INSOLOGI: Jurnal Sains dan Teknologi
https://journal.literasisains.id/index.php/INSOLOGI
ISSN 2828-4984 (Media Online) | ISSN 2828-4992 (Media Cetak)
Vol. 2 No. 5 (Oktober 2023) 934-946
DOI: 10.55123/insologi.v2i5.2669
Submitted: 06-10-2023 | Accepted: 17-10-2023 | Published: 28-10-2023

Utilization of Floating Sludge (Oil and Fat) in The Meat Processing Industry as Raw Material for Catfish Pellets

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Abstract

One of the meat processing industries in Jombang district generates large amount of floating sludge waste (oil and fat) in its grease trap unit. Without proper waste disposal, environmental problems can occur. This article examines the potential use of floating sludge waste from meat processing industries as a feed material for catfish, with the aim of reducing waste, improving economics, and lowering the production costs of catfish farming. Therefore, the purpose of this study is to analyze the optimal nutrient combination of catfish feed made from meat processing industry waste, tofu leftovers, organic vegetables, and discarded eggs. The method used is fermentation with EM_4 and sugarcane molasses, along with the addition of other waste materials to enhance the nutritional quality of the feed produced. Five variations in feed composition were analyzed using proximate analysis and compared to SNI 01-4087-2006 for feed quality requirements for Dumbo catfish.The results show that several ingredient combinations can meet most catfish feed quality standards. The best option is K3 feed, which is made from floating sludge and rejected egg waste. Although the protein content is still below the standard, this combination has the potential to reduce catfish farming costs. This article promotes the development of sustainable, environmentally friendly feed alternative and the potential reduction of industrial waste.

Keywords: *Meat Processing Industry, Grease Trap, Floating Sludge, Oil and Fat, Catfish Feed*

1. INTRODUCTION

Oils and fats are natural organic substances that dissolve in non-polar organic solvents but do not dissolve in air (Herlina & Ginting, 2002). In Jombang Regency, the meat processing industry produces floating sludge waste in the form of oil and fat in significant quantities, as recorded in the August 2022 waste logbook as much as 34,635 tons. This liquid waste is rich in protein, lipids, fiber and carbohydrates, which can be a source of microbial growth and cause environmental problems (Mofijur *et al*., 2021). Environmental problems arising from oil and fat waste include the formation of air-in-oil emulsions, which disrupt marine ecosystems, block the penetration of sunlight and inhibit the rate of photosynthesis in the air and reduce free oxygen levels in the air. The decomposition of fats and oils in conditions of lack of oxygen will cause incomplete decomposition which results in an unpleasant odor (rancid) (Metcalf et al., 1991). Another challenge in the fisheries context is the cost of producing fish food which reaches 70% of the total cultivation costs, while the price of fish food continues to increase (Muliani *et al*., 2019). This gave rise to complaints from the Fish Cultivator Group (Pokdakan) about the price of pellets (fish feed) increasing without an increase in the selling price of fish (Satoto *et al*., 2021).

The management strategy for managing oil and grease residues from grease trap units can be reuse and recycle, as suggested by Stoll & Gupta (1997). This could be a solution to overcome the two problems above, namely reprocessing oils and fats from the meat processing industry as raw materials for alternative fish feed. This is confirmed by initial test results which show sufficient nutritional content in these oils and fats. In this context, catfish is the focus because based on data from the Ministry of Maritime Affairs and Fisheries, the fish with the second highest commodity after tilapia is catfish (Badan Pusat Statistik, 2018). Catfish tend to be omnivores and carnivores so artificial feed made from oil and fat from the meat processing industry could be a suitable option (Manik & Arleston, 2021). In this research, the fish feed made refers to SNI 01-4087-2006 Indonesian Quality Standard for Dumbo Catfish Feed. However, additional protein sources are needed to fulfill the nutrition.

