

INFLUENCE OF ADDITION OF MURBEI (*Morus alba* L.) FLOWERS TO FOOD FOR FATHERING MANGROVE CRABS (*Scylla serrata*) APARTMENT SYSTEMS

ABSTRAK

Mangrove crab (*Scylla serrata*) is one of the fishery commodities that has high economic value. In Indonesia, crab cultivation has been widely developed, it can be seen from the cultivation media used, namely using vertical crab houses (apartments) with the RAS system. However, the problem in the mangrove crab cultivation system lies in the feed, the lack of nutrients in the feed results in non-optimal crab growth so that it is less attractive to consumers and causes its economic value to decline. Therefore, alternative feed is needed in the form of feed pellets that are in accordance with the nutritional needs of mangrove crabs and the addition of feed raw materials in the form of mulberry leaf flour in feed that can stimulate the growth of mangrove crabs. Therefore, this study aims to determine the optimal dose of mulberry leaf flour for mangrove crab feed in stimulating growth. This study used an experimental method conducted using a completely randomized design (CRD) consisting of 5 treatments and 3 replicates. Treatments in this study include: A (Control), B (7.5%), C (15%), D (22.5%) and E (30%). The results showed that the administration of mulberry leaf flour with different doses in mangrove crab feed had a real effect ($P < 0.05$) on the growth of absolute weight (W), absolute length (P), specific growth rate (SGR), feed conversion ratio (FCR) and feed utilization efficiency (EPP) and had no real effect ($P > 0.05$) on the Survival Rate (SR). Treatment C (15%) is the best dose of mulberry leaf flour that can support the growth and survival of mangrove crabs. The highest values were W (14.6 ± 2.6 d), P (0.6 ± 0.3 b), SGR (0.34 ± 0.06 s), FCR (18.39 ± 3.50 a) and EPP (48.51 ± 2.80 c).

Keywords: Mangrove Crab (Scylla serrata), Mulberry Leaf Flour (Morus alba L.), Apartment System.

1. INTRODUCTION

Mangrove crab (*Scylla serrata*) is a fishery commodity that has high economic value. This can be seen from the demand for the crab export market which continues to increase from 25,942.9 tons in 2019 to 32,183.3 tons in 2021 [1]. Mangrove crabs are a group of crustaceans that have a final pair of legs that are flat and used for swimming. Therefore, it is commonly called swimming crab or swimmer crab and has a hard shell and a pair of large claws [2]. In Indonesia, crab farming has developed a lot, it can be seen from the cultivation media used, namely using vertical crab houses (apartments) with the RAS system. However, the problem in the mangrove crab cultivation system lies in the feed, the lack of nutrients in the feed results in non-optimal crab growth so that it is less attractive to consumers and causes its economic value to decline. Therefore, alternative feed is needed in the form of pellet feed to meet the nutritional needs of mud crabs and the addition of raw materials to feed that can stimulate the growth of mud crabs (*Scylla serrata*) [3]. One of the ingredients that can be added to stimulate the growth of mangrove crabs is mulberry leaves.

Based on the results of several studies conducted, it is known that the addition of mulberry leaves in feed can stimulate its growth. From the research of [4] that mulberry leaf flour has no significant effect on growth, but this is due to the lack of digestibility in the feed and the dose used in the feed is not optimal. Therefore, this study aims to determine the optimal dose of mulberry leaf flour for mangrove crab feed in stimulating growth.

2. METHODOLOGY

2.1 Research Methods

This research was conducted for 43 days from April to June 2024 in Empol Preparation Village, Sekotong District, West Lombok Regency, West Nusa Tenggara Province, Indonesia. This study used an experimental method conducted using a completely randomized design (CRD) consisting of 5 treatments and 3 replicates, namely: A: 0%, B: 7.5%, C: 15%, D: 22.5% and E: 30%. Thus in this study there were 15 experimental units as shown in Figure 1.

