ISSN: 2347-467X, Vol. 07, No. (2) 2019, Pg. 584-591

Current Research in Nutrition and Food Science

www.foodandnutritionjournal.org

Effect of Knife-Fish Bone Powder Addition on Characteristics of Starch and Seaweed Kerupuk as Calcium and Crude Fiber Sources

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Abstract

Knife-fish bone is waste processing of kerupuk and amplang that have not been utilized optimally and potentially cause environmental pollution. Processing into a fish bone powder is one way to reduce environmental pollution and provide added value. It can be used as a fortification source of calcium in food products. Seaweed species are widely used in food processing as crude fiber and iodine sources. Therefore, it is necessary to do the processing of kerupuk with fortification of knife fish bone powder and seaweed as calcium and crude fiber sources. The objective of this research was to determine the effect of adding knife fish bone powder on characteristics of starch and seaweed kerupuk. The treatment in this study was the percentage of addition of knife fish bone powder: 0%, 5%, 10.15%, 20%. Calcium and crude fiber of both starch and seaweed kerupuk values varied significantly ($p<0.05$). Proximate values varied significantly ($p<0.05$) of both starch and seaweed kerupuk, except for protein and fat content. Phosphorous and whiteness level values significantly ($p<0.05$) for both starch and seaweed kerupuk.

Article History

Received: 27 September 2019
Accepted:16 May 2019

Keywords

Bone Powder;
Kerupuk;
Knife-Fish;
Seaweed.

Introduction

Knife-fish (*Chitala* sp) bone is a by product processing of kerupuk and amplang produced by small scale processors in Samarinda, East Kalimantan. Around, 16 tons of byproducts were produced every year (Statistic of Samarinda City, 2011). They consist of bones, gut and scales. Until now, fish bone has not been utilized optimally, only discarded and potentially caused environmental pollution. Processing into a fish bone powder is one

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Doi: http://dx.doi.org/10.12944/CRNFSJ.7.2.27

way to reduce environmental pollution and provide added value. It can be used as a fortification source of calcium in food products. The processing of knife fish bone powder done by Putranto et al (2015) and Kusumaningrum *et.al.,* (2016) produces calcium around 30% and 31.31% respectively. Calcium is one of the macro minerals that is needed by the body health. Calcium deficiency in children can lead to growth disorder and rickets, whereas calcium deficiency in adults can lead to osteoporosis (Almatsier, 2004).

Kappaphycus is one of seaweed widely cultivated in coastal East Kalimantan Indonesia. Its utilization is still limited to the processing of traditional products (dodol, pudding and candy). According to Astawan (2004), the utilization of seaweed can be maximized by diversification of seaweed processed products, which is one of the effort increase the efficiency and economic value. Seaweed has a high nutrient content, especially vitamins, minerals and fiber ((Lubis *et al.,* 2013). A diet high in dietary fiber can decrease serum cholesterol concentration of hyper-cholesterolemic patient, decrease insulin requirement of diabetics, decrease serum triglyceride concentration of hyper-triglyceridemia patient, have a treatment effect of obesity, decrease risk of atherosclerosis and cancer (Astawan *et al.,* 2003). Dietary fibers promote positive physiological effects to human health such as blood cholesterol reduction and blood glucose reduction. Soluble fiber is known for its blood cholesterol lowering effect and insoluble fiber is known to reduce the risk of digestion-related diseases such as colon cancer (Rohani *et.al.,* 2010).

Kerupuk is very popular in Indonesia and is a light meal as a complement to the main menu and as a snack. Kerupuk is favored by Indonesia people, both adults and children. It is a popular snack in part of East and Southeast Asia (Khan and Nowsad, 2012). Snack foods are usually high in calories but low in protein, vitamins, and other micronutrients (Akonor *et.al.,* 2017). The kerupuk product has different names depending on the country producing kerupuk. They are known as Keropok in Malaysia, kerupuk in Indonesia, Kaew Krab pla in Thailand, banch phong tom in Vietnam (Nurul *et.al.,* 2009; Tawee, 2011; Zulkarnain *et.al.,* 2014). Various types can be found on the market with various raw material such as tapioca, starch, rice and skin (cow and fish). Considering on the ingredients, processing of kerupuk, there are two types of kerupuk: kerupuk added protein sources (fish, shrimps) and without or less protein. Starch flour is one of the essential ingredients for making fish crackers (Huda *et al.,* 2009).

