Improvement of the composition value of commercial fish feeds with additional waste of torpedo scad fish scales, water hyacinth, and taro leaves

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Abstract. Waste material has a lot of nutrients needed so that it can reduce the price of fish feed. Waste that can be used includes the scales of Torpedo Scad fish (Megalapsis cordyla), taro leaves (Colocasia esculenta), and water hyacinth (Eichornia crassipes). This research was conducted to obtain the correct composition of the three wastes in influencing the physical properties and composition values of commercial fish feed. Composition values tested include levels of protein, fat, carbohydrates, ash content, and water content. This research method begins by refining the commercial pellets, fish scales of Torpedo Scad, taro leaves, and water hyacinth then filtering them with a 125 mesh sieve. After that, mix the ingredients in the ratio A1, A2, and A3. After that, test the composition value of each comparison. The results of this study indicated that the addition of Torpedo Scad fish scales, taro leaves, and water hyacinth were significantly different (P < 0.05) on protein and carbohydrate content and fish feed pellets that had been made. It can be excluded that the addition of the waste scales of Torpedo Scad fish, taro leaves, and water hyacinth has an influence on the composition of protein and carbohydrates from fish pellets.

1. Introduction
Catfish is one of the most popular fish in Indonesian society. Catfish is usually served as catfish pecel, catfish sauce, grilled catfish and so on. The amount of interest in catfish has not been accompanied by the ability to produce catfish. One of the obstacles to the catfish production process is feed. Feed is food or intake given to fish. The high need for direct feed also results in high production costs incurred by catfish farmers. Based on direct field studies, the price of fish feed is increasing day by day. As a result, production costs are high and the income of the cultivators has decreased. One example of commercial fish feed with the Hi-Pro CPP brand 781, the price per kg reaches IDR 11,000. Apart from the high price of feed, the content of feed is also a problem. The characteristics of the feed produced refer to the Indonesian National Standard (SNI) 2006, which contains protein (20-35%), fat (2-10%), ash (<12%), and water (<12%). The composition of the fish content greatly affects the growth process and the fast or slow process of the fish harvesting period. The content of fish feed also affects the physical properties of the feed [1]. Most published studies on fish pellets have been on fish nutrition and do not report data on the physical quality of feed [2].
Catfish which has the Latin name *clarias sp* in general has a body that is slippery, slimy, not scaly and grungy, has a long head and is flat down, with the top and bottom of its head covered by plate bones [3]. Catfish habitat is usually in stagnant waters that are relatively shallow, there is a shelter or a place that is slightly dark and prefers a muddy substrate. Water quality that is considered good for catfish life is a temperature ranging from 20 - 30°C with an optimal temperature of 27°C, dissolved oxygen content > 3 ppm, pH 6.5-8.6 and NH₃ of 0.05 ppm [4].

Fish feed is divided into two types of feed, namely: natural feed and artificial feed. This artificial feed is usually called pellets [1]. Feed is an important factor to support the success of catfish production. The requirement for high quality feed is that it has complete nutritional content, is easily digested by fish and does not contain harmful substances for fish. In addition, the feed must have a physical form that is durable and can survive the handling and transportation process. The characteristics of pellets according to the Indonesian National Standard (SNI) 2006 are protein (20-35%), fat (2-10%), ash (<12%), and water (<12%). The quality of protein really depends on how easy it is to digest by fish and the protein content contained in the pellets. These factors are determined by the types of amino acids that compose them because the more complete the amino acid content, the better the protein quality [5]. Fish cultivators generally provide natural feed in the seed phase. Natural feed has a fairly good nutritional content. Natural feed has a small size and fits the mouth opening of the fish seeds. Natural feeds that are often used in fish farming are *Artemia sp*, *Daphnia sp*, *Spirulina sp*, and *Tubifex sp* [6]. Based on the background description, an alternative solution is needed for making high-quality catfish feed with the appropriate content and low prices. The manufacture of catfish feed can be done through simple techniques by utilizing raw material sources that are relatively cheap or come from waste materials that are not used. The raw material waste used must contain good nutritional value and be easy to obtain when needed, be easy to process and process, contain nutrients needed by fish, and be cheap [3] Some of the waste that can be used as fish feed is the scales of Torpedo Scad, taro leaves, and water hyacinth, all of which are first prepared in the form of flour. Torpedo Scad fish scales have a high protein value so that they are able to meet protein needs, while the carbohydrate value of taro leaves and water hyacinth which functions to improve the physical properties of the feed in order to reduce the use of feed which automatically reduces production costs.

