign aromas. According to Shahidi and Ho (2012), cookies have a distinctive aroma of sweet, sweet aroma is caused by mixing eggs with butter that produces a sweet scent on cookies.

**Texture scoring test of cookies**

Texture was also one of the important parameters in cookies product acceptance by panelists. The results of the texture scoring test could be seen in Figure 4.
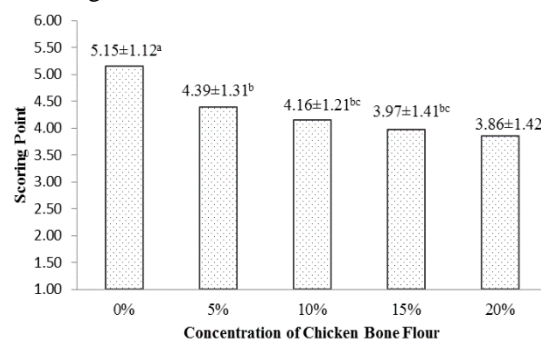


Note: Different notations between diagrams show a significant difference (p <0.05)

Figure 4. Cookies texture scoring test

Based on ANOVA in Figure 4, there was a significant difference (p<0.05) between cookies 5%, and cookies added with chicken bone flour 20%. Cookies with 0% had crunchy texture, whereas for cookies with 20% of chicken bone flour concentration had a less crunchy texture. According to Barclay and Sandall (2014), good cookies are cookies that have crunchy, light, and crumb textures.

**Taste scoring test of cookies**

Foreign flavor was an unexpected taste in a food product. The result of taste scoring test can be seen in Figure 5.
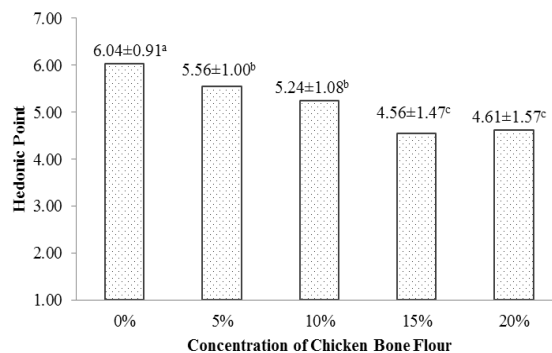


Note: Different notations between diagrams show a significant difference (p <0.05)

Figure 5. Cookies taste scoring test

Based on ANOVA in Figure 5, there was a significant difference (p<0.05) between cookies 5%, and cookies added with 20% chicken bone flour. Cookies with 0% addition had no foreign flavor, while cookies with 20% had a slightly foreign taste. The higher the substitution concentration of chicken bone flour used, the foreign taste will be tasted. According to Barclay and Sandall (2014), cookies generally have a sweet taste and "buttery".

**Color hedonic test of cookies**

The color hedonic test aims to know the panelist's preference for the color of cookies. The result of color hedonic test can be seen in Figure 6.



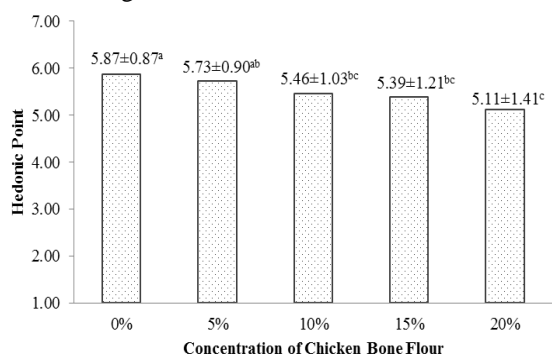Note: Different notations between diagrams show a significant difference (p <0.05)

Figure 6. Cookies color hedonic test

Based on ANOVA in Figure 6, there was a significant difference (p<0.05) between cookies 5%, and cookies added with chicken bone flour 20%. The

most preferred color cookies were cookies with 0% concentration. The higher the concentration of chicken bone flour used made the cookies darker.