The application of fish bone powder in the food processing as a calcium source and the phosphorus has been done a lot (Kaya *et.al.,* 2008; Sari *et.al.,* 2013; Apriliani 2010; Jiancong *et.al.,* 2010; Pratama *et.al.,* 2014). In the present, diversification of seaweed products is widely used as a fortification and substitution for food processing as it was done by Pakaya, *et al.,* (2014), Sirat and Sukesi (2012), Di Amora and Sukesi (2013). Development of new products from new sources becomes imperative to capture the flavor of different people with different food habits (Herdina, 2015). Light and crunchy food rich in nutrition and healthy for the body is desired by consumers (Rohani *et.al.,* 2005). Furthermore, the nutritional content of kerupuk can be enhanced by the addition of certain ingredients to increase nutritional value, flavor, improving texture and appearance (Kusumaningrum and Asikin, 2016). Based on the above, it is necessary to formulate and develop calcium and crude fiber enriched starch and seaweed kerupuk from utilizing belida fish waste and increased of seaweed utilization as crude fiber source. Therefore, the objective of this research was to determine the effect of adding Belida fish bone powder on characteristics of starch and seaweed kerupuk.

Materials and Methods

Raw Materials

Knife-fish bone were obtained from home industry of kerupuk and amplang processing in Samarinda East Kalimantan. Fishbone was taken to laboratory by carrying in coolbox, and then washed to remove other components and stored in the freezer (-20 ^{o}C) prior to processing. Starch flour and dried seaweed were obtained from the local supermarket while other seasoning were purchased from traditional market. The starch and seaweed kerupuk were produced in three steps: 1) processing of belida fish bone powder, 2) processing of seaweed paste and 3) processing of starch and seaweed kerupuk by using prepared belida fish bone powder and seaweed paste.

Processing of Knife-Fish Bone Powder

Knife-fish bone powder was made according to method of Kusumaningrum *et al.,* (2016) and Trilaksani *et al.,* (2006). First, Frozen fish bone was thawed at running potable water and washed. Then, fish bone was cooked by pressure cooking during 3 hours. After pressure cooking, fish bone was boiled at 100 ^{o}C for about 30 minutes and done 4 repetitions of boiling. The boiling repition aims to optimize for removing soluble protein of the fishbone. After that, fish bone was cut into pieces and extracted in NaOH solution 1.5 N on 60 ^{o}C for 2 hours. Alkaline solution would be more effective to solubilize and leach out more meat tissue and proteins from fish bone (Hemung 2013). After alkaline extraction, fish bone was separated with a filter cloth then washed with tap water until neutral bone (pH approximately 7.0). Fish bone was dried at 65 ^{o}C in an oven for 48 hours. Dried bone solid was milled using blender until became powder. Then the fish bone powder was used for the next stage of the experiment.

Processing of Seaweed Paste

Dried seaweed was washed to remove the salt and sand using tap water. Then the seaweed was soaked in water for about 12 hours. The soaking ratio of dried seaweed and water was 1:15. The soaking aims to expand and turns soft the dried seaweed (Siah *et al.,* 2014). After the soaking, the seaweed was drained and ground using blender. The ratio of soaked seaweed and water ratio to grinding was 1:2. Than the seaweed was blended become seaweed paste.

Processing of Starch and Seaweed Kerupuk

Seaweed kerupuk was prepared: a dough-like mixture was produced by mixing belida fish bone powder (0 g, 5 g, 10 g, 15 g, 20 g) to starch flour (100 g) and then seaweed paste (15 g), salt (3.0 g), sugar (1.5 g), garlic (1.0 g) and baking powder (0.5 g) and water (20 ml) were incorporated into the mixture (Table 1). The ingredient used as formulation in processing starch and seaweed kerupuk have been given in Table 1. The dough-like mixture was then stuffed into plastic casings with a diameter of 3 cm, a length of 15 cm and both ends were tied. Then steamed at 100 ^{o}C for 1.5 hours. Then it was cooled in refrigerator at 5-7 ^{o}C for 24 hours. After that they were sliced into around 2 mm thick slices and then dried under sunlight for 3 days (30-40 ^{o}C).

