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AN EXPERIMENTAL STUDY TO PRODUCE FISH FODDER USING ALTERNATIVE INGREDIENTS

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Abstract: *The sustainable and economic development of the fishing industry is heavily dependent upon the choice of raw materials used in fish fodder. Furthermore, an inappropriate amount or nutritional quality of fodder will impede the health and growth of the farmed fish. This work therefore aims to determine the feasibility of substituting snail flour for fishmeal in fodder. The experimental and statistical results indicated no significant nutritional difference between fodder synthesized with fishmeal or snail flour as the protein source. Therefore, snail flour can be used to replace fishmeal used in milkfish fodder without negatively affecting the health of the milkfish*
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Keywords: *milkfish food; completely randomized design; snail*

Introduction

As Indonesia is a maritime country, a well-managed fishing industry can empower thelocal and national economy. The extensive coastlines and wide watery areas provide a natural advantage for the Indonesian fishing industry. However, this sector is still facing upstream and downstream problems. Upstream, raw material and fresh fishfood production performance must be increased; downstream, there is a lack of product diversification. In 2012, over 6.27 million tons of fish were produced in Indonesia from approximately 1134.6 ha. This represents just half of the estimated sustainable marine fish potential (12.54 million tons) in all Indonesian territory and waters [1]. The market demand for fish supplies will increase with further increases in social welfare, widespread knowledge regarding the nutritional value of fish, and population.

Milkfish is a brackish water fish that provides an excellent source of animal protein that can be reached by most society. Increasing the production of milkfish, which has high economic value, can provide a nutritious food source to help increase the standard of living of Indonesian residents. As with any livestock, thechoice of feedstock is a critical factor. Supplying an inappropriate amount or quality of food negatively affects the health and growth of the fish supply [2]. The protein content of the feedstock plays an especially important role in influencing the body structure, growth, and reproduction of fish. Furthermore, as the feedstock accounts for an estimated 60%–70% of total production costs, increases in the price of fish food can cause the economic failure of any milkfish production process [3]. The high price of the fish food results from the high required protein levels, which are generally met using protein from fish flour. Synthetic foodsare often expensive.

Although saltwater and freshwater fish are renewable resources, unchecked growth in their consumption without regard for the available resources poses a threat to the sustainability of the industry. The use of synthetic fish food increases the presence of preservatives and harmful chemicals, both in the environment and in the milkfish, making them unhealthy for human consumption. The supply of feedstock ingredients thus

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represents a large challenge to improving the fishing industry [4].

Thus, researchers have aimed to diversify the feedstock of milkfish, considering the nutritional value, raw material quality, and pricing of the feed. For example, by modifying the formulation of fish fodder using soy and tofu waste, Aslamsyah (2009) demonstrated a reduction in costs without impeding milkfish growth [5]. Similarly, the production of milkfish food using worm flour as a partial substitute for fish flour demonstrated similar results [6]. Maggot flour has also been experimentally demonstrated as a protein substitute for fish flour in milkfish fodder [7].

Snails are commonly associated with household pests and have rarely been used in the production of fish fodder. However, snail flour has a composition of 59.27% protein, 3.62% fat, 2.47% crude fiber, 6.4% calcium, and 0.85% phosphorus [8]. In an effort to introduce alternative fish fodder, () demonstrated that the feedstock of red parrotfish could be substituted by snail flour up to 50%. There is no explanation about the composition of each ingredient to produce fish food, particularly for milkfish.

This work therefore aims to determine the best composition of the ingredient of fish fodder. The composition of common milkfish feedstock is first investigated to determine the nutrient requirements. There were five kinds of compositions as treatment and proximate test held to know the compositions of water, ashes, protein, fat, crude fabric, BETN, digestible energy (DE), and C/P.

