Characteristics of Cookies Formulated with Fish Protein Concentrate Powder Produced from Snakehead Fish (*Channa striata*) Extraction By-Product

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Abstract. Snakehead fish (*Channa striata*) is known as a species which is consumed by local people as functional food due to its benefits in the post operation recovery process. The extraction of snakehead fish for functional food produces solid by-product that can be utilized into Fish Protein Concentrate (FPC) powder. The FPC powder can be applied into various food products, including cookies. Study aimed to investigate the characteristics of cookies formulated with FPC powder resulted from Snakehead by-product. Study showed that addition of 5 and 10% FPC powder into cookies formulation increased fat and protein contents, improves texture as well as appearance of cookies. FPC powder with concentration of 10% resulted in cookies with higher protein content (11,41%), texture and appearance. However, further study is suggested to eliminate the fishy odor and taste produced by FPC.

1 Introduction

Snakehead fish is one of freshwater fish endemically found in almost all Indonesian waters. The fish is known to have benefits as a functional food that helps in boosting the recovery process during post medical operation. This is because Snakehead fish contains albumin and several minerals such as Fe, Cu and Zn, which play roles in human body metabolisms process [1]. Study showed that the fish possess 25.5% of protein, 1.7% of fat, as well as 0.9 mg of zinc, 62 mg calcium, 176 mg of phosphor and 150 mg of vitamin A per 100 g fish flesh, The utilization of snakehead fish is generally in the form of crude extract resulted from extraction process which is conducted at temperature of 85 °C for 30 minutes using water evaporation and filter press principal [2, 10]. The extraction process produces about 68% by-product as a waste [2]. Meanwhile, this by-product is known to have high protein content, and therefore, is potentially utilized as Fish Protein Concentrate (FPC).

Fish Protein Concentrate is produced from solid residue of snakehead fish. It is known to contain high protein content due to the process of fat and unwanted materials removal. Previous study showed that the yield of FPC produced from snakehead fish extraction by-product was ranging from 20.9 to 23.6% which contains 88.65-92.63% of protein and 0.98-1.61% of fat [5]. In food industry, application of FPC into food products is aimed to increase

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nutritional function as well as to improve the food product characteristics due to its functional properties. Protein functional properties are defined as the physico-chemical characteristics and changing formula in the food system during preparation, processing, storage and consumption [3]. Study on the addition of 10% FPC from catfish to crackers formulation showed that the crackers had higher appearance and crispiness compared to commercial crackers, while 10% catfish FPC also produced cookies with insignificant different with control in term of color, aroma, taste, crispiness and hardness [6]. Other study has attempted to fortify FPC Siam Patin on amplang snack and mi sago instant product as traditional foods in Riau, Indonesia [8]. However, study on the application of FPC produced from snakehead fish by-product into food formulation is still limited.

Cookie is one of snack product that is consumed widely by all ages. Cookie is one type of biscuits that has a high fat content as well as a crisp and dense texture. It has long shelf life and has practical shape that makes it easier to bring with, Food industry recently has developed various cookie products that offers high nutrition contents and provides essential ingredients, especially for specific consumers, such as toddler and kids. As an important substance for body and brain development in young people, it becomes one of area of interest for food manufactures to increase protein content in their products. Addition of FPC produced from snakehead fish by-product into cookie formulation can be potential alternative for food industry application since it utilizes natural resources, contains high protein content as well as help to reduce pollution caused by fish waste. The study aimed to investigate the characteristics of cookies formulated with FPC powder resulted from Snakehead by-product.

2 Materials and methods

2.1 Processing of cookies

Fish Protein Concentrate (FPC) used in the study produced from the extraction of Snakehead fish (*Channa striata*) which obtained commercially from Kabupaten Merauke traditional market. Other materials used for cookies making were 62,5g oats and 47,5g wheat flour. In addition, 27% of molase, 36% of honey, 18% of margarine, 9% of butter, 9% of water, 9% of vegetable oil, 5% of corn flour, 2% of baking soda and baking powder, 1% of ginger powder, and 0,45% of cinnamon powder. As a treatment, as much as 0%, 5%, and 10% of Snakehead FPC were used in the experiment.

