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Evaluation and Improvement of The Effectiveness of Floating Pellets with the Substitution of Chicken Feather Meal as Optimal Food for the Growth and Survival of Tilapia (*Oreochromis Niloticus*)

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Abstract

This study aims to determine the effectiveness of fishmeal substitution using chicken feather meal in pellets on growth, water quality, and survival of tilapia (Oreocromis niloticus), to determine the effectiveness of fishmeal substitution using chicken feather meal in pellets on FCR value, how the physical test value of floating pellets substituted with chicken feather meal, and what factors need to be updated in an effort to improve the quality of floating pellet feed substituted with chicken feather meal. The results of absolute growth research on fermented chicken feather meal pellets were 5.07 grams/head, non-fermented chicken feather meal pellets were 5.11 grams/head, and conventional pellets were 5.03 grams/head. While the results of absolute length growth on fermented chicken feather meal pellets were 3.21 cm/head, and absolute length growth for non-fermented chicken feather meal pellets was 3.24 cm/head, while for conventional pellets was 3.28 cm/head. The survival rate ranged from 62% - 68% during rearing with an FCR value of 0.6. Although the survival rate obtained was not good, the water quality during the study including pH, DO, and temperature showed good results in accordance with the quality standards. While the results of organoleptic observations of feed showed that the non-fermented artificial feed observed by the testers had a more pungent aroma than the fermented artificial feed, and conventional pellets tended to have a strong odor aroma. As for the texture assessment of the three types of feed, the dominant judge that all three have a hard texture.

Keywords: *Chicken Feather Flour, Feed Physical Test, Growth, Tilapia (Oreochromis niloticus), Water Quality*

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INTRODUCTION

Tilapia (*Oreochromis niloticus*) is a fish that lives in fresh water and comes from the Nile River and surrounding lakes. Tilapia fish began to be imported to Bogor in 1969. Tilapia is a freshwater food fish that is in demand by consumers other than goldfish and gourami, because tilapia has a meaty taste delicious, tasty, and doesn't have many thorns. The high consumption of tilapia has caused tilapia cultivation to begin to be developed. The advantages of tilapia fish Compared to other food fish, tilapia can grow only quickly with low protein feed, spawns throughout the year, is omnivorous, has thick flesh, and the taste of the meat is similar to red snapper (Suyanto, 2011). Tilapia farming is one type of fishery business that is widely practiced by the community. This is supported because tilapia is easy to breed and grows relatively fast. Tilapia has several advantages, namely a specific flavor, dense meat, and not too many thorns. Tilapia meat contains 17.5% protein, 4.7% fat, and 74.8% water. This is a factor that causes tilapia to have a high economic value with high market demand (Sirait, 2023). Some of the things that support the importance of tilapia commodities are its relatively high tolerance to water quality and disease. Tilapia also has a wide tolerance to environmental conditions, has a good growth ability, and is easy to grow in intensive farming systems (Carman & Sucipto, 2013). Efforts to increase tilapia production have been widely attempted by farmers, one of which is through the provision of high-nutrient feed, which means that feed is a very influential factor in the growth of tilapia seeds (Kirikanang et al., 2022).

The success of fish farming depends on providing feed in quantities appropriate to the fish's needs. Feed is one of the elements that influences the development of cultivated fish. Good quality feed is one of the key elements that determines the success of fish farming (Fradina & Latuconsina, 2022). Artificial feed containing high nutritional value will encourage faster growth of tilapia (Arifin et al., 2020). As is known, feed is the largest component of production costs in fisheries activities, reaching 60-70% of total production. According to Widodo (2009) Currently, the price of conventional feed ingredients must still be imported to meet the needs of the livestock and fisheries industry. This situation causes high production costs and it is not uncommon for farmers to experience losses. To anticipate these problems, alternative sources of local raw materials that have nutritional quality that is not inferior to fishmeal can be used as a source of animal protein for making feed, which is affordable or even utilizes waste (Prajayati et al., 2020).

