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Analysis of Proximatic Levels and Sensory Quality of Organic Fish Feed from Fermented Coconut Drain Flour and Maggot Flour

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Abstract

Background: The rise of fish farming has caused the market price of feed to increase by up to 60% of the production cost, so fish farmers need a breakthrough in new fish feed to reduce the production cost of fish farming activities. **Methods:** The type of experimental research with a Completely Randomized Design (CRD) and factorial design. There was one treatment factor and two repetitions, and each was carried out with three treatments on the fermented coconut dregs flour and maggot flour formulations, namely M1, M2, and M3. Feed testing was carried out by proximate testing of protein and carbohydrate content and hedonic quality testing for panelists with color, aroma, and texture parameters. **Results:** The results of the proximate test of the protein content of fish feed formulas M1, M2, and M3 were 7.83%, 11.64%, and 9.04%, respectively. In contrast, the carbohydrate content of fish feed formulas M1, M2, and M3 were 29.26%, 23.08%, and 27.84%, respectively. Meanwhile, the color sensory test results of formula M1, M2, and M3 feed have subsets of 2.00, 3.55, and 3.35, respectively. The results of the aroma sensory test of formula M1, M2, and M3 feed have subsets of 2.65, 3.40, and 3.35, respectively, while the results of the texture sensory test of formula M1, M2, and M3 feed have subsets of 2.65; 3.70; and 3.25 respectively. **Conclusions:** Formula M2 has the highest protein content of 11.64%, and formula M1 has the highest carbohydrate content of 29.26%. The results of the hedonic quality test of the formulas most preferred by panelists were the color and texture parameters of feed in formula M2 and the aroma of feed in formula M3.

Keywords: Fermented coconut dregs; Carbohydrates; Maggots; Fish feed; Protein

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Introduction

Fish farming has recently become very popular with increasing public awareness of nutritional status (Untari et al., 2022). An increase follows this popularity in market feed prices of up to 60% of production costs (Hutapea et al., 2022). The attitude of fish farmers who only rely on the supply of manufactured feed requires alternative fish feed to reduce production costs (Burhanuddin et al., 2022).

One of the sustainable materials that can be used is coconut dregs. Coconut dregs can become an environmental waste because they can produce up to 19.5 billion grains annually (Netcha et al., 2021). The significant by-product of coconut dregs will become a new environmental problem, so one of the management efforts can be diverted to fish feed. The nutritional content of coconut dregs includes 5.6% protein, 38.1% carbohydrates, 16.3% fat, 2.6% ash, 5.5% water, and 31.7% crude fiber (Wulandari et al., 2018). The high oil fiber content can cause the digestibility and absorption of fish to be suboptimal (Mutiasari et al., 2017).

Therefore, a fermentation process is needed. The alternative feed ingredient is maggots or larvae from the Black Soldier Fly (BSF). Maggots are a quality alternative protein source that is ready to replace the role of fish meal because adding maggots to feed ingredients

shows growth, maturation of broodstock, and development of fish seeds (Ogunji et al., 2021). This quality maggot material has nutrients, including 36.15% protein, 4720.59 kcal/kg metabolic energy, 28.12% fat, and 1.52% calcium (Rumondor et al., 2016).

In addition, maggots also have antimicrobial and antifungal content, so when consumed by fish, they increase the resistance to disease (Mulyani & Haris, 2021). The high protein content and metabolic energy of maggots are expected to replace the dependence of fish farmers on fish meal, which has a very high protein content of around 60.05% and energy of 220 kcal/kg (Dengah et al., 2016). The selection of raw materials as quality fish feed includes a combination of vegetable and animal protein materials (Sajuri, 2019). The combination used in this study is a combination of vegetable protein from fermented coconut dregs and animal protein from maggots. This study was conducted to find the levels of protein and carbohydrates and hedonic quality, such as color, aroma, and texture of fish feed, from the two combinations of raw materials, such as organic fish feed with good nutritional content.