Literature review

Fodder refers to the food provided to livestock and is categorized as high-grade when having a high protein content and containing a proper balance of proteins, fats, carbohydrates, and vitamins. When purchasing fodder, the storage time and method must be considered in addition to the quality, as most fodders expire within 2 weeks, and must be kept dry and stored in airtight containers to prevent spoilage or fungus growth. Additionally, the type of fodder must be considered, whether natural or synthetic. Synthetic fodders are made from synthetic materials and are alkaline in the form of pasta and emulsion. Wet fodders often expire quickly and thus should be used in a single feeding, although they can be stored in a cold environment for up to 3 days. The storage of fodder exceeding the recommended expiration date decreases the quality and increases the likelihood of spoilage. Overall, the raw material used in fodder must meet several requirements, including the nutritional value, ease of digestion, poison content, easy to get, and not primary needs for human.

Synthetic fodder can be further classified into complete and supplemental feeds. A complete feed is formulated to contain the proper ratio of all the essential nutrients required by the livestock and is intended to induce normal growth in livestock that did not receive the supply of vitamins from natural food. Supplemental feed consists of nutrient formulations to make up for any deficits in the regular feedstock, commonly proteins or micronutrients. Using synthetic fodder allows for the low-cost valorization of agricultural or industrial wastes while maintaining high nutritional requirements. Synthetic fodder also can be stored for a relatively long time, allowing feeding needs to be met when necessary.

Synthetic fodder used for milkfish consists of several ingredients, including fishmeal and bran smooth. Fishmeal consists of dried and milled fish or parts of fish, with or without oil, and is mainly used as an ingredient in a variety of animal fodders, including chickens, pigs, and fish. High-quality fishmeal should be free from insects, fungi, pathogenic microorganisms, bones, eyes, and any other foreign substances, have a subtle uniform color, and have a distinctive “fishy” smell [9]. Bran smooth is a waste product of rice mills that acts a supporting component in synthetic food. There are rough and there were fine, both when mixed with water is rough tasted lots of fiber, otherwise smooth like porridge chewy, both can be used as animal feed ducks, additional food fish, etc.

To meet the nutritional requirements of milkfish, vitamins and minerals must also be added to synthetic fodder. Vitamins are a set of diverse organic compounds with low molecular weight (i.e., ≤1000) that are vital for the healthy functioning of an organism but cannot be synthesized by the body in an

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adequate amount. An inadequate amount of added vitamins in a synthetic feed will result in the decline of the health of the livestock. Minerals are inorganic elements that are also necessary for normal life processes. Although fish can absorb someinorganic elements from their environment, some must be added to their feedstock. As a result, a mineral mix is added to the artificial feed in the range between 2% and 5% of the total amount of raw materials, depending on the type of fish being fed.

Experimental research is a research that seeks the influence of specific variables on other variables with tight control by Design of Experiment [10]. An experimental research study is a systematic, logical, and strictness to control the condition [11]. An experimental research can be interpreted as a method used to find a specific treatment effect against the other in uncontrolled conditions [12].

Research experiments using a trial that is specifically designed to generate the data needed to answer the research question [13]. In conducting the experiment, the researchers manipulate a stimulant, treatment, or experimental conditions and then observe the effects caused by the treatment or the manipulation. The aim of this experimental study was to investigate the hypothesis proposed in the study, predicted event, or events in the experimental background and generalize the relationship between variables.

Experiments comprise two baselines. First, at least two or more conditions or methods, that used for testing effects of a certain condition or “treatment,” as the independent variable. Second, the independent variable directly manipulated by researchers. There are two groups in the experimental design, namely, the experimental group and the control group. Both groups were as far as possible homogeneous or have similar characteristics. In the experiment given influence or treatment certain, while in control group not given. In addition, the research process is running and observed to determine the differences or changes in the experimental group.

Research methodology

To determine the best composition, a series of experiments by substituting a percentage of fishmeal with snail flour were performed, asdetailed in Table 1, where each trial was performed twice. The steps of this research are as follows :

1. Determine the composition of fish feed required according to Table 1 with fish meal substituted with snail meal. The composition of fish feed was designedfor five treatments with two replications.
2. Making fish feed
3. To test the chemical content in the laboratory to determine the protein content in the five compositions of fish feed.
4. Conduct chemical content tests in the laboratory to determine the energy content of the five fish feed compositions.
5. Analyzing differences in protein and energy levels in the five fish feed compositions using the Random Perfect Design method.
6. Analyzing the effect of increasing the percentage of snail flour on the increase in protein and energy levels.