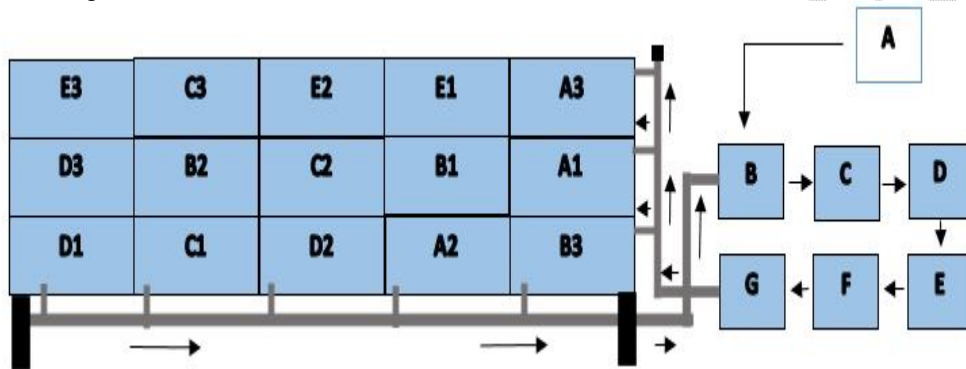


Figure 1. Experimental design

2.3 Research Procedure

The rearing container used is a jerry can container in the form of a tiered apartment. The containers were first cleaned using soap and rinsed thoroughly using fresh water. The container is then dried for 24 hours, which is then flowed with brackish water with a circulation system using a water pump before the crabs are inserted. The crabs used are crabs caught by fishermen in Empol Village, which are then selected with the criteria that there are no black spots on the body, complete limbs and the weight used ranges between 60-70 grams. Crabs that have been sorted will be acclimatized for 2-3 days in an apartment container before being given the treatment.

The next stage is feed preparation, where the feed used is repelletized shrimp feed, then added mulberry leaf flour as much as 0%, 7.5%, 15%, 22.5% and 30% according to the treatment dose. The feed that has become a dough is then oven at 60°C for 24 hours. The feed was then given to the crabs once a day in the afternoon (16.00-17.00 WITA). Feeding was carried out in Ad satiation.

During the maintenance period, the water quality parameters observed in this study were temperature, salinity, pH, and DO (*Dissolved oxygen*). Temperature, salinity, and pH measurements were carried out once a week in the afternoon while DO (*Dissolved oxygen*) measurements were carried out at the beginning and end of maintenance.

2.4 Research parameters

The main parameters tested in this study were growth parameters (weight and length growth and specific growth rate) feed conversion ratio, feed utilization efficiency, survival rate, hemocytes. Growth analysis of length, weight, survival rate was calculated using the formula by [5]. Specific growth rate, feed conversion ratio was calculated using the formula by [4] and feed utilization efficiency using the formula [6]. Hemocyte tests observed were THC and DHC which were calculated using the formula [7] and water quality data by description.

2.5 Data Analysis

Data used for the effect of the optimal dose of mulberry leaf meal on feed were analyzed using anova with a 95% confidence level. If the results are significantly different, it will be tested further with the duncan test.

3. RESULTS AND DISCUSSION

3.1 Absolute Weight

Based on the observation of the absolute weight of mangrove crabs (*Scylla serrata*) reared for 43 days, the average growth of absolute weight is in the range of 5.0 - 14.6 g seen in Figure 2. The results of ANOVA test obtained showed significant differences in each treatment. The results of the Duncan test of absolute weight in treatment A were significantly different from treatment B, C and D and not significantly different from treatment E. The best treatment was obtained in treatment C.

