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Effects of Artificial Substrates and Stocking Density on the Growth and Glycogen Content in the Cultivation of *Litopenaeus vannamei* in Floating Cage (*Karamba Jaring Apung)*

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Abstract : Research was to identify effect of artificial substrates and stocking densities on growth, glycogen, and amino acid content on *Litopenaeus vannamei*. Randomized block design with six treatment and three group used design. Treatments were intensively from PL28 for 60 days in floating cage system at stocking densities of A (100 shrimp^{-3}), B (100 shrimp^{-3} + substrates), C (200 shrimp^{-3}), D (200 shrimp^{-3} + substrates), E (300 shrimp^{-3}), and F (300 shrimp^{-3} + substrates). Shrimp growth was significantly greater at the addition substrates and lower density. Mean growth shrimp B (0,1816 gr/day), D (0,1495 gr/day) treatment F (0,1294 gr/day), this was actually better than the non-substrate which A (0,1650 gr/day), C (0,1346 gr/day), and E (0,1186 gr/day). Highest survival rate B 83,56% while the lowest was in E 74,3%. Glycogen content with the addition of substrates was ranging from 8,463-24,509 mg/g while the amino acid content of the substrate treatment was better than those without substrates. Based on the results, it can be concluded that the use of artificial substrates may be able to increase the surface area so that it could increase the stocking density and reduce the negative effects of high stocking density so as to increase the production.
Keywords : Litopenaeus vannamei, artificial substrates, growth, glycogen-amino acid.

Introduction

In the last 3 years *L. vannamei* culture technology in Indonesia has been rapidly developed. Shrimp production in Indonesia is reached in 2015[1], and particularly in Lampung Province[2] which is well-known as the center of national shrimp production. Decreased environmental quality of the ponds is one effort creates a problem which is the lower production of *L.vannamei* in ponds. This happens as a result of the ponds exploitation especially due to the farming activity of *L.vannamei* in an excessive intensive scale.

One of the efforts that can be done is to utilize the potential of the sea which still very wide for the *L.vannamei* farming with floating cage (*Karamba Jaring Apung* or KJA). *L.vannamei* farming in floating cages was first introduced in Brazil around 1993 to 1996. *L.vannamei* farming in floating cage in summer is 23% better compared to winter (SR by 76%, SGR by 0,76 g/week with FCR by 2,5)[3]. Artificial substrates on that farming can produce a remarkably good result which was SR 87% -95%, SGR 0,3 g/day and FCR 0,79[4]. The result of *L.vannamei* farming conducted in ponds and in KJA is different but it is not significant in both SR, SGR, or FCR[5]. The benefit that is gained in the intensification of *L.vannamei* cultivation in floating cage is displayed in the SR by 80% -88%, SGR by 0,13-0,15 g/day, and FCR by 1,29-1,35[6]. Utilization of sea in

L.vannamei farming by using different stocking density and substrates addition in KJA not only able to reduce the production cost such as land acquisition and electricity cost but also in terms of the *L.vannamei* product quality (amino acid content). Amino acid content in the shrimp which were cultivated on ocean salinity (>25) is better when compared to the ponds salinity (10-15 ppt)[7]. Also, the glycogen content on *L.vannamei* with different feeding frequency and carbohydrate is in the number of 16,47-34,55 mg/g sample[8].

Based on the description, we conducted a research to examine the effect of different stocking density and artificial substrates addition on the development of *L.vannamei* farming in floating cage or KJA which covers the growth, glycogen

Materials and Methods

The *L.vannamei* (*Litopenaeus vannamei*) used aged for 28 days with the average weight of 0,6 g/fish and culture for 60 days. The treatment of the juvenile was done in in the KJA of *Balai Besar Perikanan Budidaya Laut* (BBPBL) Lampung which is one of the Technical Implementation Unit (*Unit Pelaksanaan Teknis* or UPT) under the Directorate General of Aquaculture (*Direktorat Jenderal Perikanan Budidaya*), Ministry of Marine Fisheries of the Republic of Indonesia. The net size of 3m x 3m x 2,5m and size 180 cm x 180 cm for artificial substrates used was also made from white polyethylene (PE). There were 18 pieces of nets and 9 pieces of substrates. Each treatment group consisted of 6 pieces of fishnets and spreaded with *L. vannamei*; the fishnets with no substrate were as many as 3 fishnets with each stocking density of 100 fish/m3, 200 fish/m3, and 300 fish/m3 and nets with the addition of substrate with the stocking density of 100 fish/m3, 200 fish/m3, and 300 fish/m3.

