
**E-ISSN: 2347-5129**
**P-ISSN: 2394-0506**
(ICV-Poland) Impact Value: 76.37
(GIF) Impact Factor: 0.549
IJFAS 2024; 12(1): 51-55

www.fisheriesjournal.com
Received: 18-12-2023
Accepted: 22-01-2024

**Muhammad Alma Imaduddien**
Department of Aquaculture, Faculty of Fisheries and Marine Science, Diponegoro University Tembalang, Semarang, Central Java, Indonesia

**Desrina**
Department of Aquaculture, Faculty of Fisheries and Marine Science, Diponegoro University Tembalang, Semarang, Central Java, Indonesia

**Subandiyono**
Department of Aquaculture, Faculty of Fisheries and Marine Science, Diponegoro University Tembalang, Semarang, Central Java, Indonesia

**Seto Windarto**
Department of Aquaculture, Faculty of Fisheries and Marine Science, Diponegoro University Tembalang, Semarang, Central Java, Indonesia

**Vivi Endar Herawati**
Department of Aquaculture, Faculty of Fisheries and Marine Science, Diponegoro University Tembalang, Semarang, Central Java, Indonesia

**Corresponding Author:**
**Vivi Endar Herawati**
Department of Aquaculture, Faculty of Fisheries and Marine Science, Diponegoro University Tembalang, Semarang, Central Java, Indonesia

# The effect of sulphur goatfish, sesarma, and green mussel as feed on the growth and survival of mud crab (*Scylla paramamosain*) in recirculation systems

**Muhammad Alma Imaduddien, Desrina, Subandiyono, Seto Windarto and Vivi Endar Herawati**

**DOI:** https://doi.org/10.22271/fish.2024.v12.i1a.2891

**Abstract**
One of the problems faced by mud crab (*Scylla paramamosain*) farmers is their dependence on raw fish feed. The unpredictable availability of small fish feed is a consideration for using other types of feed; besides that, pond maintenance has the risk of relatively poor water quality. This study aims to determine the effect of feeding different types of feed on the growth and survival of crabs reared in a recirculation system. The study used a randomized group design with three treatments, namely feeding with sulphur goatfish (*Upeneus sulphurus*), (P1), wideng (*Sesarma spp*), (P2), and green mussels (*Perna viridis*), (P3) using ten replications. The test animals were male crabs with an average weight of 271.29±14.9g/head maintained in a recirculation system. The research was carried out in 28 days with a frequency of feeding once a day at 5%/BW /day. The best research results were produced by the wideng feed treatment (P2) (FCR 11.33±0.04, SGR 0.34±0.04% / day and SR 80%). Water quality during the study was within the optimum range of crab rearing.

**Keywords:** Kuniran, mud crab, production, recirculation

## Introduction

Mud crab (*Scylla paramamosain*) is a fishery commodity with a high selling value in the world market. The crab contains 45.40-50.58% protein, 10.52-13.08% fat, and 3,579-3,724 kcal/g energy. The export volume of crab and crab in 2020 reached 27,616 tons, an increase of around 2,000 tons compared to 2019 (Central Bureau of Statistics Indonesia, 2021). Until now, the fulfillment of crab demand still comes from nature. Crabs caught in nature are not always in a super or fat condition; many are found in a state of lack of content or thinness so that if sold, the economic value decreases. One way to utilize skinny crabs and increase their economic value is by conducting controlled fattening cultivation using a recirculation system.

Feed is an essential factor in cultivating mud crab (*S. paramamosain*). One of the problems crab farmers face is selecting the correct type of feed for crab growth and survival. Generally, crab farmers use groundfish as feed, but its availability is uncertain and depends on the season. According to Samidjan *et al*. (2019) [11], mud crab farmers complained about the limitations of groundfish as feed at the end of the year. Steps that can be taken in the search for a substitute for raw fish are the utilization of alternative feeds that can support the growth and survival of crabs (*S. paramamosain*).

Efforts that previous researchers have made for this problem are to compare other types of feed. Based on research conducted by Putra (2013), feeding low fish gets the best growth results compared to treating pellet and gold snail feed. In the research of Samidjan *et al*. (2019) [11], different types of feed obtained the highest growth in the pellet treatment at 60.58 g, followed by the wideng treatment of 50.19 g and the lowest treatment of small fish at 47.89 g. Neither study compared with shellfish feed. Both studies have not compared with green mussel feed, while green mussels have been used as lobster feed because they are high in protein and readily available. Therefore, this study aims to compare the effect of sulphur goatfish, wideng, and green mussels on the growth and survival of mud crabs (*S. paramamosain*) in a recirculation system.