Method

Time and Place

This research was conducted from December 25, 2023 to January 25, 2024. Feed production was conducted in the biology laboratory, Biology Education Study Program, FKIP, Muhammadiyah University of Surakarta. Proximate protein and carbohydrate tests were conducted at the Surakarta Quality and Goods Certification Center. The raw materials used were fermented coconut pulp flour and maggot flour.

Research Design

This type of research is an experimental study with a Completely Randomized Design (CRD) and a factorial design. There was one treatment factor and two repetitions, each carried out with three treatments and a comparison of fermented coconut pulp flour and maggot flour (Sajuri, 2019).

M1: Fermented coconut pulp flour 75g with maggot flour 35g
M2: Fermented coconut pulp flour 35g with maggot flour 75g
M3: Fermented coconut pulp flour 52.5g with maggot flour 52.5g

Table 1. Components of Feed Formulation

Raw Material	Formula (grams)		
	M1	M2	M3
Fermented Coconut Pulp Flour	35	70	52,5
Maggot Flour	70	35	52,2
Bran	5	5	5
Tapioca Flour	10	10	10
Total	**120**	**120**	**120**

Making Fermented Coconut Pulp Flour

First, to make fermented coconut pulp flour, weigh 1 kilogram of coconut pulp using a digital scale. Steaming the coconut pulp is done for 45 minutes, and then it is left to cool. Addition and mixing of tapai yeast using a ratio of 1: 0.002, namely 2 grams of tapai yeast in 1 kilogram of coconut pulp (Merdekawati et al., 2023). The incubation process is carried out for 2 days with a glass jar and covered with plastic perforated with a needle. After harvesting, the drying process is carried out using an oven at a temperature of 100°C for 30 minutes. After drying, sieving is carried out using a 40mesh sieve to be homogeneous.

Making Maggot Flour

Making maggot flour begins by pouring boiling water on the maggots. Drying using an oven at a temperature of 60°C for 24 hours (Ottoboni et al., 2018) until dry, then ground using a grinder for 2 minutes.

Making Organic Fish Feed

Mixing the ingredients according to the formulation in Table 1. gradually from small amounts of ingredients (Deran et al., 2023). Use 5 grams of bran and 10 grams of tapioca flour in all treatments as adhesives (Mukaromah et al., 2020). The boiling water is added while stirring until the flour suspension forms a dough, which is then milled and molded into pellets (Yespus et al., 2018). The pellets are oven-dried for 15 minutes at 60°C before being stored to make them last longer for proximate and hedonic quality testing to panelists.

Proximate Test of Organic Fish Feed

In this study, only proximate protein and carbohydrate content tests were conducted because using coconut dregs and maggots as raw materials was intended to increase the protein and carbohydrate content in fish feed. The proximate test of feed was performed by weighing each feed formula as much as 100 grams and then labeling it on the plastic packing; then, the sample would be tested proximately at the Surakarta Goods Quality Testing and Certification Center.

Sensory Test of Organic Fish Feed

Hedonic quality testing was conducted by involving panelists to determine the level of preference for the fish feed made. The parameters measured included three things namely color with the sense of sight (eyes), aroma with the sense of smell (nose), and texture with the sense of touch (skin). The test samples were placed in plastic labeled with codes for each treatment. Panelists were asked to provide their preference level with a value of 1-4 assessment criteria. The research criteria are presented in Table 2.

Table 2. Hedonic Quality Test Assessment Criteria

Value	Color	Aroma	Texture
4	Very Dark	Very Fishy	Very Fine
3	Dark	Fishy	Fine
2	Pale	Not Fishy	Coarse
1	Very Pale	Not Very Fishy	Very Coarse

Result

Proximate Test

The combination of fermented coconut pulp flour and maggot flour as organic fish feed has different results in each treatment. The results of the feed's nutritional analysis include protein and carbohydrate content. To determine the level of acceptance of fish feed to the community, a hedonic quality test was carried out on 20 selected panelists. The following picture of organic fish feed fermented coconut pulp flour and maggot flour for each treatment is in Figure 1.