Additional sources of protein can come from tofu dregs, organic vegetable waste, and rejected eggs. Tofu dregs contain abundant nutrients such as 26.6% protein (Masyhura et al., 2019), organic vegetable waste has a protein content of 12.64-23.50% (Muktiani et al., 2013), while rejected eggs are a source of high quality protein amounting to 54.14%. % (Nurmaslakhah et al., 2017). Research conducted by Merliza (2022) used tofu dregs, organic vegetables, and restaurant leftovers combined with waste from fish smoking to make African catfish pellets. Proximate test results show that K.2 (combination of smoked fish waste and vegetable waste) is the best combination and meets the quality criteria for African catfish feed, with a protein content of 33,82%, water content of 7,45%, ash content of 9,27% , and crude fat content 18,43%.

Tofu dregs as one of the feed ingredients for catfish contain abundant protein of 26.6% (Masyhura et al., 2019). Based on research by Anggraeni dan Rahmianti (2016), processed catfish feed products with feed variables from tofu and shrimp head dregs (AT2) produce 43.05% protein, 69.86% carbohydrates, 25.5% fat. The addition of tempeh yeast to making catfish feed can affect the levels of carbohydrates, fat, protein and fiber in the feed. Research by Kurniawan, dkk. (2022) stated that higher yeast concentrations result in lower carbohydrate content, longer fermentation time, and lower protein content in catfish feed. The higher the yeast concentration, the lower the fat content obtained. The longer the fermentation time, the lower the crude fiber content in catfish feed. The higher the yeast concentration, the higher the crude fiber content.

The use of rejected chicken eggs as raw material for African catfish feed was used in research by Suminto, et al. (2018). This research used rejected egg flour which contained crude protein of 54,14%, crude fat of 22,44%, crude fiber of 5,85%, ash of 10,67%. With this composition, the best provision for feed is 30%, which contains 33,95% protein according to the catfish's protein needs to grow. Apart from that, the dry sludge that comes out of the belt press filter device at the poultry slaughterhouse WWTP can be used as an alternative animal feed. The sludge contains 62% high protein, 20% carbohydrates, 17% fiber, around 1% fat, and minimal heavy metal content (Irshaid, et al., 2021). This study builds on existing research to analyze the optimal nutrition of catfish pellets consist of oil and fat waste from the meat processing industry with the addition of tofu waste, vegetable waste, and rejected egg waste. Apart from providing ecological benefits by reducing waste, this research is also expected to improve the economy and quality of waste and reduce the production costs of catfish cultivation.

2. RESEARCH METHODOLOGY

2.1 Research Stages

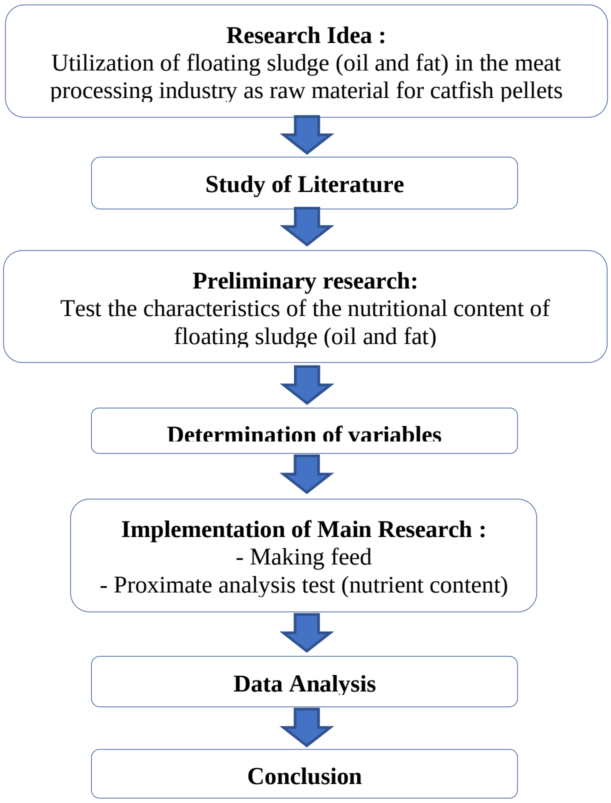

Figure 1. Flowchart of Research Stages
(Source: Researcher Data, 2023)

