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THE UTILIZATION OF MACRO MINERAL IN AQUACULTURE: APPLICATION OF CHROMIUM ADDITIVE IN MARINE CUL-TURE FISH FEED

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ABSTRACT

The nutrition diet experiments were conducted to investigate the effects of feed additive chromium-yeast in marine culture fish. The Aim of this study was to observe the effect of macro mineral chrome on the body of fish culture species. The research has been carried out in January 2020 to March 2020 using the snubnose pompano (*Trachinotus blochii*) and the cantang grouper (*Epinephelus Fuscoguttatus-Lanceolatus*) in the Floating net cages of Pangandaran Regency beach and the Brackish Aquaculture Fisheries center (BPBAP) Situbondo, East Java. The chrome content analysis was conducted at the Central Laboratory of Padjadjaran University, Jatinangor. The research of snubnose pompano was used a Completely Randomized Design (CRD) with 4 treatments of chromium dose and 3 replications, namely, A1 (feed without the addition of 0.0 ppm chromium-yeast), B1 (feed with the addition of chromium-yeast 1.47 ppm); C1 (feed with the addition of chromium-yeast 3.20 ppm), and D1 (feed with the addition of chromium-yeast 4.59 ppm). Meanwhile, The Cantang grouper also used CRD consisting of 4 different chromium dose treatments and 3 replications. The treatments used are as follows: feed with the addition of chromium-yeast 0.0 mg / kg (A2); feed with the addition of chromium-yeast 3.1 mg / kg (B2); feed with the addition of chromium-yeast 3.9 mg / kg (C2); feed with the addition of chromium-yeast 4.6 mg / kg (D2). The parameters observed were Average Daily Growth Rate, Feed Efficiency, and Chrome content in fish meat. The result showed that the addition of chromium-yeast 3.2 mg/kg of feed to snubnose pompano can produce an Average Daily Gain of 0.37 grams/day, efficiency of feed utilization of 74%, and Chrome content of 3.2 mg/kg of the best feed among all treatments. The addition of chromium-yeast of 3.9 mg/kg to the grouper feed will produce ADG (0.31 g / day), and the best utilization efficiency of feed (68.65%) among all treatments.

Keywords: snubnose pompano, cantang grouper, chrome content, chrome-yeast, daily growth rate, feed efficiency

Introduction

Beside macro minerals, marine fish also need micro minerals for their body's metabolism needs. Mineral nutrients have a great diversity of uses within the animal body. The following mineral nutrients are recognized as an essential nutrient for body functions in fish: Calcium, Phosphorus, Sodium, Molybdenum, Chlorine, Magnesium, Iron, selenium, Iodine, Manganese, Copper, Cobalt, Zinc, Fluorine, and Chromium. The prominence of each mineral nutrient in the body tissues is closely related to its functional role: As constituents of bones and teeth, minerals provide strength and rigidity to skeletal structures. In their ionic states in body fluids, they are indispensable for the maintenance of acid-base equilibrium and osmotic relationships with the aquatic environment, and integration activities involving the nervous and endocrine systems. As components of blood pigments, enzymes, and organic compounds in tissues and organs they are indispensable for essential metabolic processes involving gas exchange and energy transactions.

Fish have the ability to digest various carbohydrates, for example, omnivorous fish can utilize carbohydrates only 30 - 40%, while carnivorous fish around 10-20% of the total diet formulation, this is due to the ability of fish to produce amylase and low insulin activity. The study conducted a study of jelawat fish [1].According to [2] additional Chromium ions, in the diet can increase insulin sensitivity, which can transform blood glucose into cells. By consuming the optimum levels of Cr ions in the feed, the activity of Glucose-6-Phosphate Dehydrogenase (G6PDH) and 6-Phospho-gluconate Dehydrogenase (6PGDP) may be increase. For example; an enzyme in tilapia fish liver (*O. niloticus*), increasing protein retention from common carp , *C. carpio*, regulation of blood glucose from tilapia, *O. niloticus* [3], also daily growth rate and feed efficiency to the African catfish, *Clarias gariepinus*.