All ingredients were weighed according to the percentage used. The oats was grinded until forms a powder, then mixed with wheat flour, corn flour, baking soda, baking powder, ginger powder, and cinnamons. The mixture was then added with Snakehead fish protein concentrate with concentration of 0%, 5%, and 10% [6]. Meanwhile, molase, honey, margarine, butter, water, and vegetable oil were mixed and stirred under low heat (50ºC) until a homogenous solution was formed. The mixture of powder that has been prepared was then added into the solution and stirred until the solution was thickened and formed dough. The dough was cooled down and stored in the fridge for 30 minutes. After 30 minutes, the dough was printed using a mold and baked at 180ºC for 20 minutes. The cookies were then analyzed for its proximate values, texture and organoleptic profiles.

2.2 Proximate analyses

The proximate analyses were conducted for moisture, ash, protein and fat contents [4]. Moisture content was conducted by drying the dish at 105 ºC for 2 hours and cooled in desiccator for 30 minutes. The dish was then weighed until reach the constant weight. 2 grams of samples were placed inside the dish, dried in the oven at 105 ºC for 18 hours, and cooled in desiccator for 30 minutes and weighed.

$$\text{Moisture content (\%)} = \frac{(B-C)}{(B-A)}\ x\ 100\% \quad (1)$$

Note:
A : The initial weight of empty dish
(g) B : The weight of dish and
sample (g)
C : The weight of dish and sample after dried (g)

The dish was then put in the furnace and burned at 550ºC for 8 hours and weighed after to get ash content.

$$\text{Ash content (\%)} = \frac{(B-A)}{\text{initial weight of dish with sample}}\ x\ 100\% \quad (2)$$

Note:
A: The initial weight of empty dish (g)
B: The weight of dish and sample after burned (g)

Fat content was measured by weighing 2 g of samples and extracted with 150 mL chloroform in the soxhlet fat extractor at 60ºC for 8 hours. The mixture of fat and chloroform was evaporated in the flask and dried in the oven at 105ºC for ± 2 hours to remove the residual chloroform and water vapor. The flask was then cooled in the desiccator for 30 minutes and weighed until reached the constant weight.

$$\text{Fat content (\%)} = \frac{(C-A)}{B}\ x\ 100\% \quad (3)$$

Note:
A: The initial weight of empty flask (g)
B: The weight of sample (g)
C: The weight of flask contained fat after extraction (g)

Protein content was measured by weighing 2 g of samples, placed inside the destruction flask, added with 2 pieces of boiling rock, 15 mL concentrated H_2SO_4 (95% - 97%), 3 mL H_2O_2, destructed at 410ºC for ± 2 hours until the solution clearer, and cooled at room temperature. 25 mL H_3BO_3 4% solution was prepared, the flask contained the solution resulted from destruction was mounted on a steam distillation apparatus. 50 – 70 mL Natrium hydroxide – thiosulfate ($Na_2S_2O_3$) solution was added and distillation process was run until 150 mL distillate was obtained in the Erlenmeyer flask. The distillate was then titrated with HCl 0,2 N until the color of the solution was changed from green to natural grey. The protein content was stated in g/100 g unit sample (%).

$$\text{Protein content} = \frac{(Va - Vb)HCl \times N\ HCl \times 14.007 \times 6.25}{W} \times 100\%$$

Note:
Va : mL HCl for sample titration (ml)
Vb : mL HCl for blank titration (ml)
N : Normality of HCl standard being used
4,007 : Weight of nitrogen atom
6,25 : Protein conversion factor for
fish W : Weight of sample (g)

2.3 Texture profile analysis

The texture profiles analysis was conducted by using TAXT- Plus Texture Analyzer Stable Micro System.

