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Effect of Monosodium Glutamate in Artificial Food on Feed Utilization Efficiency, Growth, and Survival of Fingerling Tilapia *(Oreochromis niloticus)*

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Abstract

Tilapia (Oreochromis niloticus) is one of the leading freshwater fish commodities in Indonesia. The problem often faced by tilapia farmers is the low level of feed utilization, especially protein, which is still low, resulting in suboptimal growth. The glutamate content in monosodium glutamate (MSG) can act as a precursor for the formation of arginine and glutamine, which can increase the production of protease and lipase enzymes that are excreted into the intestines during the feed hydrolysis process, which is useful in increasing the absorption of nutrients in the form of protein and fat. This research was conducted using fingerling tilapia as a test fish with an average individual length of 6.59 ± 0.21 cm/fish and an average individual weight of 5.33 ± 0.27 g/fish. This research was carried out in an aquarium container measuring 40x30x30 cm with a water volume of 27 l and a density of 15 fish/aquarium. The aim of this research was to determine the effect of MSG in fish feed on total feed consumption (TKP), feed utilization efficiency (FUE), protein efficiency ratio (PER), protein retention, relative growth rate (RGR), and survival (SR) in fingerling tilapia. This research used an experimental method with a completely randomized design (CRD) of 4 treatments with 3 replications. Treatments A, B, C, and D are fed with the addition of 0 MSG in commercial feed; 0.75; 1.5; and 2.25 g/kg. Variables observed included TKP, FUE, PER, protein retention, RGR, and SR. The research results showed that MSG in feed had a significant effect ($P < 0.05$) on the FUE, PER, protein retention, and RGR values but had no effect ($P < 0.05$) on the TKP and SR values. FUE value; PER, protein retention; The highest RGR was obtained in treatment D (2.25 g/kg); FUE (87.21±2.28); PER(1.83±0.05); protein retention (50.47±0.76); The RGR (3.06 ± 0.03) and survival value for all treatments were found to be 100%. The water quality during the research was in optimal condition.

***Keywords**: Tilapia (Oreochromis niloticus), Monosodium Glutamate, Growth Parameters*

1. Introduction

Tilapia is one of the leading freshwater fish commodities in Indonesia. Tilapia race janti (larassati) is part of the red tilapia strain (*Oreochromis niloticus*). According to Prajayati et al. (2020); and Melisa et al. (2023), Larassati tilapia is a superior commodity because it has a delicious meat taste, and is thick like red snapper meat, as well as relatively faster growth, easy to cultivate, resistant to pests and diseases and has a fairly wide tolerance to environmental changes when compared with other types of freshwater fish.

According to Saputry and Latuconsina (2022), the tilapia cultivation process still experiences obstacles, namely slow growth of larvae and seeds. One of the contributing factors is thought to be that the nutritional needs of the fry are not met, namely the low value of feed utilization efficiency (FUE) in fish. This statement is supported by Restianti et al. (2016) who stated that the FUE value of fingerling tilapia is generally still low, due to the content in artificial feed being difficult to hydrolyze, resulting in slow growth. The main obstacle faced in efforts to provide additional feed in the form of artificial feed to 30 day old fingerling tilapia is that the amount of enzyme production in the digestive system is not yet optimal to digest the nutrients in the form of complex molecules contained in artificial feed.

Approaches that can be taken to overcoming this problem is by improving FUE, namely by adding certain supplements to artificial feed. According to Purbomartono et al. (2023), the addition of supplements such as vitamins, minerals and hydrolysis enzymes are capable of hydrolyzing complex protein compounds into simple elements, namely amino acids. The amino acid that can support the function of the hydrolysis enzyme is the amino acid glutamate. One way to increase the growth rate of tilapia is to add glutamate content contained in monosodium glutamate to artificial feed that already has a fairly good nutritional basis (Rerung, 2023; Nurhayati et al., 2022).

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Monosodium glutamate (MSG) is a salt that contains the non-essential amino acid glutamate of 78%. According to Tapiero et al. (2002) and Newsholme et al. (2003), the addition of the non-essential amino acid glutamate in MSG can increase glutamine in the body which plays a role in improving physiological functions and maintaining cell function. Thus, the addition of MSG in feed is expected to increase the availability of glutamine in the body, so that it can fulfill the deficiency needed for growth (Ngaddi et al. 2019).

