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CHEMICAL, PHYSICAL, AND BIOLOGICAL TESTS OF SELF-MADE FISH FEED UTILIZING LOCAL RAW MATERIALS AT THE FRESHWATER AQUACULTURE DEPARTMENT CENTER (BPBAT) TATELU NORTH MINAHASA

Uji Kimia, Fisik dan Biologi Pakan Mandiri Dengan Pemanfaatan Bahan Baku Lokal di Balai Perikanan Budidaya Air Tawar (BPBAT) Tatelu Minahasa Utara

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ABSTRACT

Feed is one of the components in fish farming activities that will affect the growth and survival of fish. The cost allocation required for feed procurement reaches 60-70% of the total production cost, so alternatives are needed to provide cheaper feed, one of which namely self-made feed using local raw materials. The purpose of this study was to test the physical (buoyancy, durability, homogeneity level, hardness level), chemical (protein, carbohydrates, fats, water, and ash), and biological (absolute weight gain, FCR, EPP) qualities. The data obtained were analyzed using quantitative descriptive analysis methods. The results of the physical test of the feed showed that the test feed had a buoyancy of 6.23 cm/sec, durability of 1441 seconds, homogeneity level of 79.32%, and hardness level of 86.51%. Chemically, the feed contained 25.85% protein, 5.81% water, 9.90% ash, 4.84% fat, and 30% carbohydrates. After being tested on tilapia fingerlings, the self-made feed produced absolute weight and length growth, FCR, EPP, and SR of 11.56 g, 4.47 cm, 1.84, 54.17%, and 90%, respectively. These results indicated the potential use of self-made feed using local raw materials to reduce dependence on commercial feed.

Keywords: Self-Made Fish Feed, Physical Analysis, Chemical Analysis, Biological Analysis

ABSTRAK

Pakan merupakan salah satu komponen dalam kegiatan budidaya ikan yang akan mempengaruhi pertumbuhan dan kelangsungan hidup ikan. Alokasi biaya yang diperlukan untuk pengadaan pakan mencapai 60-70% dari total biaya produksi sehingga diperlukan alternatif mengadakan pakan yang lebih murah yaitu pakan mandiri yang menggunakan bahan baku lokal. Tujuan penelitian ini adalah melakukan uji terhadap kualitas fisik (daya apung, ketahanan, tingkat homogenitas, tingkat kekerasan), kimia (protein, karbohidrat, lemak, air dan abu) serta biologi (pertumbuhan bobot mutlak, FCR, EPP). Data yang diperoleh dianalisis dengan metode analisis deskriptif kuantitatif. Hasil uji fisik pakan menunjukkan bahwa pakan uji memiliki daya apung 6,23 cm/dtk, ketahanan 1441 detik, tingkat homogenitas 79,32% dan tingkat kekerasannya 86,51%. Secara kimia, pakan memiliki kandungan protein sebesar 25,85%, air 5,81%, abu 9,90 %, Lemak 4,84% dan karbohidrat sebanyak 30%. Setelah diuji coba terhadap benih ikan nila, pakan mandiri menghasilkan pertumbuhan bobot dan panjang mutlak, FCR, EPP dan SR berturut-turut sebesar 11,56 g, 4,47 cm, 1,84, 54,17% dan 90%. Hasil penelitian ini menunjukkan potensi penggunaan pakan mandiri dengan menggunakan bahan baku lokal untuk mengurangi ketergantungan terhadap pakan komersial

Kata Kunci: Pakan Mandiri, Analisis Proksimat, Analisis Fisik Pakan, Analisis Biologi Pakan

INTRODUCTION

The development of cultivation businesses in Indonesia occurs both in land and sea waters. The success of fish cultivation activities will depend on many factors, one of which is the availability of feed which is a source of energy needed by cultivated biota. Feed given to cultivated biota will be swallowed, digested until finally the nutrients needed for survival are absorbed (Sukardi *et al.,* 2018). In aquaculture environments, especially at high densities, fish are more dependent on artificial feed. The advantages of using artificial feed include that it lasts longer in storage and the formulation can be adjusted to the nutritional needs of the species being cultivated.

Currently, cultivator groups in the community still tend to use commercial feed. The relatively high price of commercial feed causes production costs to also be high, where 60% to 70% of production costs are spent on feed procurement (Amalia *et al.,* 2018). Therefore, efforts are needed to minimize the allocation of feed procurement costs, one of which is by using independent feed made using local raw materials whose prices tend to be more affordable. According to Amin *et al.,* (2020), using local raw materials in making feed is one solution to reducing dependence on the use of commercial feed.