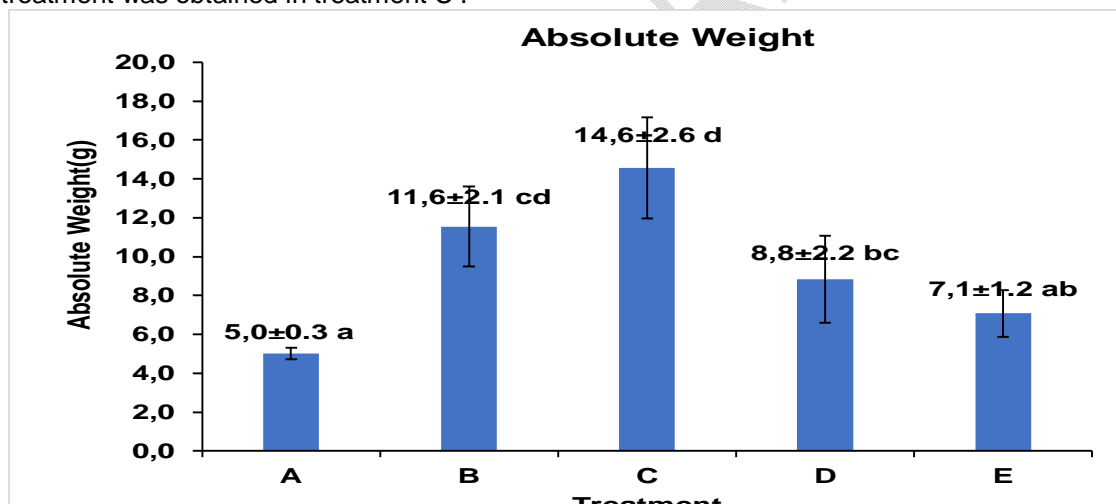


Figure 2. Absolute Weight Chart

Based on the results of the analysis that has been carried out that the administration of mulberry leaf flour in crab feed with different doses has a statistically significant effect on the growth of absolute weight, the results obtained in the highest absolute growth were obtained in treatment C which was (14.6±2.6 d) and the lowest growth value in treatment A was (5.0±0.3 a). The results obtained are still within the normal range of absolute weight growth of mangrove crabs. In line with the research [5] which obtained the results of the absolute weight of mangrove crabs, which ranged from 5.84 -12.09 g. Mangrove crabs will only grow when the crabs molt or molt. According to [8] the amount of growth in crabs depends on the increase in weight and width of the crab when molting, where the frequency of molting or molting varies which is influenced by the size and stadia of the crab. In addition, the molting level in crabs is influenced by the ecdysterone content in mulberry leaf flour. According to [9], ecdysterone is the main steroid hormone in arthropods (including crustaceans) which has the main function as a moulting hormone (skin replacement) and

controls the formation of new carapaces to replace the old carapace, in addition, it also regulates physiological functions, such as growth, metamorphosis, and reproduction. According to [4] that the use of mulberry leaf flour in feed can increase the growth of mangrove crabs. In the article it is stated that the content of nutrients and bioactive compounds in mulberry leaves contributes to increased growth.

3.2 Absolute Length

Based on the results of observation of the absolute length of mangrove crabs (*Scylla serrata*) that were kept for 43 days, the average absolute length growth was in the range of 0.0 – 0.6 cm, seen in Figure 3. The ANOVA test results obtained showed a significant difference in each treatment. The results of the Duncan test of absolute length in treatment A were significantly different from treatment C, and did not differ significantly from treatment B, D, and E. The best treatment was obtained in treatment C.