Result and Discussion

The addition of knife fish bone powder has effected on characteristic of both starch and seaweed kerupuk.

Table 1: Ingredients used in Processing Starch and Seaweed Kerupuk

Kinds of kerupuk	Ingredients	Amount (g)
Starch kerupuk	Starch flour	15
	Salt	3.0
	Sugar	1.5
	Garlic	1.0
	Baking Powder	0.5
	Knife fish bone powder	0, 5, 10, 15, 20
Seaweed kerupuk	Starch flour	100
	Seaweed pasta	15
	Salt	3.0
	Sugar	1.5
	Garlic	1.0
	Baking Powder	0.5
	Knife fish bone powder	0, 5, 10, 15, 20

The effect of knife fish bone powder addition of starch and seaweed kerupuk is shown in Figure 1. The calcium content of starch kerupuk and seaweed kerupuk varied between 2.81-6.57% and 3.49 – 6,86%, respectively The addition of knife fish bone powder was increased calcium content of starch and seaweed kerupuk ($p<0.05$). The highest content of calcium was found in 20% of knife fish bone powder added and the lowest calcium content was found at 0% (control) of knife fish bone powder added. A similar observation was reported by Mustofa and Suyanto (2011), the higher of the addition of shell crab powder, resulted the highest levels of calcium crackers produced. Kaya *et al.,* (2008), reported that the higher of substitution of catfish bone powder, resulted higher levels of calcium in biscuits. The calcium content of the present study was still higher (6.86%) with the addition of belida fish bone powder only 20% compared the results by Tababaka (2004), that reported the substitution of catfish bone powder 30% on crackers produce calcium levels 5.36%.

The crude fiber content of both starch and seaweed kerupuk fortification of knife fish bone powder ranged from 1.06-2.05% and 2.46 to 5.56% respectively, shown in figure 2. The addition of knife fish bone powder percentage was effected on crude fiber of both kerupuk produced ($p<0.05$). The lowest crude fiber content was found at 0% (control) at both starch and seaweed kerupuk, whereas the highest crude fiber content was found at 5% on starch kerupuk and 15% on seaweed kerupuk. High crude fiber in seaweed kerupuk was due to added of seaweed as the main ingredient other than starch flour. Seaweed consists mainly of fiber and is known as dietary fiber (Anggadiredja, 2006). Astawan *et al.,* (2004) explained that seaweed contains fiber of 78.94%. The fibers used in fishery products are mainly in the form of soluble fibers from seaweed and tubers added for their functional properties such as high water holding capacity, thickening or gel forming properties, but not to dietary fiber in those products (Borderias *et al.,* 2005).

