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Dietary selenium peptide supplementation for increasing the growth of African catfish *Clarias gariepinus*

Penambahan selenium peptida pada pakan untuk meningkatkan pertumbuhan ikan lele *Clarias gariepinus*

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ABSTRACT

Selenium is an essential micromineral that the body needs in modest amounts (0.2–12 mg/kg), yet it has important effects on the antioxidant defense, immune system, and digestive performance of aquatic species. This study aimed to analyze the growth of catfish (*Clarias gariepinus*) supplemented with feed additives containing selenium peptide through the coating method on feed. There were four different treatments, namely K (feed without feed additive), and feed with additive supplementation: A (3 g/kg feed), B (6 g/kg feed), and C (9 g/kg feed). A total of 15 catfish at an initial weight of 21.80 ± 0.29 g were reared in a 90×40×45 cm^3 aquarium filled with water at a volume of 108 L, for 45 days. Fish were fed three times a day at satiation. Water quality management was carried out by the use of simple filtration in the container and water replacement to ensure optimum water quality values for catfish growth. The results showed that the final biomass of catfish fed with selenium peptide was significantly different ($p<0.05$) from catfish fed without selenium peptide, with a value of 1147,50 g and 96,67% of survival rate. Based on this study, the best dose of feed additive in catfish feed was 3 g/kg of feed.

Keywords: *Clarias gariepinus*, growth, selenium peptide

ABSTRAK

Selenium adalah mikromineral esensial yang dibutuhkan tubuh dalam jumlah sedikit (0,2–12 mg/kg), akan tetapi sangat berperan dalam sistem anti-oksidatif, imunitas, dan kinerja pencernaan pada organisme akuatik. Penelitian ini bertujuan menganalisis pertumbuhan ikan lele (*Clarias gariepinus*) yang ditambahkan dengan *feed additive* mengandung selenium peptida melalui metode *coating* pada pakan. Terdapat empat perlakuan berbeda, yaitu K (pakan tanpa selenium peptida), dan pakan dengan suplementasi *feed additive*: A (3 g/kg pakan), B (6 g/kg pakan), dan C (9 g/kg pakan). Ikan lele ukuran 21,80 ± 0,29 g sebanyak 15 ekor dipelihara dalam akuarium berukuran 90×40×45 cm^3 dengan total volume air 108 L, selama 45 hari. Ikan diberi pakan tiga kali sehari secara at satiation. Pengelolaan kualitas air dilakukan dengan filtrasi sederhana serta penggantian air untuk memastikan kualitas air optimal untuk pertumbuhan ikan lele. Hasil penelitian menunjukkan biomassa akhir ikan lele dengan suplementasi selenium peptida pada pakan berbeda nyata ($p<0,05$) dibandingkan dengan kontrol dengan nilai bobot sebesar 1147,50 g dan kelangsungan hidup 96,67%. Berdasarkan penelitian ini, dosis terbaik *feed additive* yang mengandung selenium peptida adalah 3 g/kg pakan pada ikan lele.

Kata kunci: *Clarias gariepinus*, pertumbuhan, selenium peptida

INTRODUCTION

African catfish *Clarias gariepinus* is one of the popular cultivated fish in Indonesia. The demand for catfish is always increasing time by time (Utomo *et al*., 2013). High catfish demand must be followed by increasing its production. Therefore, farmers apply an intensive system using additional pellet feed (Hermawan *et al*., 2014). Like other fishes, it requires various nutritional components such as protein, carbohydrate, fat, vitamin, and mineral in feed to support its growth.

One of the factors that support their growth is controlled water quality. Deteriorating water quality may lead to various behavioral changes in fish including stress, which will have an impact on the decreasing appetite, nutrient intake, and growth (Rakhmawati *et al*., 2018). Stressed-out fish are mostly caused by changes in environmental conditions, such as oxygen level and temperature (Masjudi *et al*., 2016). As a result, the fish needs nutrients that can enhance its growth and strengthen its tolerance to external stress.

