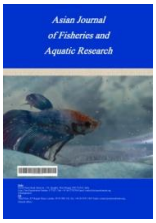

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Effects of Dietary Potassium Diformate on Growth Performance, the Relationship between Fish Length and Weight, Feed Conversion and Survival Rate of Giant Freshwater Shrimp (*Macrobrachium rosenbergii*)

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Authors' contributions

This work was carried out in collaboration among all authors. Author AN designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors Iskandar and IB managed the analyses of the study. Author WL managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

This study was purposed to determine the optimal dose addition of potassium diformate to commercial feed to increase the growth of giant freshwater shrimp. The method employed in this study was an experimental method, embracing application of a Randomized Block Design (RBD) method. It consists of four treatments and four replications. The treatments was based on the difference of potassium diformate amount in which given to giant freshwater shrimp. The difference of potassium diformate amount was 0% (control), 1%, 3%, and 5%. The sample of study used giant freshwater shrimp with a length of 4 - 6 cm. The samples were obtained from the Giant freshwater Shrimp Breeding Center, Pamarican, West Java Province. The shrimp were kept in 16 nets in a density of 20 shrimps and the size of the net cage is about 1 m^3. The parameters

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observed in this research were daily growth rate, feed efficiency, the relation between length and weight, survival rate (analyzed using ANOVA with p < 0,05), and water quality. The sampling was made every 10 days. The results showed that the addition of potassium diformate by 1% gave the best result of daily growth rate of 1.86% ± 0.60, feed efficiency value of 19% ± 1.91, survival rate of 92% with net profit Rp. 67.160.- and for the length and weight relationship has a value of b> 3 which means that it has positive allometry along with water quality parameters regarded to SNI (Indonesian national standard).

Keywords: Giant freshwater shrimp; potassium diformate; growth; net profit and survival rate.

1. INTRODUCTION

Giant freshwater shrimp (*Macrobrachium rosenbergii*) or also known as giant freshwater shrimp is a type of crustaceans, from the Palaemonidae family which has the largest size compared to other freshwater shrimp. These commodities are claimed as native fauna in various countries, including India and Indonesia [1].

Giant freshwater shrimp have started to become freshwater export commodities since the 1970 s. Giant freshwater shrimp has become a fishery commodity that has great demand both local and foreign consumers because it has a nice meaty texture. The price of giant freshwater shrimp in the local market is about Rp. 120,000.00 /kg, in size of 30 fish/kg. The local production target of giant freshwater shrimp was about 6,351 tons in 2015, 7,006 tons in 2016, 8,291 tons in 2017, 10,117 tons in 2018, and 11,719 tons in 2019 [2].

The production targets of giant freshwater shrimp from 2015 - 2019 have increased constantly. However, it did not work well because the existing stock in giant freshwater shrimp cultivators was in an unstable amount of production [3]. The decrease in production can be caused by the growth period of giant freshwater shrimp that is relatively slow and their low survival rate. Some of the reasons of low survival rate are feeding, high stocking density, disease, and water quality decline. One of the main factors that can cause the decrease in the production of giant freshwater shrimp is suboptimal feeding [4].

The feed has an important role in increasing the production of giant shrimp culture. The feed must be in high quality, nutritious, and under the requirements for consumption of giant shrimps, and it must be available continuously so that it will not hamper the production process and can provide optimal growth. The efforts to improve the composition of nutrients and the efficiency of the use of additional feed required to increase the production of aquaculture. One of the obstacles in the aquaculture business is the high price of commercial feed. The feed as the prime energy source for growth is a significant component that spends 60-70% of production costs [5]. Therefore, there is the need for efficiency in feeding or also called growth efficiency—a percentage of feed that is converted into growth changes [6].

Potassium is a positively charged ion and presents in cells, as much as 95% of potassium are in intracellular fluid. Potassium increases osmotic pressure in intracellular fluid [7]. Potassium absorption from food is completely passive and there is no specific transitions are needed. Absorption takes place in the small intestine as long as the conservation in digestive system is higher than in the blood. Potassium diformate has a lot of benefits for fish and shrimp farming activities [8]. Potassium diformate is a natural organic acid salt that has received considerable attention as a fish feed additive and the first substance to be promoted as a non-antibiotic growth promoter by the European Union. Potassium contains a form of the acid active ingredient, which is a material that can be used to optimize pH in the digestive system and release the growth of pathogenic bacteria and reduce pH in cytoplasmic bacteria [9]. It can also decrease the pH of the stomach which increases the secretion of pepsin and pepsinogen in line with accelerated the increase of protein. The initiation of mixing artificial prawns with potassium formatted feed was done to accelerate the rate of growth by increasing the efficiency of a good digestive process. This study was purposed to determine the optimal dose addition of potassium diformate to commercial feed to increase the growth of giant freshwater shrimp.