Glutamate can be used as a flavoring agent in the form of MSG which is added to human food because One of the functions of glutamate is to stimulate food consumption through the release of peptides and neurotransmitters via orexigenic neurons in the hypothalamus (Li et al. 2018). The use of MSG in fish feed was used by Lin Zhou (2006), on goldfish *Cyprinus carpio*; Zhao et al. (2015) on grass carp *Ctenopharyngodon idella*; *Caballero-solares* et al. (2015) on young *Sparus aurata*; Pereira et al. (2017) on tilapia fry; Ngaddi et al. (2019) in catfish; Marwan et al. (2022) for milkfish which states that MSG has the function of optimizing growth performance, feed efficiency, feed conversion ratio and digestive enzyme activity. The best use of MSG to add to artificial feed for tilapia fry around 15 days old is 1-2.25% and for freshwater fish the best dose is 0.87% (Pereira et al., 2017; Ngaddi et al., 2019; Kurniasih et al., 2020). Research regarding the addition of MSG to artificial feed for fingerling tilapia larassati has never been carried out. Therefore, further research is needed to determine the optimal dose of MSG in feed for tilapia growth, especially the Larassati tilapia strain.

The problem often faced by fingerling tilapia farmers is that the efficiency of feed utilization (FUE) by the fish is not yet optimal. According to Endraswari et al., 2021, who stated that the average FUE value of fingerling tilapia is still relatively low. The low digestibility of fish has an impact on low FUE values. According to Putri et al. (2021), fish digestibility of feed is influenced by several factors, namely: chemical properties of water, water temperature, type of feed, size and age of fish, nutritional content of feed, frequency of feeding, as well as the number and variety of digestive secretion enzymes found in fish digestive tract. Limited enzyme secretion, both internal and external, so the solution given in this research is to increase the total enzymes in fish digestion so that protein is easy to digest. According to Dewi et al. (2022), at the stage of digestion and food absorption the role of enzymes and the digestive tract is very important. The addition of glutamate contained in monosodium glutamate (MSG) to artificial feed can increase the activity of protease enzymes which are excreted into the intestine during the feed hydrolysis process which is useful in increasing the absorption of nutrients in the form of protein and fat. Fish intestines and protease enzymes play an important role in protein absorption (Andriani et al., 2019; Manik and Arleston, 2021). Thus, giving MSG to artificial feed is thought to be able to optimize the FUE value so that the growth rate of fingerling tilapia will be more optimal.

2. Materials and Method

2.1. Experimental diets

The test feed preparation carried out in this research was based on the use of commercial feed in pellet form. The commercial feed used contain 39% protein. Before being given to the tilapias, this feed was first mixed with monosodium glutamate (MSG) at a dose of 0; 0.75; 1.5; 2.25%. The test feed was made using the coating method. Feed and MSG are weighed first according to the dosage that has been determined. Monosodium glutamate is the added to 5 ml of water and the sprayed into the artificial food until evenly distributed. The articial feed is then dried using an oven at 400C then placed in plastic thinwall which is tightly closed. The basic oven temperature was adapted from research by Ondang et al. (2022). Proximate analysis of test feed can be seen in Table 1.

Table 1 Proxymate Analyze of the experimental diets

	Proximate Analyze(%)			
	Water	Protein	Fat	Ash content
D1 (0 g/kg food)	35	35	35	35
D2 (0.75 g/kg food)	6	6	6	6
D3 (1,5 g.kg food)	17	17	17	17
D4 (2.25 g/kg food)	20.87	20.88	20.88	20.88

Diet abbreviations, D1: 0 g MSG and 1 kg artificial food; D2: 0.75 g MSG and 1 kg artificial food; D3: 1.5 g MSG and 1 kg artificial food; D4: 2.25 g MSG and 1 kg artificial food.