One alternative raw material that still has high protein content is chicken feathers. Every day, chicken feather waste is produced from every chicken slaughterhouse, which is about 4-5% of chicken feathers from the live weight of broilers (Afriani & Hasan, 2020). This chicken feather waste if not utilized can cause serious environmental problems. Such as air pollution caused by odor, and environmental hygiene issues. The use of chicken feathers as an alternative protein source has the potential to be developed because it is cheap and easy to obtain (Krisnajati, 2019).

The availability of released feather waste and chicken feather waste which has a high protein content, namely 75% -81%, means that chicken feathers have the potential as a protein source feed that can be processed into feather meal for broiler chickens. Various treatments are needed to break the disulfide bonds in chicken feathers so that they can be used by poultry, especially broilers, using mechanical, chemical and biological degradation treatments (Saputra et al., 2024). The utilization of chicken feather meal in the feed mixture, needs to be considered several things such as its protein structure. Chicken feather protein is a type of protein that is difficult to digest, because it is classified as a type of keratin protein (Joshi et al., 2007). Keratin is composed of 14% disulfide bonds

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making it very stable, rigid, and cannot be digested properly by proteolytic enzymes such as trypsin, pepsin, and papain found in the digestive organs (Brandelli, 2008). The low digestibility of the protein is an obstacle to making chicken feathers as a protein source for fish feed. Therefore, to improve the quality of chicken feather meal as a raw material for fish feed, chicken feather meal must first be degraded, one of which is by fermentation (Mulia et al., 2013).

Keratin-degrading microorganisms include *Bacillus* sp. Bacteria (Tiwary & Gupta, 2012). B. licheniformis was used in fermentation to break down chicken feather keratin at an inoculum concentration of 6.5 x 109 colonies/ml with an inoculum amount of 10 ml. The results showed that after fermentation, the crude protein content of chicken feathers increased from 95.17% to 97.12% or increased by 2.95% (Desi, 2002). Another study conducted by (Akanda et al., 2017) used B. licheniformis to degrade chicken feathers. The results showed an increase in protein from 57.8% to 73.4%.

In previous studies, stability testing was carried out using the measurement method of (Rizki, 2023), which is with 2.5gr of pellets that are weighed first, then soaked in a beaker glass that has contained 500 mL of water and checked in real-time until the product expires. In the stability test of feed soaked into a glass beaker stored at 25ºC starting at the 20th hour after 13 minutes the feed became slimy, had a sour smell and at the 27th hour the feed became very slimy, and the smell was getting stronger. This happened in 3 repetitions and not only happened to the hydrolyzed feed, but also to the non-hydrolyzed feed. Then in the feed buoyancy test, the pellets produced in the processing are floating type pellets made using an extruder machine. This is because according to (Hutagalung et al., 2022) most fish prefer floating feed over sinking feed.

This study aims to determine the effectiveness of substitution of fish meal with chicken feather meal in pellets on growth, water quality, and survival of tilapia (*Oreocromis niloticus*), determine the effectiveness of substitution of fish meal with chicken feather meal in pellets on FCR value, determine how the physical test value of floating pellets substituted with chicken feather meal, and what factors need to be updated as an effort to improve the quality of floating pellet feed substituted with chicken feather meal. The results of this study are expected to have a positive impact and become a new innovation for farmers in the development of aquaculture.

METHOD

This research uses an experimental method with a complete randomized design (CRD), 3 different treatments with 5 repetitions. The research treatments are as follows:

P1 : Artificial feeding of fermented chicken feathers
P2 : Artificial feeding of non-fermented chicken feathers
P3 (control) : Conventional artificial feeding of fishmeal

The maintenance period in this study was 30 days. The number of fish used in this study was 150 tilapia fish. Sampling method by means of simple random sampling. Every 7 days sampling is done by taking 5 fish in each container containing 10 fish.

Feeding Calculation:
The number of fish is 150 fish, in one rearing container there are 10 tilapia fish measuring 5-7 cm (average weight 4.5 grams).

