Effect of knife-fish bone powder addition on characteristics of starch and seaweed kerupuk as calcium and crude fiber sources

Andi Noor Asikin¹, Indrati Kusumaningrum¹, Taufik Hidayat²

¹Faculty of Fishery and Marine Science, Mulawarman University Jl. Gn. Tabur No. 1, Kampus Gn. Kelua, Samarinda 75123 East Kalimantan, Indonesia
²Centre of Agroindustry Technology, Agency Assessment and Application Technology, Puspitek Serpong

Corresponding Author Email: taufikhd02@gmail.com

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.

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 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 fishbone 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 (Almatier, 2004).

Aromanthus isone 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 (Jubis 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-triglyceridermia 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 Noosad, 2012). Snack foods are usually high in calories but low in protein, vitamins, and other micronutrients (Akonor et al., 2010). The application of fish bone powder in 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). Siraat 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 the laboratory by carrying in coolbox, and then washed to remove other components and stored in the freezer (-20°C) prior to processing. Starch flour and dried seaweed were obtained from the local supermarket while other seasonings were purchased from the 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 Triilaksani 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°C for about 30 minutes and done 4 repetitions of boiling. The boiling repetition 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°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°C in an oven for 48 hours. Dried bone solid was milling 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°C for 1.5 hours. Then it was cooled in refrigerator at 5-7°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°C).

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 |

Result and Discussion

The addition of knife fish bone powder has affected on characteristic of both starch and seaweed kerupuk. The effect of knife fishbone 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 fishbone powder was increased calcium content of starch and seaweed kerupuk (p<0.05). The highest content of calcium was found in 20% of knife fishbone powder added and the lowest calcium content was found at 0% (control) of knife fishbone 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 catfishbone powder, resulted the highest 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 fishbone 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).
The addition of knife fish bone powder was affected 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 13.83% 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).

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    | 0.23a   | 1.86| 2.30| 0.16     | 37.80     |
| 5%                              | 12.03    | 0.25a   | 2.05| 6.23| 1.21     | 48.70     |
| 10%                             | 11.76    | 0.34a   | 1.67| 9.28| 2.06     | 55.43     |
| 15%                             | 11.41    | 0.35a   | 1.72| 12.25| 2.72    | 58.95     |
| 20%                             | 11.58    | 0.35a   | 1.89| 14.72| 2.98    | 60.67     |
| Seaweed                         |          |         |     |     |          |           |
| 0%                              | 13.85c   | 0.17a   | 1.7a| 2.69| 0.41c   | 34.87c    |
| 5%                              | 14.53b   | 0.26a   | 1.5b| 5.99| 1.23b   | 42.67b    |
| 10%                             | 14.77b   | 0.25a   | 1.3b| 9.10c| 2.35c   | 51.16a    |
| 15%                             | 15.04b   | 0.26a   | 1.4b| 11.57b|3.17b   | 55.52a    |
| 20%                             | 15.74a   | 0.27a   | 1.7b| 13.82b|3.70a   | 53.21a    |

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

The Table 2 showed the protein content of starch and a seaweed kerupuk range between 0.23-0.30% and 0.17-0.27% respectively. The addition of knife fishbone powder was not significantly different to the protein content on seaweed kerupuk (p>0.05), but it was significantly different to the protein content of starch kerupuk (p<0.05). This probably was due to knife fishbone powder as fortification material low protein content (Putranto et al., 2015). The starch and seaweed are not a source of protein. High content, the protein was found an addition 20% of knife fishbone 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 fishbone 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 bone powder of various percentages was not affected on the fat content of seaweed kerupuk (p>0.05) but was affected on starch kerupuk (p<0.05). The low fat content was found in 10% and the highest was found in 5% of knife fishbone powder added. Fat content of seaweed kerupuk fortification of knife fishbone 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 fishbone 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 fishbone powder added. Ash content of seaweed kerupuk fortified of knife fishbone powder in this study was higher than the BSN standard requirement 11% (BSN, 2009). Addition 15% of knife fishbone powder containing ash, according to Indonesia Standard requirements, but the addition of 20% knife fishbone powder was above the Indonesia Standard requirements. The high ash content in this study with the increasing percentage of knife fishbone powder added. This indicates that the knife fishbone powder contains a high calcium.