Independent feed from local raw materials must still consider the quality of the feed. The quality of the artificial feed can be tested physically, chemically and biologically (Fahrizal & Ratna, 2020 ; Saade & Aslamsyah, 2009 ; Yulianto, 2018).

The Tatelu Freshwater Aquaculture Fisheries Center (BPBAT) is one of the fisheries centers under the auspices of the Ministry of Maritime Affairs and Fisheries which produces self-made feed. In 2021, the Tatelu Freshwater Aquaculture Fisheries Center (BPBAT) has produced 120 tons of feed independently, where most of the feed produced is donated to fish farmers. The aim of this research is to physically, chemically and biologically test the feed produced by BPBAT Tatelu to become a reference in the use and evaluation of the quality of the independent feed produced in order to produce the best growth for the fish being kept and ultimately increase the income of the cultivating community.

METHODS

Preparation of Feed Raw Materials

Feed raw materials are prepared by first selecting local raw materials including fish meal, corn meal, coconut meal and soybean meal. After that, the raw materials are tested for protein content as a consideration for feed formulation (Table 1). The raw materials used are ground first to produce feed with a more compact texture. Refining of raw materials is carried out using a 0.5 mm mil disk.

Independent Feed Manufacturing

The formulation uses the trial and error method using MS applications. Excel is based on the protein content of raw materials which has been previously analyzed at the feed raw material preparation stage with a target amount of feed protein of 25-26% crude protein. The resulting feed formulation is shown in Table 1. The raw materials are then weighed and mixed using a horizontal mixer. The homogenized material is then molded (pelleted) using a feed molding machine with a feed size of 3 mm in diameter and 0.3-1 cm in length. Making pellets does not use water so that after printing the pellets can be cooled immediately without going through the drying process in the oven.

Table 1. Artificial Feed Formulation

Raw Material	**Protein (%) [A]**	**Raw Material Compotition (%) [B]**	**Estimation of protein in feed (%) [A x B]**
Fish flour	55,16	35	19,31
Soy flour	40	3	1,2
Fine bran	9.58	14	1,34
Coconut cake	18	17	3,06
Cornstarch	10,37	19	1.97
Tapioca	0,5	12	0.06
Total		**100**	**26,94**

Feed Chemical Test (Proximate)

Chemical tests are carried out using proximate analysis, namely analysis of protein, fat, carbohydrate, water and ash content. Testing for protein, fat, crude fiber and carbohydrate levels was carried out at the Takalar Brackish Water Aquaculture Fisheries Center (BPBAP) Laboratory. The carbohydrate content test was carried out at the Manado Industrial Research and Standardization Center. Water and ash content tests were carried out at the Tatelu Freshwater Aquaculture Fisheries Center (BPBAT) guided by SNI 01.2354. 1-2006.

Feed Physical Test

Physical tests include sinking speed, crushing speed, homogeneity and hardness tests. The sinking speed test was carried out based on a modification from Aslamsyah & Karim (2012) by inserting the pellet into a test tube containing 20 cm of water. The time required for the pellet to reach the bottom of the test tube is observed with a stopwatch and recorded. The sinking speed is obtained by calculating the distance divided by the sinking time.

The disintegration speed or stability test was carried out based on a modification from Saade & Alamsyah (2009) by placing the feed in a glass beaker containing 1 l of water. The stopwatch is turned on and observations are made every 5 minutes. Observations were carried out until the pellets broke/destroyed/decomposed into solids.

The homogeneity test was carried out based on the method from Mulia *et al.,* (2017), namely by taking 5 g of pellets which were then crushed until smooth, then sifted using a 0.5 mm sieve. Homogeneity is the percentage of feed that passes through the sieve, or whose size is smaller than the sieve size.

The feed hardness level test was carried out based on Aslamsyah & Karim (2012), namely 2 g of pellets were inserted into a 1.5 inch diameter paralon pipe. A weight of 500 g was then dropped into the pipe. The crushed pellets are then sifted using a 0.5 mm sieve. The feed remaining in the sieve is put into a porcelain cup and weighed. The hardness level is the percentage of feed that is not crushed.

Feed Biology Test

The independent feed that had been made was tested on tilapia seeds (O. niloticus) measuring 3-5 cm which were kept in an aquarium measuring 40x40x40 cm3. The aquarium was filled with 72 l of water and 30 seeds were stocked in one aquarium. Feed is given with a frequency of 3 times/day, namely at 07:30, 12:00 and 16:00 with a dose of 20% of the fish biomass.