2.4 Organoleptic profile analysis

The cookies were evaluated for their sensory attributes using scoring and hedonic tests conducted by 15 semi well-trained panelists. The attributes measured for scoring test were appearance, odor, taste and texture (BSN, 2009). The scoring test was described with 1 to 9 scales, 1 represents the lowest features and 9 represents the highest features. The lower scores mainly indicated that there was a quality decrease and score 1 is associated with the border line of each attribute.

2.5 Data analysis

The study was using Completely Randomized Design of experiment with one variable, namely concentration of fish protein concentrate. Three replicates were run for proximate and texture analyses, while in organoleptic test, replication is represented by number of panelist. The obtained data were then statistically analyzed using ANOVA (One-way Analysis of Variance) at 5% level of significance ($p<0.05$) and continued with Tukey's test when a significant different was identified between samples.

3 Results and discussion

3.1 Proximate value

The results of proximate values cookies enriched with Snakehead fish protein concentrate were presented in Figure 1. Cookies with addition of 5 and 10% FPC showed significantly higher values in moisture, fat and protein content compared to control without FPC ($P>0.05$). The moisture content of cookies enriched with 10% and 5% of FPC were 5,1 and 5,6%, respectively, while in control was only 3.8%. The moisture content of commercial biscuit was reported 3.19% [6] which is not different with the moisture value of biscuit control in this experiment. The moisture content of biscuit enriched with FPC was higher due to FPC has ability to retain water, determined by WHC (water holding capacity), thus increasing the moisture content of the products.), Previous study showed that water holding capacity values of snakehead fish protein concentrate are from 5.3 to 6.9% depending on the pH used for its extraction [6]. The higher moisture content of the biscuit enriched with FPC causes the biscuit has less crisp texture compared to control. However, the biscuit resulted in the experiment

meets the biscuit standard (SNI 01-2973-1992), which stated that moisture content of biscuit should be maximum of 5% [7].

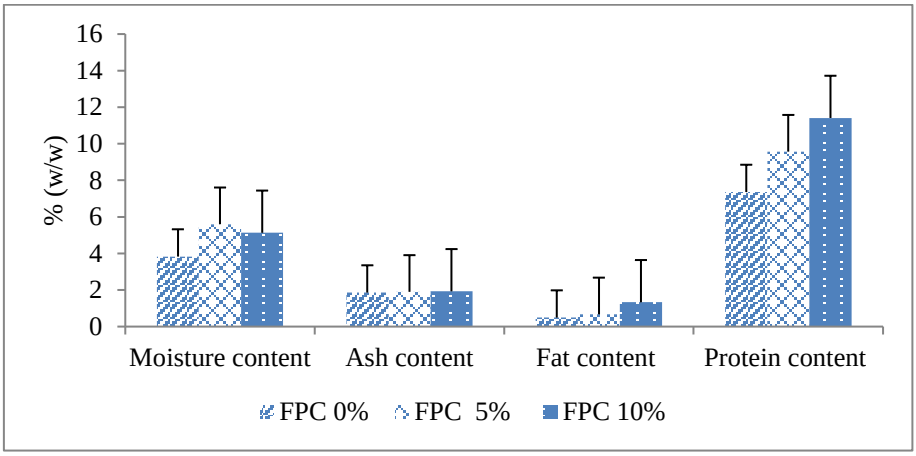

Fig. 1. Proximate values of cookies formulated with Snakehead FPC and control.

Similarly, cookies enriched with both 5 and 10% of FPC showed higher fat content rather than control. Cookies with addition of FPC 5 and 10% contained 0.67 and 1.33% of fat, respectively. Meanwhile, the fat content of cookies control was 0.49%. This is probably due to the ability of FPC to absorb fat, although its value is quite low. FPC obtained from Snakehead fish has fat absorption capacity of 1% [5]. Fortification of FPC with higher concentration resulted cookies with higher fat content. Comparing to standard of biscuit (SNI 01-2973-1992) [7], which stated that fat content of biscuit should be maximum 9%, the fat content of biscuit in the experiment was considered low.