The use of a recirculation system is expected to maintain optimal water quality.

## Materials and Methods
This research was conducted from February to March 2023 at the Marine Science Laboratory, Faculty of Fisheries and Marine Science, Diponegoro University. The test animals were adult male crabs (*S. paramamosain*) with an average body weight of 271.29±14.9g/head. Mud crabs were obtained from collectors in Mangkang Kulon and Kendal. The number of crabs used in the study was 30, with a stocking density of 1 crab/box maintained in a recirculating apartment system. The test feeds used were sulphur goatfish (P1), wideng (P2), and green mussels (P3). Feeding was once a day at a dose of 5% of biomass weight at 16:00-17:00. The nutritional content of the feed can be seen in Table 1.

**Table 1:** Proximate Analysis of Mud crab Feed (*S. paramamosain*)

| Feed Type | Water (%) | Ash (%) | Crude Lipid (%) | Crude Fiber (%) | Crude Protein (%) |
|---|---|---|---|---|---|
| Sulphur Goatfish (P1) | 5,89 | 11,18 | 10,36 | 4,88 | 66,98 |
| Wideng (P2) | 7,18 | 4,79 | 2,19 | 11,14 | 36,85 |
| Green Mussel (P3) | 13,93 | 39,80 | 7,16 | 3,19 | 67,98 |

**Source:** Animal and Agriculture Sciences Laboratory, Diponegoro University

The experimental design carried out in this study used a Randomized Group Design (RAK). This study used three treatments, each with ten replications with separate filtration systems for each treatment. The treatments used in this study are as follows:

**P1:** Feeding treatment using sulphur goatfish at a dose of 5% of biomass per day.

**P2:** Feeding treatment using wideng at 5% of biomass daily.

**P3:** Feeding treatment using green mussels at a dose of 5% of biomass per day.

### Feed Conversion Ratio (FCR)
According to Xu *et al.* (2022), FCR is calculated using the following formula:

$$\mathrm{FCR} = \frac{F}{(Wt + D) - Wo}$$

### Description
FCR: Feed conversion

W0: Weight of test animals at the beginning of the study (g)

Wt: Weight of test animals at the end of the study (g)

D: Total weight of test animals that died during the study (g)

F: The amount of feed consumed (g)

### Specific Growth Rate (SGR)
According to Steffens (1989), SGR is calculated using the following formula:

$$\mathrm{SGR} = \frac{\mathrm{Ln}\, Wt - Wo}{t} \times 100\%$$

### Description
SGR: Specific growth rate (%/day)

Ln Wt: Ln carapace width weight of test animals at the end of the study (g)

Ln W0: Ln weight or carapace width of test animals at the beginning of the study (g)

T: Duration of study (days)

### Survival Rate (SR)
According to Effendis (2002) [5], the survival rate is calculated using the following formula.

$$\mathrm{SR} = \frac{Nt}{No} \times 100\%$$

### Description
SR: Crab survival rate (%)

Nt: Number of crabs alive at the end of the study (tail)

N0: Number of crabs alive at the beginning of the study (fish)

### Water Quality
Water quality parameters observed during the study were temperature, pH, salinity, dissolved oxygen, and ammonia. Temperature, pH, salinity, and dissolved oxygen were measured every morning and evening. At the same time, ammonia measurements are carried out every week. Temperature measurements using a thermometer, pH measurements using a pH meter, dissolved oxygen using a DO meter, salinity measurements using a refractometer, and ammonia measurements using a reagent/test kit.

### Statistical analysis
The data obtained during the study included FCR, specific growth, and survival rates. The data were tested for normality and homogeneity. If the data is normal and homogeneous, then further analyzed using analysis of variance (ANOVA) to determine the effect of different types of feed on mud crabs (*S. paramamosain*) on growth and survival with a recirculation cultivation system. If found to have a significant effect ($p<0.05$), Duncan's multiple area test was conducted to determine the differences between treatments.