Before being given, the feed is mashed first using a blender so that it fits into the mouth of the tilapia fry. Length and weight sampling is carried out at the beginning and end of rearing, and every 15 days fish weight and length sampling is carried out.

Tilapia seed maintenance is carried out for 45 days. To maintain water quality, water changes are carried out 40% per day through siphoning. Several parameters measured in biological tests include feed conversion ratio, feed efficiency, absolute growth and survival rate.

The feed conversion ratio (FCR) is determined using the formula according to Effendie (2002) $FCR = \frac{F}{(Wt+D)-Wo}$ where FCR is the feed conversion ratio, F is the amount of feed (g), Wt is the final weight of the fish (g), D is the weight of the dead fish (g) and Wo is the initial weight of the fish (g).

Feed utilization efficiency is expressed in percentages based on $EPP = \frac{Wt-Wo}{F} \times 100\%$where EPP is feed utilization efficiency (%), Wt is the initial weight of the fish (g), Wo is the final weight of the fish (g), and F is the weight of feed (g).

Absolute growth consists of absolute length and absolute weight. Absolute weight growth is determined using the formula according to Effendie (1997): W = Wt - Wo where W is the absolute weight growth (g), Wt is the final weight of the fish (g) and Wo is the initial weight of the fish (g). Absolute length growth is calculated using the formula according to Effendie (1997) namely $L = Lt - Lo$ where L is absolute length growth, Lt is the final length of the fish (cm) and Lo is the initial length.

Survival rate (SR) is calculated using the Effendie (2002) formula, namely $SR = \frac{Nt}{No} \times 100\%$, where SR is the survival rate, Nt is the final number of live fish (tails) and No is the number of fish stocked (tails).

RESULT

Chemical tests are carried out with proximate tests on independent feed to determine the quality of the feed based on the nutritional content in it. The proximate test results are shown in Table 2.

Table 2. Proximate Test Results of Independent Feed Made from Local Raw Materials

Parameter Tests	**Tests Result (%)**	**Tilapia Feed Quality Requirements (%) (SNI 01-7242-2006)**	
		Enlargement	Nursery
Proteins	25,85	Min, 30	Min, 25
Fat	4,84	Min, 5	Min 5
Carbohydrate	30	-	-
Water	5.81	Maks, 12	Maks, 12
Ash	9.90	Maks, 13	Maks, 13

Average data on the physical test results of independent feed made using local raw materials which include sinking speed, disintegration speed, homogeneity and level of hardness are shown in Table 3.

Table 3. Physical Test Results of Independent Feed Made from Local Raw Materials

Parameter Tests	**Resulst Tests**
Sinking speed (cm/sec)	6,23
Destruction speed (sec)	1441
Homogeneity (%)	79,32
Hardness level (%)	86,51

The results of the biological feed test are shown in Table 4. It was found that during the 45 day rearing period, the absolute weight growth of tilapia seeds was 11.56 g with a daily growth rate of 0.26 g/day. The absolute length growth obtained was 4.47 cm with a daily length growth rate of 0.1 cm/day. Meanwhile, the survival rate was obtained at 90%.

Table 4. Biological Test Results of Independent Feed Made from Local Raw Materials

Parameter Tests	**Result Tests**
Absolute weight growth (g)	11,56
Absolute length growth (cm)	4,47
Survival rate (SR) (%)	90
Feed conversion ratio (FCR)	1,84
Feed utilization efficiency (EPP) (%)	54,17

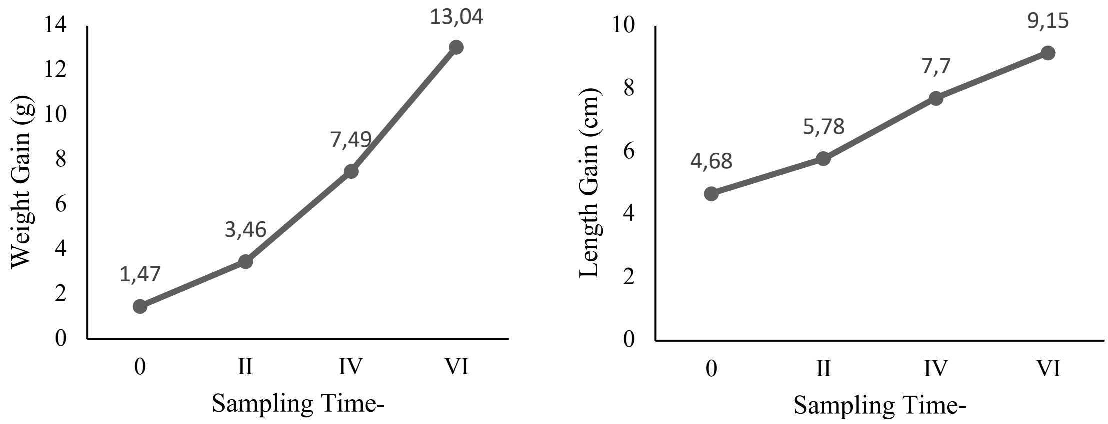

Figure 1. Growth graph of tilapia fry (*O. niloticus*) reared for 45 days using independent feed made from local raw materials: A) Weight growth; B) Growth in length