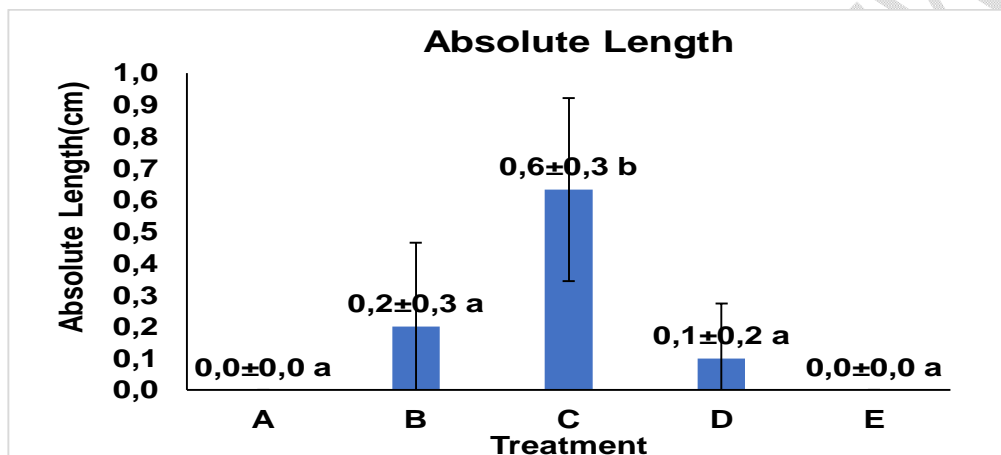


Figure 3. Absolute Length

The growth yield of absolute length is directly proportional to the yield of absolute weight. The growth of mangrove crabs was higher in treatment C which was (0.6±0.3 b) and the lowest in treatment A of (0.0±0.0 a), and treatment E was (0.0±0.0 a). This result is because the crab does not undergo molting so that the length of the carapace does not grow. From the results of the study [10] the results of measuring absolute length increase during the 4-week study, there was no real increase in length. This is shown by the absence of a molting process in each treatment. And reinforced by the statement [11] the absolute length increase is seen if there has been a molting process in the crab. According to [12] statement, molting is one of the important factors in cultivation because it is related to the growth and production of mangrove crabs. According to [9] The molting process is a phenomenon that absolutely occurs in crustaceans, including mangrove crabs. However, these events do not take place in the same time and number due to differences in physiological mechanisms influenced by internal and external factors of each species. The results obtained in this study are still within the normal range of absolute length growth of mangrove crabs. In line with the research of [13] which obtained the result of the absolute length of mangrove crabs, which is in the range of 0.4-1.2 cm. Mangrove crabs are characterized by molting because crabs have a hard outer shell that cannot grow. Therefore, in order for the crabs to grow, the old carapace must be replaced with a new and larger one. Molting in crabs is influenced by several factors, one of which is the addition of active ingredients to feed that can stimulate growth, namely mulberry leaf flour. Mulberry leaf flour contains active compounds. According to [9] mulberry contains chemical compounds that are proven to be able to accelerate molting, these chemical compounds are ecdysterone, inosterone, lupeol, β-sitosterol, rutin, moracetin, scopoletin, benzaldehyde, eugenol, linalol, benzyl alcohol, butylamine, acetone, choline, and quercetin.

3.3 Specific Growth Rate

Based on the observation results of the specific growth rate of mangrove crabs (*Scylla serrata*) that were kept for 43 days, the average growth of the specific growth rate was in the range of 0.12 – 0.34 g seen in Figure 4. The ANOVA test results obtained showed a significant difference in each treatment. The results of the Duncan specific growth rate test in treatment A were significantly different from treatment B, C and D and did not differ significantly from treatment E. The best treatment was obtained in treatment C.