On the other hand, *O. aureus* activity and RNA / DNA ratio increased while fed with the optimal levels of Chrome minerals, in addition to the growth rate and feed efficiency of the *Hemibagrus nemurus* baung fishalso increased [4]. According to the previous research [1], adding Cr in the pimple fish feed increased the carbohydrate metabolism and growth performance. The purpose of this research is to observe the absorption of Chrome minerals in aquaculture fish feed (snubnose pompano and grouper) to the growth and the amount of Chrome minerals in fish meat.

Material and Method

The research was used snubnose pompano in Floating Net cage and other materials were pH Meter, DO Meter, Mercury Thermometer, Drain, Digital Scales, Basin, Ruler, Plastic wrap, Pressure Cooker, Refractometer, digital camera, Stationery. Marine fish feed was used as a fish feed, Chrome-yeast mineral was used as an additive of fish feed.

Two experiemental designs were conducted separately using a Completely Randomized Design (CRD). This study consisted of four chromium dosage treatments and three replications, namely feed without the addition of 0.0 ppm chromium-yeast (A1); feed with the addition of chromium-yeast 1.47 ppm (B1); feed with the addition of chromium-yeast 3.20 ppm (C1), and feed with the addition of chromium-yeast 4.59 ppm (D1). Treatment for the grouper experiement was feed with the addition of chromium-yeast 0.0 mg/kg (A2), feed with the addition of chromium-yeast 3.1 mg/kg (B2), feed with the addition of chromium-yeast 3.9 mg/kg (C2) and feed with the addition of chromium-yeast 4.6 mg/kg (D2).

Growth performance and feed utilization from both experiments were evaluated in terms of Average Dailiy Weight Gain (DWG, g/ day), Feed Efficiency (FE, %) and Chrome contained in fish meat. The results obtained were analyzed for diversity using the ANOVA table and to find out the effect between treatments was done by Duncan's test with a confidence level of 95%.

Result and Discussion

Average Daily Weight Gain

The Average Daily Weight Gain (DWG) is the difference between final body weight and initial body weight by the initial body weight during experimental periods. This parameter gives information on how much weight would be generated per day during the study. The average body weight gain of snubnose pompano is shown in Table 1 and Cantang grouper in Table 2.

Treatment	Average Daily Weight Gain (gr/day)
A (control)	0.25 ^a
B (chromium-yeast 1.47 mg / kg)	0.31 ^a
C (chromium-yeast 3.20 mg / kg)	0.37 ^b
D (chromium-yeast 4.49 mg / kg)	0.30 ^ª

Table 1. Average Daily Weight Gain (gr/day) of snubnose pompano fed by an additive Chromium-yeast

*The values followed by the same lowercase indicate significantly different based on Duncan's Multiple Range Test at a 95% confidence level.

The treatment of chromium-yeast showed better DWG results than controls. According to previous study [5], the presence of chromium in the body can form complex compounds called glucose tolerance factor (GTF), which are compounds that can stimulate insulin activity and carry a lot of glucose into cells. [3] states that an increase in insulin in the blood accelerates the introduction of blood glucose into cells so that a decrease in blood glucose levels occurs more quickly. The process is related to increased insulin activity in the presence of chromium [6]. This indicates that blood glucose can be immediately utilized by cells as a source of metabolic energy. The provision of organic Chrome minerals of 3.2 mg/kg of feed gives the star snubnose pompano DGR of 0.37 grams/day.

Table 2. Average Daily Weight Gain (gr/day) of Cantang grouper fed by an additive Chromium-yeast

Treatment	Average [Daily Growth Rate	(g / day)*	
A (control)	0.26 ^ª			
B (chromium-yeast 3.1 mg / kg)	0.28 ^b			
C (chromium-yeast 3.9 mg / kg)	0.31 ^c			
D (chromium-yeast 4.6 mg / kg)	0.27 ^b			

*The Values followed by the same lowercase indicate significantly different based on Duncan's Multiple Range Test at a 95% confidence level.