2.2. Experimental protocol

Fingerling tilapia was purchased from the tilapia seed center (Central Java province, Indonesia) and transported to the laboratory of the Faculty of Fisheries and Marine Sciences, Diponegoro University. After that, 180 fish were selected and transferred to each aquarium at a density of 15 fish per aquarium. The fish are quarantined for a month and given commercial feed for acclimatization. After measuring the weight and length of the fish, 15 fish (mean body weight and length of 5.33±0.27 g and 6.59±0.23 cm, respectively) were randomly placed in each aquarium. In total, 4 treatments and 3 replications were maintained for 42 days. Feeding was carried out manually using the ad satiation method, three meals a day. Water temperature and pH were measured at 26.20±0.69 ˚C and 7.08±0.21 respectively and dissolved oxygen was close to saturation.

2.3. Growth Performance Calculations

Growth parameters including feed consumption rate (FCR), feed utilization efficiency (FUE), protein efficiency ratio (PER), protein retention, relative growth rate (RGR), survival rate (SR), were calculated as follows (Campos et al. 2019):

FCR = F1+F2+...+Fn

FUE = 100 x [(wt-wo) / F]

PER = WG/ Crude protein intake

Protein Retention: 100 x [(N gain/ N intake)]

RGR = 100 × [(final weight – initial weight/ initial weight) / days of treatment]

SR = 100 × (number of final alive fish / number of initial fish)

2.4. Analyses

In this study, RAL 4 treatments were used with 3 repetitions. Each feed contains 78% glutamate in the form of monosodium glutamate (MSG) with different doses as follows:

Dietary A: Artificial feed contains MSG 0 g/kg feed;

Dietary B: Artificial feed contains MSG 0.75 g/kg feed;

Dietary C: Artificial feed containing MSG 1.5 g/kg feed;

Dietary D: Artificial feed containing MSG 2.25 g/kg feed.

The dosage treatment for MSG above refers to research by Pereira et al. (2017); Ngaddi et al. (2019) and Kurniasih et al. (2020), which states that the best MSG addition for tilapia seeds is 1-2.25% and for freshwater fish with catfish cultivars the best dose is 0.87%, because based on molecular weight calculations MSG contains 78% glutamate. Determination of protein levels is based on research (Ramadan et al., 2022) which states that the minimum protein dose in feed for tilapia growth is 30%. Feed is given at satiation with a feeding frequency of 3 times a day, namely at 08.00; 12.00; and 16.00 WIB. The stocking density of tilapia seeds in this study was 50 individuals/m^2. The number of fingerling in 1 aquarium is 15 individuals. The stocking density of tilapia seeds in the range of 30 fish/m^2-50 fish/m^2 is considered quite optimal (Salsabila and Suprapto, 2018).

2.5. Stastistical Analyses

The data were subjected to one-way ANOVA and Duncan Multiple Range Test to find significant differences among the treatments (P<0.05). Analyses were conducted in SPSS v.20. The data were subjected polynomial orthogonal and analyze by maple v.22.

3. Results and Discussion

3.1. Results

The addition of monosodium glutamate (MSG) to artificial feed had a significant effect (P < 0.05) on the relative growth rate (RGR) of fingerling tilapia (*O. niloticus*). Finally, there was no significant difference among the groups in terms of VSI (P>0.05) (Table 2).

Table 3 Growth performance after 42 days feeding with different regimens.

	D1	D2	D3	D4
TFC (g)	129.94±6.36^b	125.40±5.50^a	117.67±4.61^a	106.69±3.37^{ab}
FUE (%)	46.69±1.71^a	71.63.9±2.58^b	77.95±2.08^c	87.21±2.28^d
PER (%)	1.22±0.04^a	1.66±0.06^b	1.72±0.05^b	1.83±0.05^c
Protein Retention	33.41±0.30^a	37.55±0.86^{ab}	45.66±0.74^{ab}	50.47±0.76^c
RGR (%)	1.78±0.09^a	2.47±0.03^b	2.66±0.04^c	3.06±0.03^d
SR	100.0±00	100.0±00	100.0±0.00	100.0±0.00

Different letters within a row indicate significant differences among the treatments (n = 3; P < 0.05).
[1] TFC, Total Feed Consumption
[2] FUE, Feed Utilization Efficiency
[3] PER, Protein Efisiensi Ratio
[4] Protein Retention
[5] RGR, Relative Growth Rate
[6] SR, Survival Rate