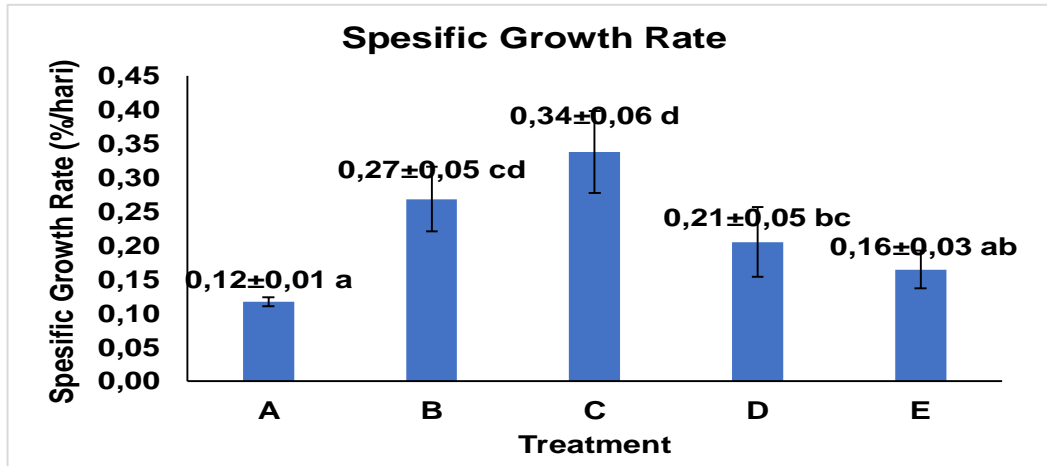


Figure 4. Specific Growth Rate (SGR) Chart

The highest *specific growth rate of mud crab (Scylla serrata)* was obtained in treatment C which amounted to $(0.34 \pm 0.06 \text{ d})$ and the lowest in treatment A which amounted to $(0.12 \pm 0.01 \text{ a})$. The SGR value is still within normal limits for mangrove crab growth based on research by [6] the average value of SGR is 0.09-0.50 %/day. Molting is one of the important factors in mangrove crab cultivation because it is related to growth and production. The addition of mulberry leaf powder to the feed gives significant results for the growth of mud crabs. The content of *ecdysteroids* in mangrove crabs can accelerate molting in crabs. However, the use of mulberry leaf powder in feed has an optimum limit. According to [12] naturally in crabs there is already the hormone *ecdysterone*, so the provision of excess hormones will not be utilized properly.

3.4 Feed conversion ratio

Based on the results of the observation of the feed conversion ratio of mangrove crabs (*Scylla serrata*) that were kept for 43 days, the average feed conversion ratio was obtained in the range of 18.39 – 41.81 g seen in Figure 5. The ANOVA test results obtained showed a significant difference in each treatment. The results of the Duncan feed conversion ratio test in treatment A were significantly different from treatment B, C and D and did not differ significantly from treatment E. The best treatment was obtained in treatment C.

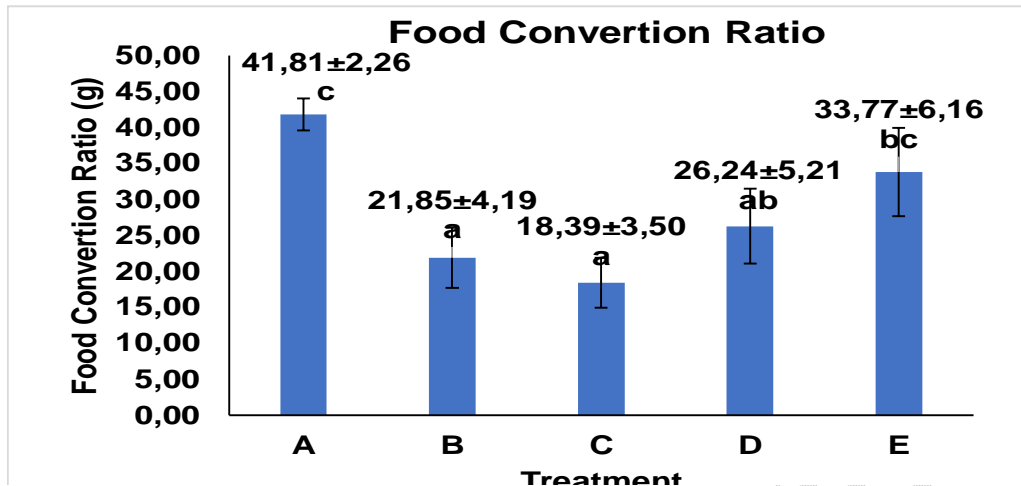


Figure 5. Graph Of Feed Conversion Ratio (FCR)