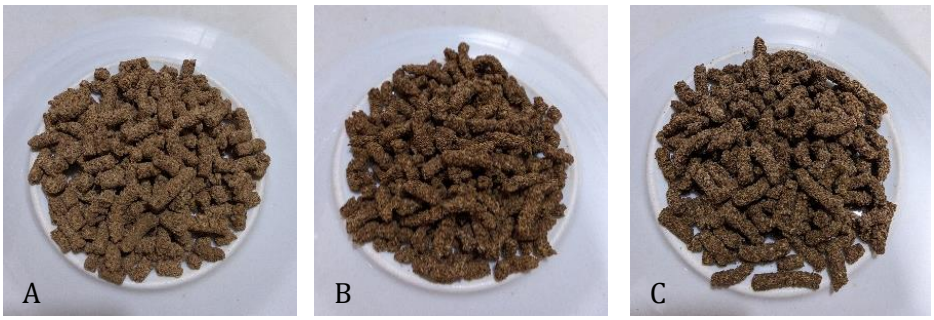

Figure 1. Organic fish feed of fermented coconut pulp flour and maggot flour. A (Formula 1); B (Formula 2); and C (Formula 3)

The results of the organic fish feed, combined with fermented coconut pulp flour and maggot flour, produced protein and carbohydrates, as shown in Table 3.

Table 3. Results of Duncan's test (DMRT) of Protein Content of Feed Samples

Content	Sample Protein Content Results		
	M1	M2	M3
Protein (%)	7,83 ± 2,34[a]	11,64 ± 5,16[a]	9,04 ± 2,85[a]
Carbohydrate (%)	29,26 ± 6,71[a]	23,08 ± 2,12 [a]	27,84 ± 11,01 [a]

Description: a = the same letter notation means there is no real difference at the Duncan test level (DMRT), which has a value of 5%

The protein content of the combination of fermented coconut pulp flour and maggot flour as organic fish feed obtained an average result in the M1 treatment of 7.83%, the M2 treatment of 11.64%, and the M3 treatment of 9.04%. The carbohydrate content of the combination of fermented coconut pulp flour and maggot flour as organic fish feed obtained an average result in the M1 treatment of 29.26%, in the M2 treatment at 23.08%, and the M3 treatment at 27.84%. The graph of the proximate test results using SPSS software can be seen in Figure 2.

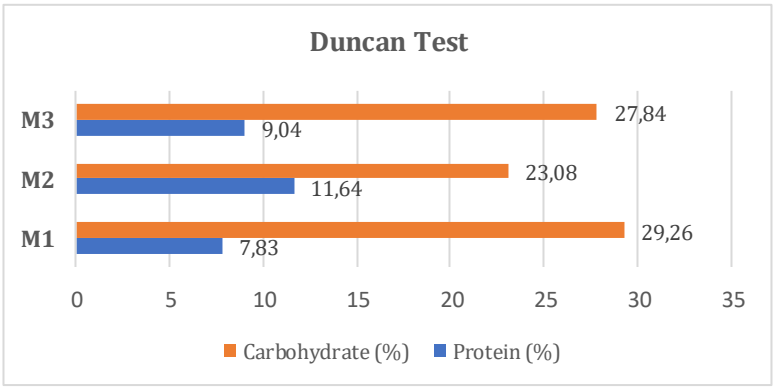

Figure 2. Graph of the Average Protein and Carbohydrate Content of Organic Fish Feed from Fermented Coconut Pulp Flour and Maggot Flour

Hedonic Quality Test

The results of the hedonic quality test from 20 panelists of organic fish feed combination of fermented coconut pulp flour and maggot flour after going through the Duncan test on SPSS software can be seen in Table 4.

Table 4. Results of the Duncan Test Hedonic Quality Test

Variable	Treatment (Average)		
	M1	M2	M3
Color	2,00[a]	3,55[b]	3,35[b]
Aroma	2,65[a]	3,40[b]	3,35[b]
Texture	2,65[a]	3,70[b]	3,25[c]

Description: a, b, and c are the same letter notation, meaning there is no real difference at the Duncan test level (DMRT), which has a value of 5%.

