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The use of fish waste substituted with soybean flour in making fish feed on the physical quality of fish feed

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Abstract
The study aims to determine the possibility of using fish waste substituted with soybean flour as one of the raw materials for making fish feed on the physical quality of fish feed. The research design used a completely randomized design with 3 treatments of comparison of the use of fish waste substituted with soybean flour; each treatment A was 40% fish flour and 20% soybean flour. Treatment B had 42% fish waste flour and 18% soybean flour, Treatment C had 44% fish waste flour and 16% soybean flour, while Treatment K had 100% fish waste flour. The results of the study showed that in terms of the physical quality of fish feed, in general the feed meets the requirements of fish feed, especially in terms of the attractiveness of the feed and the color of the feed, but in terms of the solubility and hardness of the feed, the fish feed produced is classified as high so that its solubility is also low. Therefore, it is recommended for the manufacture of further feed to reduce the amount of feed adhesive

Keywords: Fish waste, soybean flour, fish feed, physical quality, feed solubility

Introduction

Fish feed is one of the important factors that affect the growth and productivity of fish farming, which is around 60-70% of the total production costs that are allocated for the aspect of feed availability (Andriani *et al*., 2016) [4]. Fish feed is an important factor in cultivation, but farmers have difficulty finding high-quality feed at affordable prices (Fauzy *et al*., 2024) [10]. Feed plays an important role in aquaculture and affects the success of fish farming production (Islama *et al*., 2024) [17].

The availability of quality feed has a significant impact on the quality and quantity of fish production, but there are still obstacles where many farmers complain about the difficulty of obtaining high-quality feed at affordable prices (Sandra *et al*., 2019) [31]. Fish feed is a major component in the intensification of fishery products sourced from fish farming activities (Fahrizal and Ratna, 2020) [6]. Utomo (2015) [33] said that feed is very important in the development of fish farming businesses because around 40-60% of the cost of intensive fish production comes from the cost of providing feed. Most fish farmers still rely on feed supplies from manufacturers (commercial feed), while feed prices are still relatively high. This causes an imbalance between the income obtained by fish farmers and the production costs incurred during the production process, considering that more than 60% of the total production costs come from feed costs (Irawati *et al*., 2023) [13].

The use of fish feed for cultivation efforts other than those already available on the mark*et al*so requires efforts to find feed ingredients that are relatively cheap and easy to obtain, such as agricultural product waste or industry from other materials that are not or are underutilized as alternative feed, without ignoring the nutritional value, survival, and growth of fish (Rimalia, 2021). One of the potential alternative feed ingredients that can be utilized is fish fillet waste. The fisheries industry currently produces quite a lot of fish fillet waste, around 67% of total production (Rahimatul, 2021). According to Grasela *et al*. (2022) [11], the fish auction place (TPI) is one of the fish auction places in Makassar City that has a lot of fish waste and has the potential to be used as a source of protein in making fish feed. Fish waste from community catches has not been managed properly by the community because it has low economic value. With the development of increasingly advanced technology, fish waste from community catches in the market can be used as a substitute for pellet feed to overcome the relatively expensive cost of commercial feed. This study focuses on analyzing the physical quality aspects of fish feed produced from making fish feed with one of the raw material sources being fish waste.

In order to obtain fish feed with good physical properties in water, it is necessary to use a binder (adhesive material) in the mixture of fish feed ingredients. Binders or adhesive materials are additional materials that are deliberately added to the feed formulation to unite all the raw materials used (Saade & Aslamyah, 2009) [29]. The adhesive material used in this study was tapioca flour. Furthermore, the characteristics of the physical properties of sinking feed, such as sinking speed, stability in water, and buoyancy, affect the efficiency of feed utilization by fish (Nguyen *et al*., 2020) [24].

Material and Methods

This research was conducted from February to April 2024 at the Laboratory of the Department of Agricultural Technology, Makassar State University. The working procedure for making fish waste flour refers to the research (Sahar *et al*., 2024) [30] as follows:

- **Fish waste preparation process:** collect fish waste, including heads, fins, bones, tails, and innards, from the remaining fish available.
- Clean fish waste from dirt and other foreign objects to ensure cleanliness before processing.