A significant increase was shown by protein content of cookies formulated with FPC ($P>0.05$). Addition higher concentration of FPC produced cookies with higher protein concentration compared to control. Cookies formulated with 5 and 10% FPC had 9.57 and 11.4% protein content, respectively, while cookies without FPC was only 7.36%. According to standard of biscuit (SNI 01-2973-1992), the protein content of biscuit should be minimum 9% [7]. Addition of FPC has improve protein contained in the biscuit, thus fulfilling those criteria.

3.2 Texture profiles

Texture profile of the cookies in various concentration of FPC is represented in Figure 2. Cookies control without addition of FPC showed highest force to break the texture, means that the cookies possessed hard texture. Hardness value of cookies control without addition of FPC was 2286 Nmm^2. Addition of FPC, as shown in Figure 2, significantly decreases the hardness of the cookies ($P>0.05$), produces softer texture. Addition of 5% FPC into cookies formulation decreased hardness of cookies, reaching to 985 Nmm^2. Cookies formulated with 10% of FPC had the lowest hardness with 878 Nmm^2, indicating that higher concentration of FPC improves the texture of cookies. This is associated with the ability of FPC to retain water, enabling the cookies possess softer texture. Water holding capacity (WHC) of FPC from snakehead fish are 5.3 to 6.9%, influences the water content and texture of the cookies [5]. Previous study using 10-25% FPC of catfish in cookies formulation showed similar result, where10% FPC produced the lowest hardness value. However, the study also showed that higher concentration of FPC added into formulation (15 and 25%) produced cookies with higher hardness value [6].This

indicates that FPC can improve the texture of the cookies when it is added in concentration of less than 10%.

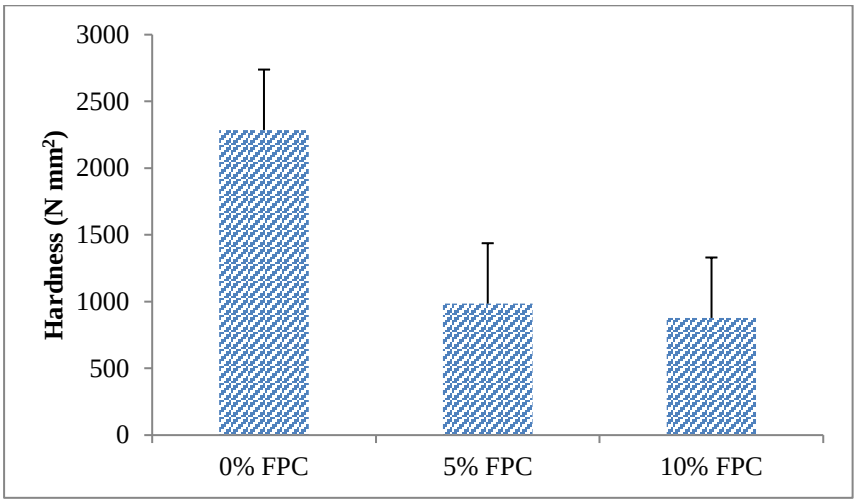

Fig. 2. Texture profile of cookies formulated with FPC and control.

3.3 Organoleptic profiles

Results of hedonic test of cookies formulated with FPC for four attributes, namely appearance, texture, taste and odor, are presented in Figure 3. The scores of cookies formulated with FPC are slightly higher for attributes of appearance and texture, but lower for attributes of taste and odor. However, the values are statistically not different ($P<0.05$), Panelist assessed that the cookies formulated with 5 and 10% FPC showed a better appearance compared to control, because of homogenous shape and smooth surface. This result is higher compared to other study conducted on carp and shark FPC fortification into biscuit which were accepted by panelist with concentration up to 3% [9].

In term of texture, addition of FPC into cookies formulation also produced cookies with more crispy but soft texture inside the mouth. The result is in accordance with profile texture results of cookies, where addition of 5 and 10% of FPC into cookies formulation lowering the hardness of the cookies (Figure 2). Previous study on the formulation FPC catfish into biscuit showed similar result, where at concentration 10% FPC, cookies possessed crispiness close to control [6]. However, study reported that addition of higher concentration of FPC (up to 25%) into cookies formulation produced higher hardness values [6].