## Aroma hedonic test of cookies

The hedonic aroma test aims to know the panelist's preference for the aroma of cookies. Foreign aroma in cookies may lower the panelist's preference for cookies. The results of the hedonic aroma test can be seen in Figure 7.
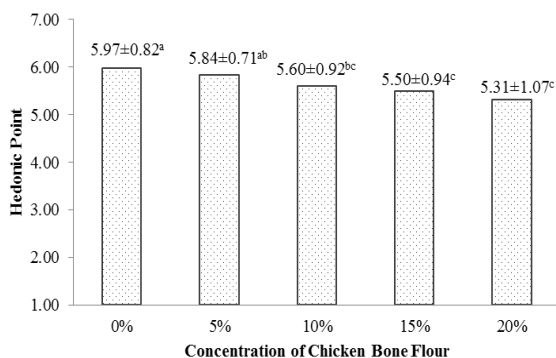
Note: Different notations between diagrams show a significant difference (p <0.05)

Figure 7. Cookies aroma hedonic test

Based on ANOVA analysis in Figure 7, there was a significant difference (p<0.05) between cookies 5%, and cookies added with chicken bone flour 20%. Based on data, the higher the concentration chicken bone flour, the panelists increasingly disliked the smell of cookies but still accepted by the panelists.

## Texture hedonic test of cookies

The texture hedonic test aims to know the panelist's preference for the texture of the cookies. Cookies typically have crunchy texture, hard-textured cookies can lower panelist preferences. The results of the texture hedonic test could be seen in Figure 8. Based on ANOVA, there was a significant difference (p<0.05) between cookies 5%, and cookies added with chicken bone flour 20%. The graph showed that the higher the addition of chicken bone flour, the panelist preferences will decrease, but still accepted by the panelists.
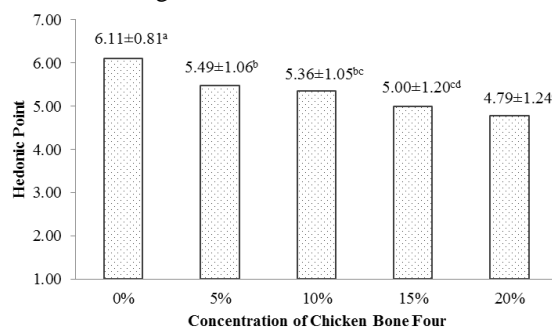
Note: Different notations between diagrams show a significant difference (p <0.05)

Figure 8. Cookies texture hedonic test

## Taste hedonic test of cookies

The taste hedonic test aims to know the panelist's preference for the taste of cookies. The results of the taste hedonic test can be seen in Figure 9. Based on ANOVA in Figure 9, there was a significant difference (p<0.05) between cookies 5%, and cookies added with chicken bone flour 20%. Cookies with 0% had no foreign taste, while cookies with 20% substitution chicken bone flour had a noticeable foreign taste.
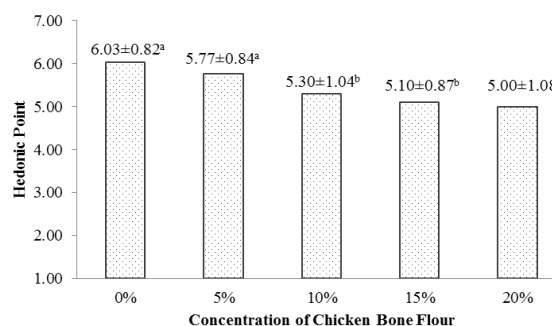
Note: Different notations between diagrams show a significant difference (p <0.05)

Figure 9. Cookies taste hedonic test

The lower the added concentration of chicken bone flour, the higher cookies preferred by panelists. According to Noble (2006), teste is a component of flavor that can increase consumer acceptance of a product cookies.

## Overall hedonic test of cookies

The overall hedonic test aims to know the panelist's preference for the overall cookies. The overall hedonic test results can be seen in Figure 10.

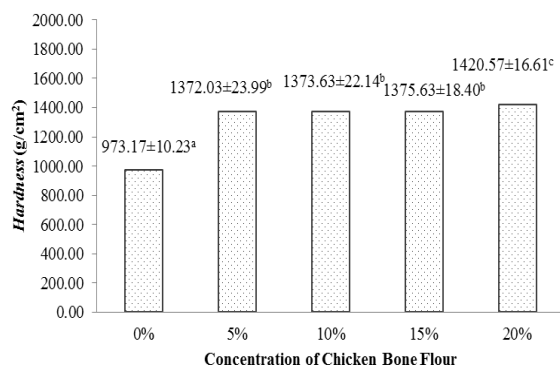Note: Different notations between diagrams show a significant difference (p <0.05)

Figure 10. Cookies overall hedonic test

The overall hedonic test was the overall acceptability of the panelists against the cookies being made. Based on ANOVA in Figure 10, there was a significant differences (p<0.05) in cookies with addition chicken bone flour 0% and 5% cookies with addition 10, 15, and 20%.

