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Hasnidar[1], Andi Tamsil[1], and Kamaruddin[2]

[1]Department of Aquaculture, Faculty of Fisheries and Marine Science, Universitas Muslim Indonesia, Makassar 90231, South Sulawesi, Indonesia
[2]Research Institute for Brackish Water Aquaculture Fisheries and Fisheries Extension (BRPBAP3), Maros 90512, South Sulawesi, Indonesia

Email: hasnidar.yasin@umi.ac.id

Abstract. Moulting in crabs can be accelerated by adding moulting hormone. Phytoecdysteroids are an active compound found in certain plants, for example amaranthus, that are analogous to the moulting hormone in crustaceans. The aim of this study was to determine the effect of phytoecdysteroid administration through injection and artificial feed on moulting and growth of mud crabs (*Scylla olivacea*). Mud crabs with carapace width 61–62 mm and weight 50–51 g were reared in individual crab boxes with dimensions 25x20x20 cm. The selected crabs were injected with amaranthus extract at a dose of 1 mL/crab (I), then placed in the crab boxes and kept in a pond. Amaranthus leaves were dried in an oven at 60ºC for 24 hours, ground using a hammer mill, and mixed with other feed ingredients. Different doses of amaranthus flour were applied: 0%, 10%. 12.5%, 15%, 17.5% and 20%. Moulting and growth data were analysed for a variance. The results showed that the administration of phytoecdysteroids from amaranthus by injection and through artificial feed had no effect on the percentage of mud crabs moulting, survival rate, growth, and feed conversion value. The mud crabs were not able to take full advantage of the artificial feed provided because of the inappropriate size of the feed and the fragile structure that cause wasted and uneaten feed.

1. Introduction

Moulting in crabs is a process of changing the shell which is influenced by the moulting hormone. The concentration of moulting hormone in crabs fluctuates based on moulting phases [1-4] and the phases of the moon [5]. The use of pure moulting hormone 20-hydroxyecdyson (20-HE) at a dose of 1.0 µg / mL is known to stimulate faster moulting and growth in the mud crab *Scylla olivacea* [6]. The use of the 20-HE hormone to stimulate moulting in crabs is uneconomical and its availability is limited, so other hormone sources are needed.

Phytoecdysteroids are bioactive compounds produced by certain types of plants, including amaranthus, which have active ingredients analogous to the moulting hormone in crabs. Amaranthus extract has been used to stimulate moulting in mud crabs using an injection method [7,8], mixed with artificial feed [9]; and in artificial food formulations made from mulberry flour [10]. Information is needed on the effect of repeated

application of moulting hormone by injection and through an artificial feed on moulting and growth in mud crabs.

2. Method

Specimens of the mangrove crab *Scylla olivacea* (Herbst, 1796) were selected with carapace widths of 61–62 mm and weights of 50–51 g. The rearing containers were crab boxes with dimensions of 25x20x20 cm. One crab was reared in each box. The boxes were placed on a raft constructed from paralon pipes with a diameter of 1¾" and placed in a pond. Amaranthus extract was obtained from the market under the name "Vitomolt". Available in powder form, instructions for application are listed on the packaging. The selected crabs were injected with the amaranthus extract at a dose of 0.1 mL/crab [7]. During the rearing period, the crabs were given artificial feed at a rate of 5% body weigh/day, with a feeding frequency of 2 times a day.

Fresh amaranthus leaves were dried in the oven at 60ºC for 24 hours, then crushed using a hammer mill. The amaranthus flour was mixed with other feed ingredients to become pelleted feed. The percentage of amaranthus flour used in the feed varies according to the treatment (Table 1). The parameters measured were: moulting percentage, survival rate, absolute growth in carapace width and weight, and feed conversion ratio. The data from the measurements were analysed for variance (ANOVA), and the Duncan post-hoc test was applied if there were significant between treatment differences at the 95% confidence level [11].