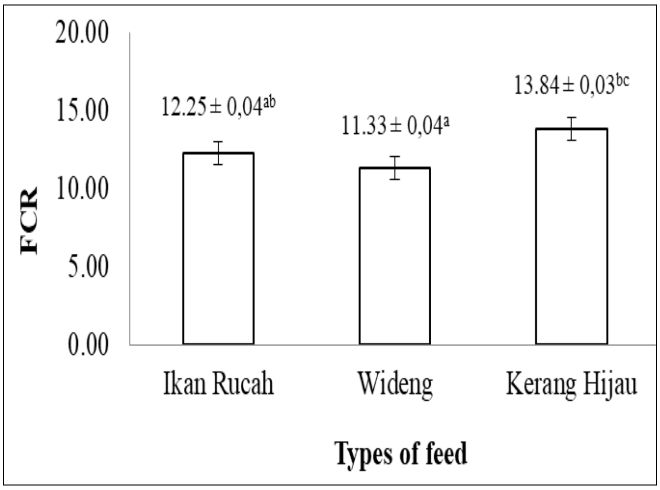
## Result
The study's results of the effect of feeding different types of feed on FCR, SGR, and SR of mud crabs during the study are presented in Table 2.

**Table 2:** The SGR, FCR and SR of the crabs during study

| Types of feed | Observation variable | | |
|---|---|---|---|
| | SGR (g) | FCR (%) | SR (%) |
| Sulphur goatfish (P1) | 0,31±0,04$^{b}$ | 12,25±2,13$^{ab}$ | 80,00±42,16$^{a}$ |
| Wideng (P2) | 0,34±0,04$^{bc}$ | 11,33±1,25$^{a}$ | 80,00±42,16$^{a}$ |
| Green mussel (P3) | 0,27±0,03$^{a}$ | 13,84±2,49$^{bc}$ | 80,00±42,16$^{a}$ |

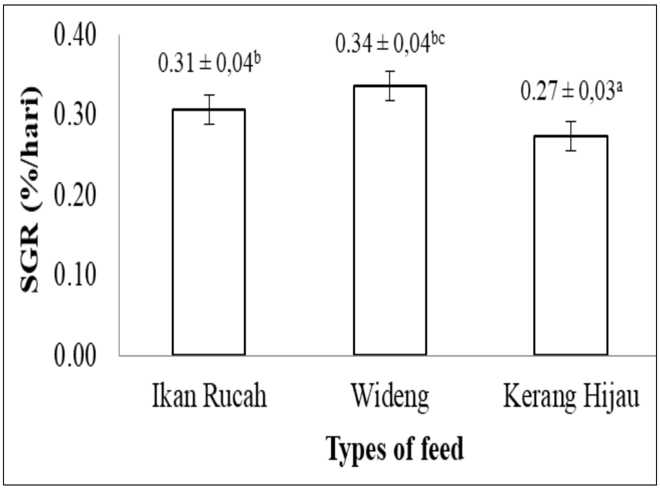
**Notes:** Values with different superscripts indicate significant differences between treatments ($p<0.05$).

Based on the data of FCR Mean Value, SGR of Mud Crab (*S. paramamosain*) during rearing, the following graph is made:



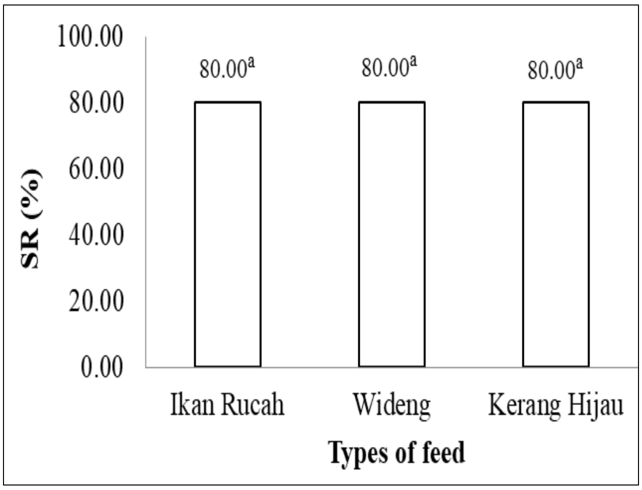

**Notes:** Values with different superscripts indicate significant differences between treatments ($p<0.05$).

**Fig 1:** Histogram of Food Conversion Ratio (FCR) Calculation




**Notes:** Values with different superscripts indicate significant differences between treatments ($p<0.05$).

**Fig 2:** Histogram of *Survival Growth Rate* (SGR)




**Notes:** Values with different superscripts indicate significant differences between treatments ($p<0.05$).

**Fig 3:** Histogram of Survival Rate (SR)

**Water Quality:** The results of water quality measurements during maintenance show that the value of water quality is still suitable as a living medium for mud crabs (*S. paramamosain*). The results of water quality measurements can be seen in Table 3.