- **Fish waste processing process:** boil the fish waste in boiling water to remove bacteria and germs. After boiling, dry the fish waste by drying it in the sun or using a dryer to reduce its water content.

- **Fish waste grinding:** grind the dried fish waste into a fine powder using a grinding machine.

- **Storage and usage process:** store the finished feed in a closed container (standing pouch) to prevent contamination and maintain cleanliness. All equipment and materials used in this process are clean and sterile to avoid contamination that can affect the quality of the feed.

The research design used a completely randomized design with 3 treatments of comparison of the use of fish waste substituted with soybean flour; each treatment A is 40% fish flour and 20% soybean flour. Treatment B has 42% fish waste flour and 18% soybean flour, Treatment C has 44% fish waste flour and 16% soybean flour, while treatment K has 100% fish waste flour. Furthermore, other ingredients such as corn flour, fine bran, and tapioca flour have the same amount or dose. All treatments were carried out with 3 replications. Next, prepare other feed ingredients consisting of soybean flour, corn flour, fine bran, and tapioca flour as an adhesive. Soybean flour and corn flour are obtained by buying them on the market and then grinding them into flour. While tapioca flour is obtained from the market. After all the ingredients are available, the next step is to make feed with the formula as in Table 1.

Table 1: Research design and treatment

Feed Making Materials	Treatments			
	A (%)	B (%)	C (%)	K (%)
Fish waste flour	40	42	44	60
Soy flour	20	18	16	0
Cornstarch	20	20	20	20
Fine bran	16	16	16	16
Tapioca flour	4	4	4	4
Amount	100	100	100	100

The stage of making fish feed is to prepare the ingredients and tools to be used, then all ingredients are mixed into a container with the amount of composition that has been determined based on the treatment being tried. Then the ingredients that have entered the container are added with enough warm water and stirred using a mixer with the aim that the dough ingredients can be mixed evenly. Next, the dough is ground with a pellet-molding tool. After that, drying is carried out using a drying room for 3-5 days. After drying, the feed is then packed using plastic Ziplocs and stored at room temperature. The feed that has been made is then subjected to physical tests consisting of tests on the attractiveness, solubility, hardness, and color of the fish feed.

1. Feed Attractiveness Test

The feed allure test was conducted with the aim of determining how attracted the fish were to approach and consume the test feed given. Observations were made using a stopwatch with the aim of observing the time required by the bileh fish to consume the test feed. The stopwatch started when the feed had touched the water and was at a distance of 40-50 cm from the fish (Islama *et al*., 2024) [16].

2. Feed Solubility Test

The solubility of feed in water tested in this study was the speed of feed breakdown. The feed was put into a 250 ml plastic cup filled with water. Furthermore, it was observed carefully, and the time required for the feed to disintegrate was calculated using a stopwatch. The parameters observed visually were the speed of breakdown and the speed of sinking through the equation v = distance/time (t) (Islama *et al*., 2024) [15].

3. Feed Hardness Test

The hardness level of fish feed is measured by inserting 2 g of feed into a 1 m high PVC pipe. Then the feed is dropped with a weight weighing 500 g. The feed that has been dropped is then sieved using a sieve with a sieve size of 0.5 mm. The hardness level is calculated as the percentage of feed that is not destroyed using a sieve (Saade & Aslamyah, 2009) [28].

4. Feed Color Test

Feed color testing is grouped into 3 categories, namely brown, light brown, and dark brown (Islama *et al*., 2024) [14].

After the feed testing is carried out, the next step is data processing and analysis using descriptive analysis.

Results and Discussion

1. Feed Attractiveness (Seconds)

Figure 1 shows the highest attractiveness of fish feed made in treatment C and the lowest in treatment B. Thus, the feed that gets the fastest response from the test animals in this study using tilapia is in treatment B. Ismi *et al*. (2017) [18] stated that feed that has a fresh, pungent, and non-rancid odor can be categorized as good-quality feed. The smell, taste, and color of the feed are closely related to the attractiveness of the feed, where there are certain types of fish that are selective in stimulating feed (Mudjiman, 2008). Wulandari *et al*. (2017) [34] also stated that smell and color can be easy and fast response indicators in describing feed products. The quality of feed must have good stability so that it does not break down quickly in water and the feed nutrients are not easily broken down in the maintenance media (Paolucci *et al*. 2012) [25]. Rakhmawati *et al*. (2017) [27] stated that feed is categorized as good if it has a bright color without any spots. Fish are slightly different from other livestock.

