POTENTIAL OF WASTE-BASED ANIMAL PROTEIN FOR FISH FEED

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ABSTRACT

The growth and survival of farmed fish are significantly influenced by their diet. Fish feed must be formulated to meet the demands of fish and must have a full nutritional profile, be simple for fish to digest, and not include any dangerous ingredients (anti-nutrients). Since fish meal has an animal protein content of 60–80% and an 80–90% feed digestibility, it is frequently used to produce feed. Fish meal is exceedingly hard to come by and still depends on imported ingredients. Use of waste products from various agrocomplex activities can serve as a substitute source of protein for fish feed ingredients. The amount of waste produced by livestock and fishing operations is still relatively considerable (20–30%). Solid waste from fishing activities includes fish parts from the canning and smoking industries, as well as scales and gills. Fish meal cannot entirely be replaced as a source of animal protein by the use of animal protein sources derived from waste. In order to treat waste as ingredients for fish feed, this study will examine a number of sources of animal protein.

Keyword: *aquaculture, feed, fish, protein, waste*

1. INTRODUCTION

The accomplishment of fish production is determined by several factors, one of which is feed. Feed is an important factor in the growth and survival of cultured fish [1]. Fish feed must be in accordance with the needs of fish, which has complete nutritional content, is easily digested by fish and does not contain harmful substances (anti-nutrients) [2]. Fish farming activities are often faced with high feed costs, which are around 60-70% of the total production costs [3].

Fish meal as a source of animal protein is often used to prepare feed since it contains 60-80% protein with feed digestibility of 80-90% [1]. The availability of fish meal is very limited and still depends on imported components. This causes the price of commercial feed to be higher, hence that production and marketing costs also increase [4]. Therefore, substitute raw materials are needed to reduce production costs.

One alternative source of protein for fish feed ingredients is to use waste from various agro-complex activities. Waste generated from fishery and livestock activities is still quite high, which is around 20-30%. For example, if fish production reaches 6.5 million tons per year in Indonesia [5], it means that about 2 million tons are wasted as waste. Waste generated from fishing activities is solid waste such as pieces of fish meat, scales, and gills from the fish canning or fish smoking industry. Utilization of animal protein sources from waste cannot completely replace fish meal as a source of animal protein, however it can reduce the amount of fish meal used in feed formulations hence that feed is more economical. Recommendations for the utilization of animal protein from waste in feed formulations for carnivorous fish are 20% and herbivorous and omnivorous fish only reach 25% [6]. This paper will review several sources of animal protein based on waste treatment as fish feed ingredients.

2. CHEMICAL PROPERTIES OF PROTEINS AND THEIR FUNCTIONS FOR FISH

Protein in nature is found in colloidal form. The solubility of protein in water varies, from the insoluble (keratin) to the highly soluble (albumin). Proteins can be denatured by heat, strong acids, alkalis, alcohols, acetone, urea and salts of heavy metals. Denaturation is a process that changes the structure of a molecule without breaking the covalent bonds.

Denaturation is usually accompanied by loss of biological activity and significant changes in some physical properties and functions. If a protein is denatured, it will lose its unique structure and therefore its chemical, physical and biological properties will change. An example in this case is an enzyme that is inactivated by heat. Denaturation and coagulation of proteins are aspects of stability that can be related to the arrangement and sequence of amino acids in proteins. Protein has several functions for fish, namely:

a. As a building substance, protein functions to repair damaged or shrinking tissue (tissue repair and maintenance) and to build new tissue (protein growth and formation).
b. Protein can be catabolized as an energy source or as a substrate for carbohydrate and fat tissue.
c. Protein is needed in the body to make up hormones, enzymes and other important biological substances such as antibodies and haemoglobin.