2. MATERIALS AND METHODS

This research was conducted in the Kawungsari Farmers Group pool, Bantarkawung Hamlet, Kertayasa Village, Cijulang District, Pangandaran

Regency. The research was conducted from August 2019 to February 2020. The tools used in this research were 16 nets measuring 1m, DO meters, pH meters, ammonia test kits, and digital balance sheets. The material used were 320 giant freshwater shrimp with a length of 4-6 cm, commercial feed, and potassium diformate.

The method used in this research was experimental by using a randomized block design (RBD). The randomized block design (RBD) consisted of four treatments with four replications, namely:

- Treatment A: Commercial feed without adding potassium diformate as a control.
- Treatment B: Commercial feed with the addition of 1% potassium diformate.
- Treatment C: Commercial feed with the addition of 3% potassium diformate.
- Treatment D: Commercial feed with the addition of 5% potassium diformate.

2.1 Experimental Units

The giant freshwater shrimp fingerlings (the size of 4-6 cm) that will be treated are acclimatized for 7 days in a fiber container which was given aeration and commercial feed. The biomass was weighed on the first day to determine initial weight. Feeding was carried out thrice a day, at 08.00 a.m, 12.00 p.m, and 18.00 p.m Indonesian time using a mix of test feed which was 5% of fish biomass, potassium diformate with different amounts in each treatment according to research methods. The giant freshwater shrimp was reared for 40 days. The calculation of survival, biomass weighing, length, and amount of shrimp feed consumption were carried out once every 10 days. The measurement of water quality was carried on the first day of the study and once every 10 days until the 40^{th} day.

2.2 Experimental Fish

Giant freshwater shrimps with the size 4 - 6 cm size were obtained from the Giant Freshwater Shrimp Breeding Center, Pamarican, West Java Province.

Giant freshwater shrimp were kept in a net as a culture media with a density of 20 shrimps/net. Shrimp were weighed every 10 days to get the value of weight gain, feed efficiency, and survival. Measurement of water quality in goramy habitat, namely temperature, DO (dissolved oxygen) and pH, it was carried out every 10 days to maintain the fish environment under the standard values required for shrimp to live.

2.3 Experimental Diets

The nutritional content of the commercial feed used must be under the requirements of 4-6 cm giant freshwater shrimp. The steps of adding potassium diformate into commercial feed were by adding potassium diformate into the feed and then stir until it became homogeneous, then sprayed the feed using 10% water so that the formulated potassium bounds to the feed, after that, dried it with aeration and finally the feed was ready to use. The feed that has been mixed with potassium diformate must be completely dry because if it is wet, it would decay easily. Feed mixing is done once every 10 days.

2.4 Observed Parameters

2.4.1 Daily growth rate

Giant shrimp as in other crustaceans shows growth once it starts to molt. Growth is analyzed by weight and length, following the formula for daily growth.

$$\alpha = \frac{lnWt - lnWo}{t} x100\%$$

Note:

α : Daily Growth Rate of weights
Wt : Average weight at the end of treatment (t-day)
Wo : Average weight of initial treatment (day 0)
T : Observation Duration (days)

2.4.2 The relationship between fish length and weight

One of the values that can be seen from the length relation of fish weight is the form or type of growth. If the value is b = 3, it means isometric which shows that the fish does not change its shape or the length increase in fish is balanced by the weight gain. If the value is b < 3, it means a negative allometric where the length increase is faster than the weight gain and If b > 3, it means positive allometric which indicates that the weight gain is faster compared to the length increase. The relationship between length and weight can be calculated by the formula:

$$W = a L^b$$

Note:

W : total fish weight (g)
L : total length of fish (cm)
a and b : constants of regression results (obtained by regression statistical tests)

2.4.3 Efficiency feeding

Culturing shrimp during research needs the level of efficiency of feed consumed. Calculation of feed efficiency is determined based on the difference in weight of fish biomass when it weighed and biomass of dead fish with initial biomass weight and compared with the amount of feed (F) that has been eaten.

$$EP = \frac{(Wt+Wd)-Wo}{F} X100\%$$

Note:

EP = Feed efficiency (%)
Wt = Final total weight (g)
Wd = Total weight of dead fish (g)
W0 = Initial total weight (g)
F = Total amount of feed consumed (g).