In this research, EM4, which is specialized for seafood and sugarcane molasses, was fermented for 4 days with the addition of other waste materials to increase the nutritional value of the feed produced. There were five treatment options in this study. The variation made is the composition of the materials used. Before sampling, the material requirements are calculated by first determining the amount of pellet production that will be made in each combination treatment with the comparison of the material composition listed in Table 1.

2.2 Research variable

2.2.1 Fixed Variables

- Total pellet weight 1 kg/variation
- Fermentation time 4 days
- Tapioca Flour (1%)
- Pollard (7%)
- Maggot Flour (10%)
  Vitamins and Premix (2%)

2.2.2 Independent Variable

Combination Variations:

Table 1. Material Composition

Combination	Material Composition (%)								Total Pellet Weight
	Floating Sludge of Meat Processing Industry	Tofu Dregs Waste	Organic Vegetable Waste	Rejected Egg Waste	Tapioca Flour	Pollard	Maggot Flour	Vitamins dan Minerals	
K0 [1]	100	-	-	-	-	-		-	1 kg
K1 [2]	50	30	-	-	1	7	10	2	1 kg
K2 [3]	50	-	30	-	1	7	10	2	1 kg
K3 [4]	50	-	-	30	1	7	10	2	1 kg
K4 [5]	20	20	20	20	1	7	10	2	1 kg

(Source: Researcher Data, 2023)

Information:
1. K0 (oil and fat of meat processing industry 99%);
2. K1 (oil and fat of meat processing industry 50% + tofu dregs waste 30%);
3. K2 (oil and fat of meat processing industry 50% + organic vegetable waste 30%);
4. K3 (oil and fat of meat processing industry 50% + rejected egg waste 30%);
5. K4 (oil and fat of meat processing industry 20% + tofu dregs waste 20% + organic vegetable waste 20% + rejected egg waste 20%).

2.2.3 Dependent Variable

a. Crude Protein Content
b. Crude Fat Content
c. Crude Fiber Content
d. Water Content
e. Ash Content

2.3 Steps of Making Catfish Feed

The steps of making fish pellets from oil and fat for the meat processing industry are as follows:

1. Clean all materials from existing dirt.
2. Boil the rejected egg waste first for 10 minutes.
3. Dry each waste below the sun or by oven at a temprerature of 105^{o}C until completely dry. Then grind it until it has a flour texture using a blender and sift it as finely as possible so that the ingredients last longer.
4. Mixing each waste flour with other ingredients: tapioca flour, pollard, maggot flour, vitamin and mineral premix. Mixed according to the specified composition. Then add water little by little until smooth and add 2 bottles of fish oil.
5. Fermentation process for each variation by adding 20 ml EM4, 20 ml molasses and sufficient water. Then placed in a tightly closed container and left for 4 days.
6. The dough is molded using a meat grinder and cut into ± 3 mm pieces and then dried in the sun or placed in an oven at 50-80^{o}C until dry.

2.4 Data analysis

Data analysis uses proximate analysis. Various methods and parameters were tested, including:

- Measuring moisture content using method of 930.15 (*oven*) AOAC 2019
- Measuring ash content using method of 942.05 (*dryashing*) AOAC 2019
- Measuring fat content using method of 2003.06 (*Soxhlet*) AOAC 2005
- Measuring protein content using method of 2001.11 (*Kjeldahl*) AOAC 2019
- Measuring crude fiber content was measured using the SNI-01-2891-1992 method.

The results of the proximate analysis of the artificial feed were then compared with the feed quality standards for Dumbo Catfish which refer to SNI 01-4087-2006. Next, these results were analyzed descriptively. Apart from that, an analysis of the best nutrition for catfish feed combinations was also carried out.