**Table 3:** Water quality parameter values during the study

| Parameter | Kuniran | Wideng | Green mussel | Optimum |
|---|---|---|---|---|
| pH | 7,26-8,3 | 7,42-8,35 | 7,23-8,35 | 7,2-8,8[a] |
| Salinity (ppt) | 20-25 | 20-25 | 21-25 | 15-25[b] |
| temperature (°C) | 27,2-32,5 | 27,2-33 | 26,3-33,2 | 26-32[c] |
| DO (ppm) | 6,11-7,27 | 6,32-7,54 | 6,17-7,77 | >3[d] |
| Amonia (mg/l) | 0-0,065 | 0,001-0,046 | 0,009-0,031 | <1[e] |

**Notes:** [a]: Kanna (2006) [8], [b]: Susanto (2008) [12], [c]: Rusdi dan Karim (2006) [10], [d], [e]: Kuntiyo *et al*., (1994) [9].

The measurement of water quality variables during the study showed that the value of each water quality parameter was still in good condition as a medium for mud crab cultivation. This is based on literature regarding the optimal water quality conditions for mud crab cultivation.

## Discussion

**Growth:** The feed conversion ratio is the ratio between the amount of feed given and the weight gain produced by mud crabs (*S. paramamosain*). The smaller the feed conversion value, the more efficient the feed utilization; conversely, the greater the feed conversion value, the more inefficient the feed utilization. The results of the analysis of variance showed that the provision of different types of feed had a significant effect ($p<0.05$) on the feed conversion ratio of mud crabs (*S. paramamosain*). The best feed conversion ratio value was achieved by the treatment of mud crabs (*S. paramamosain*) fed with wideng (P2) 11.33±0.04, followed by sulphur goatfish (P1), (12.25±2.13) and green mussels P3 (13.84±2.49). The results of research by Samidjan *et al*. (2019) [11] showed that the Wideng treatment obtained an FCR value of 6.47, while in the research of Wicaksono *et al*. (2014) [13], wideng treatment obtained an FCR of 4.76. The feed conversion ratio in the wideng treatment produced lower results than the sulphur goatfish and green mussel feed treatments. It is suspected that the nutrient content in wideng feed can be digested well by mud crabs (*S. paramamosain*). In addition, much of the feed is eaten, and little remains so that the energy obtained from the feed can be used optimally.

Feeding 5% day of the mud crab feeding treatment with wideng (P2) resulted in a higher SGR compared to the treatment of sulphur goatfish (P1) and green mussels (P3). This is reinforced by Ambia *et al*. (2014) [2], stating that the level of feed utilization efficiency is determined by weight gain and the amount of feed given. The results of the research by Samidjan *et al*. (2019) [11], Wideng treatment obtained an FCR value of 6.47, while in the research by Wicaksono *et al*. (2014) [13], Wideng treatment obtained an FCR of 4.76. The difference in research results is due to differences in maintenance systems, test crab sizes, and maintenance time.

Mud crab (*S. paramamosain*) growth is directly proportional to the specific growth rate (SGR). Mud crab growth can be maximized if the specific growth rate is maximized. According to Aslamsyah and Fujaya (2009), mud crab growth is influenced by the seedlings' size, the cultivation media's water quality, and the feed given. The results of the analysis of variance showed that the provision of different types of feed had a significant effect ($p<0.05$) on the specific growth rate of mud crabs (*S. paramamosain*). The best specific growth rate was achieved by the treatment with wideng feed (P2), which amounted to 0.34±0.04%, followed by sulphur goatfish (P1), (0.31±0.04%), and green mussels (P3) (0.27±0.03%). This is probably because wideng is a natural food in mud crab habitats and has an amino acid profile