2.4.4 Survival rate

Survival is a comparison value between the number of organisms that live at the end of culture with the number of organisms at the time of stocking expressed in percentages where the greater the percentage value indicates the more organisms that live during culture. Survival can be calculated by the following formula:

$$SR= \frac{Nt}{No} \text{ x } 100\%$$

Note:

SR : Survival Rate (%).
Nt: Number of fish that lived at the end of the treatment and the end of the challenge test.
No : Number of fish at the beginning of the observation and before the challenge test.

2.4.5 Water quality

Water quality measurements in this research included temperature, DO (Dissolved Oxygen), and pH (temperature, DO and pH, respectively, measured with a thermometer, pH meter, and DO meter).

2.5 Data Analysis

Data on growth, feed efficiency, and survival rates were calculated using analysis of variance with the F test at 95% confidence intervals if there were significant differences followed by Duncan's multiple range test. Data on length relation were analyzed through regression graphs and explained descriptively, while water quality data were analyzed descriptively and compared with SNI.

3. RESULTS AND DISCUSSION

3.1 Growth

Growth is an increase in size in the form of length or weight in a certain time [10]. Growth occurs due to an excess of energy and protein input derived from feed. The excess energy input is used by the body for metabolism, movement, reproduction, and replacing damaged cells. Factors that affect fish/shrimp growth are internal factors (genes/heredity, cell division, age) and external (water temperature, feed, disease and parasites, dissolved oxygen, ammonia, and salinity). Feed is one of the factors that greatly influence the growth of fish because of its role as an energy supplier to increase growth and survival [11].

One way to find out shrimp growth is by calculating the daily growth rate of shrimp. Daily growth rate serves to find out the growth percentage of fish weight per day during a certain time of culture. The results of the observation showed that the addition of different potassium diformate doses in the diet showed variable results. Giving potassium diformate in giant freshwater shrimp feed gives a good response to shrimp growth. This can be seen from the increase in the average weight of individual shrimps every sampling (once every 10 days). The following Fig. 1 shows a graph of the weight gain curve of giant freshwater shrimp.

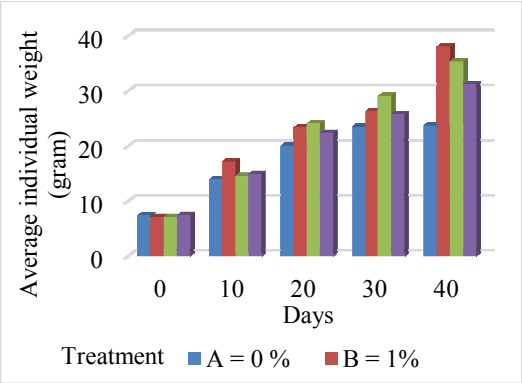

Fig. 1. Growth curve weight of shrimp

Giving potassium diformate gives better growth results than control treatment. These results are consistent with Lückstädt's research (2012) by giving potassium diformate in a dose of 0.8% to vannamei shrimp with an initial weight of 57 grams gave result of the final weight about 256 grams or 309 grams heavier compared to the control treatment. Yustiati (2019) stated that giving pottassium diformate to nilem fish at the dose of 0.3% gave a daily growth rate of 2.7%.

Observation results from day 0 to day 40 show that the feed mixed with potassium diformate at doses of A (0%), B (1%), C (3%) and D (5%) have logarithmic phase in growth pattern for each treatment, wherein this phase the growth rised quickly and the weight of shrimps increase every day. The results of the percentage of daily growth rate can be seen in Fig. 2.

Based on the observation for 40 days, the daily growth rate of giant freshwater shrimp those were given potassium diformate had different results. The highest value of observation was in treatment B with a magnitude of 1.86%, while the smallest was in the treatment A that reached about 1.58% in which treatment A is a control treatment. This indicates that by giving potassium diformate to the feed will help giant freshwater shrimp with short intestine grow more optimal.