Amount of feed per day	$= average\ weight\ of\ fish\ x\ population\ x\ 5\%$	(1)
Average fish weight	= 4.5 grams	
Feed calculation	= 4.5 x10 x 5% = 2.25 grams	
	= 2,25 : 3 times = 0.75 grams/day/1 container	
Morning (08.00 am)	= 40% = 0.3	
Afternoon (13.00 WIB)	= 30% = 0.225	
Afternoon (17.00 WIB)	= 30% = 0.225	

During the study, water sprinkling and water changes were carried out. Water changes are made every 2 days, by reducing ½ of the cultivation water and then adding new water with the same amount.

Data Analysis

Absolute Weight Growth

Absolute weight growth was calculated using (Effendie, 1997) formula:

$$Wm = Wt - W \qquad (2)$$

Description:
Wm = absolute weight growth (grams)
Wt = Weight of biomass at the end of the study (grams)
Wo = Biomass weight at the beginning of the study (grams)

Absolute Length Growth

Absolute growth is calculated by the formula (Effendie, 1997) :

$$Lm = Lt - Lo \qquad (3)$$

Description:
Lm = absolute length growth (cm)
Lt = Length at the end of the study (cm)
Lo = Length at the beginning of the study (cm)

Survival Rate

The unit value of survival rate is percent (%). To determine the survival rate can use the following formula (Effendie, 1997) :

$$SR = \frac{Nt}{No}\ x\ 100\% \qquad (4)$$

Description:
SR = Survival rate (SR)
Nt = Number of fish at the end of the period (tail)
No = Number of Fish at the Beginning of the Period (Tail)

Feed Conversion Ratio (FCR)

FCR can be calculated using the following formula:

$$FCR = \frac{F}{((Wt-D)-Wo)} \quad (5)$$

Description:
FCR = Feed Conversion Ratio
F = Amount of feed consumed during the rearing period (g)
Wt = Final biomass (g)
Wo = Initial biomass (g)
D = weight of dead fish during maintenance (g)

RESULTS AND DISCUSSION
Weight Growth

The results showed that tilapia fry gained weight during 30 days of rearing using fermented chicken feather meal substitution pellets, non-fermented chicken feather meal substitution pellets, and conventional pellets. The data showed that the absolute average weight for fermented chicken feather meal pellets was 5.07 grams/head, non-fermented chicken feather meal pellets was 5.11 grams/head, and conventional pellets was 5.03 grams/head.

Table 1. Average Absolute Weight of fermented chicken feather meal pellets, non-fermented chicken feather meal pellets, and conventional pellets

Week	fermented chicken feather meal pellets	non-fermented chicken feather meal pellets	conventional pellets
0	4,5	4,5	4,5
1	5,96	5,92	6,04
2	7,07	6,88	6,87
3	9,04	9,24	9,04
4	9,57	9,61	9,53
Absolute Weight	5,07	5,11	5,03

From the results of the study, the weight gain of the three treatments was obtained. The treatment of fermented chicken feather meal pellets and non-fermented chicken feather meal pellets, as well as conventional pellets showed good growth. This shows that conventional pellets can be substituted with chicken feather meal, because chicken feather meal can match the growth of tilapia given conventional pellets, so chicken feather meal can be used as a local raw material that has a high protein content and provides fast growth in aquaculture activities.

By using SPSS Version 25 software, the absolute weight variation was obtained in the fermented chicken feather meal feeding treatment, non-fermented chicken feather meal feeding treatment, and conventional feeding treatment. Based on the T test at the real level of 0.05, it can be stated that the absolute weight gain between fermented and non-fermented chicken feather meal feeding is not significantly different from conventional feeding which can be seen in table 2.