3. RESULTS AND DISCUSSION

3.1 Preliminary Research

Preliminary research, namely in the form of an initial analysis to find out the characteristics and potential of floating sludge, is discussed through initial analysis of the proximate test, which is a chemical method used to identify biochemical components in food ingredients or food products, including fish pellets. The initial proximate test involves measuring ash content, water content, crude fiber content, protein content and fat content in floating sludge. The results of this initial proximate test are documented in Table 2.

Table 2. Proximate Test Results for Floating Sludge (Oil and Fat) in the Meat Processing Industry

Parameter	**Rate (%)**	**SNI (%)**
Water content	8,76	Max. 12
Ash content	5,95	Max. 13
Crude protein content	22,10	Min. 28
Crude fat content	37,17	Min. 5
Crude fiber content	2,16	Max. 8

(Source: Research Results, 2023)

Preliminary test results show that floating sludge has crude fiber content, crude fat content, water content, and also ash content in accordance with SNI 01-4087-2006 quality standards for Dumbo catfish (Clarias gariepinus) feed. However, the results of the crude protein content in floating sludge is still below standard, in rate 22.1%, while the minimum SNI standard is 28% for Dumbo catfish feed during the rearing period. It was obtained from the raw materials used by the meat processing industry, namely animal flesh, which definitely contains high protein levels. The general characteristics of liquid waste from the meat processing industry are that it has high solubility and a mixture of organic substances, and has high protein and fat content (Inayati & Suhadi H. S, 2013). So that the remaining waste materials from the production process that enter the WWTP still contain protein nutrition, although the levels are not as high as the initial levels.

The water content meets SNI standards because it is supported by the drying process using the drying method in the sun and by oven. This is able to evaporate most of the water content in a material. So that floating sludge originating from liquid waste can change into a denser and harder form.

The ash content is in accordance with SNI standards because the liquid waste contains inorganic materials, although the amount is not as much as organic materials. These inorganic materials can come from dust and sand that enter liquid waste during the production process of industry. According to Marpaung & Septiyani (2020), the ash content gives an idea that there are impurities entering, such as silicate soil, dust, sand or metal originating from processing and production processes. Apart from that, the ash content can also come from minerals contained in the production raw materials used in the meat processing industry, namely chicken, beef and fish. The animal's meat contains minerals from food that the animal has previously consumed. So that the production activities of the meat processing industry produce liquid waste which also contains minerals and is one of the causes of the ash content in floating sludge (oil and fat).

Apart from that, the crude fat content is also the same as the protein content. The test results for the crude fat content of floating sludge were 37.17%. This is also due to several types of fat contained in beef, namely phospholipids, cerebroside and cholesterol (Buckle et al in Maiyena & Mawarnis, 2022). Therefore, industrial wastewater also contains a lot of oil and fat, as stated by Arifudin et al. (2019) that wastewater resulting from the production process of the food processing industry contains large amounts of organic material and fat/oil.

And the last parameter is crude fiber content. The amount of carbohydrates (crude fiber) in meat processing industry waste is not as much as protein and fat, because meat is the basic ingredient those used in production do not contain too many carbohydrates. According to (Nurhidayat, 2023), the carbohydrate content in chicken meat is around 1,2%. Meanwhile, beef is only 0,5% (Soeparno, 2005). Apart from that, crude fiber can also be obtained from using flour as a product dough. So the flour ingredients used to make nuggets, sausages, and so on are carried away as waste water when cleaning the production room and have the potential to become crude fiber levels in the waste water. Therefore, in this study, floating sludge from the meat processing industry contained crude fiber levels, but the amount was only small.

According to Parjus *et al*. (2011), that the oil and fat trapped in the grease trap unit has the potential to be used as an alternative such as animal feed. The problem of the lack of protein content in floating sludge can be helped by adding other rich raw materials of protein such as maggot flour and waste materials from tofu dregs, organic vegetables, rejected eggs, and so on. This can also be seen in research by Merliza (2022) which used a mixture of waste from tofu dregs and organic vegetables as an additional source of protein in making catfish feed which came from the main ingredient of fish smoking waste and was proven successful in increasing the protein content of the feed.