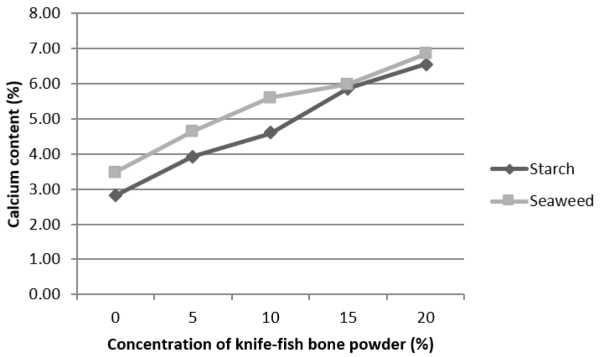

Fig. 1: Calcium Content of Starch and Seaweed Kerupuk

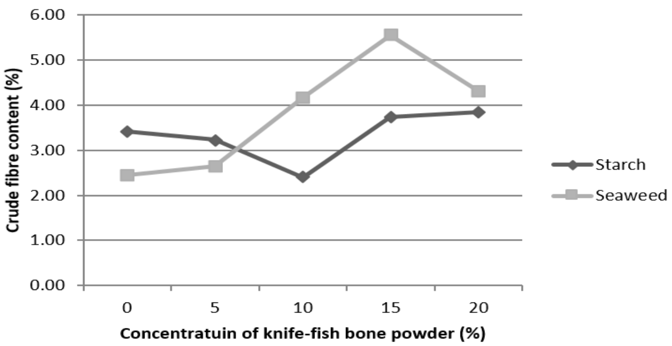

Fig. 2: Crude Fiber Content of Starch and Seaweed Kerupuk

The addition of knife fish bone powder was effected on all parameters except protein and fat content (Table 2). The Table 2 showed that the moisture content of starch kerupuk range between 11.41%-12.76% and moisture content of seaweed kerupuk range between 13.85% to 15.74%. The moisture content of seaweed kerupuk fortified knife fish bone powder significantly different ($p<0.05$), where the moisture increased with the increased in knife fish bone powder added. As a dried product, fish crackers are expected to have low moisture content. Commercial fish cracker studied had moisture contents between 9.37 and 13.83% (Huda *et al.,* 2010). The moisture content of starch kerupuk meets the requirement on National Indonesian Standard requirement was 12% (BSN, 1992). Meanwhile, the moisture content of seaweed kerupuk in this study still high compared with moisture content based on Indonesia Standard requirement. This was probably due to the addition of fish bone powder that is hygroscopic that can absorb water favor from the environment. A similar observation was reported by Jayanti (2009), that addition of crab shell powder was increased moisture content of cracker. Beside that, imperfect drying (sun drying) was causing the moisture content of the kerupuk still high in this study. The weather condition is also taken into account in fish cracker production (Zulkarnain et al., 2014). Furthermore, control of moisture in crackers is necessary to optimize the quality of the product and the production process (Huda *et al.,* 2010).

The Table 2 showed the protein content of starch and a seaweed kerupuk range between 0.23-0.35% and 0.17-0.27% respectively. The addition of knife fish bone powder were not significantly different to the protein content on seaweed kerupuk ($p>0.05$), but it were significantly different to the protein content of starch kerupuk ($p<0.05$). This probably was due to knife fish bone powder as fortification material low protein content (Putranto *et al.,* 2015). The starch and seaweed are not a source of protein. High content, protein was found at addition 20% of knife fish bone powder compared to the control sample (0%) on both starch and seaweed kerupuk. Protein content of kerupuk in this study was lower than the protein content in the minimum Indonesian Standard (SNI) required at least 4% (BSN, 1992).

The fat content of seaweed kerupuk fortified knife fish bone powder produced in this study range from 1.67-2.05% for starch kerupuk and 1.38 to1.78% for seaweed kerupuk (Table 2). The addition of knife fish

Table 2: Proximate, Phosphor and Whiteness of Starch and Seaweed Kerupuk Fortified With Knife-Fish Bone Powder (n=15)

Knife fish bone powder addition	Characteristic of kerupuk					
	Moisture	Protein	Fat	Ash	Phosphor	Whiteness
Starch						
0%	12.76	0.23^{a}	1.86	2.30	0.16	37.80
5%	12.03	0.25^{a}	2.05	6.23	1.21	48.70
10%	11.76	0.34^{b}	1.67	9.28	2.06	55.43
15%	11.41	0.35^{b}	1.72	12.25	2.72	58.95
20%	11.58	0.35^{b}	1.89	14.72	2.98	60.67
Seaweed						
0%	13.85^{c}	0.17^{a}	1.7^{a}	2.69^{e}	0.41^{e}	34.87c
5%	14.53^{b}	0.26^{a}	1.5^{a}	5.99^{d}	1.23^{d}	42.67^{b}
10%	14.77^{b}	0.25^{a}	1.3^{a}	9.10^{c}	2.35^{c}	51.16^{a}
15%	15.04^{b}	0.26^{a}	1.4^{a}	11.57^{b}	3.17^{b}	55.52^{a}
20%	15.74^{a}	0.27^{a}	1.7^{a}	13.82^{a}	3.70^{a}	53.21^{a}

Means followed by a different letter within the same column are significantly different ($p<0.05$)

bone powder of various percentages was not effected on the fat content of seaweed kerupuk ($p>0.05$) but was effected on starch kerupuk ($p<0.05$). The low fat content was found in 10% and the highest was found in 5% of knife fish bone powder added. Fat content of seaweed kerupuk fortification of knife fish bone powder in this study was higher than the Indonesia Standard (SNI) requirement 0.8% (BSN, 1992).