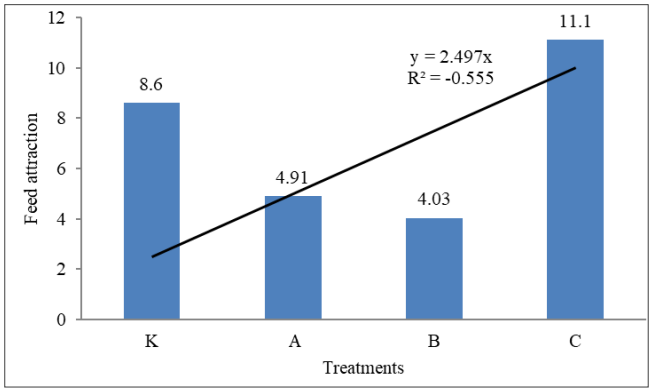


Fig 1: Attractiveness of Feed to Fish

2. Feed solubility (minutes)

In making fish feed, it turns out that it does not only require the right formulation of raw materials, both in terms of the type of raw materials and the composition of nutrients; what is no less important is the quality of the fish feed after being spread into the water. Many feeds that have been successfully made with nutritional quality that meets the requirements but sink quickly are easily destroyed and decomposed in water, even though not all of them have been eaten by the fish (Irawati *et al*., 2023) [12]. Mudjiman (2008) [22] stated that the buoyancy of feed is related to the specific gravity of the feed. The greater the specific gravity (SG) of the feed compared to the specific gravity of water (SG of water = 1), the faster the feed in question sinks. If the SG of the feed is around 1, then the feed will float, while if the specific gravity of the feed is less than 1, the feed will float.

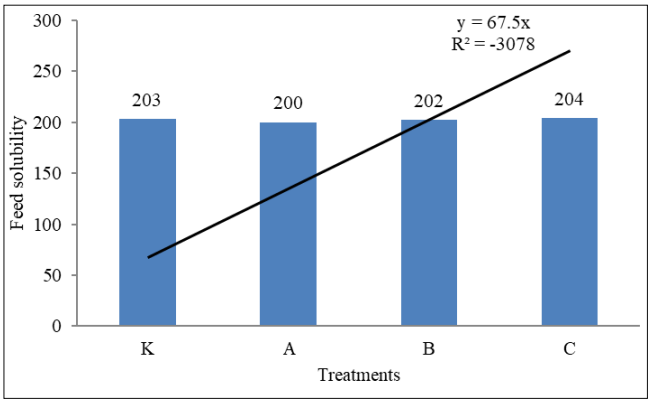


Fig 2: Solubility of fish feed

Figure 2 shows that all treatments used have almost the same solubility, which is in the range of 200-204 minutes before the fish feed dissolves in water, and the solubility of the feed in this study is relatively high. This is thought to be due to the high tapioca flour adhesive given. Good artificial feed remains intact in water for at least 3 hours (Afrianto and Liviawaty, 2005) [3]and can last more than 15 minutes for catfish feed, 5 minutes for carp feed, and 90 hours for tilapia feed (Utomo, 2015). The finer the feed ingredients, the more stable the feed will be in the water so that it does not quickly sink to the bottom or break apart (Wulansari *et al*., 2016) [35]. Feed that has a good resistance index will remain compact, sturdy, and not easily brittle or broken (Fauzy *et al*., 2024) [9].