The content of organic chromium (Cr + 3) in feed gives different results to the average daily growth rate. This phenomenon is related to the ability of Cr + 3, especially in the form of chromium-yeast, in increasing the potential for insulin performance [7]. Chromium contained in feed increases insulin performance through GTF. Increased insulin activity in the blood accelerates the introduction of blood glucose into target cells. Glucose in the blood can be immediately used as an energy source to meet the energy needs of metabolism, resulting in savings in protein feed. Feed protein will be used for body protein synthesis, to increase the growth rate of fish [8].

Chromium in treatment C is in the right amount range so that it can function optimally. This is in line with the statement of [3], namely chromium supplementation in the form of chromium-yeast into the feed to a certain optimal level, able to increase feed efficiency and daily growth rate of fish. According in [9] shows that the treatment of adding Cr + 3 of 3.9 ppm to feed gives the best growth rate results for tiger grouper fish.

The fish in treatment B had a higher daily growth rate value compared to the control treatment but were lower compared with treatment C. This is suspected because the chromium content in the feed is quite low, so the biological function of chromium decreases which causes insulin activity was low. Low levels of chromium in feed can cause the flow of glucose into target cells to be disrupted, so the availability of energy and carbohydrates to meet metabolic needs becomes insufficient [1]. The reduced availability of energy from carbohydrates causes the growth rate of fish was low.

In addition to treatment B, fish in treatment D also have low weight gain value. The greater chromium content compared to other treatments does not produce a better daily growth rate. High levels of chromium make insulin performance capacity reach maximum levels. Increased absorption of glucose supply into the bloodstream is not matched by its utilization in cells. This resulted in a decrease in the function of chromium biology. Provision of high chromium content in feed can cause interference with the metabolic system of the fish's body [10]. In addition, chromium content in feed that is too high can also suppress the function of various other minerals in the digestive tract, so that protein synthesis and growth rates are low [1].

Efficiency of Feed Utilization

The efficiency of feed utilization indicated by Feed Efficiency (FE) which the comparison between the growth produced with the amount of feed given. Feed Efficiency (FE) shows how much feed can be utilized by fish [11]. This values can also be used as indicators of suitability or quality of feed given to fish. The higher the efficiency of feed utilization, the better the quality of the feed. The highest value of FE of snubnose pompano showed in treatment C by adding chromium-yeast as much as 3.20 ppm. The value of feeding efficiency is directly proportional to the growth produced, meaning that growth will change in line with changes in feeding efficiency if the amount of feed given does not change [12]. The greater the value of the efficiency of feeding, the better the fish utilize the feed provided so that the greater the bodyweight of the fish produced. The values of FE by giving chromium-yeast as much as 3.20 ppm shows a value of 74%. This results showed that 74% of feed that can be eaten perfectly and utilized by fish for metabolism and growth performance. The results of The Cantang grouper treated with the addition of Chrome minerals also showed the same result. The treatment C (adding chromium-yeast 3.9 mg/kg) showed a highest result of FE (68.65%). The results were significantly (p<0.05) greater than fish in other treatments and explained in details in Table 3 for snubnose pompano and Table 4 for Canang grouper.

Table 3. The Feeding Efficiency of snubnose pompano fed by Chromium-yeast addtive

Treatment	Feed Efficiency (%)
A (control)	67 ^ª
B (chromium-yeast 1.47 mg / kg)	69 [°]
C (chromium-yeast 3.20 mg / kg)	74 ^b
D (chromium-yeast 4.59 mg / kg)	67 ^a

*Values that are followed by the same lowercase indicate different based on Duncan's Multiple Range Test at the level 95% confidence.

