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Abstract. Vitomolt is a feed additive in fattening mud crabs (*Scylla olivaceae*). The study aimed to determine the best dose of vitomolt for meat quality and nutrient retention for fattening Scylla olivaceae. It was conducted at the Educational Farm of Universitas Hasanuddin, Barru Regency, Indonesia. The treatments were various doses of vitomolt in the feed, which 0, 200, 400, 600 mg kg^{-1} of feed. Rearing was held for 60 days and fed 5% body weight daily. The analysis showed that the dose of vitomolt in the feed affected the percentage of meat carcass weight, fat content, fat retention, and crab energy retention. However, it did not affect protein content, crude fiber, Nitrogen-Free Extract (NFE), ash content, and crab protein retention. The best percentage of meat carcass weight at a dose of vitomolt 400 mg kg^{-1} and same from a dose of 200 mg kg^{-1}, while the best fat content, fat retention, and energy at a vitomolt dose of 600 mg kg^{-1} and different from a dose of 400 and 200 mg kg^{-1}, but different from the control. Vitomolt with a 200 mg kg^{-1} of feed is the best dose to produce the highest meat quality and nutrient retention in fattening crabs.

Introduction

Mud crab (*Scylla* sp.) is a fishery commodity with high-selling value. According to Karim (2013), crabs have high nutritional value, and the mud crab's market is not difficult because the need for exports and seafood restaurants is quite high [1]. Mud crab is one of the people's favorite foods because of its high nutritional value and contains various important nutrients [2]. According to Mardiana et al. (2015), market opportunities for mud crabs are wide open and prospective, both in domestic and foreign markets [3]. With a demand of more than 450 tons per month, the average price of mud crabs in the market is around Rp. 40,000-200,000 per kg. This case encourages cultivators to increase crab production, which is crab fattening cultivation.

Aslamyah et al. (2010) stated that mud crab contains a nutritional composition of 30% ash, 37.6% protein, 6.34% fat, 10.8% crude fiber, 14.36% NFE, and muscle glycogen 11.42 mg g^{-1} [4]. The proximate analysis results of mud crab meat contained 44.85-50.58% protein, 10.52-13.08% fat, and 3.579-3.724 kcal g^{-1} energy [5]. Aslamyah et al. (2021) claimed that in the mud crab digestive tract, there are cellulase, amylolytic, proteolytic, and lipolytic microbes that play an important role in the physiological function of the digestive tract, which contributes cellulase enzymes and exogenous

digestive enzymes amylase, protease, and lipase [6]. The presence of these enzymes allows crabs to utilize the feed carbohydrates.

The success of crab fattening cultivation is affected by the nutritional composition of the feed provided. Feed plays a very important role in fattening crabs. Crabs need carbohydrates and fats to source energy and maintain tissue shape and function. According to National Research Council (1994), protein is the most important substance of all the nutrients required by fish because it is a constituent substance and the main energy source for fish [7].

To hasten the fattening process, crabs need to be given a feed additive. Feed additives are additional feed ingredients given to crabs through mixing feed. Adding feed additives to the mud crab's feed aims to obtain optimal growth. One of the materials that can be used as a feed additive is vitomolt. Vitomolt is a feed additive made from spinach extract containing phytoecdysteroids and crab molting hormones [8]. Fujaya et al. (2011) showed that the injection of vitomolt in mud crabs could fasten molting and not cause high mortality [9]. In addition, the growth of crabs that received vitomolt was greater than those that were not given vitomolt. Gunamalai (2003) suggested that steroid hormones have the main function as a molting hormone, regulating physiological functions such as growth and reproduction [10]. Vitomolt, which contains phytoecdysteroids, is included in the steroid group when added to the feed. Besides being able to hasten the growth and molting, it can also increase the efficiency of protein utilization in the feed. Thus, it can improve the quality of crab meat and increase nutrient retention from the feed consumed. Therefore, it is necessary to examine the appropriate dose of vitomolt as a feed additive for fattening mud crab, Scylla olivaceae, on meat quality and nutrient retention of mud crab.

2. Methods

2.1. Research location and time

The research was conducted in the educational pond of Universitas Hasanuddin, Bojo Village, Mallusetasi District, Barru Regency, South Sulawesi, Indonesia. Crab and feed comparative tests were performed at the Feed Chemistry Laboratory, Faculty of Animal Husbandry, Universitas Hasanuddin, Makassar.