Table 1. Feed formulations used as treatments (% dry weight amaranthus leaves)

Ingredients	**Treatments (% amaranthus leaves in feed)**					
	DB 0	**DB 10**	**DB 12.5**	**DB 15**	**DB 17.5**	**DB 20**
Fishmeal	40	40	40	40	40	40
Crab shell meal	10	10	10	10	10	10
Copra meal	10	9	8	9	8	7
Corn meal	14	11	9.5	6	4.5	3
Seaweed meal (*Gracilaria* sp.)	3	3	3	3	3	3
flour	15	9	9	9	9	9
Amaranthus flour	**0**	**10**	**12.5**	**15**	**17.5**	**20**
Fish oil	3	3	3	3	3	3
Soya oil	1	1	1	1	1	1
Vitamin mix	3	3	3	3	3	3
Mineral mix	1	1	1	1	1	1
Total	**100**	**100**	**100**	**100**	**100**	**100**

3. Results and Discussion

The moulting percentage and survival rate of mud crabs treated by repeated injection of phytoecdysteroid hormones and artificial feed made from amaranthus flour are presented in Figure 1.

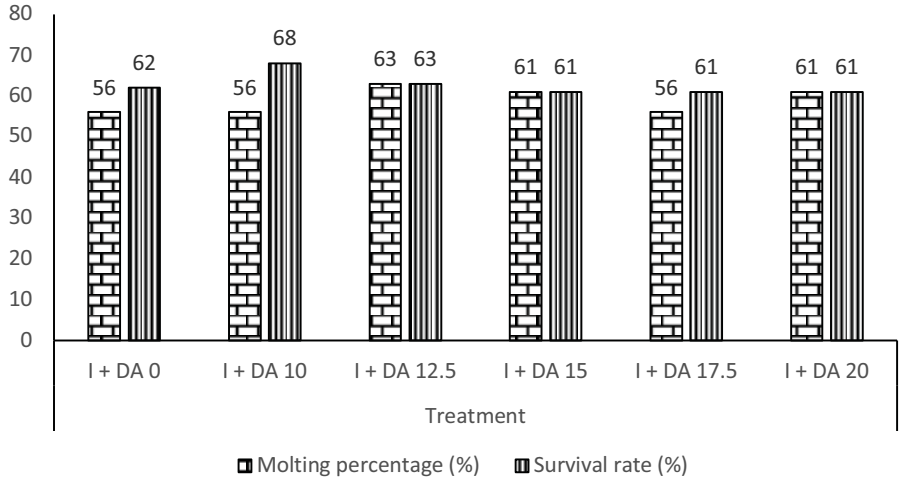

Figure 1. Moulting percentage and survival rate of mangrove crabs injected with phytoecdysteroid hormones (I) and given feed with different doses of amaranthus (DB 0% to 20%)

The analysis of variance showed that the treatment had no effect ($P > 0.05$) on either the moulting percentage or the survival rate of mangrove crabs. The moulting percentage obtained was 56-63%, this value was higher than the moulting percentage of mangrove crabs fed artificial feed made from mulberry flour, which was only ± 40% [10]. It indicates that injecting amaranthus extract containing phytoecdysteroids is a stimulant for crab moulting. However, the inclusion of amaranthus flour in artificial feed did not give any additional positive response in terms of crab moulting. This may have been because the feed fed was not consumed optimally by crabs. Many of the feed pellets were wasted as they crumbled when they were eaten by the crabs.

The survival rates obtained in this study were in the range 61-68%, lower than the cultured mangrove crab injected with mulberry extract at a dose of 100 ppm [12], which was ± 92%; 80-87% [10]. The low survival rate obtained in this study was thought to be because the artificial feed provided was not able to meet the energy requirements of the crabs in order for them to survive. A large amount of unconsumed feed is believed to be the main cause of energy deficiency in crabs.

The growth performance of mangrove crabs during the study in terms of carapace width and weight is presented in Figure 2, and shows that the growth of carapace weight and width was not significantly different ($P > 0.05$) between treatments. This indicates that repeated treatment with phytoecdysteroid hormone after injection through providing feed with different doses of amaranthus flour did not significantly affect the growth of the mangrove crabs. The artificial pelleted feed was small in size, making it difficult for the crabs to eat; furthermore, the pellets disintegrated very easily when in water. Mangrove crabs have an eating method of slowly tearing the food apart. The low survival rate in this study shows that the energy available for survival was limited, and therefore energy for growth was even more limited.