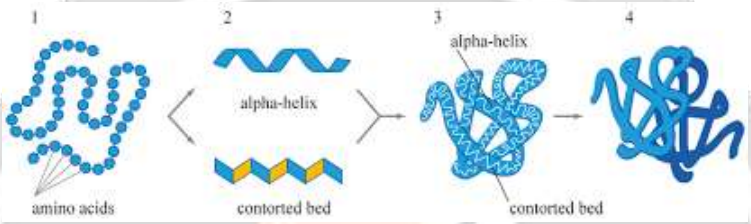

Figure 1. Protein Structure: 1) Primary; 2) Secondary; 3) Tertiary; 4) Quaternary[1]

3. VARIOUS WASTE-BASED ANIMAL PROTEINS

Meat Bone Meal (MBM)

Meat Bone Meal (MBM) is flour made from meat and bones left over from cattle slaughter (except horns, feathers, nails, faeces, blood, and rumen contents) which are processed into flour as a protein source. According to [7], MBM is the result of animal processing waste that is used as raw material for feed and is a source of protein and minerals. The results of the waste treatment come from the meat and bones of cows, goats, and sheep which are carried out by heating and pressing at a certain temperature and pressure. If the results obtained are above 4.4% phosphorus content, it is called meat and bone meal [8].

Generally, MBM is the product of processing cattle (such as cow), hence that its composition can vary, although the raw materials used are excellent and employ high-tech processing methods [9]. The quality of MBM varies greatly, depending on the method of manufacture and the body part used as raw material for boiling and drying MBM flour, which contains 50% protein, 8% fat, 28% ash, 10% Ca and 5% P [8]. The protein contained in MBM is approximately 45-55% [10]. MBM is a source of protein, energy and minerals, especially Ca and P [11]. In addition, it also contains high levels of the amino acid lysine, however, the content of methionine and cysteine in MBM is low [8]. According to [12] the crude protein contained in MBM flour is 53.70% (Table 1).

Table 1. Nutritional composition of MBM

Composition	Percentage
Protein	50.4%
Fat	10%
Calcium	10.3%
Phosphor	5.1%
TME_N	2666 kcal/kg

[1] https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcSw4HEuFP-9_eY6ZnP5u2IbeGxygGvKgWnJ2Q&usqp=CAU

Amino acids:	
Methionine	0.7%
Cystine	0.7%
Lysine	2.6%
Threonine	1.7%
Isoleucine	1.5%
Valine	2.4%
Tryptophan	0.3%
Arginine	3.3%
Histidine	1%
Leucine	3.3%
Phenylalanine	1.8%
Tyrosine	1.2%
Glycine	6.7%
Serine	2.2%

Tuna Fish Waste

Waste is waste generated from a production process, both industrial and domestic (household), whose presence in a certain place and at a time is not desired by the environment because it has no economic value. Waste generated from industrial or domestic (household) activities in the fishery sector is solid waste in the form of pieces of fish meat, scales and gills. Tuna fish waste can be in the form of meat from cuts, offal, bones, heads and fins. This tuna fish waste can be found in wholesale and traditional markets. Tuna fish waste can provide benefits as a raw material for protein feed sources, especially for reducing and even replacing fish meal. Tuna fish waste has a fairly high nutritional content (Table 2).

Table 2. Nutrient Content of Tuna Fish Waste

Chemical Composition	**%**
Protein	38.54
Water	75.91
Ash	9.47
Fat	12.75
Fibre	-

Source: Source: Results of Proximate Analysis at the Laboratory of Animal Feed Nutrition and Chemistry, Faculty of Animal Husbandry, Unpad (2017).

Crab Waste (*Portunus pelagicus*)

The crab processing industry produces the most waste in the form of shell waste. Shell waste produced in one crab weighing 100-350 g ranges from 51-150 g [13]. The shell of the crab can be processed into chitin. Research has been carried out concerning the ratio of the demineralized crab carapace with 1N HCl 1:15 (w/v) and then the demineralized powder is deproteinized with 1N NaOH in a ratio of 1:15. From this process, 20.24% chitin was obtained [14].