Table 2. T-test of Tilapia Weight Data

Tilapia absolute weight gain	N	Df	T	sig.(2-tailed)
fermented chicken feather meal pellets	5	14	7,225	0,981
non-fermented chicken feather meal pellets	5	14	7,230	0,985
conventional pellets	5	14	7,196	0,90

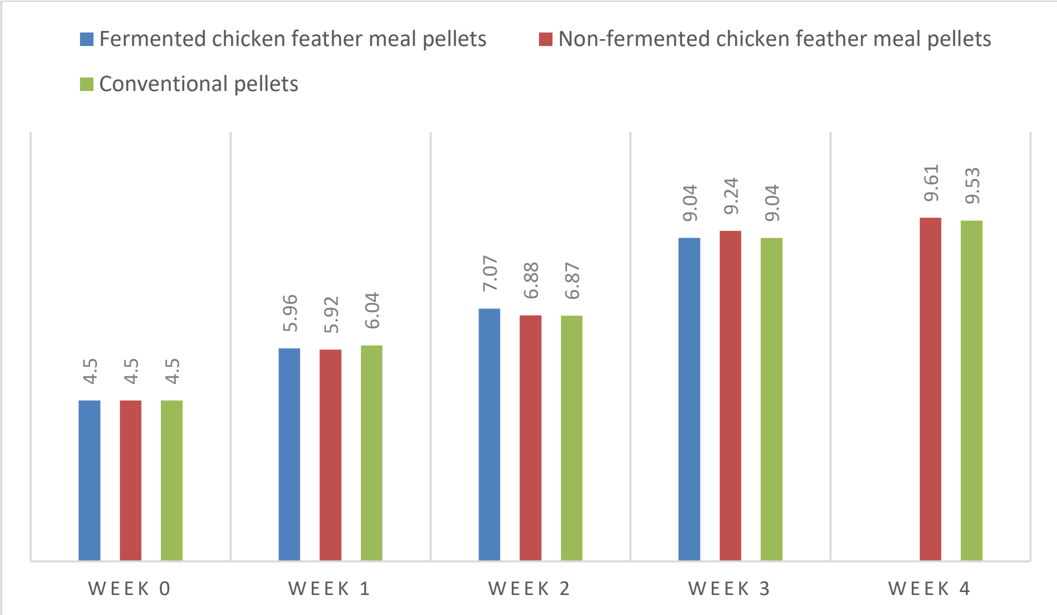

Figure 1. Total Weight Growth Chart

Based on the graph of fish weight growth rate in (Figure 1), it can be seen that tilapia seeds treated with fermented chicken feather meal pellets, non-fermented chicken feather meal pellets and conventional pellets have almost uniform absolute weight growth rates. Overall, tilapia weight gain increased in all feeding treatments. According to (Rachmawati & Samidjan, 2017) the increase in weight is due to each feed given can be responded by fish and used for metabolic processes and growth. Growth is influenced by the balance of nutrients contained in the feed. This is in accordance with (Aslamyah & Fujaya, 2010), that fish will consume feed to meet their energy needs, most of the feed is used for metabolic processes and the rest is used for other activities such as growth.

Length Growth

The results showed that tilapia fry fed with fermented chicken feather meal substitution pellets, non-fermented chicken feather meal, and conventional pellets experienced long growth during thirty days of rearing. The results showed that the absolute average growth for fermented chicken feather meal pellets was 3.21 cm/head, and the average growth for non-fermented chicken feather meal pellets was 3.24 cm/head, while for conventional pellets was 3.28 cm/head which can be seen in table 3.

Table 3. Average Absolute Length of fermented chicken feather meal pellets, non-fermented chicken feather meal pellets, and conventional pellets

Week	fermented chicken feather meal pellets	non-fermented chicken feather meal pellets	conventional pellets
0	5	5	5
1	6,22	6,08	6,06
2	7	6,86	6,94
3	7,83	7,94	7,95
4	8,21	8,24	8,28
Absolute Length	3,21	3,24	3,28

From the results of the study, the length gain of the three treatments was obtained. The treatment of fermented chicken feather meal pellets and non-fermented chicken feather meal pellets, as well as conventional pellets showed good growth. This demonstrates that chicken feather meal can substitution conventional pellets because it can match the growth of tilapia grown on conventional pellets. As a result, chicken feather meal can be used as a locally available, high-protein raw material that promotes rapid growth in aquaculture operations. The length growth of tilapia fry in each treatment showed good growth every week. According to Ananda et al. (2015), the growth of the early phase of fish life initially runs slowly for a while but then growth goes quickly and is followed by slow growth again at an old age.