2.2. Material and methods

The study was designed in a Completely Randomized Design (CRD) with four treatments and six replications. The treatment test included various doses of vitomolt in the feed, which were 0 (control), 200, 400, and 600 mg kg^{-1}.

2.3. Animal testing

The specific animals used were male and female mud crabs (*Scylla olivacea*) with a weight of 107.08 ± 11.93 g/head. The total of test crabs was 240, every 60 crabs per treatment.

2.4. Rearing container

The container used in this study was a crab box with a length, width, and height of 30 x 20 x 15 cm. The test animals were kept individually in crab boxes and placed on a bamboo raft with a float, so that crab floated on the surface of the pond water at a depth of ±80 cm.

2.5. Feed

The feed that is used in this study was artificial feed with fermented raw materials recommended by [11] and [12], with a nutritional composition consisting of protein, fat, crude fiber, NFE, ash, and energy with a concentration of 41.93, 7.43, 7.82, 29.33, 13.49%, and 2767.63 kcal/kg respectively. The feed was enriched with vitomolt by dissolving vitomolt with 50 mL of vitoferme and 20 mL of water for every 2.5 kg of feed. The mixture was shaken until dissolved and homogeneous. Furthermore, the solution was

sprayed on the feed evenly using a sprayer and was dried properly. Dry feed is stored in a plastic bag until it is used.

2.6. Research procedure

The test crabs that had just arrived at the experimental site were first acclimatized by dousing the crabs with pond water. After that, they are sorted out to get healthy crabs and complete organs. The test crabs were put in a rearing container and acclimatized for two weeks. Before being given treatment, the test crabs were weighed, and the length and width of the carapace were measured. The weighing was done using an electric weight checker with an accuracy of 0.1 g and measuring the width of the carapace using a sliding ruler with an accuracy of 0.1 mm as initial data. Rearinge is conducted for one month. During the cultivation, crabs fed a dose of 5% of body weight with a frequency of once every two days. Feed was given with vitomolt and without vitomolt alternately. Visual observations were made daily to control the test crab's development. If the crab is found dead and/or molting, crabs are weighed and recorded during the research. Molting crabs were returned to the crab box for additional growing until they were done. Ammonia was detected at the start and conclusion of maintenance, and daily water quality observations, including temperature, salinity, dissolved oxygen, and pH were made. A thermometer was used to measure the temperature, a hand refractometer to measure salinity, a DO meter to detect dissolved oxygen, a pH meter to assess pH, and a lab to test for ammonia.

2.7. Research variables

The variables observed were meat quality and crab nutrient retention. The meat quality observed included the percentage of meat carcass weight and the chemical composition of the crab's body.

2.7.1. Percentage of crab meat carcass weight. Measured by removing the crab meat from the body, claws, walking legs, and swimming legs. Then, the crab was weighed using an electric check weigher with 0.1 g. The percentage of crab meat was determined by comparing the weight of the meat with the total weight of the crab times 100.

2.7.2. The body chemical composition. The comparison approach was used to examine the contents of protein, fat, crude fiber, NFE, and test fish ash at the start and end of the study [13]. Dry ashing method for ash content, oven method for moisture content, Soxhlet method for lipid content, Kjeldahl method for protein content, various methods for carbohydrate content, and bomb calorimeter for energy content.

2.7.3. Nutrient and energy retention. Analyzed from the feed comparative test data, as well as crab body at the beginning and end of the experiment. Energy retention was analyzed by converting protein, carbohydrate, and fat data from feed and crab body in kcal. Nutrient and energy retention were analyzed using the formula [14]:

$$\text{Nutrien Retention} = \frac{\text{Final nutrient weight in the body} - \text{Initial nutrient weight in the body}}{\text{Nutrient weight supplied}} \times 100 \quad (1)$$

1

2.8. Data analysis

The data obtained in this study were analyzed using analysis of variance. The data that significantly affected the analysis was continued with the W-Tuckey further test. As an analytical tool, the SPSS 21 program is used.