The effect of mulberry leaf flour addition on *Feed conversion ratio* of mangrove crab (*Scylla* sp.) gave significantly different results. The highest *feed conversion ratio* was in treatment A which amounted to (41.81 ± 2.26) c) and the lowest in treatment C amounted to (18.39 ± 3.50) a). The results obtained are still within the normal range of mangrove crab FCR. In line with the research of [7] which obtained the results of mangrove crab FCR which ranged from 9.63-62.61g. So from these results it can be concluded that the best *Feed conversion ratio* is in treatment C because the smaller the value obtained, the better the FCR value. According to [14] stated that the FCR value is related to the quality of the feed and the quality of the feed given. Therefore, the lower the FCR value, the better the quality of the feed and the more efficient the feed is used for the growth of mangrove crabs. In addition, the addition of mulberry leaves to the feed can affect the FCR value because the addition of mulberry leaves makes the feed easy to digest and is a source of energy for mangrove crabs. According to [15] feed that has good nutritional intake can support crab growth which is through the addition of *ecdysteroid* hormones which are a source of energy, steroids, and sterols that can help the metamorphosis process and crab growth.

3.5 Feed Utilization Efficiency

Based on the results of the observation of the efficiency of the use of mangrove crab feed (*Scylla serrata*) which was raised for 43 days, the average feed utilization efficiency was obtained in the range of 35.85 – 48.51% as seen in Figure 6. The ANOVA test results obtained showed a significant difference in each treatment. The results of the Duncan test of feed utilization efficiency in treatment A were significantly different from treatment B, C and D and did not differ significantly from treatment E. The best treatment was obtained in treatment C.

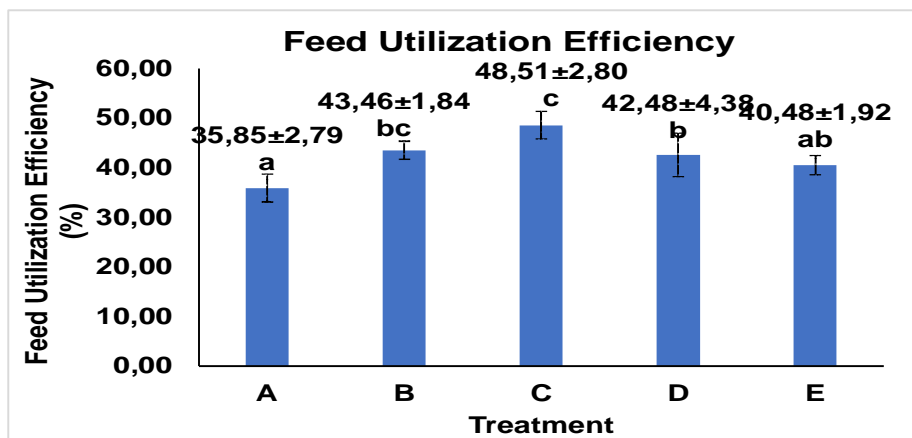


Figure 6. Graph of Feed Utilization Efficiency

The efficiency of feed utilization during the maintenance of mangrove crabs (*Scylla serrata*) was obtained in treatment C, which was (48.51±2.80 c) with mulberry leaf flour of 15% and the lowest in treatment A, which was (35.85±2.79 a) without mulberry leaf flour. The results obtained are still within the normal range of EPP for mangrove crabs. In line with the research of [16] which obtained the results of mangrove crab EPP ranging from 22.05-63.49%. This proves that treatment C is the best treatment because the higher the protein efficiency value of a feed means the more efficient the use of feed protein in supporting growth. According to [17] that the high value of feed utilization efficiency is also influenced by the quality of protein in the feed, and the quality of feed protein is influenced by its source of origin and by its amino acid content. In addition, mulberry leaf flour in feed can affect the level of digestibility of the feed given. According to [5] feed added with hormone *disteroid* is highly preferred by crabs so that it can increase their appetite and can accelerate their growth and can increase the efficiency of crab feed utilization.