Results and discussion

Feed production test with fishmeal substitution with flour snails

Fish fodder was produced in a series of trials substituting a percentage of fishmeal with snail flour; the composition of each trialed fish fodder is detailed in Table 1, where each trial was performed twice. Changes in the composition of fish feed to determine changes in content in fish feed when fish meal is substituted with snail meal which is a control factor. Substitution of fish meal with snail flour was carried out at various levels, namely 0%, 25%, 50%, 75%, and 100%. In Table 1 it can be seen that in experiment A, fish meal was 70gram (100% of the composition of fish meal and snail flour) and without a mixture of snail flour (0%). In experiment B the composition of fish meal was 52.5 grams (75%) and snail flour was 17.5 grams (25%), while in experiment C the composition of fish meal was 35 grams (50%) and snail flour was also 35 grams (50%). For experiment D, the composition of fish meal was 17.5 grams (25%) and snail flour was also 52.5 grams

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(75%) while in experiment E did not use fish meal (0%) and 28gram snail flour (100%). For other ingredients such as soybean flour, bran flour, wheat flour, fish oil, vitamins, minerals, adhesives and water are fixed.

The control factor in this study was the amount of fish meal and snail meal used to determine the protein content and energy content/digestible energy (DE) in fish feed. The control factor chosen was due to limited fish resources and is a human food need. In addition, the price of fish meal is more expensive than snail flour so that snails can be used as an alternative to substitute fish meal. Replication was carried out twice with the assumption that the experimental results had the same component characteristics. The amount of fish feed made is 250gram according to the needs of the experiments carried out. Due to the need for testing the content of fish feed in the laboratory only requires <100 grams, then the amount of fish feed of 250 grams is considered sufficient.

The snail fodder was first prepared, as presented in Figure 2, by:

1. releasing the snail meat from the shell,
2. drying the snail meat in an oven for approximately 90 min,
3. blending the dried snail meat, and
4. sieving the blended flour.

Figure 2. Snail flour production process

Next, the fish fodder was prepared, using the snail and soybean flour as protein, bran and polar flour as carbohydrates, fish oil as fat, and a vitamin and mineral mix. The raw materials were weighed and then blended together to form a homogeneous mixture having the smallest percentage to the highest percentage and added CMC gluten around 3%–5%.

The homogeneous blend of ingredients was knead into a printable dough that was then fed to a printing press to produce round, elongated noodles. These noodles were cut into smaller pieces to be fed to the fish. They were then oven-dried or sun-dried, cooled to room temperature, put in a plastic bag, labeled, and stored in a dry place. The treatment level tested in the substitution of fishmeal with snail flour in making fodder milkfish, namely: feed A: 0%, feed B 25%; feed C 50%; feed D 75% and E 100% starch feed snails. Food that has been so tested to the Faculty of Animal Nutrition Laboratory.

Table 1. Raw Material Composition of Fish Fodder Ingredient on Each Treatment.

Trial	A		B		C		D		E	
Raw Material	%	mass (g)	%	mass (g)	%	mass (g)	%	mass (g)	%	mass (g)
Fishmeal	28	70	21	52.5	14	35	7	17.5	0	0
Snail flour	0	0	7	17.5	14	35	21	52.5	28	70
Soybean flour	30	75	30	75	30	75	30	75	30	75
Bran flour	20	50	20	50	20	50	20	50	20	50
Wheat flour	18	45	18	45	18	45	18	45	18	45
Fish oil	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5
Vitamin mix	2	5	2	5	2	5	2	5	2	5
Mineral mix	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5
Gluten	5	12.5	5	12.5	5	12.5	5	12.5	5	12.5
Water	10	25	10	25	10	25	10	25	10	25

Note: Each treatment was 250 g

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Composition of resulting synthetic feed

The nutritional composition of the synthesized milkfish fodder was analyzed; the results, summarized in Table 2, indicated that all studied trials sufficiently met the nutritional needs of the milkfish in all aspects (i.e., protein, carbohydrates, fats, vitamins, and minerals).