Table 4. T-test of Tilapia Length Data

Tilapia absolute length gain	N	Df	T	sig.(2-tailed)
fermented chicken feather meal pellets	5	14	6,852	0,976
non-fermented chicken feather meal pellets	5	14	6,824	0,975
conventional pellets	5	14	6,846	0,97

By using SPSS Version 25 software, the absolute length variation was obtained in the fermented chicken feather meal feeding treatment, non-fermented chicken feather meal feeding treatment, and conventional feeding treatment. Based on the T test at the real level of 0.05, it can be stated that the absolute length gain between fermented and non-fermented chicken feather meal feeding is not significantly different from conventional feeding. This can be seen in table 4.

Based on the graph of the length growth rate of tilapia seeds in (Figure 2), it shows that the highest growth rate is in conventional feed with the body length of tilapia seeds obtained at 8.28 cm. Followed by non-fermented chicken feather meal pellet feed with the acquisition of tilapia seed body length of 8.24 cm. Then fermented chicken feather meal pellet feed with the acquisition of 8.21 cm.

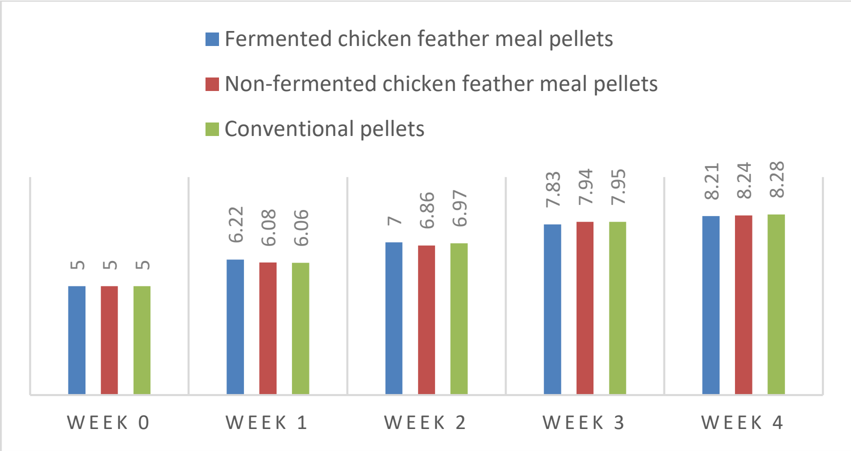

Figure 2. Total Length Growth Chart

This shows that the provision of conventional feed types, non-fermented chicken feather meal pellets and fermented chicken feather meal pellets is not much different. However, chicken feather meal pellets can be used as an alternative feed for aquaculture, because the nutritional content in chicken feather meal pellets can compensate for the nutritional content of conventional pellets so that they can meet the nutritional needs of fish.

Survival Rate

The results of the survival rate of tilapia fry during the study obtained results for feeding fermented chicken feather meal pellets, non-fermented chicken feather meal pellets, and for feeding conventional pellets can be seen in Table 5 as follows.

Table 5. Survival Rate Calculation Results

Pellets	Initial stocking number (fish)	Final stocking number (fish)	SR (%)
Fermented chicken feather meal	50	34	68
Non fermented chicken feather meal	50	31	62
Conventional	50	31	62