3.6 Survival Rate

Based on the observation results of the survival rate of mangrove stingrays (*Scylla serrata*) kept for 43 days, which was obtained was 100% in all treatments Figure 7. The results of the ANOVA test obtained provide results that are not denied for each treatment. The best treatment was obtained in all treatments.

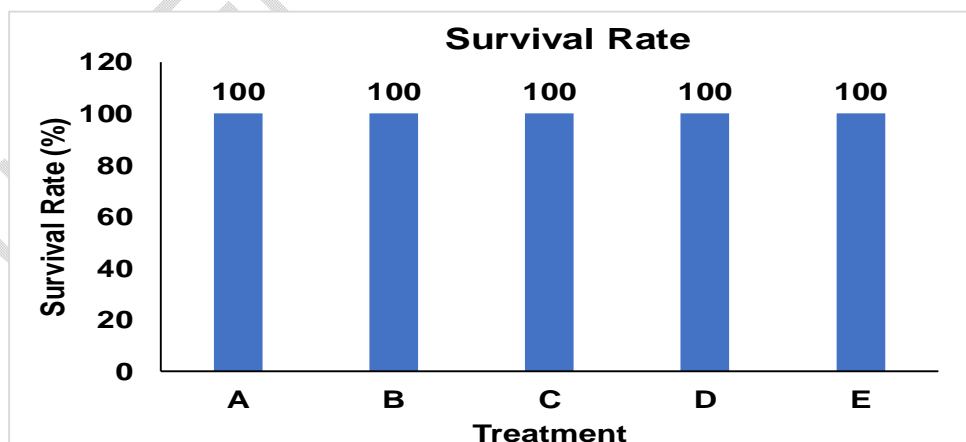


Figure 7. Survival rate graph (SR)

Survival rate is an important parameter in mangrove crab (*Scylla serrata*) cultivation. Based on the results of the research conducted, it shows that the addition of mulberry leaf

flour can increase the survival rate of mangrove crabs, where the survival rate obtained is very good, namely 100% in all treatments. This high survival rate is in line with the research of [18] explaining that maintenance with a single system can increase crab survival to 100% because crabs are protected from cannibalism and the maintenance system used is an apartment system with the use of recirculation or RAS which also contributes to the high survival rate.

3.7 Hemocyte

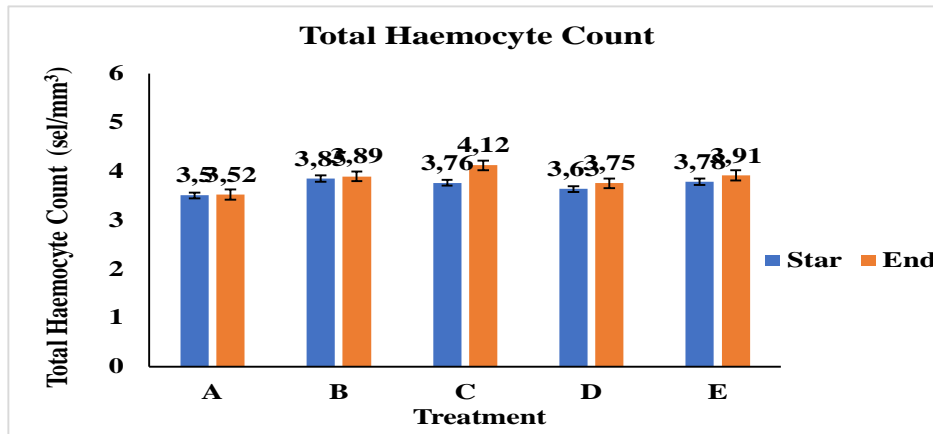


Figure 8. Total Haemocyte Count

Table 1. Diferential Haemocyte Count

Treatment	Diferential Haemocyte Count (%)					
	Star			End		
	Hialin	Granulosit	Semi granulosit	Hialin	Granulosit	Semi granulosit
A	35	36	29	34	39	27
B	46	34	20	38	42	20
C	37	37	26	41	37	30
D	47	30	23	48	31	21
E	37	38	25	43	35	22