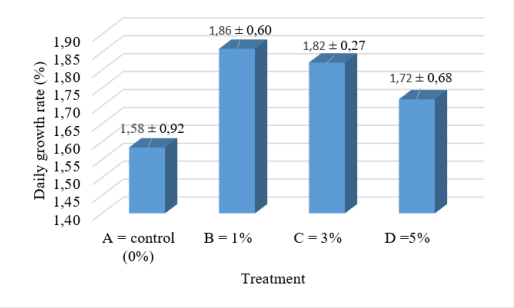

Fig. 2. Daily growth rate

Based on the results of the analysis of variance in giant freshwater shrimp with the addition of potassium diformate (0%) A, (1%) B, (3%) C and (5%) D significantly affected the daily growth rate of giant shrimps. Treatment A is significantly different from all treatments. The highest daily growth rate was in treatment B with a value of 1.86% ± 0.60. This indicates that giant shrimps that have a short intestine helped by the addition of diformate. Potassium in the feed will make growth more optimal [12]. Potassium diformate can increase fish growth by lowering gastric pH, stimulating the secretion of pepsin and pepsinogen which can further increase the digestion of food protein. Pepsin enzyme activity can be optimum at pH 2 or acidic conditions, thus the use of potassium diformate can optimize the activity of pepsin to break down proteins into peptides by lowering intestinal pH. Another function of potassium diformate in the intestine is that it can also break down pathogenic bacterial cells in the digestive tract so that the absorption of nutrients in the digestive tract will become optimal and increase fish growth [13].

3.2 Feed Efficiency

Feed efficiency is a picture of feeding given to increase growth. The greater the value of feed efficiency, the better the shrimp do the absorption of feed so that the greater weight of the meat produced. The high feed efficiency also means the better quality and absorption of the feed to be converted into meat, so the cheaper cost of producing feed needed to produce fish meat. In relation with the response of shrimp to the food eaten in terms of the level of digestion, absorption of food substances, and metabolic processes that occur in the body of the shrimp. Each shrimp has a different response to the same food, in terms of the characteristics of shrimps that are active against the artificial feed and protein absorption in the body of the shrimp [14].

The results of research on the efficiency of feed added potassium diformate for giant prawns have varying values. The value of feed efficiency can be seen in Fig. 3.

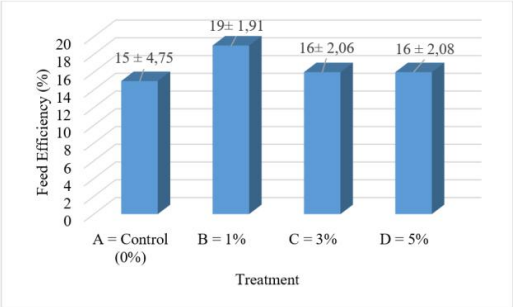

Fig. 3. Feed efficiency

Research results analyzed from variance with 95% confidence intervals showed results that were not significantly different. But the addition of potassium diformate can increase the value of

feed efficiency of giant freshwater shrimp compared to the shrimps that were not given potassium diformate. The highest value of feed efficiency in treatment B by giving potassium diformate 1%, had a value of feed efficiency of 19%, the lowest value obtained in treatment A (control) without giving potassium diformate by 15%. It means that potassium diformate can kill pathogenic bacterial cells in the digestive tract and increase the number of commercialized bacteria so that the nutrients contained in the feed are easily absorbed, and the feed given to the fish can be utilized efficiently then it increases the value of feeding efficiency and makes the digestive tract of animals acidic [15].

3.3 Survival Rate

The survival rate is the percentage of fish that live from the number of fish kept during a culture period in a rearing culture media. Fish survival is influenced by several factors including water quality, availability of feed that is suitable for the needs of the fish, ability to adapt, and stocking density [11]. Survival rates can be used to determine the tolerance and ability of fish to live. The results of the survival research can be seen in Fig. 4.

Based on observation for 40 days, the treatment that has the highest percentage value is treatment A, namely without giving potassium diformate with the survival percentage value of 98%, while the survival of giant freshwater shrimp given the addition of potassium diformate to feed has the survival value of 90% (treatment B by giving potassium diformate 1%), treatment C with potassium diformate 3% has the survival value of 81% and treatment D with 5% potassium diformate has the survival value of 93%.