Based on the results of this study, the survival rate of tilapia with fermented chicken feather meal pellet feeding was 68%, chicken feather meal pellet feeding was 62%, and conventional pellet feeding was 62%. The survival rate of tilapia fry during the study showed a poor level due to food factors that were difficult to digest by tilapia. The pellets used had a hard texture and a larger size than the standard pellet size for tilapia fry, so they had to be crushed before use so that the pellets could be consumed by tilapia. This problem cannot be separated from the limitations of the extruder machine used to print the feed size, which can only print one type of feed size. Based on the Badan Standardisasi Nasional (2018) optimal size of tilapia pellets for breeding, the maximum diameter is 2 mm and the size of pellets for enlargement is 2-5 mm in diameter, while in this study the size of the pellets used was greater than 2 mm, which was a factor in the low survival rate in this study. And according to (Mulqan et al., 2017) which states the tilapia population during the best maintenance if the survival rate is 81-87%. However, fish mortality is suspected during the environmental adaptation process because fish mortality is obtained at the beginning of maintenance and adaptation to the feed given is slow. As the opinion (Harun et al., 2023) states that the adequacy of the amount and type of feed is sufficient to support the basic needs of fish and can support the life of fish.

Food Covertion Rate (FCR)

The FCR calculations obtained during the study for feeding fermented chicken feather meal pellets, non-fermented chicken feather meal pellets, and conventional pellet feeding can be seen in Table 6 as follows.

Table 6. FCR Calculation Results

Feed (Pellets)	Total weight Overall (kg)	Weight of dead fish (kg)	Total feed given during rearing (kg)	FCR
Fermented chicken feather Meal	0,327	0,155	0,496	3,90
Non fermented chicken feather meal	0,314	0,180	0,475	5,33
Conventional	0,333	0,177	0,497	4,47

Based on the results of this study, it was found that the FCR value of fermented chicken feather meal pellets to get 1 kilogram (kg) of tilapia meat requires 3.90 kilograms (kg) of feed, for non-fermented chicken feather meal pellets to get 1 kilogram (kg) of tilapia meat requires 5.33 kilograms (kg) of feed, and for conventional pellets to get 1 kilogram (kg) of tilapia meat requires 4.47 kilograms (kg). The FCR value obtained is not good because the results of the FCR calculation are in accordance with the opinion of (Khairuman & Amri, 2008) which says that the feed conversion value or FCR of tilapia is in the range of 0.8-1 kg. The higher the protein value, the lower the FCR value. Where to produce 1 kg of fish requires less feed.

Water Quality Data

The results of water quality observations include pH, DO, and temperature. Where the average pH value during maintenance ranges from 7.0-8.0. The DO observation during the study had a value of 4.0-6.0. While the average value of temperature ranges from 28-30^{0}C. The average value of these three parameters is still classified as good, where this value is still in accordance with SNI.

Table 7. Water Quality Measured During the Study

Observation	pH	DO	Temperature
Fermented chicken feather Meal	7,0-8,0	4,0-6,0	27-30 °C
Non fermented chicken feather meal	7,0-8,0	4,1-6,0	28-30 °C
Conventional	7,0-8,0	4,1-6,0	28-30 °C

It is very important to pay attention and control the water quality. As the fish are still susceptible to stress when there is a significant change in the water quality, this will inevitably halt the growth of the fish. Separating diseased fish and disposing of food scraps in the rearing container are additional efforts to maintain water quality. This is done to prevent the disease from spreading to other fish. The chances of survival will be reduced if the treatment takes too long.

Physical Test of Feed

Stability Test

Stability testing was conducted using the measurement method used by (Rizki, 2023), where 2.5 grams of pellets were weighed first, then immersed into a glass bottle containing 500 milliliters of water. At the beginning of the test, the feed soaked in the glass bottle was kept at 25°C and after 20 hours, the feed became very slimy, had a sour and very pungent odor. This occurred in 2 repetitions and occurred in both hydrolyzed and non-hydrolyzed feed. According to Mishra et al., (2002), the stability test calculation is as follows:

Feed stability test of hydrolyzed TBA:

$$Water\ stability = \frac{\text{dry weight of pellets after soaking in water}}{\text{dry weight of pellets before soaking in water}} \text{ x } 100 \qquad (6)$$

$$Water\ stability = \frac{\text{2,9 gram}}{\text{2,5 gram}} \text{ x } 10\ 0$$

Water stability (%) = 1.16 x 100

Water stability (%) = 116

Non-hydrolyzed TBA feed stability test:

$$Water\ stability = \frac{\text{dry weight of pellets after soaking in water}}{\text{dry weight of pellets before soaking in water}} \text{ x } 100 \qquad (7)$$

$$Water\ stability = \frac{\text{4,1 gram}}{\text{2,5 gram}} \text{ x } 100$$

Water stability (%) = 1.64 x 100

Water stability (%) = 164

Conventional feed stability test:

$$Water\ stability = \frac{\text{dry weight of pellets after soaking in water}}{\text{dry weight of pellets before soaking in water}} \text{ x } 100 \qquad (8)$$

$$Water\ stability = \frac{\text{2,7 gram}}{\text{2,5 gram}} \text{ x } 100$$

Water stability (%) = 1.08 x 100

Water stability (%) = 108

Buoyancy

Floating feed is made with sophisticated equipment (extruder) which uses a high pressure system, incorporating air when printing so that it is light and has buoyancy (Tarigan, 2023). Another alternative technique is to utilize the results of microbial metabolism so that gas is trapped in the feed so that it can float (Jiménez, 2020). The buoyancy test can be seen in table 8 below.

Tabel 8. Observation of buoyancy of fermented chicken feather meal pellets

Time (seconds)	Number of Floating Feed	Number of Sinking Feed
20	1 grain	9 grains
40	1 grain	9 grains
60	1 grain	9 grains
120	2 grains	8 grains
180	2 grains	8 grains
240	2 grains	8 grains
300	3 grains	7 grains
360	3 grains	7 grains
420	4 grains	6 grains
1440	6 grains	4 grains
2880	7 grains	3 grains
4500	7 grains	3 grains

Tabel 9. Observation of buoyancy of non fermented chicken feather meal pellets

Time (seconds)	Number of Floating Feed	Number of Sinking Feed
20	3 grains	7 grains
40	2 grains	8 grains
60	2 grains	8 grains
120	2 grains	8 grains
180	2 grains	8 grains
240	3 grains	7 grains
300	3 grains	7 grains
360	4 grains	6 grains
420	4 grains	6 grains
1440	5 grains	5 grains
2880	5 grains	5 grains
4500	5 grains	5 grains

Tabel 10. Observation of buoyancy conventional pellets

Time (seconds)	Number of Floating Feed	Number of Sinking Feed
20	6 grains	4 grains
40	6 grains	4 grains
60	5 grains	5 grains
120	5 grains	5 grains
180	5 grains	5 grains
240	4 grains	6 grains
300	4 grains	6 grains
360	4 grains	6 grains
420	4 grains	6 grains
1440	4 grains	6 grains
2880	6 grains	4 grains
4500	6 grains	4 grains

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Based on the results of this buoyancy test, fermented chicken feather meal pellets, non-fermented chicken feather meal pellets, and conventional pellets when put into a beaker glass containing 500 mL of water, initially the feed sinks, but when checked periodically the feed will rise to the surface and float alternately. This is because when making feed, the extruder machine will reduce the water content in the feed. Because the extrusion process consists of several combinations of processes including mixing, cooking, kneading, shearing and forming (Fellows, 2000).

Organoleptic

a. Smell

Smell testing with three samples of artificial feed products substituted with fermented and non-fermented chicken feather meal, as well as conventional pellets from 40 testers obtained results, that :

Tabel 11. Smell testing with three sample pellets

Pellet Type	No smell	Very weak smell	Slight smell	Strong smell	Very strong smell
Fermented chicken feather meal	4 people	-	25 people	11 people	-
Non-fermented chicken feather meal	-	-	-	12 people	28 people
Conventional	4 People	-	-	16 people	20 people