Water hyacinth can be used as a leaf protein concentrate (KPD) which has a crude protein content of 40%. In terms of palatability, the use of water hyacinth will be more profitable if it is mixed with other feeds such as torpedo scad fish scales and taro leaves [7]. Torpedo scad fish scales as the main protein source to replace expensive commercial fishmeal can provide high protein content (26.92%). Taro leaves also play a role as the main carbohydrate source (81.52%), so that the composition of fish feed is nutritionally balanced between protein and carbohydrates.

2. Materials and methods

2.1. Materials

The materials used in this study were Torpedo Scad fish scales (*Megalapsis cordyla*), water hyacinth flour (*Eichornia crassipes*), taro leaf flour (*Colocasia esculenta*), and commercial fish pellets. Torpedo Scad fish known by various local names in Indonesia, such as hard-tailed fish, cengcaru, kerongan, and cengkurungan are easily obtained sources of animal protein. This fish is a small pelagic of the Carangidae family, and can grow to a maximum length of 80 cm with a weight of 4 kg, and a general length of 45 cm [8]. Torpedo Scad fish are pelagic fish that live in groups on the surface of the water to the offshore [9]. Testing has been carried out to determine the content of Torpedo Scad fish scales in the Biochemistry laboratory of the Faculty of Chemistry, Universitas Sumatera Utara, that the test results show that the contents of the scales of Torpedo Scad fish consist of 26.92% protein and 5.15% fat, respectively. The local raw material that can be used to make fish pellets is taro leaves. Taro leaves have a fairly high nutritional content, which contains 27.80% protein and a gross energy level of 3,821 cal/g. Apart from having high enough nutrition, taro leaves are also easy to get. This is because taro has good adaptability so that it can grow in dry or wet places [10]. Taro plants grow ideally in areas with
temperatures 21-27°C, humidity 50-90%. Taro contains many chemical compounds produced from secondary metabolism such as alkaloids, glycosides, saponins, essential oils, resins, sugars and organic acids. Taro tubers contain 18.2% easily digested starch, 1.42% sucrose and sugar and 23.7% carbohydrates [11]. The results of chemical analysis show that water hyacinth contains organic matter which is rich in vitamins and minerals, and also contains high protein and fat. Water hyacinth as a feed ingredient which contains a relatively high crude fibre element of 16.79% can be increased its nutritional value or digestibility by fermentation. Water hyacinth is generally considered a weed that is easy to adapt to its environment, reproduces fast, and is strong, so that in a short time it will fill the waters. An abundance of water hyacinth can inhibit the supply of oxygen to the bottom and block the penetration of sunlight which is so necessary for life [12].

2.2. Research method

2.2.1. Materials preparation. The samples of Megalaspis cordyla fish scales that have been collected are then washed first with running water to remove dirt and remaining meat. Each cleaned scale is then dried in the sun to dry. After the scales are dry, all parts of the scales are cut into small pieces using scissors. Then mashed using a blender until it becomes flour and sieved with a size of 125 mesh. Water hyacinth is cleaned by washing it then taking the leaves and midrib 5 cm from the bottom of the leaves then drying them in the sun to dry. The dried water hyacinth is then mashed using a blender until it becomes flour and sieved with a size of 125 mesh. The taro leaves are cleaned and cut into small pieces and separated from the bone leaves. The sample was dried and mashed and filtered with a size of 125 mesh.

2.2.2. Mixing of ingredients. The ingredients that have been mashed are then mixed in a ratio of 3 combinations, namely:
• A1 (50% Commercial pellets, 35% Fish Scales, Taro Leaves, 10%, Water Hyacinth 5%)
• A2 (40% Commercial pellets, 45% Fish Scales, Taro Leaves, 10%, Water Hyacinth 5%)
• A3 (30% Commercial pellets, 55% Fish Scales, Taro Leaves, 10%, Water Hyacinth 5%)

2.2.3. Protein content testing. Calculation of protein content using the khedjal method is as follows (12).

\[
PC = \frac{(V_1 - V_2) \times N \times 0.14 \times c.f \times d.f}{w}
\]

PC = protein content
V1 = The HCL volume of 0.01 was used in the sample captivity
V2 = The HCL volume used for the blank is used
N = HCL normality
c.f = Conversion factor for protein from food in general; 6.25
d.f = Dilution factor
w = Snippet weight

2.2.4. Carbohydrate content testing. The difference in the percentage of the sum of the test results for the total ash, protein, fat and moisture content.

2.2.5. Fat content testing. Calculation of fat content using the Soxlet method is as follows [13]:

\[
FC = \frac{w_1 - w_2}{w}
\]

FC = Fat Content
w = Snippet weight in grams
\[ w_1 = \text{The weight of the measuring flask of fat after extraction in grams} \]
\[ w_2 = \text{The weight of the measuring flask of fat before extraction in grams} \]

2.2.6. *Ash content testing.* The principle of determining the ash content by conditioning all organic substances at a high temperature of about 500-600°C, then the remaining combustion products are weighed. The number of samples to be ignored, is weighed a certain number depending on the type of material.