Microminerals are essential micronutrients in the feed that are also needed in the growth process (Hasrah *et al*., 2016). Selenium as an important micromineral is required in small amounts in the body but affects the metabolism and health of aquaculture organisms (Faiz, 2021; Suprayudi *et al*., 2013). According to Prabhu *et al.* (2014), the selenium supplementation for fish is between 0.2–12 mg/kg feed. Selenium can increase fish's growth by secreting insulin in the pancreas, hence increasing the metabolic rate in the body (Garg, 2007). Unstable environmental condition is one of the causes of free radical in the body, and for that reason, SOD and GPx enzyme are required (Kong *et al*., 2017).

Stress conditions in fish can lead to decreasing immune systems and antioxidants, causing them to be vulnerable (Tang *et al*., 2018). In addition, selenium is also an integral part of the enzyme glutathione peroxidase (GPx) which plays a role in the cellular defense process against oxidative damage to the cytoplasmic structure (Hamzah *et al*., 2012). There are two types of selenium, namely organic and inorganic selenium. Selenium peptide is an organic selenium, which is bound to organic compounds in the form of amino acids. Biopeptides in selenium peptides contain two or more amino acids that can bind with body proteins and therefore can be stored or released as needed, suggesting better absorption within the body (Suprayudi *et al*., 2013).

Peptides are selective material from protein and are tolerable by the body (Fosgerau and Hoffman, 2015). The use of peptides can increase fish growth by increasing digestive enzymes (Kusumaningtyas, 2018). The biopeptides also have various functional roles, such as antihypertensive, antioxidant, and antimicrobial (Tamam *et al*., 2018). The effects of the dietary organic selenium have been studied on several aquaculture organisms, including tilapia *Oreochromis niloticus* (Suprayudi *et al*., 2013), humpback grouper *Cromileptes altivelis* (Hamzah *et al*., 2012), juvenile abalone *Haliotis discus hannai* Ino (Wang *et al*., 2012), white shrimp *Litopenaeus vannamei* (Kemal *et al*., 2023), and juvenile catfish *Clarias gariepinus* (Kemal, 2020).

Those studies demonstrated that the selenium addition positively affected fish growth. A study conducted by Kemal (2020) on juvenile catfish (0.77 ± 0.01 g) fed with feed additive (supplement by Aquacell containing selenium peptide) showed the best results at the highest dose tested, 7.5 g/kg of feed. Further study on the effect of dietary selenium peptide supplementation on grow-out size catfish, at a higher dose than 7.5 g/kg of feed, is required to investigate complete insight into the applicability of this technique. This study aimed to analyze the effects of feed supplement containing selenium peptide at various doses using the coating method on the growth performance and feeding cost valuation of the grow-out size catfish.

MATERIALS AND METHODS

The research was carried out for 45 days, starting from December 26, 2021, to February 8, 2022, at the Fish Nutrition Laboratory. Feed proximate analysis was conducted at the Fish Nutrition Laboratory, and water quality analysis was done at the Aquaculture Environmental Laboratory, Department of Aquaculture, Faculty of Fisheries and Marine Sciences, IPB University.

Experimental design

This study was conducted with an experimental method using a completely randomized design consisting of four feed treatments done in four replicates; one control treatment (without selenium peptide supplementation) and three feed additive treatments (supplement by Aquacell containing selenium peptide 2 mg/L) at doses of 3, 6, and 9 g/kg of feed.

Feed coating (Experimental feed)

The experimental feed used was a commercial diet (33.21% protein and 4.95% fat) added with selenium peptide through the coating method. The feed ingredients consisted of Aquacell Feed Premixes (PT. Aquacell Indo Pasifik). The feed additive containing selenium peptide used in this study is a product developed by PT. Aquacell Indo Pasifik. Selenium peptides were weighed according to the treatment doses, diluted in bio peptide solvent (10 ml/kg feed) and water (100 ml/kg feed), and further stirred until evenly distributed and homogeneous. Feed was dried in a closed room for at least four hours before feeding. Feed was stored in airtight containers at room temperature. The results of the proximate analysis of feed for each treatment using the AOAC method (2012) are presented in Table 1.