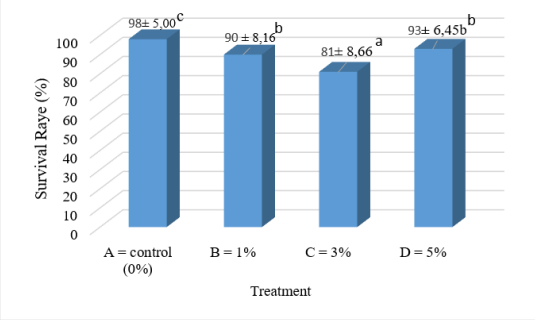

Fig. 4. Survival rate

Based on the variance test, this research has a real effect with the 95% confidence interval. The results between treatment A and the other treatments were significantly different while the results between treatment B and C were significantly different and the results between treatment B and D were not significantly different. The highest survival value was in treatment A with a value of 98% and the lowest was Treatment C with a value of 81%.

The low survival rate in treatment C is suspected to be caused by the water depth that is less than 50 cm. The difference in survival rates between treatments A and C is due to the different depths of ponds. Giant freshwater shrimp have an average living habit in 80 cm water depth. Giant freshwater shrimp live in the demersal column. If the depth of the giant freshwater shrimp water is not fit with the habit, it will cause death [16].

3.4 Relationship Length and Weight

Based on research conducted, giant freshwater shrimp have different sizes between treatments, a measurement of length and weight gain of fish can be a value of b. A value of b = 3 means that the growth of fish is balanced between the length increase and the weight gain (isometric). If the value of b < 3, then the growth in length is more dominant than the growth in weight (negative allometry). If b> 3, weight growth is more dominant than growth in length (positive allometry) [17]. The value of b is analyzed through a regression graph, with a scatter graph that is shown in Fig. 5.

The results show that the relationship between length and weight in a regression produces y = 3.8505x - 4.714 and determinant R2 = 0.7737. The value of b obtained from the linear regression calculation is 3.8505, meaning that b> 3 shows a positive allometry growth, the results of the relation between length and weight.

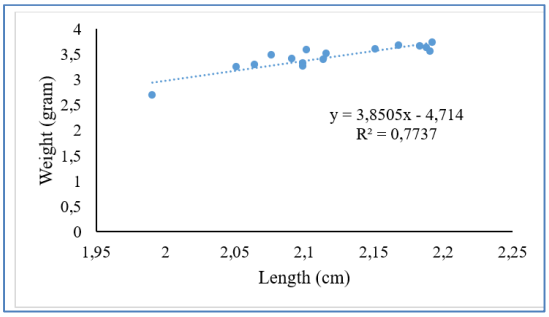

Fig. 5. Length and weight relation

Table 1. Results of water quality parameters based on each treatments

Treatment	Beginning – End				
	Temperature (°C)	*DO* (ppm)	pH	Ammonia (ppm)	Water depth (cm)
A	27,2-29	4,3-5	7	0	70-90
B	27,1-28,7	4 – 5	6,5	<0,01	65-80
C	27-29	3,5 – 4	7	<0,01	45-70
D	27,5-28	4 - 4,5	7	0	65-80
INS* (2014)	24-30°C	Min 3	6,5 – 8,5	<0,02	80

*Note: *Indonesian National Standard*

Table 2. Net profit count

Treatments	End / tail weight (gram)	TC (Rp)	TR (Rp)	π (Rp).-
A (Control)	4,74	17600,-	40484,25,-	22884,25,-
B (1% PD)	7,60	23280,-	90440,-	67160,-
C (3% PD)	7,05	24480,-	68737,5,-	44257,5,-
D (5% PD)	6,23	25240,-	59808,,-	34568,,-

Note: TC = Total Cost, TR = Total Revenue, and π = Net Profit

3.5 Water Quality

Water quality is one of the things that need to be considered in aquaculture activities because it influences the growth, survival, and development of fish. Table 1. shows the results of water quality parameter.

Based on the results of water quality measurements, the temperature range obtained is around 27-29°c. The temperature range can still be considered as ideal for giant freshwater shrimp because it is still under suits the standard of water temperature range for shrimps. The dissolved oxygen (DO) content in culture media is in the range of 3.5-4.5 ppm [18].

The degree of acidity (pH) of water obtained is 6.5-7. The optimal range of water pH for raising shrimps range from 6.5 to 8.5. This shows that the pH range of water is still in the normal range [18].

Ammonia in shrimp culture media ranges from 0-0.01 ppm. Good ammonia for giant freshwater shrimp is about < 0.02. So that for the giant freshwater shrimp pond, it is still suitable to be used as a culture media for giant freshwater shrimp [18].

The depth of water in the culture media ranges from 45-90 cm. Water depth for giant freshwater shrimp is about 80 cm. For treatment C it has the lowest water depth (at 45-60 cm) which makes the life habits of giant freshwater shrimp slightly disturbed and caused the death of shrimps [18].