The most accepted cookies were cookies with 5% addition, because it had no foreign taste and aroma, and it also had crunchy texture and bright color.

**Instrumentation Analysis of Cookies Texture**

Texture measurement on cookies was done using the Texture Analyzer. Texture measurement on cookies aim to find out how hard cookies was. The texture results on cookies can be seen in Figure 11.
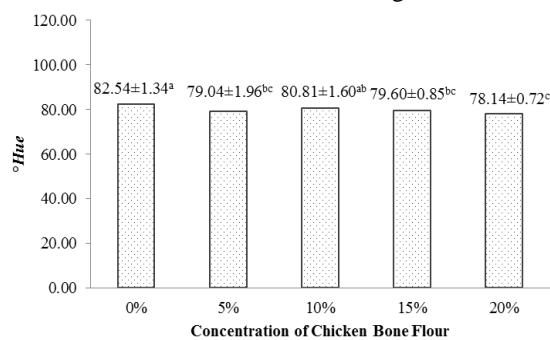


Note: Different notations between diagrams show a significant difference (p <0.05)

Figure 11. Cookies tesxture analysis

Based on the ANOVA in Figure 11, there was a significant difference (p<0.05 %) between the control cookies and all cookies added with chicken bone flour. The higher the concentration of chicken bone flour used causes the texture of cookies to become harder.

**Color**

Color analysis on cookies was done using Chromameter. The color parameter tested was °Hue. The result of °Hue could be seen in Figure 12.



Note: Different notations between diagrams show a significant difference (p <0.05)

Figure 12. Cookies color analysis

Based on the ANOVA in Figure 12, there was a significant difference (p<0.05%) between the cookies with 0% and 20% chicken bone flour. The graph result showed the highest °Hue found on cookies with 0% was 82.54±1.34. Cookies with the lowest added of chicken bone flour had a lighter color compared to cookies with higher added.

**Comparison of Control Cookies with Best Formula Cookies**

Cookies with the best formulation were determined by texture and organoleptic test, i.e scoring test and hedonic test. Based on the results of the scoring test, hedonic test and texture test were selected cookies with the most close to cookies control, i.e cookies with the substitution of 5% concentration chicken bone flour. Cookies with the best formulation chosen was cookies which was added by 5% of chicken bone flour, and then were analyzed proximate and compared with cookies control.

Table 2. The proximate analysis result of cookies with the best formulation and control cookies

| Analysis | Cookies added 5 % of chicken bone flour | Control cookies 100 % wheat flour | SNI 01-2973 |
|---|---|---|---|
| Moisture,% | 4.46±0.11 | 4.29±0.15 | Max 5 |
| Fat,% | 27.82±0.45 | 26.58±0.80 | Min 9.5 |
| Protein,% | 9.71±0.26 | 8.12±0.06 | Min 9 |
| Ash,% | 2.34±0.09 | 1.20±0.02 | Max 1.5 |
| Carbohydrate,% | 55.82±0.85 | 59.80±0.72 | Min 70% |
| Calcium, mg/100g | 464.03±8.83 | 38.56±0.13 | --- |

The results of this proximate analysis were compared with SNI 01-2973 for cookies. Moisture, fat and protein of the best formulas cookies and control cookies were still in the range, except ash and carbohydrate. The ash content was higher than the SNI, this was due to the high ash content that came from minerals of chicken bone flour. Protein content of best formulation cookies was higher than the control cookies. This was because of the high protein of chicken bone flour which was 46.89±0.91%, so produced cookies with higher protein content compared with control cookies. The fat content for the best formulation cookies was also higher than the control cookies, because of the fat from chicken bone flour was used, which is 13.79±0.28%. The ash of best formulation cookies was also higher compared to the control cookies. Carbohydrate of the best formulation cookies were lower than those of control cookies. This was due to the high content of other cookies, including the content of protein, fat, and ash that cause the lower carbohydrate (by difference calculation).