Table 4. The Feeding Efficiency of Cantang grouper fed by Chromium-yeast addtive		
Treatment	EPP between Treatment (%)	
A (control)	58.33 a	
B (chromium-yeast 3.1 mg / kg)	64.04b	
C (chromium-yeast 3.9 mg / kg)	68.65c	
D (chromium-yeast 4.6 mg / kg)	61.92b	

^{*}Values that are followed by the same lowercase indicate different based on Duncan's Multiple Range Test at the level 95% confidence.

Chromium (Cr) is classified in essential micro minerals. Physiologically, the main role of Cr is related to glucose metabolism, which is to increase the potential for insulin activity. Chromium is an important component of GTF (Glucose Tolerance Factor) [13]. GTF is a water-soluble component of liver, blood plasma, brewer's yeast, and several biological and cell extracts. GTF containing Cr has the potential to increase insulin bioactivity by two times in transferring glucose to cells, glycogenesis, lipogenesis, and transport, and amino acid uptake [14].

Chrome levels in fish meat

The chromium content in the feed consumed by grouper seeds accumulates in the body of the fish. Heavy metals such as chromium accumulate in fish body tissues, namely the gills, liver, and fish flesh [15]. The body tissues of the fish that were tested for chromium content in this study were part of the meat. The results of testing the chromium content in fish meat is used to determine whether or not the research fish is suitable for consumption by humans. Fish that contain heavy metals exceed the threshold of human consumption if consumed will potentially cause various diseases both in the short and long term [16]. The results of chromium content in fish meat for each treatment can be seen in Tables 5 and 6.

Table 5. Chromium content in snubnose pompano Star

Treatment	Chromium in Meat (mg / kg)	
B (Yeast Cr 3.1 mg / kg)	0.6208	
C (Yeast Cr 3.9 mg / kg)	0.6553	
D (Yeast Cr 4,6 mg / kg)	1,0301	

Based on the Food and Drugs Administration regarding food metal contamination, the maximum allowable chromium metal content limit is 1 mg/kg, from this information it has been seen that the maximum amount of Chrome allowed is 3.9 mg/kg of feed, although based on the provisions of the Director-General of POM No . 03725 / B / SK / 89, the maximum limit of metal contamination in food is 2.5 mg/kg. The amount of chromium content in fish meat has not exceeded the threshold for human consumption.

Table 6. Chromium content in Cantang Grouper Meat

Treatment	Chromium in Meat (mg / kg)
B (Yeast Cr 3.1 mg / kg)	0.2871
C (Yeast Cr 3.9 mg / kg)	0.3694
D (Yeast Cr 4,6 mg / kg)	0.4412

In addition, when the chromium added to the feed increased, the amount of chromium that accumulates in fish meat also will be increased. This is in line with the research of the chromium content in the flesh of black fish continues to increase along with the increasing amount of chromium added to the feed given [1].

Based on the Food and Drugs Administration of Indonesia, the amount of chromium content in fish meat has not exceeded the threshold for human consumption. Based on this requirement, it can be concluded that the chromium contents in the fish meat of this study (snubnose pompano and Cantang grouper) were still below the threshold and safe for human consumption. The chromium contained in the feed is already in an organic form so it is safe for consumption by humans. According to [13] that chromium with a three-dimensional (Cr + 3) is not toxic if consumed within reasonable limits.

Conclusion

In conclusion, the results of the present experiment clearly demonstrate that feed additive Chromium-yeast could be an effective supplement for marine fish culture such as snubnose pompano and Cantang grouper without negative effects. The chromium-yeast to snubnose pompano with a concentration of 3.20 ppm can increase the average Daily Weight Gain by 0.37 gram/day and resulted the Feed Efficiency about 74%. The other hand, for Cantang grouper, by adding of 3.9 ppm chromium-yeast in feed resulted an Average Daily Wieght Gain of 0.31 g / day, and the best Feed Efficiency (68.65%) among all treatments. The addition of Chrome does not effect on the amount of Chrome in snubnose pompano meat at least up to 0.37 ppm, which is equal to 0.6208 - 0.6553 ppm.

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