3. Results and discussion

3.1. Results

The percentage of carcass weight of crab meat which is given treatment with feed containing various doses of vitomolt is presented in Figure 1. At the same time, the body's chemical composition, including protein content, ash fat, crude fiber, and NFE, as well as nutrient retention, includes protein retention, fat retention, and energy retention. They are presented in Tables 1 and 2.

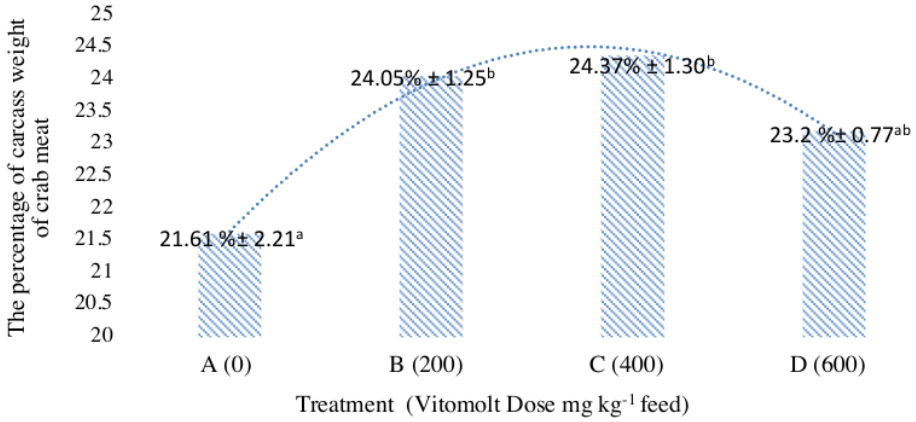

Figure 1. Percentage of carcass weight of crab meat treated with feed contains various doses of vitomolt.

Table 1. The chemical composition of the crab body with the treatment of feed contains various doses of vitomolt.

Vitomolt doses treatment (mg kg^{-1} of feed)	Body chemical composition (% dry weight)				
	Protein Content	Fat Content	Ash Content	Crude Fiber Content	NFE content
A (0)	70.30±0.29^{a}	16.85±1.13^{a}	5.41±1.48^{a}	3.89±0.75^{a}	3.55±0.20^{a}
B (200)	70.46±0.62^{a}	17.98±1.30^{ab}	4.36±0.71^{a}	3.92±0.49^{a}	3.28±0.15^{a}
C (400)	70.41±0.60^{a}	19.13±0.38^{ab}	3.56±1.20^{a}	3.57±0.46^{a}	3.33±0.24^{a}
D (600)	70.14±1.60^{a}	19.61±0.74^{b}	3.33±0.61^{a}	3.62±0.48^{a}	3.29±0.26^{a}

Note: Different letters in the same column indicate a significant difference ($p<0.05$)

Table 2. Crab nutrient retention with the treatment of feed contains various doses of vitomolt

Vitomolt Doses Treatment (mg kg^{-1} of feed)	Retention (%)		
	Protein	Fat	Energy
A (0)	5.39 ± 3.95^{a}	10.02 ± 5.29^{a}	0.05 ± 0.02^{a}
B (200)	6.94 ± 1.78^{a}	17.93 ± 9.30^{ab}	0.08 ± 0.03^{ab}
C (400)	8.24± 1.83^{a}	26.47 ± 6.73^{b}	0.11 ± 0.02^{ab}
D (600)	10.70 ± 1.14^{a}	25.64 ± 1.87^{b}	0.12 ± 0.01^{b}

Note: Different letters in the same column indicate a significant difference ($p<0.05$)

The analysis of variance showed that various doses of vitomolt given into the feed for 31 days of crab rearing had a significant effect ($p <0.05$) on the percentage of meat carcass weight, fat content, fat

retention, and crab energy retention. However, it had no effect ($p > 0.05$) on protein content, crude fiber, NFE, ash content, and crab protein retention.