similar to mud crabs compared to sulphur goatfish and green mussels. According to Sudhakar *et al*. (2009), the content of essential and non-essential amino acids in the crustacean rice field crab (*Parathelphusa maculata*) is complete. Essential amino acids are lysine 6.96% and arginine 8.38%.
arginine 8.38%, leucine 8.36%, while non-essentials are tyrosine 1.91%, glutamic acid 11.53%, and aspargine reached 12.8%. Amino acid is a molecular framework of protein constituents needed by the body and is a constituent of structural proteins, hormones, and enzymes.
The results of the study found that the wideng treatment provided the best SGR value; this contradicts the results of research by Wicaksono *et al*. (2014) [13], that the highest specific growth rate was in the treatment of sulphur goatfish followed by wideng and squid treatment. The difference in results is caused by different factors in the source of the test animals obtained, the size or weight of the test animals, and the maintenance method. In addition, the quality of feed does not depend on the high protein alone; it is also determined by the ability of fish to digest and absorb feed. The specific growth rate is influenced by the culture medium's feed quality and water quality. One of the factors that affect the growth rate is if there is an excess input of energy and amino acids (protein) contained in the feed (Ekaputri *et al*., 2018) [6]. The higher the energy contained in the feed, the greater the possibility of a specific growth rate. According to Agus (2007) [1], the energy from food is utilized by mud crabs for adaptation, replacement of damaged cells or tissues, activity, metabolism, reproduction, and finally, growth. Using the recirculation method, according to observations, affects the stability of water quality parameters due to filtration that keeps the water in optimal conditions. In addition, significant growth is thought to be due to mud crabs being kept in a limited space (single room). Furthermore, Agus (2007) [1] said that limited space can minimize energy to move to maximize energy for growth.

**Survival Rate:** Livability is one of the parameters of success in aquaculture. The higher the percentage of survival, the better, but the lower the percentage, the worse. Survival is obtained from the ratio of the number of individuals alive at the end of the experiment to the number of individuals at the beginning of the experiment to determine how far the ability of mud crabs (*S. paramamosain*) to survive (Djunaidah *et al*., 2004) [3]. Two of the factors that affect survival are biotic and abiotic factors. According to Winestri *et al*. (2014) [14], biotic factors include competition for food, predation, parasites, density, age, adaptability to the environment, and the handling process, while abiotic factors are water quality.
In the study, feeding with different types did not have a significant effect ($p$>0.05) on the survival of mud crabs (*S. paramamosain*). This is indicated by the three treatments' survival value of 80%. Deaths occurred in weeks 3 and 4, based on observations of dead mud crabs found ocloasmis ectoparasites in the gill organs. The presence of parasites in crabs can cause death. This is reinforced by Herlina *et al*. (2018), who state that octolasmis parasites can kill crabs because they interfere with the respiration system.

**Water quality:** Based on the results of pH measurements during the study, the P1 treatment ranged from 7.26-8.3, the P2 treatment ranged from 7.42-8.35, P3 treatment ranged from 7.23-8.35. This indicates that the pH range in each treatment is still considered optimal for the survival of mud crabs. According to Kanna (2006) [8], the optimal pH for mud crab growth ranges from 7.2-8.8. Waters with an acidic pH and a high alkaline value can cause death in crabs. This is because pH affects physiological and biochemical processes, including the activity of gill organ enzymes that impact oxygen consumption.
Based on the results of salinity measurements during the study, the P1 treatment ranged from 20-25, the P2 treatment from 20-25, and the P3 treatment from 21-25. This indicates that the salinity range in each treatment is still considered optimal for the survival of mud crabs. According to Susanto (2008) [12], the optimal salinity for mud crabs ranges from 15-32 ppt or is included in brackish waters. Triyanto (2012) states that salinity ranging from 15-25 ppt is optimal for mud crab growth.
Based on the results of temperature measurements during the study, the P1 treatment ranged from 27.2-32.5, the P2 treatment ranged from 27.2-33, and the P3 treatment ranged from 26.3-33.2. This indicates that the temperature range in each treatment is not feasible because it exceeds the tolerance limit of crabs. According to Rusdi and Karim (2006) [10], the optimum temperature for mud crab rearing is 26 ºC-32 ºC. Temperatures that are less than the optimum point affect the decrease in organism metabolism, while temperatures above 32 ºC or significant temperature changes will cause organisms to experience stress.
Based on the measurement of dissolved oxygen (DO) content during the study, the P1 treatment ranged from 6.11-7.27, the P2 treatment ranged from 6.32-7.54, P3 treatment ranged from 6.17-7.77. This indicates that the range of DO in each treatment is still considered optimal for the survival of mud crabs. According to Gunarto (2013), the optimal value for mud crab growth is >3 mg/l. A decrease in dissolved oxygen levels in water can inhibit biota activity because oxygen is essential to the chemical process of aquatic biology.
Based on the measurement of ammonia content ($NH_3$) during the study, the P1 treatment ranged from 0-0.065, the P2 treatment ranged from 0.001-0.046, P3 treatment ranged from 0.009-0.031. This indicates that the range of ammonia in each treatment is still considered optimal for the survival of mud crabs. According to Kuntiyo *et al*. (1994) [9], the highest ammonia level for mud crab life is a maximum of 1 mg/l. Waters with high ammonia can cause organism poisoning. Each species of aquatic organism has a different tolerance limit for ammonia in the water. Uncontrolled ammonia will cause aquatic organisms to consume more oxygen and damage the gills.