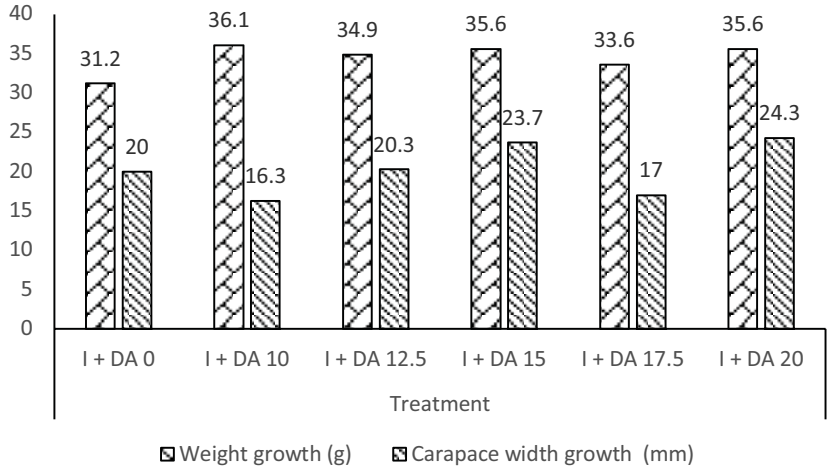

Figure 2. Growth in weight and carapace width of mangrove crabs injected with phytoecdysteroid hormones (I) and given feed with different doses of amaranthus (DB 0% to 20%)

One of the parameters which are often used in assessing feed utilization rates is the Feed Conversion Ratio (FCR). The FCR values obtained in the study are presented in Figure 3. Different doses of amaranthus flour in artificial feed had no effect on the FCR value ($P < 0.05$). The FCR obtained in this study was in the range 6.3-6.7, which is very high compared to the FCR value of 3.9-4.8 for the different doses of mulberry leaf meal treatment in [10]. Research with different levels of feed protein and fat treatment resulted in FCR 3.3-4.2; treatments with different feed percentage gave FCR 3.37–8.08 [13].

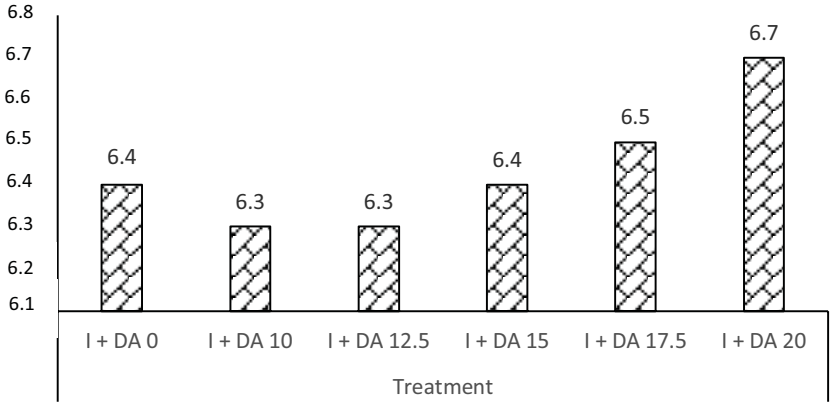

Figure 3. Feed Conversion ratio of Mangrove crabs injected with phytoecdysteroid hormones (I) and given feed with different doses of amaranthus (DB 0% to 20%)

The high value of feed conversion obtained in this study was due to the fact that much of the artificial feed was not consumed by crabs, as it disintegrated and was wasted. In general, the application of artificial feed in rearing mangrove crabs still has a high feed conversion value ([14]: 2.5). This indicates that the artificial feed fed was not optimally utilized. The nature of the mangrove crab that grabs the feed using its claws and shreds the feed when it is put in its mouth can cause much of the feed to be destroyed, especially when provided in the form of dry pellets.

4. Conclusion

Repeated administration of phytoecdysteroids by injection and through the feed did not affect the mangrove crab moulting percentage, survival rate, growth and feed conversion rate. The mangrove crabs were not able to take full advantage of the artificial feed given because the size of the feed was not suitable and the structure of the feed easily disintegrated, causing a high proportion of uneaten and wasted feed.

Acknowledgement

Thank you to the Institute for Human Resources Research and Development, Indonesian Muslim University (UMI) Makassar for funding this research.

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