Milkfish fodder for milkfish weighing 0.01–0.035 g requires 52%–60% of protein; those weighing 0.04 g require 40% of protein; and those weighing 0.5–0.8 g require 30%–40% of protein[14]. Thus, they need less protein in their feed as they grow. Juvenile fish require a fat and carbohydrate feedstock content of 7%– 10% and 20%–30%, respectively. The balance of protein and energy in the diet affects the growth of the fish. Protein is used mainly in the maintenance and growth of the fish by reducing the oxidation of protein into energy. This is to meet the energy needs of non-protein, such as carbohydrates, and fats. Fodder with an optimum protein-to-energy ratio illustrates the point of balance between the amount of energy required for basal metabolism and growth. An increase in the energy content of the feed can cause the fish to consume the food at a slowerpace, thus limiting their intake of other essential nutrients and reducing their growth. Instead, feed that energy shortages will cause the feed protein is used as energy for the purposes of fish metabolism. This is the basis for this study to analyze the protein content and energy content in 5 kinds of experiments carried out bysubstituting fish meal and snail meal for two replications.

Table 2. The Results of Laboratory Testing

Trial	Dry Ingredients	Water Level (%)	Ash Level (%)	Organic Ingredient (%)	Rough Protein (%)	Rough Fat (%)	Rough Fiber (%)	Nitrogen-free Extract Ingredients (%)	Rough Energy(kcal/gr))
A1	93.15	6.85	12.11	87.89	27.41	10.86	11.13	31.64	2664.0
A2	94.11	5.89	13.66	86.34	25.71	12.41	12.76	29.56	2585.2
B1	92.98	7.02	11.07	88.93	23.43	8.65	8.59	41.25	2785.4
B2	94.38	5.62	11.79	88.21	24.03	9.96	11.01	37.59	2723.3
C1	89.43	10.57	13.90	86.10	26.87	9.36	7.55	31.47	2595.4
C2	90.22	9.78	13.16	86.84	22.98	10.43	8.67	34.98	2610.3
D1	94.12	5.88	12.89	87.11	22.45	9.50	11.95	37.33	2641.6
D2	94.87	5.13	11.76	88.24	22.98	9.23	9.59	41.30	2792.0
E1	92.87	7.13	10.76	89.24	29.92	10.26	8.14	33.78	2808.0
E2	94.50	5.50	11.79	88.21	24.27	9.37	7.89	41.18	2838.4

In table 2 indicates a balance between the amount of energy and protein. Protein is used as a function of fish maintenance and growth by reducing protein oxidation into energy. This is to meet the energy needs of non-protein, such as carbohydrates and fats. From Table 4.2 it can be seen that the composition of milkfish feed with fish meal substitution with snail flour can be done up to 100%.

Design of experiments

Fully randomized trials were used. Through this method, the levels of crude protein and feed DE experimental results five treatments were tested to get a conclusion on whether there is a difference between the resultsof the five treatments.

Analysis of protein content

Analysis of a fully randomized design was conducted to prove whether treatment composition of fish feed ingredients to yield significant result toward increased levels of protein. Fifth ingredients composition was examined by replicating data capture as much as two times. Table 3 presents the grouping of replication in accordance with the composition of each.

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Table 3. Rough Protein Contents in Fish Feed

	Rough Protein				
Replication	A	B	C	D	E
1	27.41	23.43	26.87	22.45	29.92
2	25.71	24.03	22.98	22.98	24.27

In the fifth the energy content of the composition testing using a randomized design perfectly, with different results among the five treatments, testing is done to prove the level of significance of the difference of each fish feed. The hypothesis of this study is:
H_0: No difference between the rough protein of the fifth mixture of fish feed
H_1: Difference between the rough protein of thefifth mixture of fish feed
Furthermore, the calculation of the sum of squared error of observation to the sum of the squares on the experiment results. The results are summarized in Table 4.