In Merliza's research (2022), the mixture composition for the main waste material was 50%, other waste (tofu dregs and vegetable waste) was 30%, and the remaining 20% was supporting material (adhesives and vitamins). So, from the existing references, it can be used as a basis that these waste materials have the potential and are suitable to be used as additional ingredients for making fish feed so that the nutrition of catfish feed made with floating sludge as the main ingredient can be increased. So it is hoped that it can produce catfish feed that complies with SNI 01-4087-2006.

3.2 Primary Research

This research discusses the nutritional content of catfish feed. This nutritional content is very important in determining the best feed combination. This feed mix is made up of a variety of ingredients, including used fats and oils from the meat processing industry, tofu scraps, organic vegetables, and rejected eggs. The best feed combination is determined based on detailed testing that measures water, ash, protein, fat, and crude fiber content. The raw materials used increase the nutrient content of the feed.

3.2.1. Water Content in Feed

Water content is the percentage of water content in the ingredient in fish feed. This water content can be measured by dry weight or wet weight. Water content affects feed quality, including fish acceptance of feed, freshness and perishability (Winarno, 2008). Moisture content is also important in determining where to store feed and comparing the nutrient quality of ingredients under the same conditions (Muliani *et al*., 2019). According to SNI 01-4087-2006, the water content in catfish feed must be less than 12%.

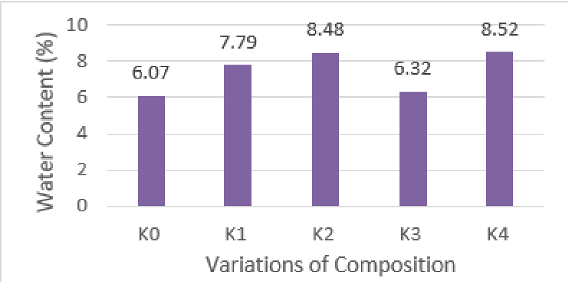

Figure 2. Water Content of Feed Test Results
(Source: Analysis Results, 2023)

The test results in Figure 2 show that all combination treatments have water content below 12%, which meets SNI standards. The most optimal water content was found in the lowest K0 combination feed, namely 6,07%. This is because the weather is hot and the drying time is quite long in the process of making feed. The drying time is drying the material for 7 days and drying after the palleting process for 3 days so that the feed is completely dry. This is in line with Rasyaf's (1992) statement which states that factors that influence moisture levels are the storage method, climatic conditions in the storage area, and the duration of the drying process, all of which have an impact on the quality of feed raw materials. To dry the materials, we need to use high temperatures and a long time. So that, a lot of water will evaporate from the material (Desrosier, 1988). Then, differences in moisture levels in feed are also caused by the influence of the water content contained in the constituent ingredients mixed with excess water (Darsudi et al., 2008).

3.2.2. Ash Content in Feed

Ash is an inorganic residue from the process of burning food. Ash content in fish feed is related to fish digestibility and growth. According to SNI, the ash content in catfish feed must be less than 13%. In this study, the proximate test results in Figure 3 show the coarse ash content in the feed that has been prepared for catfish. There were three treatment combinations that showed coarse ash content below 13%, namely K0 at 10,48%, K1 at 8,44%, and K3 at 10,49%. These results are in accordance with the SNI 01-4087-2006 standard. However, the most optimal in terms of ash content is the combination K.1, with the lowest ash content.