W-Tuckey further test showed that the highest percentage of crab meat carcass weight was shown at a dose of vitomolt 400 mg kg^{-1} of feed, followed by doses of 200 and 600 mg kg^{-1} of feed, but there was no difference between the three. The lowest percentage of carcass weight was in the control treatment and was not different from the treatment with a 600 mg kg^{-1} vitomolt dose of feed. The highest fat content in the crab's body was at a dose of vitomolt 600 mg kg^{-1} of feed, followed by doses of 400 and 200 mg kg^{-1} of feed, but there was no difference on these three. The lowest fat content was in the control treatment and was different from the other three treatments. The highest fat retention was shown by crabs fed with a dose of vitomolt 400 mg kg^{-1} of feed followed by doses of 600 and 200 mg kg^{-1} of feed, but there was no difference between these three. The lowest fat retention in crabs was found in control but not different from the 200 mg kg^{-1} of feed dose. The highest energy retention was obtained by crabs fed with a dose of vitomolt 600 mg kg^{-1} of feed, followed by doses of 400 and 200 mg kg^{-1} of feed, but there was no difference between these three. Energy retention in crabs was lowest in control, and there was no difference in doses of 200 and 400 mg kg^{-1} vitomolt dose of feed.

3.2. Discussion

Vitomolt is a molting stimulant extracted from the spinach plant (*Amaranthus* spp.) and has been shown to increase the growth and molting of crabs because vitomolt contains phytoecdysteroids. Based on the results, the best percentage of crab meat carcass weight which the administration of vitomolt 400 mg kg of feed. Fujaya et al. (2011) explained that the presence of ecdysteroids affects protein synthesis that occurs in the body to support optimum body mass growth so that it has an impact on weight gain [9]. Furthermore, it was explained that the response of crabs to vitomolt is also influenced by the right dose of ecdysteroids, which can stimulate molting and increase growth. The opposite will happen if the dose used is too high. Austin et al. (1972) explains that high hormone concentrations cause hormone receptor production to be inhibited, and the ability of receptor cells to bind hormones decreases [15]. The receptor is a biological device in the body that is in charge of recognizing the code carried by a hormone. When the receptor performance decreases, the formation of new products, such as proteins, will be inhibited. This condition will have an impact on growth and molting.

The carcass weight of meat and body chemical composition of mud crab (*Scylla olivacea*), including crude protein, crude fat, ash, crude fiber, and NFE, describe the quality of crab meat. It can be seen that the administration of vitomolt as a feed additive did not reduce the quality of crab meat and even produced better quality than the control. According to Houlihan (2008), protein synthesis is the most basic growth process. Without large-scale protein production, growth will not occur [16]. However, the body's cells have a certain limit in protein accumulation. If this limit has been reached, any additional amino acids in the body will be deaminated and used as energy or stored in adipose cells as fat.

Other parameters such as nutrient retention, protein, fat, and energy retention in test crabs which is given a feed containing higher vitomolt than control. It is a positive response from vitomolt, which contains phytoecdysteroids. The results of the research by Fujaya (2007) showed that injection of spinach extract in crabs could accelerate and synchronize molting did not cause death, and the growth of crabs that received spinach extract application was greater than without spinach extract application [8]. Gunamalai et al. (2003) suggested that ecdysteroids are the main steroid hormones in arthropods that have the main function as a molting hormone while also regulating physiological functions, such as growth metamorphosis and reproduction [10]. This hormone is secreted by organ Y in the form of ecdysone. In the hemolymph, this hormone is converted to the active hormone 20-hydroxyecdysone by the 20-hydroxylase enzyme found in the epidermis of organs and other body tissues. Circulating 20–hydroxyecdysone titers vary throughout the molting phase. Immediately after ecdysis (molting), the titer is very low throughout the intermolt phase.

Besides that, as a steroid hormone, phytoecdysteroids predictably have an anabolic effect by increasing protein synthesis. Hoar (1983) suggested that the most central steroid metabolism is the activation of protein metabolism [17]. Several research results showed an increase in the growth of

cultured fish when given feeds containing the synthetic steroid hormone 17-methyltestosterone. Aslamyah (200) reported that applying 17-methyltestosterone in feed effectively reduced feed protein use by up to 20% and increased parrotfish's growth and feed efficiency [18]. Preston et al. (2002) suggested that ecdysteroids also increase protein formation through increased mRNA synthesis [19]. Ecdysteroids also stimulate carbohydrate metabolism and lipid biosynthesis and act as immunostimulants and antioxidants [20].

4. Conclusion

Based on the results of the research that has been done, it can be concluded that vitomolt as a feed additive can improve the meat quality and nutrient retention of the test crabs. The dose of vitomolt that can be added to feed for fattening mud crabs, Scylla olivaceae is 200 mg kg^{-1} of feed.

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