Table 4. The Result of The Calculation

Symbol	Explanation	Result
Ry	Sum square observation	6252,5
PBy	Sum square mean	27,3245
∑*Y2*	Sum square treatment	6305,118
Ey2	Sum square errors	25,29275

Next, the calculations Central Square (*KT*) on each resource variance according to the respective degree of freedom (df). The results of further calculations used to determine the amount of the value of F count is 1,350, which is presented in Table 5.

Table 5. Calculation Ratio of Rough Protein Test

Source	*Dk*	*JK*	*KT*	F ratio	F Table
Mean	1	73135630	73135630		5,19
Ingredient percentage	4	66885,27	16721,32	4,94243	
Error	5	16916,09	3383,218		
Total	10				

The resulting F count was smaller than the value of F table; thus, H_0 was accepted. No significant difference was observed between therough protein of the fifth mixture of fish feed better use of fishmeal and snail flour. Theseresults can be used as a reference that the quality of fish feed ingredients pure fishmeal or snail flour mixture has the same protein content.

Analysis of energy content

Finally, the variation in energy content with the substitution of snail flour for fishmeal was analyzed to determine whether additional flour as a raw material companion snail can be done in the process of making fish feed. Furthermore, analysis of randomized design perfectly done to prove whether treatment composition of feed ingredients to yield significant results to increased energy content. Fifth ingredient composition was examined by replicating data capture as much as two times. Table 6 presents a grouping of replication in accordance with the composition of each, as follows:

Table 6. Energy Content in Fish Feed

	Energy				
Replication	A	B	C	D	E
1	2664	2785,4	2595,4	2641,6	2808
2	2585,2	2723,3	2610,3	2792	2838,4

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In the fifth the energy content of the composition testing using a randomized design perfectly, with different results among the five treatments, testing is done to prove the level of significance of the difference of each fish feed. The hypothesis of this study is:
H_0 : There is no difference between the energy content of the fifth mixture of fish feed.
H_1 : There is a difference between the energy content of the fifth mixture of fish feed.

Furthermore, the calculation of the sum of squared error of observation to the sum of the squares on the experiment results. The results of the calculation are presented in Table 7.

Table 7. Calculation Results

Symbol	Explanation	Result
Ry	Sum square observation	73135630
PBy	Sum square mean	66885,27
∑*Y2*	Sum square treatment	73219431
Ey2	Sum square errors	16916,09

The Central Square (KT) on each resource variance according to the respective freedom of degrees (df). The results of further calculations used to determine the amount of the value of F count is 1,350, which is presented in Table 8

Table 8. Calculation Fratio of Energy Content Test

Sumber Variansi	*Dk*	*JK*	*KT*	*F Hitung*	*F Table*
Rata-rata	1	73135630	73135630		5,19
Persentase Bahan	4	66885,27	16721,32	4,94243	
Ketentuan	5	16916,09	3383,218		
Total	10				

The resulting F count was smaller than the value of F table; thus, H_0 was accepted and H_1 was rejected. No significant differences were observed between the energy content of the fifth mixture of fish feed better use of fishmeal and snail flour. These results can be used as a reference that the quality of fish feed ingredients pure fishmeal or snail flour mixture has the same energy content. Viewed from an aspect of the above test showed that no significant difference in the content of protein and energy produced in fishmeal and snail mixing flour. Both a chemical test to analyze the quality of forage fish. Based on the test chemical on the test fee showed that the substitution of fishmeal to snail flour with different levels of quality products the same feed. Result of the proximate analysis indicates the nutrient content of forage feed is in the range of test needs of fish. Therefore, snail flour can be used to completely replace fishmeal with fish fodder.

Conclusion

In an effort to increase the sustainability and decrease costs of milkfish farming, this work analyzed the effect of replacing fishmeal with snail flour in milkfish fodder. The following conclusions were drawn:

1. No significant difference in nutritional value was observed by replacing fishmeal with snail flour. Thus, snail flour can fully replace fishmeal in milkfish fodder.
2. No significant difference in DE was observed by replacing snail flour with fishmeal. Calculation of chemical test value shows that the DE in combination fishmeal and snail flour is similar.
3. Similarly, no significant differences in the protein content were observedbetween the milkfish fodder usingfishmeal and that using snail flour.

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