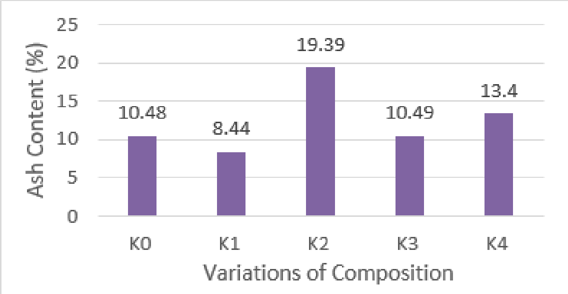

Figure 3. Ash Content of Feed Test Results
(Source: Analysis Results, 2023)

Ash content in feed is an inorganic component that cannot be consumed by fish (Zaenuri et al., 2014). If the ash content is too high for feed, it indicates the presence of many inorganic subtances or subtances that cannot be consumed by fish. One of the reasons for high ash content is excessive steaming, especially in feeds made from flour. This process can cause the ash content to increase significantly due to gelatinization of the flour due to too high a heating temperature. Apart from that, feed K2 and K4 also contain lots of minerals that come from vegetable waste such as cabbage, mustard greens, kale and lettuce. This mineral content ultimately increases the ash content in feed. Previous research shows that the relationship between ash content and mineral content is if the ash content is high, so the mineral content is also high (Sudarmadji & Bambang, 2003). In other words, the lower the ash content, the higher the content of organic materials such as protein, fat and crude fiber.

The mineral content in vegetable waste is quite high. For example, 100g of cabbage contains 64 mg calcium, 8 mg sodium, 0.7 mg iron, and 26 mg phosphorus (Pracaya, 2001). Meanwhile, 100 grams of fresh and steamed water spinach leaves and stems contain 21,956 mg magnesium, 247 mg potassium, 47 mg calcium, 56 mg sodium, and 31 mg phosphorus (Jacoeb & Purwaningsih, 2012). The mineral content in 100 grams of dried mustard greens is 14.21 mg iron, 38.4 mg phosphorus, 526 mg calcium, 770.1 mg potassium, and 129.1 mg magnesium (Marsigit & Hemiyetti, 2018). Therefore, the high mineral content in vegetable waste contributes to increasing the ash content in K2 and K4 feed, even exceeding the SNI standards set.

3.2.3. Crude Protein Content in Feed

Protein is the main energy source that allows fish to develop. Protein molecules (oxygen, nitrogen, hydrogen, carbon, sulfur, and phosphorus) are needed by fish for energy, tissue repair, growth, and reproduction. African catfish, which are omnivorous fish that have a tendency to become carnivorous, really need protein in their food (Manik & Arleston, 2021). SNI for catfish feed stipulates that the minimum protein content required is 28%.

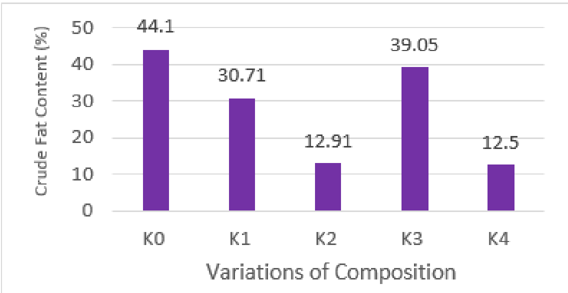

Figure 4. Crude Protein Content of Feed Test Results
(Source: Analysis Results, 2023)

The proximate test results in Figure 4 show that there is no feed combination that has a protein content above 28%. The combination of K0 has a protein content of 23,68%, K1 of 23,09%, K2 of 18,3%, K3 of 24,8%, and K4 of 20,3%, all of which do not meet SNI standards for catfish feed. However, the fish feed of K3, which is made from suspended sludge and rejected egg waste, contains the highest protein among all combinations. The increase in protein levels in K0, K1, and K3 feed is caused by the fermentation process, which has been proven in previous research (Rachmawati et al., 2006). The decrease in protein levels in the feed is thought to occur due to excessive drying during the process of drying vegetable waste in an oven. Protein levels in feed are greatly influenced by temperature, heating time and water content. The heating process during pelleting can cause protein denaturation in the feed (Herawati & Royani, 2019). Therefore, long drying and high temperatures cause a decrease in protein levels in feed ingredients (Romadhon et al., 2013).