Preparation of container

A total of 16 tanks at the dimension of 90×40×45 cm^3 were filled with water until a depth of 35 cm (volume of 108 L). The maintenance container was completed with an aeration system, filter, and water heater. Water temperature is kept between 27-36 °C, pH is kept between 6.6–8.2, and dissolved oxygen is kept above 5 ppm.

Experimental fish

The fish used in this study were obtained from a commercial Farm (Cinangka Farm) at Cinangka, Dramaga, Bogor, West Java Province. About fifteen catfish were maintained at a stocking density of 15 fish tank with an average individual weight of 21.80 ± 0.29 g. Sampling was done on the-15, 30, and 45 days of culture to weigh fish biomass. Water quality management was carried

Table 1. Feed composition and proximate analysis of the experimental feed.

Composition	Dose of feed additive (g/kg feed) in dry weight			
	0	3	6	9
Feed Premixes				
Macro Ingredients	94.275	94.275	94.275	94.275
Aquaboost	3	3	3	3
Aquacell Vitaco™ [a]	0.1	0.1	0.1	0.1
Macro Minerals	2.2	2.2	2.2	2.2
Aquacell Minera™ [b]	0.2	0.2	0.2	0.2
Anti oxidant	0.015	0.015	0.015	0.015
Anti Mold	0.05	0.05	0.05	0.05
Zymepro™ [c]	0.125	0.125	0.125	0.125
Phytazyme™ [d]	0.015	0.015	0.015	0.015
Proteas-Pro™ [e]	0.02	0.02	0.02	0.02
	100	100	100	100
Proximate composition				
Water (%)	9.17	10.17	9.50	9.50
Protein (%)	33.21	34.73	34.29	34.8
Fat (%)	4.95	5.75	4.79	4.24
Ash (%)	9.10	9.65	10.68	9.76
Crude Fiber (%)	3.78	3.26	3.19	3.18
NFE (%)[f]	48,96	46.62	47.05	48.03
GE (kcal/kg)[g]	4352.82	4417.55	4319.86	4336.19

Note: [a]Vitamin Premix, containing vitamin A, D3, E, K3, B1, B2, B6, B12; [b]Mineral Premix, containing iron, copper, zinc, manganese, selenium, iodine; [c]Multienzyme Premix, containing NSP enzymes; [d]Phytases enzyme premix; [e]Protease enzyme premix; [f]Wet nitrogen-fee extract (NFE) = 100 - (water + protein + lipid + ash + crude fiber) and dry NFE = 100 - (protein + lipid + ash + crude fiber); [g]Gross energy (GE) composition of dry feed was calculated based on protein = 5.64 kcal/g protein; lipid = 9.44 kcal/g lipid; and carbohydrates or NFE = 4.11 kcal/g carbohydrate (Watanabe, 1998).

out by replacing 30% of the water every two days for the first 15 days, 50% every day for the second 15 days, and 80% every day during the last 15 days of the culture period.

Fish feeding

Fish were fed *at satiation* (until the fish are no longer chasing the feed) three times daily at 07.00, 13.00, and 19.00, for 45 days.

Experimental parameters

The experimental parameters observed were final biomass (Bt), final individual weight (Wt), feed conversion ratio (FCR), survival rate (SR), specific growth rate (SGR), feed intake (FI), and protein efficiency ratio (PER).

FCR

FCR was calculated using formula according to Cai *et al*. (2022):

$$FCR = \frac{\text{feed consumption}}{(\text{final biomass} - \text{initial biomass})}$$

SR

SR was calculated using formula according to Mello *et al*. (2023):

$$SR = \frac{\text{final fish number}}{\text{initial fish number}} \times 100$$

SGR

SGR was calculated using formula according to Yang *et al*. (2022):

$$SGR\ (\%/\ day) = \frac{\ln\ (\text{final weight} - \ln\ (\text{initial weight})}{\text{days}} \times 100$$

PER

PER was calculated using formula according to Zhang *et al.* (2023):

$$PER = \frac{\text{final biomass} - \text{initial biomass}}{\text{feed intake} \times \text{dietary protein content}} \times 100$$