It can be concluded that these values are still within the normal range of crab THC. In line with the research of [19] which obtained the total haemocyte count of mangrove crabs, which ranged from 3.50×10^6 - 3.85×10^6 cells/mm³ at the beginning and end of maintenance, which ranged from 3.52×10^6 - 4.12×10^6 cells/mm³ in Table 1. The differential haemocyte count value at the beginning of maintenance was obtained in the range of 35-47%, granulocytes in the range of 30-38%, and semi-granulocytes in 20-29% and at the end of maintenance in the range of hyaline in the range of 38-48%, granulocytes in the range of 31-48%, and semi-granulocytes in 20-30%. According to [20], mangrove crabs have hemocytes that act as immuno-effectors, blood cells that show physiological functions and immune responses, including phagocytosis activity to maintain homeostasis. Thus, the observation of THC is very important to know its role in the crab's immune system and the level of crab resistance to disease attacks as well as as one of the parameters of the stress response. According to [21] mulberry leaves contain active compounds, namely tannins, alkaloids, steroids, and flavonoids. This content acts as an inhibitor of the growth of pathogenic bacteria which can increase the immunostimulant in mangrove crabs. In addition, mulberry leaves have an important role in reducing stress in crabs. Mulberry leaves contain ecdysteroids that can minimize stress levels due to their ability as an adaptogen. According to [12], mulberry leaves adaptogenic, antimutagenic, hypocholesterolemic,

immunostimulating, nutritional, and stamina enhancers. In this case, mulberry leaves play an important role in maintaining immunostimulants and adaptogens, can increase the body's resistance to stress and can prevent fatigue and increase energy.

3.8 Water Quality

The water quality obtained during the rearing period of mangrove crabs (*Scylla serrata*) is in the normal range that can support the survival rate and growth of mangrove crabs.

Table 2. Water Quality

Parameters	Obtained Range	Ideal Range	Reference
DO	5,2-63	>5	[22]
pH	7,02-7,04	7,0-9,0	[22]
Salinity	22-25	10-25	[22]
Temperature	27,4-28,8	25-35	[22]

Water is a living medium for aquatic organisms, when viewed from a physical perspective, water is a living space that provides space for biota. Water quality is a crucial factor in mangrove crab (*Scylla serrata*) aquaculture, affecting growth, survival, and molting. Water quality parameters that support the growth of mangrove crabs include dissolved oxygen, temperature, salinity, and pH. Water quality measured during the study, such as temperature (27.4-28.8°C), salinity (22-25 ppt), and pH (7.02-7.04) and DO (5.2-6.3 ppm) values are still within the appropriate range for the growth and survival of mangrove crabs. This is in accordance with the findings of that the [22] optimum range of values for salinity is 10-25 ppt, optimum DO > 5 ppm, temperature 25-35 °C, pH 7.0-9.0. Optimal salinity can help the growth and osmoregulation process in crabs.

4. Conclusion

The conclusion from the research that has been carried out is that the administration of mulberry leaf flour with different doses in mangrove crab feed has a real effect ($P < 0.05$) on the growth of absolute weight (W), absolute length (P), specific growth rate (SGR), feed conversion ratio (FCR) and feed use efficiency (EPP) and has no real effect ($P > 0.05$) on survival (SR). Treatment C (15%) was the best dose of mulberry leaf flour that could support the growth and survival of mangrove crabs with the highest values, namely W (14.6±2.6 d), P (0.6±0.3 b), SGR (0.34±0.06 s), FCR (18.39±3.50 a) and EPP (48.51±2.80 c).

CONSENT

All authors declare that 'written informed consent was obtained from the patient (or other approved parties) for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editorial office/Chief Editor/Editorial Board members of this journal

ETHICAL APPROVAL

Principles of laboratory animal care" (SNI 9057-3:2023) were followed, as well as specific national laws where applicable. All experiments have been examined and approved by the appropriate ethics committee.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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