Table 3. Chemical Characteristics of Crab Shell Flour (*Portunus pelagicus* Linn.)

Parameters	**Content of Shell Flour**	
Moisture (%)	3.24 ± 0.74	
Ash (%)	72.28 ± 0.58	
Ca (mg/g)	299.41 ± 5.90	
P (mg/g)	12.35 ± 0.07	
pH	9.31 ± 0.15	
Parameters	**Content of Claw Meat (mg/100g)**	**Content in Body Meat (mg/100g)**
Na	353.5 ± 8	319.8 ± 20
K	308.9 ± 19	303.8 ± 19
Ca	150.9 ± 6	87.6 ± 7
Mg	55.8 ± 2	48.8 ± 2
P	120.6 ± 47	154.2 ± 27

Zn	4.68 ± 0.1	3.72 ± 0.4
Fe	0.45 ± 0.02	0.68 ± 0.03
Mn	0.06 ± 0.02	0.16 ± 0.03
Cu	2.08 ± 0.05	1.49 ± 0.09

Source: [15], [16]

4. UTILIZATION OF ALTERNATIVE ANIMAL PROTEIN FOR FISH FEED

Several research results have been carried out and indicate an appropriate results regarding the use of waste as a source of animal protein in fish feed. The results of these studies are presented in Table 4.

Table 4. Several Studies on Utilization of Animal Protein for Fish Feed

Alternatives Protein	Treatments	Results	References
Red Bigeye (*Priacanthus macracanthus)* waste	Utilization of red bigeye (*Priacanthus macracanthus*) waste as an alternative fish feed	The nutritional content obtained is crude protein (51%), crude fat (8.66%), crude fiber (3.99%), dry matter (88.64%), and ash (26%).	[17]
Shrimp waste	Processing of shrimp waste to obtain animal protein source feed ingredients	Good nutritional quality is obtained from processed shrimp waste containing crude protein (42.23%), crude fiber (19.87%), fat (9.56%), and nitrogen retention (66.20%)	[18]
Tuna (*Thunnus* sp) waste	Utilization of tuna fish waste as an alternative protein source for the growth of milkfish (*Chanos chanos*)	Fish feed with tuna waste has a very significant effect on the growth of milkfish. The growth of milkfish weight reached 54.47 g from the initial weight of 3.73 g and the survival was 73.33%. The protein content obtained reaches 40%.	[19]
Earthworms (*Lumbricus rubelllus*)	Utilization of earthworms as alternative animal protein for African catfish feed	The nutritional content obtained were protein (65.24%), fat (11%), ash (6%) and nitrogen without extract (19%). The results showed that the specific growth rate of African catfish was 2.04 ± 0.02 and the SR was 96.67%.	[20]
Mackerel Tuna (*Euthynnus affinis)* waste	Utilization of alternative protein sources from mackerel tuna fish waste to feed catfish fry	The results showed that the test feed with mackerel tuna fish waste gave the best results for the daily growth rate of 3.34% and feed utilization efficiency of 55.82%. Protein content (29.8%), fat (7.49%), moisture (11.55%), ash (17.45%), fiber (3.07%)	[21]
Anchovy (*Stolephorus* sp.) waste	Utilization of anchovy waste as an alternative protein for fish feed	The results showed that the nutritional content obtained was protein content (44.43%), fat (6.35%), moisture (11.27%), ash (6.62%) and carbohydrates (9.06%).	[22]

Shark (*Carcharhinus* sp.) waste	Substitution of fish meal with shark waste meal on the growth of African catfish	The results showed that the growth of African catfish fed shark waste processed feed was 1.26%/day, feed efficiency was 38.64% and SR (55%). The nutritional content of the feed is protein (33.50%), crude fat (5.46%), ash (11.21%), and crude fiber (5.19%)	[23]

5. CONCLUSIONS

Based on the literature search, it can be seen that waste is a natural material that has great potential to be used as a source of animal protein in fish and livestock feed.

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