For attributes of taste and odor, cookies formulated with FPC were still lower compared to control. Addition of FPC powder into cookies was identified to produce fishy odor and had a slightly bitter after taste according to panelist. Similar result was also reported by other study, which stated that addition of fishery-derived ingredient into food products affects negatively on the sensory characteristics of the product, especially for attribute of flavor and odor, if it used at inappropriate concentration [11, 12, 13].

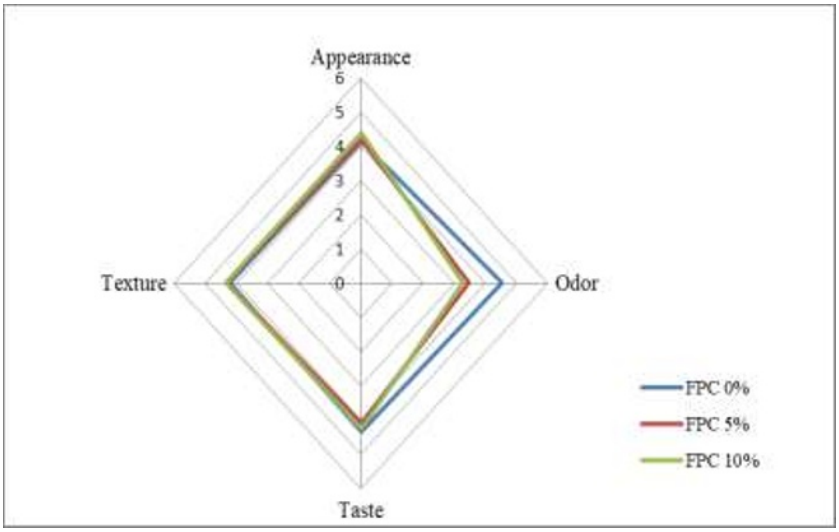

Fig. 3. Hedonic score for four attributes of cookies formulated with FPC and control.

For overall hedonic, panelist mostly still preferred cookies without addition of FPC (Figure 4). This is likely because the odor and after taste produced by FPC affected the sensory attributes of cookies. However, addition of FPC into cookies formulation has proved to improve texture and appearance of the cookies. Further research on methods for eliminating fishy odor and unpleasant taste were needed to improve cookies properties, so that it will be well-accepted by panelist.

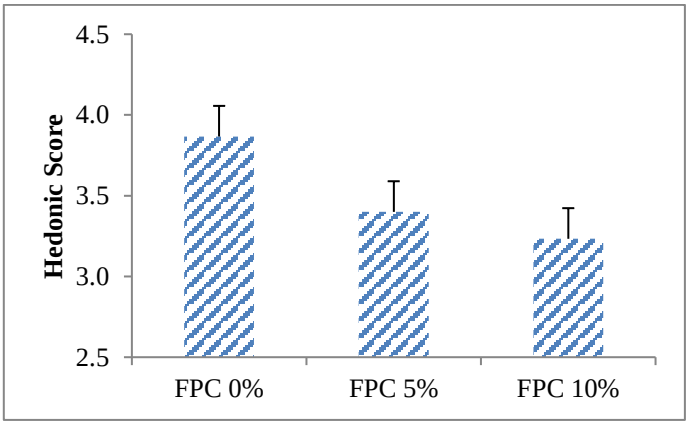

Fig. 4. Overall hedonic score of cookies formulated with FPC and control.

3 Conclusions

Snakehead fish protein concentrate is potential to be used in cookies formulation. Addition 5 and 10% of fish powder into cookies formulation increased protein, fat and moisture contents. Addition of FPC into cookies formulation also resulted in better appearance and crispy but soft texture of cookies. However, Further research to eliminate fishy odor and unpleasant taste were needed to improve cookies properties, so that it will be well-accepted by panelist

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