**Conclusions**

1. Feeding different types of feed (sulphur goatfish, wideng, and green mussels) had a significant effect on feed conversion ratio (FCR) and specific growth rate (SGR) but no significant effect on survival (SR).
2. The treatment of feeding wideng (Sesarma spp) to mud crabs (*S. paramamosain*) produced the highest specific growth rate (SGR) of 0.34±0.04%/day and the lowest feed conversion ratio (FCR) of 11.33±0.04 compared to the other treatments. The survival rate of the three treatments was uniform at 80%.

**Reference**

1. Agus M. Comparative analysis of fat crab (*Scylla* Sp) with bulk and single room systems in ponds. Scientific Journal of Fisheries and Marine, Aquatic Pen Volume1

April 2008. Publisher of the Faculty of Fisheries, Pekalongan University. ISSN: 0216-5449; c2007.
2. Ambia M, Eriyuni, Irwanmay. Effect of feeding with different protein content on the growth of milkfish (*Chanos Chanos*). Faculty of Agriculture, University of North Sumatra. Central Bureau of Statistic. Fishery Products Export Statistics 2016-2020, Ministry of Marine Affairs and Fisheries, Jakarta; c2014.
3. Djunaidah, Toelihere, Effendie, Sukimin, Riani. Growth and survival of mangrove crab (*Scylla paramamosain*) seeds reared on different substrates. Faculty of Fisheries and Marine Sciences. Diponegoro University. Journal of Marine Science. 2004;9(1):20-25.
4. Effendie MI. Fisheries Biology. Nusatama Library Foundation. Bogor; c1997.
5. Effendie MI. Fisheries Biology. Nusatama Library Foundation. Yogyakarta; c2002. p. 163.
6. Ekaputri RA, Arief M, Rahardja BS. Effect of Chitosan Addition in Commercial Feed on Specific Growth Rate and Protein Retention of Vaname Shrimp (*Litopenaeus Vannamei*). Journal of Marine and Coastal Science. 2018;7(2):39-50.
7. Fujaya Y, Aslamyah S, Fudjaja L, Alam N. Soft Crab Farming and Business: Molting Stimulation with Spinach Extract. Firstbox Media; c2019.
8. Kanna I. Mud crab Farming, Hatchery and Enlargement. Kanisius. Yogyakarta; c2006.
9. Kuntiyo, Zaenal A, Tri Supratno KP. Guidelines for Mud crab (S. *Serrata*, Forskal) Cultivation in Ponds. Center for Brackish Water Aquaculture. Jepara; c1994.
10. Rusdi I, Karim MY. Optimum salinity for survival and growth of mud crab lets (*Scylla paramamosain*). Center for Marine Aquaculture Research, Gondol. Faculty of Marine Science and Fisheries UNHAS, Makassar, Journal of Science & Technology. 2006;6(3):149-157.
11. Samidjan I, Rachmawati D, Pranggono H. Technology engineering of mud crab (*Scylla Paramaosain*) cultivation through feed and environmental engineering to accelerate growth and survival. Pena Akuatika: Scientific Journal of Fisheries and Marine. 2019;18:2.
12. Susanto GN. Mud crab (*Scylla* sp.) Spawning in bamboo cages in ponds. Proceedings. Seminar on Research Results and Community Service, Department of Biology FMIPA University of Lampung; c2008.
13. Wicaksono DL, Zainuri M, Widianingsih W. Effect of different natural feeds on soka crab growth in Mangunharjo Village Pond, Tugu District. Journal of Marine Research. 2014;3(3):265-273.
14. Winestri, Rachmawati D, Samidjan I. Effect of Vitamin E addition in artificial feed on the growth and survival of mud crab (*S. paramamosain*). Journal of Aquaculture. 2014;3(4):40-48.