Cookies with the best formulations had higher content of calcium compared with control cookies, 464±8.83 mg/100 g and 38.56±0.13 mg/100 g for control cookies. This high content of calcium came from the addition of 5% chicken bone flour. Calcium content of chicken bone flour used was 18061.12±54.20 mg/100 g.

Based on the serving quantity of cookies 30 g, best formula cookies (with 5% of chicken bone flour) meet 13.9% of RDA calcium per day. If presented in 100 g, those best formula cookies meet 46.29% of calcium AKG per day. Based on the results obtained, cookies with 5% concentration of chicken bone flour can be labeled as cookies products that had high calcium.

**CONCLUSION**

The best chicken bone flour was chicken bone flour which had the highest calcium content and also

had the lowest fat content. The best flour was made from kampong chicken bone and used cabinet dryer for the drying process. Physico-chemical characteristic of those best chicken bone flour had 34.63% yield, 4.92% moisture content, 46.89% protein, 13.79% fat, 31.50% ash, 2.90% carbohydrate content, density 0.60 g/ml, water absorption 138.57%, degree of whiteness 49.47%, and calcium content 18061.12 mg/100 g. The more % of chicken bone flour concentration added, the color of cookies will be darker, more foreign smell and taste, had a less crunchy texture. The most preferred cookies were cookies with addition of 5% chicken bone flour. Based on the results obtained, cookies with 5% chicken bone flour (best formulation process) could be labeled as products that had high calcium because it meets 46.29% of RDA calcium per day.

## REFERENCES

Association of Official Analytical Chemists (AOAC), (2005), *Official Method of Analysis*, Association of Official Analytical Chemists Inc., Gaithersburg.

Badan Pusat Statistik, (2015), Konsumsi Rata-Rata per Kapita Beberapa Macam Bahan Makanan Penting, 2007-2014. Available from: *https://www.bps.go.id/linkTabelStatis/view/id/950*.

Badan Standarisasi Nasional, (1992), *SNI 01-2973-1992. Cookies*, BSN, Jakarta.

Barclay, A. and Sandall, P., (2014), *The Ultimate Guide to Sugars and Sweeteners: Discover the Taste, Use, Nutrition, Science, and Lore of Everything from Agave Nectar to Xylitol*. New York. The Experiment.

Kotecki, J.E., (2011), *Physical Activity & Health: An Interactive Approach*, Sudbury, MA: Jones and Bartlett.

Latief, F., (2006), Karakteristik Sifat Fisik Tepung Tulang Ikan Serta Tepung Daging dan Tulang, *Skripsi*, Institut Pertanian Bogor, Bogor.

Noble, A., (2006). Taste – Aroma Interactions. Journal *Trends in Food Science & Technology,* 7, pp. 439-444.

Priyono, P., (2008), Penambahan Tepung Tulang Ikan Cakalang (Katsuwonus pelamis) Dalam Pembuatan Cookies Tinggi Kalsium, *Skripsi*, Universitas Pelita Harapan, Karawaci.

Rosalin, E., (2006), Peningkatan Nilai Gizi Cookies dengan Pemanfaatan Daging Tulang Leher Ayam Pedaging dan Brokoli (Brassica olaracea L. var italicia Plenck) Giling, *Skripsi*, Institut Pertanian Bogor, Bogor

Shahidi, F. and Ho, T., (2012), *Flavor Chemistry of Ethnic Foods*. Springer.

Subagjo, A., (2007), *Manajemen Pengolahan Roti dan Kue*, Graha Ilmu, Yogyakarta.

Sudarmadji, S., Haryono, B., dan Suhardi. (2003), *Analisa Bahan Makanan dan Pertanian*, Liberty, Yogyakarta.

Winarsih, W., Rusmana, D., dan Wradimadja, R., (2012), Pengaruh Perendaman Limbah Tulang Ayam Menggunakan NaOH terhadap Tingkat Dekolagenasi, Kandungan Kalsium dan Fosfor, *Skripsi*, Fakultas Peternakan Universitas Padjadjaran.