The decrease in protein levels can also be affected by the moisture content in the feed raw materials and variations in the waste used. The protein content in the raw materials that make up fish feed also contributes to differences in protein levels in feed (Romadhon et al., 2013). Fish's need for protein ranges from 20-60% of the total weight of food, with an optimal requirement of around 30-36%. Protein levels in K0, K1, K3, K4, which range from 20-24%, still meet the protein needs of fish, even though fish growth may not be optimal. However, K2 feed does not meet the protein requirements for fish because the protein content is below 20%

3.2.4. Crude Fat Content in Feed

In designing feed composition, fat has an important role in increasing the ability of fish to float on the surface of the water (Mahyuddin, 2008). n general, the functions of fat include being a source of energy, being a basic ingredient for hormones, supporting the transport of fat-soluble vitamins, acting as an insulator against temperature fluctuations, and functioning as a protector for the body's internal organs (Manik & Arleston, 2021).

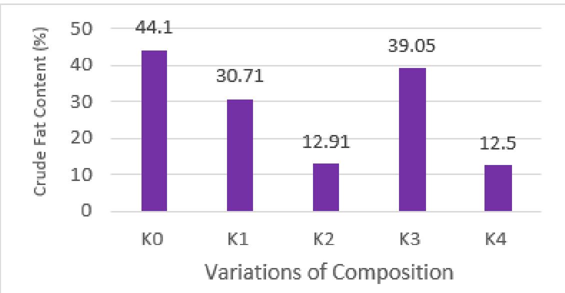

Figure 5. Crude Fat Content of Feed Test Results
(Source: Analysis Results, 2023)

Figure 5 shows the results that there are significant variations in crude fat content between the combinations. The fat content ranges from 12,5% to 44,1%, with the K0 combination having the highest fat content because it contains more floating sludge from meat processing industry waste. The results of this research are in line with research conducted by Merliza (2022), who also found that the K0 feed combination had a higher fat content compared to other combinations. This is likely caused by differences in the quality of the feed ingredients used.

Apart from that, this research also noted that K2 and K4 feeds have lower fat content and are in accordance with the needs of catfish. This could be explained by the ingredients used in the feed, such as tofu scraps, vegetable waste, and unused eggs, which have a lower fat content compared to floating sludge. This research supports previous findings which show that the composition of raw materials greatly influences the fat content in fish feed (Zaenuri et al., 2014). As like the opinion of Muliani et al. (2019), who also stated that the high or low fat content in feed also really depends on the high or low level of fat contained in the raw materials. These factors are important to consider in an effort to produce fish food which is nutritious and healthy for fish.

3.2.5. Crude Fiber Content in Feed

Crude fiber is some of fiber type that animals cannot eat it, but even in small amounts can make a positive contribution in facilitating the digestive process. However, based on previous research (Herawati & Royani, 2019), the higher the crude fiber content in the feed, the lower the digestibility of the feed. The SNI standard for catfish feed stipulates that the maximum required crude fiber content is 8%.

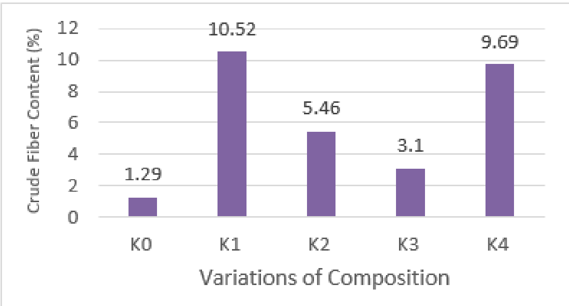

Figure 6. Crude Fiber Content of Feed Test Results
(Source: Analysis Results, 2023)

In this research, crude fiber content tests were carried out on several types of feed with various combinations of raw materials. The proximate test results presented in Figure 6 show that there are three combination treatments (K0, K2, and K3) which have crude fiber content below 8%, which meets the SNI 01-4087-2006 catfish feed standards. The most optimal crude fiber content in catfish feed is contained in the K0 combination feed. However, feed with crude fiber content that does not meet SNI standards is combination feed K1 and K4, with respective levels of 10,52% and 9,69%. Crude fiber content in feed is influenced by the raw materials used.