3. Feed hardness level (%)

Jaelani *et al*. (2016) [19] stated that good-quality fish feed is feed that has a high durability index (pellet durability index). The feed will not be easily physically damaged during the handling process (Fauzy *et al*., 2024) [8]. Rakhmawati *et al*. (2017) [26] stated that the main factor that influences the level of feed hardness is the composition of raw materials and binders used in the feed formulation. Figure 3 shows that the highest level of feed hardness is in treatment B and the lowest in treatment C. The level of feed hardness is related to the solubility of fish feed. High levels of feed hardness cause low solubility of fish feed. Feed with a resistance index above 80% is considered to be of good quality. Feed in this category tends to be more solid and is not easily broken or damaged when handled (Fauzy *et al*., 2024) [7]. Feed with a resistance index between 70% and 80% is included in the medium-quality category, while feed with a resistance index below 70% is included in the low-quality category, which means it is more susceptible to physical damage (Siahaan *et al*., 2014) [32]. The heavier the weight of the load that can be supported by the feed, the harder the artificial feed is. According to Afrianto and Liviawaty (2005) [2], artificial feed with higher hardness is made from relatively finer raw materials.

A mixture of fine feed ingredients will cause high pellet hardness. This is because the bonds between particles that are influenced by the material pressing process during manufacture will be stronger so that pellets with high hardness are obtained (Mudjiman, 2004) [12]. In addition, good fish feed has a compact texture and a fine and uniform particle size of raw materials (Afrianto & Liviawaty, 2005) [1]. A mixture of fine feed ingredients will cause high pellet hardness. This is because the bonds between particles that are influenced by the material pressing process during manufacture will be stronger so that pellets with high hardness are obtained (Mudjiman, 2004) [12].

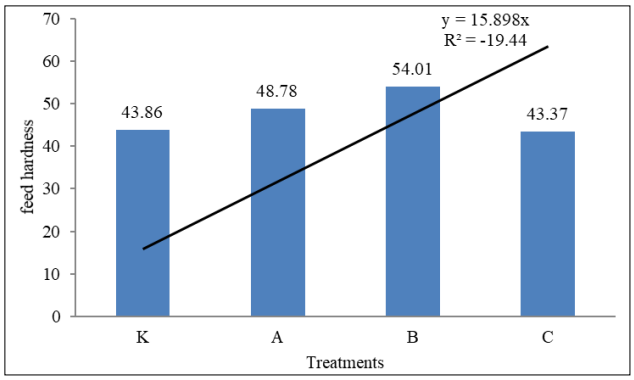
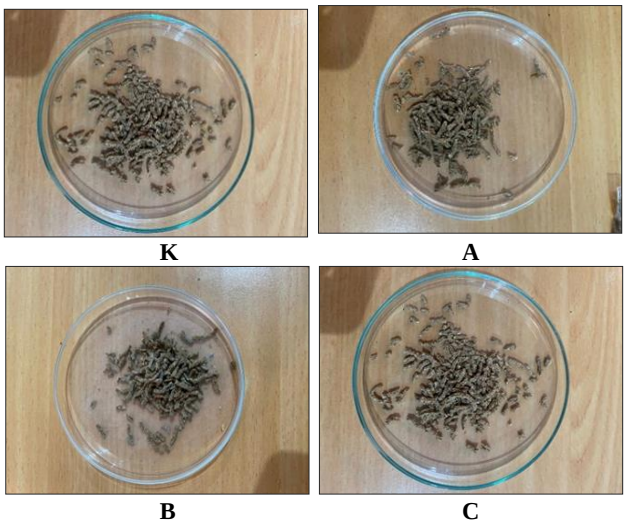


Fig 3: Level of hardness of fish feed

4. Feed Color

The figure shows that, based on the color aspect of fish feed, all feeds made in this study have the same color, namely brown. The color of the feed is highly dependent on the type of raw material used (Aslamyah 2012) [5]. According to Kamarudin *et al*. (2018) [20], visually attractive feed can increase fish appetite, so it is important to consider the appearance of the feed in an effective feed formulation. According to Mulia *et al*. (2017) [23], the physical form of fish feed is greatly influenced by the type of material used, the size of the mold, the amount of water, the processing method after the process, pressure, and the use of adhesives.



Conclusion

The physical properties of the feed produced in this study generally meet the requirements of fish feed, especially in terms of the attractiveness of the feed and the color of the feed, but in terms of the solubility and hardness of the feed, the resulting fish feed is classified as less suitable because the fish feed has a high level of hardness and low solubility. Therefore, it is recommended for further feed production to reduce the amount of feed adhesive.

Compliance with ethical standards

Disclosure of conflict of interest

There is no conflict of interest in this research.

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