3.2.Discussion

3.2.1. Total Feed Consumption

The addition of monosodium glutamate (MSG) to commercial artificial feed with 38% protein had a significant effect (P < 0.05) on total feed consumption (TFC). Fingerling tilapia (*Oreochromis niloticus*). According to Pereira et al. (2007), total feed consumption is a value that shows the amount of feed consumed by fish in a certain time period. The higher the total feed consumption in a cultivation, the greater the opportunity for the cultivated biota to grow. The addition of MSG produces different total feed consumption values for each treatment A, B, C, and D of 129, 94±6.36; 125.40±5.50; 117.67±4.61 and 106.69±3.37 g. Total feed consumption in treatment D (2.25 g/kg) was 106.69±3.37 less than treatment A (0 g/kg), which was 129.94±6.36.

The addition of MSG could reduce the level of stress in tilapia can be seen through feeding behavior before using the treated feed. Fish that are not fed

MSG doses tend to be more aggressive than fish that are given MSG doses. This is thought to be because the glutamate content in MSG can reduce the stress level of fish. The stress level can cause the fish's appetite to increase, so that the level of feed consumption also increases. Stress levels can reduce blood glucose levels, so crime rates will increase. A high level of feed consumption does not guarantee high growth. The addition of MSG to fish can produce a minimum amount of feed consumption and a maximum growth rate; this shows that the level of feed efficiency is higher, so that the fish feed conversion ratio can be reduced. This is confirmed in the orthogonal polynomial test, which shows that when the MSG dose is increased by 0 g/kg, it produces a TFC value of 129.93 g. However, if the MSG dose is increased by 2.25 g/kg (D), it can produce TFC up to 106.68 g. The resulting growth was also higher. compared to feed that was not given additional doses of MSG (Yan, 2006; Yuliana et al., 2021).

Fingerling tilapia that were treated with the addition of MSG consumed less feed than fish in treatment A. Apart from that, the growth of fingerling tilapia added to MSG can grow faster than fish in treatment A. The increase in glutamate content in MSG is directly proportional to the increase in glutamine; the increase in glutamine will be able to increase the activity of digestive enzymes, so that the growth obtained will be faster (Yan, 2006). Glutamate can be used as a flavoring agent in the form of MSG, which is added to human and animal food because one of the functions of glutamate is to stimulate food consumption through the release of peptides and neurotransmitters via orexigenic neurons in the hypothalamus (Li et al. 2018). Glutamate is an excitatory neurotransmitter that functions to stimulate the central nervous system of invertebrates. Glutamate functions as a hypophysiotropic regulator to control the release of growth hormone, luteinizing hormone (LH), and prolakin, as well as pituitary hormone. Through cell signaling in the central nervous system, it can promote feed intake for fish (Astuti, 2018).

The TFC value of the treatment with MSG added was lower than that of treatment A. According to Stageari and Suhenda (2009), the criteria for good feed for fish, apart from being determined by its nutritional value, are also influenced by the aroma of the feed. The addition of MSG for 42 days can affect the TFC value of tilapia, allegedly because MSG added to commercial feed cannot be an attractant and has a normal aroma, so it cannot increase the fish's appetite and has no effect on increasing the value of feed consumption. Attractants are ingredients that are mixed into feed in small quantities and function to increase appetite for feed intake, growth, and fish consumption of feed. The fish's response to feed begins with olfactory stimuli, which are captured by special neurons located in the olfactory epithelium and are called olfactory sensory neurons (OSNs). Then OSNs transmit sensor information from the nose to the nervous system (Khasani 2013; Nurlim 2022).