Phosphorus content on seaweed kerupuk fortified knife fishbone powder was shown that the higher the percentage of knife fishbone 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 fishbone powder added. The high content of phosphorus in cracker of this research caused fishbone 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 fishbone 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 fishbone powder given maximum whiteness level compared to the other treatments. The color of fishbone 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), whereby 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 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 addition of knife fishbone powder has effect on the starch and seaweed kerupuk as calcium and crude fiber sources. The addition 15% of knife fish bone powder addition were affected by whiteness level of both starch and seaweed kerupuk.

References

1. Akonor Paa T, Nanam T. Dziedzoave, Erwelyn S. Buchman, Edna Aireku Essel, Francis Lavoe, Keith T. Tomlins. Sensory Optimization of Cracker Developed from High-Quality Cassava Flour, Starch, and Prawn Powder. 2017; Food Sci Nutr 5(3): 564-569. CrossRef
2. Almatsier, S. Basic principles of Nutritions. Jakarta: PT. Gramedia Pustaka Utama. 2002.
3. Amora, S. D., Sukes. Antioxidant Extraction on Nugget from Eucheuma cottonii. J. Science and Art. 2013;2(2):23-25.
4. Anggadireja, J., Irawati, S., Kusmiyati. Potential and Benefits of Pharmaceutical Seaweed. National Seminar of Seaweed Industry. Jakarta.
5. Aprillani, I. S. Utilization of Patin Fish Bone (Pangasius hypophthalmus) Flour in Making Ice Cream Cone. Underthesis. Bogor. IPB. 2010.
6. Astawan, M., S. Koswara, F. Herdiani. The Utilization of Seaweed (Eucheuma cottonii) to Increase Iodine and Dietary Fibre Contents of Jam and Dodol. J. Teknol. dan Industri Pangan, 2004;15(1):61-69.
7. Borderias, A. J., Alonso, S. I, and Perez-Mateos, M. New applications of fibers in foods: Addition to Fishery Products. Trends in Fd. Sci and Tech. 2005;16(10):458-465. CrossRef
8. BSN. National Standardization Agency of Indonesia. Jakarta. 1992.
9. Hemung, B.O. Properties of Tilapia Bone Powder and Its Calcium Bioavailability Based on Transglutaminase Assay. International Journal of Bioscience, Biochemistry and Bioinformatics. 2013;3(4):306-309
10. Herdiana, D. S. Cutterfish Cracker Product Quality Control To Reduce The Total Of Product Defects In Trading Company Ardial, Banyuwangi Regency. International Food Research Journal.2015;22(4):1513-1518.
11. Huda, N., Ang Lie Leng, Chong Xian Yee and Herpandi. Chemical Composition, Color And Linier Expansion Properties of Malaysian Commercials Fish Cracker (Keropok). J. Food Ag-Ind. 2010;3(5):473-482.
12. Huda, N., Boni, I, and Noryati. I. The Effect of Different Ratios of Dory Fish to Tapioca Flour on The Linear Expansion, Oil Absorption, Color and Hardness of Fish Crackers. International Food Research Journal. 2009;16:473-482.
13. Jayanti, A. E., Utilization of Flavor of Shrimps Head of Penaeus monodon in Making Calcium Crackers from Crab Shells (Portunus). Underthesis. Bogor. IPB. 2009.
Effect of knife-fish bone powder addition on characteristics of starch and seaweed kerupuk as calcium and crude fiber sources

14. Jiancong, H., Shanggui, D., Chao, X., Guozhong, T. Preparation And Biological Efficacy of Haddock Bone Calcium Tablets. Chinese Journal of Oceanology And Limnology. 2010;XXVIII(2):371-378. CrossRef

15. Kaya AOW, Santoso J, Salamah E. Utilization of Patin Fishbone Powder as Source of Calcium and Phophorus in Producing Biscuit. Ichthys. 2008;7(1):9-14

16. Khan, M. and A. K. M. A. Nowad. Development Of Protein Enriched Shrimp Crackers From Shrimp Shell Wastes. J. Bangladesh Agril. Univ. 2012;10(2): 367-374. CrossRef

17. Kusumaningrum I and Asikin NA. The characteristic of calcium fortified fish kerupuk from belida (Chitala sp) fish bone. Jurnal Pengolahan hasil perikanan Indonesia. 2016;19(3):233-240. CrossRef