Data calculation and analysis

The save cost data were calculated using Microsoft Excel 2019 Program by counting the use of dry feed consumption and feed additive and each was timed by FCR (calculated per kg feed). The parameters of production performance were processed and analyzed using Microsoft Excel 2019 and SPSS version 16.0. The data were tested for normality and homogeneity before performing an analysis of variance (ANOVA). Later, one-way ANOVA at a 95% confidence interval was conducted to determine the significant difference in the treatment of production performance parameters. Duncan's multiple range test was performed if any significantly different result was obtained.

RESULTS AND DISCUSSION

Results

The performance of catfish production with feed additive treatment containing selenium peptide supplemented in feed through the coating method for 45 days of maintenance is presented in Table 2. Significant differences (P<0.05) were shown in final biomass, final individual weight, and specific growth rate parameters between the

Table 2. Production performance of catfish given various doses of feed additive containing selenium peptide.

Experimental Parameters[1]	Dose of feed additive (g/kg feed)			
	0	3	6	9
B0 (g)	327.34 ± 8.08[a]	326.14 ± 2.06[a]	327.19 ± 2.67[a]	327.54 ± 3.73[a]
Bt (g)	854.5 ± 124[b]	1147.5 ± 178[a]	1097.3 ± 159[ab]	1041.5 ± 188[ab]
W0 (g)	21.8 0.54[a]	21.7 ± 0.14[a]	21.8 ± 0.18[a]	21.8 ± 0.25[a]
Wt (g)	63.2 ± 7.68[b]	79.0 ± 10.55[a]	76.7 ± 6.47[ab]	70.4 ± 11.14[ab]
SR (%)	90.0 ± 3.85[b]	96.7 ± 3.85[ab]	95.0 ± 6.38[ab]	98.3 ± 3.33[a]
FI (g)	783.8 ± 151[a]	1035 ± 162[a]	974.5 ± 127[a]	886.10 ± 178[a]
FCR	1.3 ± 0.10[a]	1.2 ± 0.04[a]	1.20 ± 0.03[a]	1.2 ± 0.05[a]
SGR (%/day)	2.4 ± 0.31[b]	2.9 ± 0.32[a]	2.8 ± 0.19[ab]	2.6 ± 0.37[ab]
PER	2.6 ± 0.21[a]	2.7 ± 0.09[a]	2.7 ± 0.07[a]	1.6 ± 0.11[a]

Note: 1) Initial biomass (B0); final biomass (Bt); initial individual weight (W0); final individual weight (Wt); survival rate (SR); feed intake (FI); feed conversion ratio (FCR); specific growth rate (SGR); the protein efficiency ratio (PER). 2) Different letters in the same row indicate significantly different treatment effects (P<0.05). The values shown are the mean and standard deviation.

treatments applied, thus indicating that selenium peptide supplementation affected the production of catfish.

Based on the results of the one-way ANOVA analysis, the overall growth performance of catfish with selenium peptide supplementation was better and significantly different (P<0.05) in final biomass, final individual weight, and specific growth rate parameters from the control treatment. The final biomass (Bt), the final individual weight (Wt), and the specific growth rate (SGR) of fish in the control treatment are lower and significantly different (P<0.05) from feed additive supplementation treatment at the dose of 3 g/kg of feed. A significant difference (P<0.05) was also shown in the survival rate (SR) parameter, with the highest SR observed at the treatment of 9 g/kg of feed while the control treatment had the lowest survival. Generally, the survival rate (SR) of the supplemented feed was higher than the control treatment, but a significant difference (P<0.05) was only observed at a supplementation dose of 9 g/kg. However, several parameters, such as feed intake (FI), feed conversion ratio (FCR), and protein efficiency ratio (PER) showed no significant difference (P<0.05) between the control treatment and the selenium peptide supplementation treatments.