3.2.2. Feed Utilization Efficiency

The addition of monosodium glutamate (MSG) to artificial feed had an effect ($P < 0.05$) on the feed utilization efficiency (FUE) of fingerling tilapia. The highest feed utilization efficiency value was in treatment D (2.25 g/kg) at 87.21±2.28, while the lowest value was in treatment A (0 g/kg) at 46.69±1.71. The FUE value in treatment D was higher than in treatments A, B, and C. This was because the addition of glutamate in the form of MSG could increase fish digestibility. Apart from that, in the orthogonal polynomial test carried out on the Maple 2022 application, the results showed that the most optimal dose of MSG in this study was in treatment D (2.25 g/kg). According to Clara (2017), the feed utilization efficiency value with the addition of 1% glutamic acid is 30.62 ± 4.01 and with the addition of 1% MSG is 35.22 ± 4.72. Both feed efficiency values are higher when compared to without treatment (0% glu), namely 27.41 ± 3.66. The EPP value in this study can be said to be good because it has exceeded 50%, so fingerling tilapia is able to make maximum use of the feed provided for its growth. The minimum good growth value for fingerling tilapia is above 75%. A good EPP value indicates that the feed consumed is of good quality, so that it can be easily digested and utilized efficiently by fish (Maulidin et al., 2016; Zakaria et al., 2018). The EPP value is closely related to growth. . According to Marzuqi et al. (2012), feed efficiency shows how much feed the fish can utilize to grow and develop. A high EPP value indicates that fish require less food to increase their body weight, which means that the energy from the feed can be utilized optimally for growth. The addition of MSG affects the level of feed utilization efficiency. This is thought to be because the glutamate content in MSG plays a role in the synthesis of essential amino acids, namely arginine and proline,46 as well as glutathione as an antioxidant, which plays a role in maintaining intestinal health. The glutamate content in MSG is a source of synthesis of glutathione, which is an important component of the cellular antioxidant defense system, protects cells from injury due to oxidative stress, and maintains various vital functions (Zhao et al. 2015). The addition of MSG will increase the antioxidant capacity of the fish intestine, thereby increasing the level of intestinal absorption. fish will also increase. This proves that feed utilization plays an important role in the fish growth process. The important role of the glutamate content in MSG is for growth; it has a major influence on protein synthesis through a number of mechanisms in the body (Li et al. 2009).

First, glutamine increases the mechanistic target of rapamycin (mTOR) in cell signaling (Wu, 2013). Mammalian target of rapamycin (mTOR) is a large serine/threonine kinase that plays an important role in various cellular processes, such as regulation of cell growth and metabolism, initiation of intracellular protein synthesis, and development and proliferation of adaptive immune functions (Husna and Shadevi, 2017). Based on these results, similar results have been reported regarding intestinal protein synthesis and mucosal growth in various fish species, including hybrid striped bass, grass carp, and turbots (Cheng et al., 2012; Xu et al., 2014; Jiang et al., 2015; Gu et al., 2017). The addition of MSG to fingerling tilapia feed has a different effect on each treatment. A high EPP value indicates that feed can be utilized efficiently for growth. The addition of MSG to commercial feed has also been proven to increase its protein content. The highest protein content was in the addition of MSG in treatment D (2.25 g/kg), namely 47.616%. Protein is the main organic material in fish tissue. According to Subandiyono and Hastuti (2020), feed quality can be measured by the protein content in it. Feed protein is the most important component that influences fish growth performance. Low levels of protein in feed cause decreased fish growth. This is confirmed by Rachmawati et al. (2017). High feed efficiency indicates efficient use of feed, so that only a small amount of protein is broken down to meet energy needs and the rest is used for growth. Consuming MSG in feed can fulfill the fish's need for glutamate, which functions to detoxify ammonia into glutamine in tilapia feed and is optimal for reducing the liver's workload. This can result in less feed consumption and greater feed efficiency (McGoogan and Gatlin, 1999; Ngaddi et al., 2019).

3.2.3. Protein Efficiency Ratio

Protein efficiency ratio (PER) is a value that shows the amount of fish weight produced from the weight of protein in the test feed consumed. The results of the research showed that the addition of monosodium glutamate (MSG) in fingerling tilapia artificial feed had a significant effect ($P < 0.05$) on the PER value of fingerling tilapia. The PER value for each treatment was significantly different; the values for treatments A, B, C, and D are 1.22 ± 0.04; 1.66 ± 0.06; 1.72 ± 0.05; and 1.85 ± 0.05.