The results of growth monitoring showed that the average weight growth of tilapia seeds in the first sampling was 1.47 g/fish, in the 2nd sampling it weighed 3.46 g/fish, in the 3rd sampling it weighed 7.48 g/fish, and in the fourth sampling the tilapia seeds that were reared weighed 13.04 g (Figure 1). Measuring the length growth of tilapia (*O. niloticus*) seeds, it was found that the average length growth of tilapia seeds (*O. niloticus*) in the first sampling was 4.68 cm/head, in the 2nd sampling it was 5.78 cm/fish, in the 3rd sampling it was 5.78 cm/fish. 7.70 cm/head, and in the 4th sampling it was 9.15 cm/head (Figure 1).

DISCUSSION

The sinking speed test aims to determine the speed at which the pellet sinks to the bottom of the media and the average sinking speed for BPBAP Tatelu self-feeding is 6.23 cm/sec. This result is faster than the sinking speed of independent feed by Aslamsyah & Karim

(2012) with a sinking speed of 5.070-5.64 cm/sec. Hutagalung *et al.,* (2021) stated that the specific gravity of the feed will affect the sinking speed of the feed. If the specific gravity of the feed is greater than the specific gravity of water (ρ water = 1) then the feed will sink faster and vice versa. It is also stated that feed with low water content will have higher buoyancy because there are more air-filled cavities, thereby increasing its buoyancy. Mulia & Maryanto (2014) stated that the buoyancy of feed is also influenced by the concentration of the adhesive used, where the addition of adhesives such as tapioca flour or wheat flour as much as 10% in independent feed produces the highest buoyancy value, even equal to commercial feed.

The category of feed that is considered physically good is stated by Krisnan & Ginting (2009), namely feed with high stability and density, resistance to impact, moderate water absorption and low expansion ratio. Saade & Aslamsyah (2009) stated that feed stability is a value that states the ability of feed to survive in water until the feed is destroyed. According to Mudjiman (2008), the stability of pellets is at least 10 minutes so that they are not wasted because they are destroyed before being eaten by fish, which can ultimately cause a decrease in water quality, for example a decrease in DO which can threaten the survival of fish. Based on this, the independent feed produced meets the physical characteristics requirements for disintegration speed, namely 1441 seconds or 24 minutes 1 second (Table 3). Yulianto (2018) stated that the stability or speed of disintegration of feed in water is also related to the raw material used as adhesive. Raw materials that function as adhesives include fine bran, tapioca flour and wheat flour. Apart from that, based on the research results of Saade & Aslamsyah (2019), seaweed flour is a potential adhesive and has been proven to extend the disintegration time of feed in water with better stability than commercial feed. Low feed stability in water can cause the feed to be difficult for fish to eat because the feed is easily dispersed and destroyed (Saade & Karim, 2012).

The level of homogeneity is expressed in the percentage of feed whose size is <0.5 mm. The feed that passes through the sieve is 79.32%. Feed homogeneity is related to the texture or level of fineness of the raw material where fine raw materials will produce better pellets with a high level of homogeneity. Mulia *et al.,* (2017) stated that homogeneity is also related to feed raw materials which act as glue to unite all feed ingredients which makes the structure more compact, strong and homogeneous.

Feed with a high level of hardness is considered better and the level of hardness is influenced by the fineness of the raw material and water content (Mulia *et al.,* 2017 ; Fahrizal & Ratna, 2019). Fine raw materials will produce feed that is more compact and stronger so that the level of hardness is also high (Aslamsyah & Karim, 2012). The level of hardness of the independent feed in this study was quite high, allegedly because local raw materials had been re-milled before mixing. In the process of making feed, water is not added so that the water content is quite low and increases the hardness of the feed (Table 3).