The graph of the hedonic quality test results can be seen in Figure 3.

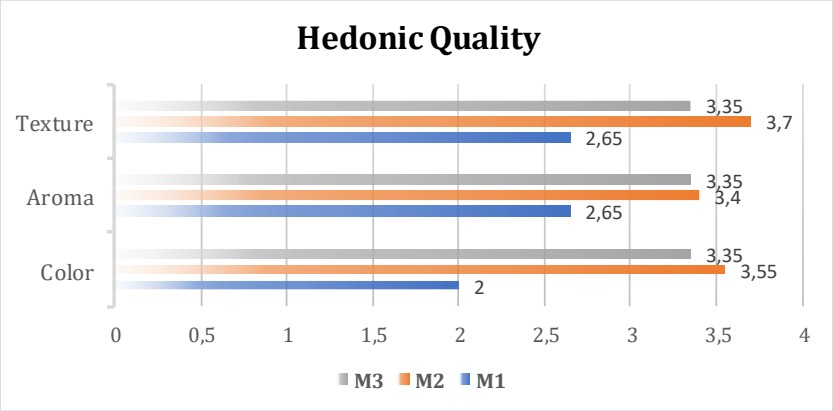

Figure 3. Duncan's Hedonic Quality Graph Including Aroma, Texture and Color

Discussion

Organic Fish Feed Protein Content

Based on the results of Table 1. Analysis of the protein content of organic fish feed fermented coconut pulp flour and maggot flour, the highest value in formula M2 was 11.64%, while the lowest was in formula M1 at 9.04%. The results of the Duncan test showed no significant difference in the protein content of the feed in each treatment because adding the amount of maggot flour greatly influenced the protein content. This can be seen in Figure 1. The highest protein content, with a content of 11.64% on the average of the M2 formulation, was obtained at the highest maggot flour comparison, thus proving that adding maggot flour can affect the protein content of fish feed.

The source of high protein comes from fresh maggots at 36.15% (Rumondor et al., 2016) so that it can support the protein content of coconut pulp, which is relatively low because it is dominated by crude fiber content (Deran et al., 2023). The protein content of maggots from feed decreased in the oven process, which was carried out for too long, and the use of high temperatures so that the maggot protein was denatured. Fermented coconut pulp fish feed and maggot flour have not met the general fish requirement standards because the minimum protein required by fish is 20% (SNI, 2022). However, the highest protein content obtained showed that the feed could meet the results of the study conducted (Merdekawati et al., 2023) that the substitution of fermented coconut pulp in commercial feed as much as 18% obtained a protein content of 8.68% and obtained significant results on fish growth.

Carbohydrate Content of Organic Fish Feed

Based on the results of Table 1. In the analysis of the carbohydrate content of fermented coconut pulp fish feed and maggot flour, the highest value was in formula M1 at 29.26%, while the lowest was in formula M2 at 23.08%. The results of the Duncan test showed a significant difference in the protein content of the feed in each treatment because the addition of fermented coconut pulp flour greatly influenced the carbohydrate content. This can also be seen in Figure 1.

The primary source of carbohydrates in feed comes from fermented coconut dregs because, according to (Azir et al., 2017), maggots are a source of animal nutrition with a low carbohydrate content of 0.05% or less than 1%. In addition, the source of carbohydrates comes from 10 grams of bran with a carbohydrate content of 34.1% and 5 grams of tapioca flour with a carbohydrate content of 6.99%, which is used as an adhesive to maintain feed density. The addition of bran and tapioca flour does not significantly affect the feed's carbohydrate content because of its small amount and usefulness in feed. From the feed raw materials, the highest results were obtained at 29.26%, showing a slight decrease in

carbohydrate content. This happens because the fermentation process of coconut dregs successfully converts a little carbohydrate into more straightforward carbohydrates (Djonu et al., 2020). The carbohydrate content of the feed successfully met the carbohydrate standards needed by fish as in the study (Amarwati et al., 2015), the optimum carbohydrate content needed by fish ranges from 20-40% in omnivorous fish and around 10-20% in carnivorous fish. The carbohydrate content of organic fish feed fermented coconut pulp flour and maggot flour also has a carbohydrate content that is not much different from commercial feed on the market, with a carbohydrate content ranging from 20-30% after a literature study of the nutritional value of commercial feed from various brands. Carbohydrates are essential for fish synthesizing non-essential amino acids and fats when conditions are threatened (Yanto et al., 2019).