In fermented pellets, the smell is not so strong, this is because the fermentation period in the sample of chicken feather flour does not occur, while the non-fermented feed has a very strong smell, this is because the non-fermented chicken feather flour sample experiences uncontrolled decay and the flour sample is not sterilized first, so it has a strong smell (Rizki, 2023). Conventional pellets also have a strong smell.

b. Texture

Testing the texture of artificial pellets substituted with fermented and non-fermented chicken feather meal, as well as conventional pellets from 40 testers found on table 12. The texture of the three types of pellets has a hard texture because the extrusion process involves high pressure and high temperature used to form the pellets. This process causes the feed ingredients to become compact and dense, resulting in pellets with a hard texture. And also during the extrusion process, the moisture content in the feed ingredients is usually reduced, which also contributes to the hardness of the pellets.

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Tabel 12. Texture testing with three sample pellets

Pellet Type	Very soft texture	Soft texture	Medium texture	Strong texture	Very strong texture
Fermented chicken feather meal	-	-	-	40 people	-
Non-fermented chicken feather meal	-	-	-	40 people	-
Conventional	-	-	-	40 people	-

c. Color

Color testing on artificial pellets substituted with fermented and non-fermented chicken feather meal, as well as conventional pellets from 40 testers found that:

Tabel 13. Color testing with three sample pellets

Pellet Type	Non-bright color	Least bright color	Bright color	Brighter color	Brightest color
Fermented chicken feather meal	-	-	15 people	20 people	5 people
Non-fermented chicken feather meal	25 people	15 people	-	-	-
Conventional	30 people	10 people	-	-	-

Based on the table above, fermented chicken feather meal pellets have a bright color compared to non-fermented chicken feather meal pellets and conventional pellets. this is because the extrusion and drying process can cause color changes due to the maillard reaction (reaction between protein and sugar) which can produce a brown color. Then the use of high temperature during extrusion or drying can cause darkening of the pellet color. However, the brightness or color of pellets is often not a top priority in fish feed formulation. More focus is given to nutrient content, buoyancy stability and feed efficiency. The use of additional colorants to brighten pellets may not be considered economical or necessary, especially in large-scale production. Overall, although the brightness of fish pellets can be influenced by various factors, fish pellets tend not to be bright in color due to the predominance of raw materials that are naturally darker in color, as well as production processes that can darken the color of the pellets. The main focus in fish pellet manufacturing is on nutritional quality and feed efficiency, not on color aesthetics.

Growth Evaluation and Feed Physical Test

The results of observations of weight and length growth data of tilapia seeds carried out during the study showed good results with the acquisition of an increase that was not much different. However, this is inversely proportional to the survival rate of tilapia seeds. Due to several factors, namely the level of texture of the type of feed that affects the digestibility of tilapia seeds. This is reinforced by the opinion of most respondents who stated that the feed used had a hard texture when tested during the study. In addition, the size of the feed does not match the proportional size, making it difficult for tilapia seeds to eat the pellets, especially in the type of non-fermented chicken feather meal pellets. Efforts for this problem are to grind the feed so that it reaches the right size and the feeding procedure is softened first.

CONCLUSION

Based on the results of the study, the substitution of chicken feather meal in floating pellets has a positive impact on the growth and survival of tilapia (*Oreochromis niloticus*). The use of chicken feather meal not only increases feed efficiency but also improves the quality of nutrients received by tilapia. This can be seen from the significant increase in growth rate and survival of tilapia fed pellets with chicken feather meal substitution compared to conventional pellets. These results indicate that chicken feather meal is an effective and sustainable alternative as a fish feed ingredient, especially in an effort to reduce dependence on fishmeal which is more expensive and less environmentally friendly. Furthermore, the results of this study also showed that the buoyancy stability and organoleptic characteristics of pellets substituted with chicken feather meal remained within acceptable limits. This means that in addition to the nutritional benefits, pellets with chicken feather meal also meet the physical quality standards required for fish feed. Thus, the application of chicken feather meal as a substitute ingredient in fish feed can be considered an important innovation in the aquaculture industry, helping to achieve a balance between the nutritional needs of fish and environmental sustainability.

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