Discussion

Feed additives containing 2 mg/L selenium peptides were used in this study to supplement the catfish feed with different concentration feed additives: 3, 6, and 9 g/kg. In general, the growth of fish fed with feed additive showed better results (P<0.05) when compared to fish at control treatment (Table 2). The best growth was obtained at a dose of 3 g/kg feed which resulted in a 25% increase in final weight and a 34% increase in the final biomass compared to the control treatment. This finding was might due to the role of selenium that supported the fish's metabolic performance, hence affecting fish growth. Additionally, selenium is a component of the enzyme iodothyronine deiodinase (ID), which plays role in the catalysis of the hormone thyroxine (T4) into the active form of the hormone triiodothyronine (T3) (Suprayudi *et al*., 2013).

The increased thyroxine will break down insulin, causing an increase in insulin production by the pancreas (Zairin *et al*., 2005), thus, accelerating the metabolism process of protein and carbohydrates. The feed additive given contains a mixture of biopeptide. The same result was stated by Ulzanah (2019), the addition of peptide can promote growth in tilapia fish. Fish with selenium supplementation treatment resulted in better survival. Selenium contained in the feed additive can improve the immune system as a key component of the glutathione peroxidase (GPx) enzyme which protects cells from oxidative damage (Suprayudi *et al*., 2013).

The peptides contained in feed additives also possessed antimicrobial properties to prevent pathogen outbreaks and disease in fish (Kusumaningtyas, 2013). Feed intake and feed conversion ratio (FCR) tended to have similar values and did not show a significant difference (P>0.05). That indicates the feed was optimally converted into bodymass. Similarly, the study conducted by Hamzah *et al.* (2012) on juvenile grouper given selenium at different doses resulted in a not significantly different feed consumption between treatments. Moreover, the results obtained by Hasrah *et al*. (2016) in catfish given organic selenium supplementation in the form of selenomethionine at different levels indicated that the amount of feed consumption was not significantly different both in catfish given low and high doses of selenium.

Calculation of feed costs was carried out to determine the effectiveness of the use of feed additives to the cost of feed. Based on the calculation, the use of feed additives resulted in a more efficient feed cost in catfish culture. The feed cost was calculated by comparing the consumed dry feed, FCR, and feed additive cost per 1 kg of feed. The best result of feed cost calculation in this study concerning the use of supplement by Aquacell was found in the treatment of 3 g/kg.

Table 3. Calculation of feed costs (on a dry feed basis as an assumption).

Treatments	Dry Feed Intake (g)	Dry FCR	Feed Cost/kg Catfish	Feed Cost Saving/ kg Catfish
3 g/kg of feed	931.49 ± 126.18	1.09 ± 0.03	Rp 12,299	2.65%
6 g/kg of feed	877.05 ± 99.35	1.08 ± 0.02	Rp 12,497	1.09%
9 g/kg of feed	797.48 ± 138.63	1.09 ± 0.04	Rp 12,995	-2.86%
Control	705.39 ± 117.89	1.15 ± 0.08	Rp 12,634	0%

It was 2.65% more cost-effective compared to the control (Table 2). The calculation is carried out using the assumption that the feed cost is Rp. 11,000/kg, and the cost of the feed additive used is Rp. 100,000/kg.

One kg of fish produced in the treatment of 3 g/kg of feed made a feed cost saving of Rp. 335 (2.65%) compared to the control treatment. These results are considered good for the segmentation of catfish grow-out culture due to the high stocking density and productivity in catfish farming. Feed cost remains the highest portion of production cost (Zaenuri *et al*., 2014), reaching about 60-70% in the aquaculture business (Ernawati *et al*., 2016). Farmers' production will be significantly impacted by an increase in feed prices that is not offset by an increase in the selling price of the fish (Sujono & Yani, 2015). Therefore, the profit margin received by the farmer is highly affected by feed costs at the time of production.

CONCLUSION

Selenium peptides supplementation was able to improve the production performance of catfish. The best dose for feed additive using supplement by Aquacell containing selenium peptide was 3 g/kg feed. The final result obtained showed that selenium peptide supplementation increased growth by 25% and saved feed costs by 2.65% compared to the control treatment at a dose of 3 g/kg feed.

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