The protein content of the feed will determine the growth of biota. The choice of feed used by cultivators usually considers the suitability of the nutritional content of the feed to the needs of the cultivated species. The results of the test for the protein content of the feed produced did not differ much from the formulation made from the raw material (Tables 1 and 2). The protein content obtained is considered adequate, where in fish farming the food generally used contains protein above 25%. as according to Kordi (1997), feed with a protein content of 20-25% is adequate and can trigger faster growth of tilapia. Mudjiman (2008) states that fish feed should contain 20-40% protein.

The results of testing the fat content obtained from the independent feed showed that the fat content was still less than 5%. If used as feed for tilapia, the fat content of the feed should be increased, where according to SNI 01-7242-2006 the fat content of tilapia feed, both for nursery and rearing, is recommended to be at least 5%. Mudjiman (2008) states that fish feed should have a fat content of 5-14%. Apart from that, research results from Niagara *et al.,*

(2024) showed that tilapia whose feed contained 8% fat showed higher feed efficiency values, triglyceride and cholesterol levels than tilapia whose feed contained 5% fat. Another study by Munisa *et al.,* (2015), a feed fat content of 11% resulted in efficient feed utilization, protein utilization efficiency and a higher survival rate in catfish. It is stated that fat is a source for fish's daily activities, including body resistance. Fat in feed in amounts appropriate to the needs of biota acts as a protein sparing effect so that energy from protein can be allocated more optimally for growth (Niagara *et al.,* (2024). Excessive fat content in feed will increase the risk of rancidity due to oxidation reactions during feed storage period.

Carbohydrates are also an important macro nutrient because they are a source of energy which is economically cheaper. In SNI -0-7242-2006 concerning artificial feed for tilapia, the minimum optimal level of carbohydrate feed is not stated. Mudjiman (2008) states that fish feed should have a carbohydrate content of 10-20%. The carbohydrate content in feed will be absorbed and utilized as a source of energy for metabolism and growth. Excess energy produced and not utilized from carbohydrate digestion is used as reserve energy by being stored in the form of glycogen. This excess energy is also used for the synthesis of amino acids and fats to support growth.

The results of this research show the potential of independent feed to support the growth in weight and length of tilapia fry during the rearing period (Figure 1). Many factors influence growth, including genetics, hormones, and environmental conditions. Basically, growth occurs through the addition of new tissue originating from mitotic cell division with energy and protein intake from feed (Prajayanti *et al.,* 2018). The absolute weight growth obtained in this study was higher when compared to the results obtained by Hasan (2021) who obtained an average growth of tilapia fry with feed supplemented with fish oil, namely 3.28 g. The results obtained were also higher than research by Niode *et al.,* (2017) who reared tilapia seeds with different types of feed and the highest absolute growth obtained was 4.99 g cm.

Good feed utilization is indicated by a low FCR value. Low FCR indicates the effectiveness of feed in adding biomass and more efficient use of feed (Ihsanuddin, 2014; Hendriana *et al.,* 2023). The FCR obtained in this study was lower than the FCR of tilapia research results from Christin *et al.,* (2021) whose value was 2.16-2.36. Hendriana *et al.,* (2023) reared tilapia using different feed and obtained an FCR of 1.69-1.85, not much different from the FCR obtained in this study. Low FCR will increase feed utilization efficiency (EPP). The EPP of the independent feed tested in this study was found to be 54.17%. This result is not much different from the research of Nurhasanah *et al.,* (2016) who obtained an EPP of 56.84-60.69% from testing self-feeding for tilapia by replacing fish meal with salted fish meal. Apart from that, Amarwati *et al.,* (2015) also obtained an EPP value for tilapia seeds of 36.52-54.02% from the results of independent feed testing which added fermented cassava flour. Feed can be said to be good if the EPP value is more than 50% (Craig & Helffrich, 2002). Feed EPP and FCR are determined by the protein content in accordance with the nutritional needs of a species. With FCR values <2.0 and EPP >50% obtained (Table 4), it can be said that the local raw materials used have met the protein needs of tilapia seeds. The survival rate (SR) of tilapia seeds during the 45 day rearing period was quite high, namely 90% and had exceeded the SNI 6141:2009 standard regarding the production of black tilapia (O. niloticus) seeds with an SR value of >70%.

CONCLUSION

Based on the research results, independent feed produced using local raw materials is quite suitable as a feed supply for cultivation activities, especially tilapia cultivation, especially with its nutritional value content which is close to SNI 01-7242-2006 concerning artificial feed for tilapia (*Oreochromis* spp) in cultivation. intensive. However, efforts need to be made to increase the protein and fat content of feed and further research is needed to compare independent feed and commercial feed, especially from the aspect of biological testing.

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