There are two feeds with high crude fiber content, K1 and K4, contain a mixture of tofu dregs waste. According to research by Duldjaman (2004), tofu dregs waste contains high crude fiber levels of 22,65%. Even though the crude fiber content of tofu dregs decreased in this study, it still exceeds SNI standards due to the high crude fiber content of the raw material. Apart from tofu dregs, research results also show that maggot flour has a fairly high level of crude fiber content, namely 30,2803% (Mahendra, 2020). This crude fiber content also plays a role in increasing the crude fiber content in feed. Apart from that, high fiber content in feed can also be caused by excessive fermentation duration, which causes an excessive decrease in water content in the material and reduces the crude fiber content in the feed (Fajarudin et al., 2013). All of these factors must be taken into account in developing quality catfish feed.

3.2.6. The Best Composition of Catfish Food

Table 3. The Comparison of Nutrients in Combination Feeds

Parameter	SNI (%)	K.0	K.1	K.2	K.3	K.4	Commercial Feed (Trademark SAFIR 2)
Water Content	Max. 12	6.07%	7.79%	8.48%	6.32%	8.52%	12%
Ash Content	Max. 13	10.48%	8.44%	19.39%	10.49%	13.4%	13%
Crude Protein Content	Min. 28	23.68%	23.09%	18.53%	24.48%	20.53%	32%
Crude Fat Content	Min. 5	44.10%	30.71%	12.91%	39.05%	12.5%	5%
Crude Fiber Content	Max. 8	1.29%	10.52%	5.46%	3.10%	9.69%	6%

(Source: Analysis Results, 2023)

In this research, the nutrition of five feed combinations that have been made is analyzed, by comparing them with SNI 01-4087-2006. These results are presented in Table 3. It can be seen that K.3 feed stands out as the best choice when compared with SNI 01-4087-2006. The combination of K.3 feed comes from floating sludge with rejected egg waste. The combination of K3 and K1 successfully meets most of the SNI parameters, including crude fat, moisture content, ash and crude fiber. However, one aspect that still does not meet standards is the protein content. K3 has higher protein levels compared to K1. Feed of K3 has several advantages, namely high ash content and low water content so that it can improve feed performance by allowing it to float longer compared to K0, K1, K2, and K4. The low crude fiber content in K.3 is also beneficial because it makes fish digestion easier. Even though K.3 has good nutrition, commercial feed (K.5) still has the highest protein content, namely 32%. This is because commercial feed is produced using special technology and through detailed composition calculations and repeated testing to ensure it complies with SNI. However, K.3 can still be used as a reference for making alternative feed for fish farmers who want to save on feeding costs.

4. CONCLUSION

The combination of feed made from floating sludge (oil and fat) of the meat processing industry and rejected egg waste (K.3) has the best nutrition if seen from SNI 01-4087-2006 which is the quality standard for catfish feed. The K.3 feed combination has low water content, high ash content, and quite low crude fiber content. Even though the protein content is still below SNI standards, K.3 can be used as an alternative feed for catfish which can reduce cultivation costs. However, attention is needed regarding the high levels of crude fiber in some feed combinations. The use of tofu dregs, organic vegetable waste and rejected eggs as additional sources of protein in catfish feed has the potential to reduce industrial waste and feed production costs. However, the feed needs to change the composition of the ingredients, especially the ingredients that have the highest protein value, to increase the amount to produce feed with a protein value that meets SNI. This research contributes to reducing environmental pollutionby developing alternative fish feeds. So that the production costs in catfish cultivation can be saved. Apart from that, the results of this research can also motivate more research on industrial waste management and the development of waste-based fish feed.

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