The addition of MSG was proven to influence the PER value in rearing. Fingerling tilapia larassati. The PER value is influenced by the fish's ability to absorb the protein content contained in the feed; the higher the PER value, the better it can be an indicator of the quality of the feed provided. The higher the PER value indicates that protein can be utilized optimally for growth because fish are able to utilize carbohydrates better for metabolism, so the existing protein can be utilized optimally for growth. According to Amarwati (2015), omnivorous fish are able to digest 20–40% of food carbohydrates but cannot digest them efficiently because the availability and activity of amylase enzymes such as protease and lipase in the digestive tract are quite low. This is confirmed by Yanto et al. (2018). Carbohydrates are one of the main sources of energy, so their presence is one of the most important factors in the fish's body. The energy produced carbohydrates will be used for metabolism, and the rest for growth. If there is the right balance of protein and energy in the feed, then most of the protein will be used as building blocks for the body for growth, while non-The rotein energy from fats and carbohydrates will be used as a source of energy for activities. The PER value in this study has a significant effect, presumably because the composition of essential amino acids in the feed is optimal. Thus, giving MSG to feed can increase the value of protein retention and PER in tilapia fingerlings (Levi et al., 1974; Reeds et al., 2000; Lante et al., 2015).

3.2.4. Protein Retention

The addition of monosodium glutamate (MSG) in feed can increase the activity of protease enzymes, which play a role in the absorption of feed nutrients. The addition of MSG can increase the activity of protease enzymes in the intestines of catfish. Protease enzymes in the fish intestine function to increase the efficiency of the absorption of feed nutrients (Kurniawati, 2019; Zhao et al., 2012). Protease enzyme activity in the intestine plays an important role in nutrient absorption. The glutamate content in MSG acts as a precursor (a compound that precedes other compounds in the metabolic pathway), specifically in the biosynthesis of essential amino acids, namely arginine, proline, and glutathione, as antioxidants that play a role in maintaining intestinal health. Thus, giving MSG to fingerling tilapia can increase the value of protein retention and metabolism in fish digestion, so that the efficiency of fish feed utilization increases (Reeds et al. 2012). Glutamate is contained in MSG, and glutamine is derived from detoxification.

Ammonia in the fish's body becomes quantitatively glutamine it is the most important energy source for the fish's intestines. Providing these two amino acids in feed is very important to increase growth and feed efficiency. For example, in rainbow trout, adding 2% glutamate to feed can increase the thickness of the proximal intestinal microvilli and increase fish weight (Yoshida et al. 2016). Glutamate in combination with glutamine has also been proven to be able to increase the height of the villi in fingerling tilapia and gourami, which in turn is related to the improvement and development of the fingerling's intestinal function. Apart from that, glutamate is also able to increase the thickness of the mucosal walls and create mucosal folds in the intestine that become thicker (Da Silva et al., 2010; Zhao et al.,2015; Jia et al., 2017; Li and Wu, 2019).

Fish feed with the addition of glutamate or glutamine can increase the activity of amino acid digestive enzymes in goldfish. Glutamate and glutamine are amino acid chains that connect carbohydrates and proteins. According to Subandiyono and Hastuti (2020), protein can be optimally utilized for growth because fish are able to utilize carbohydrates better for metabolism, so existing protein can be utilized more optimally. maximum for growth. Apart from that, it is also able to effectively increase the thickness of the mucosal walls, increase the number of goblet cells and lymphocytes, and cause the folds of the intestinal mucosa to become thicker and denser. This shows that glutamine in feed can increase intestinal surface area. for better absorption of nutrients in the intestine (Qu et al. 2019).

3.2.5. Relative Growth Rate

The addition of monosodium glutamate (MSG) to artificial feed had a significant effect ($P < 0.05$) on the relative growth rate (RGR) of fingerling tilapia (O. niloticus). The RGR value is thought to be influenced by the fish's ability to absorb the protein content contained in the feed. Physiologically, food will have an influence on the growth and development of fish and as a source of energy, movement, and reproduction (Isnawati et al. 2015). Feed that enters the fish's body will be processed in the body, and the nutritional elements in the feed will be absorbed and utilized to build tissue so that growth occurs. The growth rate of fish is greatly influenced by the type and quality of feed given. The addition of MSG to commercial feed can improve the quality of the feed, as evidenced by the increase in protein in it (Appendix 1). Good-quality feed will result in fish growth and high feed efficiency. If protein is broken down into amino acids and their components, then protein absorption in fish will be much easier. Good protein absorption has a positive effect on increasing biomass weight. The higher the RGR value indicates that