Organic Fish Feed Color

Based on Table 4. This shows that the average Duncan test on feed color has a very different value in formula M1 compared to formulas M2 and M3. In contrast, formulas M2 and M3 have values that are not significantly different from the panelists' acceptance of feed color. Figure 3 shows that the highest subset score is in formula M2, with a value of 3.55, and the lowest score is in formula M1, with a value of 2. From the results of these values, the color of the M2 formula feed is most preferred by panelists with very dark physical characteristics. The dark color of the feed in the M2 formulation is influenced by the process of baking maggot flour for too long at a high temperature, resulting in a brownish maggot color. The baking process causes maggots to shrink due to water loss, so amino compounds and reducing sugars form brown polymer melanoidins (Sirait, 2019). The color of other raw materials, such as fermented coconut pulp flour, bran, and tapioca flour, does not affect the color produced by the feed. The results of the color of the feed preferred by the panelists align with research (Akerina et al., 2022), which states that the criteria for good fish feed is brown.

The aroma of Organic Fish Feed

Based on Table 4. This shows that the average Duncan test on feed color has a very different value in formula M1 compared to formulas M2 and M3. In contrast, formulas M2 and M3 have values that are not significantly different from the panelists' acceptance of feed color. Figure 3 shows that the highest subset score is in formula M3, with a value of 3.35, and the lowest score is in formula M1, with a value of 2.65. From the results of these values, panelists prefer the aroma of formula M3 feed, with fishy to very fishy characteristics. This aroma is produced from a combination of the two raw materials with a ratio of 1:1. The fishy aroma produced by maggots comes from the body fat content, which is relatively high compared to fish meals (Fadilla et al., 2023). Maggot fat undergoes oxidation and rancidity reactions at high temperatures due to the oven process (Ralahalu & Fredriksz, 2021). The fishy aroma of coconut pulp is caused by changes in several compounds from the fermentation process so that the coconut pulp becomes more fragrant (Zainab & Azizah, 2022). After mixing the two ingredients, the aroma produces a fish feed that is very attractive to the panelists' sense of smell.

Organic Fish Feed Texture

Based on Table 4. This shows that the average Duncan test on feed texture has a very different value in each treatment regarding the panelists' acceptance of feed texture. Meanwhile, Figure 3 shows that the highest subset score is in formula M2, with a value of 3.7, and the lowest score is in formula M1, with a value of 2.65. From the results of these values, the texture of formula M2 is most preferred by panelists with very smooth physical characteristics. The texture of the feed is influenced by the tapioca flour used with the help of high-temperature water for the homogenization process of the feed mixture. Tapioca flour has a main amylopectin starch content when treated with high-temperature water to form a gelatinization process. It can affect a dough's structure, shape, and texture, making it more

elastic and smooth (Costa & Manihuruk, 2021). The feed results have not met the smooth standards like commercial market feed, but the M2 formula is the smoothest compared to other formulas. This happens because the characteristics of dry maggots in the flouring process release fat content in their bodies, thus affecting the release of amylose from the granules and inhibiting gelatinization (Aini et al., 2010). This makes the texture of the feed fibrous but dense.

Conclusion

Formula M2 produced the highest protein content of 11.64%, with the addition of maggot flour significantly affecting the protein content of the feed. Formula M1 produced the highest carbohydrate content of 29.26%, proving that the addition of fermented coconut dregs significantly affected the carbohydrate content of the feed. The panelists' preference for color was determined by the criteria of very dark and the smoothest feed texture in formula M2. At the same time, the most fishy aroma parameter was in formulation M3.

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Declaration statement

The authors report no potential conflict of interest.

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