2.2.7. *Water testing.* The water content is calculated by formula [13]:

\[
TM = \frac{w}{w_1} \times 100\%
\]

\[ TM = \text{Total Moisture} \]
\[ w = \text{Snippet weight before drying in grams} \]
\[ w_1 = \text{Losing weight after drying in grams} \]

2.2.8. *Statistical analysis.* All data were analysed using SPSS. ANOVA for protein and carbohydrate content. When the addition of fish scales is significant with a probability of less than 0.05 it is considered significant for all analysis [14].

3. Results and discussion

3.1. *Characterization of pellet composition*

Table 1 shows the characterization of the pellet composition. The results showed that torpedo scad fish scales had a higher protein content than commercial pellets. These results indicate that the addition of torpedo scad fish scales can increase the protein content in the commercial pellet.

| Name                  | Protein Content (%) | Carbohydrate Content (%) | Fat Content (%) | Water Content (%) | Ash Content (%) |
|-----------------------|---------------------|--------------------------|----------------|------------------|-----------------|
| Commercial Pellets    | 17.56%              | 51.46%                   | 6.45%          | 16.86%           | 5.66%           |
| Torpedo Scad Fish Scales | 26.92%            | 43.31%                   | 7.42%          | 9.82%            | 12.53%          |
| Taro Leaves           | 2.97%               | 81.52%                   | 2.80%          | 10.55%           | 2.16%           |
| Water Hyacinth        | 3.84%               | 76.25%                   | 2.98%          | 13.24%           | 3.69%           |

In the science of animal feed nutrition, the most attention is protein content and carbohydrate content. The protein value of Torpedo Scad fish scales has a much greater value than the protein content of commercial pellets. Meanwhile, water hyacinth and taro leaves have very large carbohydrate content. This large carbohydrate value will strengthen the physical and mechanical properties of fish pellets so that they are durable.

3.2. *Combination of mixing pellets and fish scales in protein content*

Figure 1 shows the combination of mixing pellets and fish scales in protein content. The results showed that commercial pellet was supplemented with 35%, 45%, and 55% torpedo scad fish scales, taro leaves 10%, and water hyacinth 5% able to increase the protein content of commercial pellet.
In Figure 1 it can be seen that with the addition of variations in the scales of Torpedo Scad fish, the percentage of protein content increases. This is consistent with the results of the analysis of Torpedo Scad fish scales protein test in Table 1, where the percentage of protein content produced by Torpedo Scad fish scales is higher than the protein content of commercial pellets. Increasing the value of the content in protein will have implications for the rapid growth of fish, because protein is a source of building blocks for fish bodies. From the results of data analysis using ANOVA, it was found that the P value was 0.003. This value shows that there is a significant effect of adding variations from the scales of Torpedo Scad fish, taro leaves, and also water hyacinth.

3.3. Combination of mixing pellets and fish scales in carbohydrate content

Figure 2 shows the combination of mixing pellets and fish scales in carbohydrate content. The results showed that commercial pellet was supplemented with 35%, 45%, and 55% torpedo scad fish scales, taro leaves, 10%, and water hyacinth 5% able to increase the carbohydrate content of commercial pellet.

In Figure 2 it can be seen that with the addition of variations in the scales of Torpedo Scad fish, the percentage of carbohydrate content increases. This is consistent with the results of the analysis of Torpedo Scad fish scales carbohydrate test in Table 1, where the percentage of carbohydrate majority are sourced from taro leaves and water hyacinth. This is in accordance with previous research, in the research the effect of adding tapioca flour to the physical and mechanical properties of artificial fish feed for about 12 weeks old tilapia with fish length of 10-12 cm with three variations of adding tapioca flour, namely 5%, 7.5% and 10% [1]. From the results of data analysis using ANOVA, it was found that the P value is less than 0.005. This value shows that there is a significant effect of adding variations
from the scales of Torpedo Scad fish, taro leaves, and also water hyacinth on the increase in the carbohydrate composition of fish pellets A1, A2, and A3.

4. Conclusions
The addition of Torpedo Scad fish scales was able to increase the percentage of protein and carbohydrate values from fish pellets. The results of the data analysis showed an increase in the value of the percentage of protein and carbohydrate content with the addition of the scales composition of Torpedo Scad fish, taro leaves, and water hyacinth. From data analysis using ANOVA shows that there is a significant effect of adding variations from the scales of Torpedo Scad fish, taro leaves, and water hyacinth.

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Acknowledgements
The authors would like to thank Universitas Sumatera Utara for the funding through TALENTA 2020 Penelitian Dosen Muda Scheme and Integrated Research Laboratory for the chemicals and facilities.