Feed can be used by the fish optimally. The minimum RGR value can be said to be good, namely 75%. Protein can be utilized optimally for growth because fish are able to utilize carbohydrates better for metabolism, so existing protein can be utilized optimally for growth (Li et al., 2012). The addition of MSG to feed has been proven to increase the RGR value. This is thought to be caused by the ammonia content in the maintenance medium being quite high before changing the water, namely 0.07590-0.12165 mg/L, and after changing the water 0.00270-0.00405 mg/L. This is thought to occur because of an additional supply of glutamate. contained in MSG in feed should be needed when the cultivation medium has high levels of ammonia because the glutamate content in MSG can be utilized to become glutamine when fish are exposed to water with high ammonia. as one way to convert ammonia into a less toxic substance. In conditions where ammonia exceeds normal limits, the addition of MSG to feed increases the efficiency of essential amino acid utilization so that the protein retention value will increase along with increasing growth (Zhao et al.). 2015). This has been proven in Yusup (2016): the addition of glutamate to feed can improve the growth performance of catfish. It is thought that the addition of MSG to feed can fulfill the supply of glutamate that fish require in the process of converting ammonia to glutamine. The formation of glutamine can reduce the level of ammonia excretion so that the level of ammonia in the blood becomes lower. Increased glutamate synthesis is a process of detoxifying endogenous ammonia in the body and converting it into glutamine (Kurniawati, 2019).

3.2.6. Survival Rate

The survival value for each treatment A, B, C, and D was 100 ± 0, indicating that the addition of different doses of MSG to fingerling tilapia feed did not affect the survival of fingerling tilapia. One of the factors that influences survival is water quality. The water quality in the research medium is maintained in optimal conditions for the life of fingerling tilapia. Apart from that, the low stocking density of 1 fish per liter resulted in no competition for space, oxygen, or food during the research.

3.2.7. Water Quality

Based on research on fingerling tilapia (O. niloticus), it shows that the water quality during maintenance is still in quite good condition. Water quality management during maintenance is carried out by providing aeration to the cultivation media; this serves to increase the oxygen supply. Water quality maintenance can be done by means of a water dispensing system (siphon) and water changes. The water quality values for dissolved oxygen, temperature, pH, and ammonia parameters are respectively 5.00–6.86 mg/L, 26.00–28.700 °C, 7.40–7.70 °C, and 0.00270-0.12165 mg/L.

The ammonia concentration is slightly higher than expected due to the accumulation of waste metabolites in the form of feces, urine, and ammonia. The process of excretion of ammonia from the fish's body occurs through the gills by diffusion from the blood to the water through ion exchange. The process of excretion of ammonia from the fish's body in conditions of high environmental ammonia will be hampered, resulting in an increase in ammonia levels in the fish's body. Increasing ammonia levels in the body causes an increase in enzyme activities such as glutamate dehydrogenase (GDH), glutamine synthethase (GS), alanine aminotransaminase (ALT), and aspartate aminotransaminase (AST), as well as increased concentrations of various non-essential free amino acids, especially aspartate, alanine, glutamate, glutamine, and taurine. Increased enzyme activity and concentrations of non-essential free amino acids cause ammonia detoxification through the formation of glutamine and free amino acids, increased GDH is able to produce glutamate, so glutamate needs will be met with the help of GS to convert ammonia into glutamine (Ngaddi et al., 2019; Kurniasih et al., 2020).

4. Conclusion

Based on the research that has been carried out, the following conclusions can be drawn: The addition of MSG at different doses to fingerling tilapia (*Oreochromis niloticus*) feed has a significant effect ($P < 0.05$) on TKP, EPP, PER, protein retention, and RGR; however, it has no effect ($P < 0.05$) on the SR value. A dose of 2.25 g/kg is the optimum dose to increase the EPP value, RGR, and SR with a value of 87.2%, 3.23%, and 100%, respectively.

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