18. Kusumaningrum I, Sutono D, Pamungkas BF. Recovery of Belida Fish Bone Byproduct as a Rich Calcium Powder by Alcali Method. Jurnal Pengolahan Hasil Perikanan Indonesia. 2016;19(2):148-155. CrossRef

19. Lubis, Y. M. Erfiza, N. M., Ismatuahrmih, Fahrizal. Effect of Seaweed Concentration (K. alvezii) and Flour Type in Making Wet Noodle. Agricultural Hue. 6(1):413-420

20. Mustofa, K.A., Suyanto, A. Effect of the Addition of Flour Shell Crab (Portunus Pelagicus) Variation on Calcium, the Ability to Swell and Organoleptic Properties of Ongkok Cassava's Crackers. Jurnal Pangan dan Gizi. 2011;2(3):1-14.

21. Nuru, H., Boni, J., Noryati, I. The Effect of Different atios of Dory Fish to Tapicoa Flour on The Linear Expansion, Oil Absorption, Color, and Hardness of Fish Crackers. International Food Research Journal. 2009;16:159-165.

22. Pakaya, S.T., Yusuf, N., Mile,L. Crackers Characteristic of Sago nd Seaweed Subtitution nd Fortification. Fisheries Scientific Journal and Marine. 2014;2(4):174-179.

23. Pratama, R.I., Rostini, I., Livawaty, E. Characteristics of Biscuit with Janglus (Isiliophorusss) FishBone Flour' Supplementation. Aquatica. 2014;5(1):30-39.

24. Putranto, H. F., Asikin, N. A., Kusumaningrum, I. Properties of Belida (Chitala sp) Fish Bone Powder as Calcium Source Based on Protein Hydrolisis Method. Zia'rah. 2016;41(1):11-17.

25. Rohani, A. C., Salasiah, M. N., Ashadi, Y. Effect of Cereal Fiber on The Physico-Chemical Quality and Sensory Acceptability of Instant Fish Crackers. Journal of Tropical Agriculture And Food Science. 2010;38(1):39-49.

26. Sari, F.K., Ishartani, D., Parnanto, NH., Anam, C. Effect of Addition of Catfish Bone (Clarias sp.) and Cowpea (Vigna Ungulicula) on Sweet Corn Milk (Zea Mays Saccharata) Content of Calcium and Protein. Journal Teknosains Pangan. 2013;2(1):66-72.

27. Siah, W. M., Aminah, A., Ishak, A. Optimization of oaking Conditions for The Production of Seaweed (Kappaphycus alvezii) paste using Response urface Methodology. International Food Research Journal. 2014;21(1): 471-477.

28. Sirait D.W. Sukesi. Antioxidant on Meatball of Eucheuma cottoni. J. Science and Art Poots. 2012; 1(1):1-4.

29. Tababaka, R. Utilization of Patin Fish Bone Flour (Pangasius sp) for Addition of Crackers. Underthesis. Bogor. IPB. 2004.

30. Tawee, T. K.MiniReview Cracker “Keropok”: A Review on Factors Influencing Expansion. International Food Research Journal. 2011;18(3):855-866.

31. Trilaksani, W., Salamah E. & Nabil, M. Utilization of Tuna (Thunnus sp) Fish Bone As a Calcium Source by Protein Hydrolisis Method. Buletin Teknologi Hasil Perikanan. 2006;(X:2)(3):34-45.

32. Wang, Y. Zhang, M. and Mujumdar, A. S. Effect Of Cassava Starch Gel, Fish Gel And Mixed Gels And Thermal Treatment on Structure Development and Various Quality Parameters in Microwave Vacuum-Dried Gel Slices. Food Hydrocolloids. 2013;33:26-37. CrossRef

33. Zulkarnain, O.W., I. Zunaidi, I.M. Tarmizi, M. Lugman, A. Kharudin, A.M. Redhwan, A.B. Samat, Waisi Nuroho, D. Shafie. Homogenous Fish Cracker Dryer Using Hybrid Control System. Australian Journal of Basic and Applied Science. 2014;8(4):450-454.
Effect of knife-fish bone powder addition on characteristics of starch and seaweed kerupuk as calcium and crude fiber sources

https://www.foodandnutritionjournal.org/volume7number2/effect-of-knife-fish-bone-powder-addition-on-characteristics-of-starch-and-seaweed-kerupuk-as-calcium-and-crude-fiber-sources