3.6 General Discussion

Giant freshwater shrimp lives in demersal waters. The minimum water depth for giant freshwater shrimp is 80 cm. The results on treatment B have the depth range between 70-90 cm, giant freshwater shrimp cultivated with the addition of potatoes have a survival value of 51.33%. Although treatment B had the survival value of 90%, it was still greater. Giant freshwater shrimp have a fairly high price. Every 70 shrimps/kg price about Rp. 90,000. With the results of the research that shows the survival of everything above 50%, the net profit count can be seen in Table 2.

The results of the net profit calculation show that B treatment's survival is smaller than the control treatment but economically more profitable.

4. CONCLUSIONS AND RECOMMENDATIONS

This research concludes that by giving potassium diformate of 1%, it gives a daily growth rate of 1.86% ± 0.60, feed efficiency in value of 19% ± 1.91, survival value of 90% ± 8,16 with the highest net profit value of Rp. 67,610.- while for the relation of length and weight value reaches b > 3 that means the growth of giant freshwater shrimp is called positive allometry.

It is recommended for giant freshwater shrimp farmers to add potassium diformate as much as 1% to commercial feed.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Maskur, Mukti SR, Taukhid, Angela ML, Desy S, Nurzain, Dewi RM, Andi R, Trinita DS, Point I. Handbook of fish pests and disease control. Directorate of fish and environmental health, directorate general of aquaculture, the ministry of maritime affairs and fisheries; 2014.
2. DJPB. Galah shrimp cultivation improves farmer's welfare; 2019.
3. Tambunan. and sincere. SME Giant prawns (*Macrobranchium Rosenbergii*) intensive. Ghalia Indonesia, Jakarta; 2009.
4. Fatagar SH. Total consumption of *Macrobrachium rosenbergii* pole shrimp feeding with different types of attractants. thesis, Bogor: Bogor Agriculture Institute; 2014.
5. Maharani S. Cultivation: Enlargement of giant scale prawns. Yogyakarta: Katahati; 2009.
6. Handajani H, Widodo. Fish nutrition. UMM Press. Poor. 2010;271.
7. Almatsier S. Basic principles of nutrition. PT. Gramedia Main Library. Jakarta; 2001.
8. Nermeen MA, Naela MR. Ebiotic Effect of a dietary acidifier (Potassium diformate) on the health status of cultured *Oreochromus niloticus*. Journal of Advanced Research. 2015;6: 621-629.
9. Luckstadt C. Effect of dietary sodium formatted on performance and litter quality in broilers until 42 days post-hatch. Worlds. Poult. J. Berlin; 2012.
10. Effendie I. Fisheries biology. Pustaka Nusantara Foundation. Bogor; 1997.
11. Effendie I. Water quality study for water resources and environmental management. Kanisius. Yogyakarta. 2003; 258.
12. Granli T, Kjeldse KC, Overland M. Antimicrobial properties of dietary potassium formatted. In: Tehnical Symposium. Germany; 2002.
13. Winarno FG. Food enzymes. PT. Gramedia Main Library. Jakarta. 1995; 113.
14. Nugroho SJ. Development of use of biogas waste from cattle manure as a source of raw material for Tilapia (*Oreochromis niloticus*). Essay. Degree program. Bogor Agricultural Institute. Bogor; 2010.
15. Sheng JL, Lin JL, Ting W. Ontogeny of Protease, Amylase and Lipase with potassium formated in the alimentary tract of hybrid juvenile tilapia *Oreochromis niloticus* X *Oreochromis aureus*. Fish Physiology and Biotechnology. 2006;32: 295-303.
16. Roslani D. Monitoring of water quality during white tail disease in *Macrobrachium rosenbergii* Galah Shrimp, 1879 in Cisolok, Sukabumi. Essay. Aquaculture technology and management study program. Department of aquaculture. faculty of fisheries and marine science. Bogor Agricultural Institute; 2007.
17. Nasir M, Zainal A, Muchlisin, Abdullah A, Muhammadar. Relationship between Length and Condition of Betutu Fish (*Oxyeleotris marmorata*) in Ulim River, Pidie Jaya Regency, Aceh Province, Indonesia. Unsyiah 1 (3) Marine and Fisheries Student Scientific Journal. 2010; 262-267.
18. Indonesian national standards. Habits of giant prawns. BSN: Jakarta; 2014.

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