Table 2 showed, the ash content of the seaweed kerupuk increased with an increased in the percentage of knife fish bone powder added for starch and seaweed kerupuk. The ash content in this study different significantly ($p<0.05$). The lowest ash content was found in 0% (control) and the highest was found in the 20% knife fish bone powder added. Ash content of seaweed kerupuk fortification of knife fish bone powder in this study was higher than the BSN standard requirement 11% (BSN, 2009). Addition 15% of knife fish bone powder containing ash, according to Indonesia Standard requirements, but the addition of 20% knife fish bone powder was above the Indonesia Standard requirements. The high ash content in this study with the increasing percentage of knife fish bone powder added. This indicates that the knife fish bone powder contains a high calcium.

Phosphorus content on seaweed kerupuk fortified knife fish bone powder was shown that the higher the percentage of knife fish bone powder added on starch and seaweed kerupuk, the high phosphorus content of the kerupuk produced (Table 2). The phosphorus content of seaweed kerupuk differ significantly ($p<0.05$). The level of phosphorus starch and seaweed kerupuk ranged from 0.16-2.98% and 0.41 to 3.70%, respectively, where the lowest phosphorus content was found at 0% (control) and the highest phosphorus content was found in the 20% of knife fish bone powder added. The high content of phosphorus in cracker of this research caused fish bone powder which was added as a source of phosphorus, calcium and carbonate (Trilaksani, *et al.,* 2006). Phosphorus is one of the minerals necessary by the body, and fish bones are one of the cheapest sources of phosphorus that is still not utilized. Phosphorus is the second largest mineral after calcium, which is 1% of body weight. Approximately 58% of the phosphorus in the body are present as calcium phosphate, which is part of the hydroxyapatite salt in the bone and the tooth that is not soluble (Almatsier, 2003).

The whiteness level of both starch and seaweed kerupuk fortified by knife fish bone powder ranged from 37.80-60.67% and 34.87 to 55.52% respectively (Table 2). Varied percentages of knife fish bone powder addition were affected by whiteness level of both starch and seaweed kerupuk ($p<0.05$). The lowest whiteness level was found at 0% in both two kinds of kerupuk (starch and seaweed), whereas and the highest was found at 20% on starch kerupuk and 15% of knife fish bone powder added on seaweed kerupuk. In this study was shown that the addition 15% of knife fish bone powder given maximum whiteness level compared to the other treatments. The color of fish bone powder as fortified material contributed to the whiteness level of seaweed kerupuk produced. The results of this study were different from the research results of Tababaka (2004), where by the addition of catfish bone powder tends to cause browning color in the cracker. The fish bone powder containing protein and predictive sugar which will experience Maillard reaction by heat. Currently, slight browning, including the Mailard reaction and the caramelization by heat, as well as changes in pigment concentration caused by dehydration and the expansion, might be among the factors that determine the color of crackers (Wang *et al.,* 2013).

Conclusion

The addition of knife-fish bone powder has effect on the starch and seaweed kerupuk characteristics on calcium content, ash content, phosphor content and whiteness. The concentration of fish bone powder up to 20% shows high levels of whiteness for both of kerupuk.

Acknowledgement

Thank you for funding assistance from research incentives from the Ministry of Research and Technology (Kemenristekdikti), which is this research can be completed properly.

Funding

This study is funded by Research Grant from ministry Reseacrh Technologi, Grant No.029/SP2H/LT/DRPM/II/2016

Conflict of Interest

The author(s) declare no conflict of interest.

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