In this study feed used was a commercial pellet of "Irawan" brand (30% protein) produced by PT. Central Pertiwi Bahari, Lampung, Indonesia.Frequency of the feeding was carried out 7 times a day and fed as much as 8%-4,5% of the shrimp biomass per day during the study. The cultivation of *L.vannamei* was maintained for 2 months (60 days).Sampling of the shrimp was done once a week due to the growth observation. The sampling which was intended to determine the glycogen content of the shrimp was carried out at the end of the study. Samples of each treatment were taken to be dried by using the oven at a temperature of 80°C for 48 hours. After the drying process, the samples were crushed by using a blender to form a powder. Then, the formed flour was wrapped in aluminum foil and kept in a labeled plastic clip. As a result, this flour was the sample used to determine the content of glycogen by using Anthron method[9] while the determination of amino acids content was implemented by using UPLC method. The observation of water quality parameters was established in every single week. The observed parameters of water quality were the temperature, brightness, depth, water flow speed, salinity, DO, pH, nitrite, nitrate, ammonia, and phosphate.

Table 1. Water Quality Parameters During the Research

No	Parameter	Group		
		I	II	III
1	pH	8,64	8,66	8,65
2	DO (mg/L)	6,12	6,14	5,91
3	Suhu (°C)	30,4	30,5	30,6
4	Salinitas (ppt)	32	32	30
5	Nitrit (mg/L)	0,082	0,101	0,129
6	Nitrat (mg/L)	1,520	1,460	1,900
7	Amoniak (mg/L)	0,093	0,108	0,153
8	Phosfat (mg/L)	0,063	0,119	0,103

Research use was a randomized block design (*Rancangan Acak Kelompok* or RAK). The first factor of this treatment was to use a stocking density (100 shrimp^{-3}, 200 shrimp^{-3}, and 300 shrimp^{-3}), while the second factor was the addition of the substrate. Each treatment was repeated for 3 times, and thus the number of the unit was 18 experimental units (net). The parameters observed in this study include the survival rate (SR), specific growth rate (SGR), feed conversion ratio (FCR), feed efficiency (EP), glycogen content, and amino

acid content. The observation of the data during the study was analyzed by using the analysis of variance with a confidence level of 95%, followed by Tukey's test by using SPSS version 16.0.

Table 2. General Data Research

Group	Treatment	Stocking density	Harvest	Final Weight (gr)	Final Biomass (gr)	Survival Rate (%)	FCR	SGR (gr/day)	EP (%)
I	A (100)	1,800	1,386	10.500	13,372	77.00	1.51	0.1650	66.33
	B (100+S)	1,800	1,504	11.497	16,598	83.56	1.18	0.1816	84.91
	C (200)	3,600	2,725	8.134	22,164	75.69	1.40	0.1256	71.22
	D (200+S	3,600	2,880	8.365	24,091	80.00	1.30	0.1294	76.82
	E (300)	5,400	3,948	7.714	30,454	73.11	1.40	0.1186	71.34
	F (300+S)	5,400	4,226	8.362	35,338	78.26	1.24	0.1222	80.71
II	A (100)	1,800	1,356	9.047	12,267	75.33	1.50	0.1408	66.65
	B (100+S)	1,800	1,401	9.215	12,911	77.84	1.28	0.1436	66.66
	C (200)	3,600	2,612	7.980	20,842	72.55	1.51	0.1230	66.48
	D (200+S)	3,600	2,708	8.150	22,072	75.23	1.39	0.1258	72.12
	E (300)	5,400	3,886	7.245	28,157	71.97	1.65	0.1108	60.65
	F (300+S)	5,400	4,121	7.473	30,798	76.32	1.44	0.1146	72.20
III	A (100)	1,800	1,376	9.717	13,372	76.45	1.34	0.1520	74.77
	B (100+S)	1,800	1,433	11.035	15,813	79.61	1.28	0.1739	78.08
	C (200)	3,600	2,695	8.675	23,376	74.85	1.41	0.1346	70.82
	D (200+S	3,600	2,791	9.568	26,708	77.54	1.19	0.1495	83.82
	E (300)	5,400	4,012	7.714	30,950	74.30	1.38	0.1186	72.36
	F (300+S)	5,400	4,167	7.932	33,050	77.16	1.29	0.1294	77.66

Results and Discussion

The observation of average water quality parameters during the study is presented in Table 1. Based on the results below, it shows that the location of the research is still in the requisite range for mariculture. Average weight of shrimp in each treatment is ranged from 7,245 to 11,497 gr after 60 days. Shrimp growth on lower stocking densities (100 shrimp-3) will be higher when compared to the hight stocking densities (300 shrimp-3)[10]. Average growth rate of shrimp is increased more significantly in used artificial substrate compared with the non-substrate treatment (Figure 1). The of artificial substrates in the cultivation container will have a positive influence on the growth of shrimp; microorganisms will grow on the surface of substrate which it can be used as a natural food source for the shrimp[11]. *L.vannamei* culture in KJA is more profitable, this provides a lot of organic particles that are beneficial to the growth of shrimp[12].

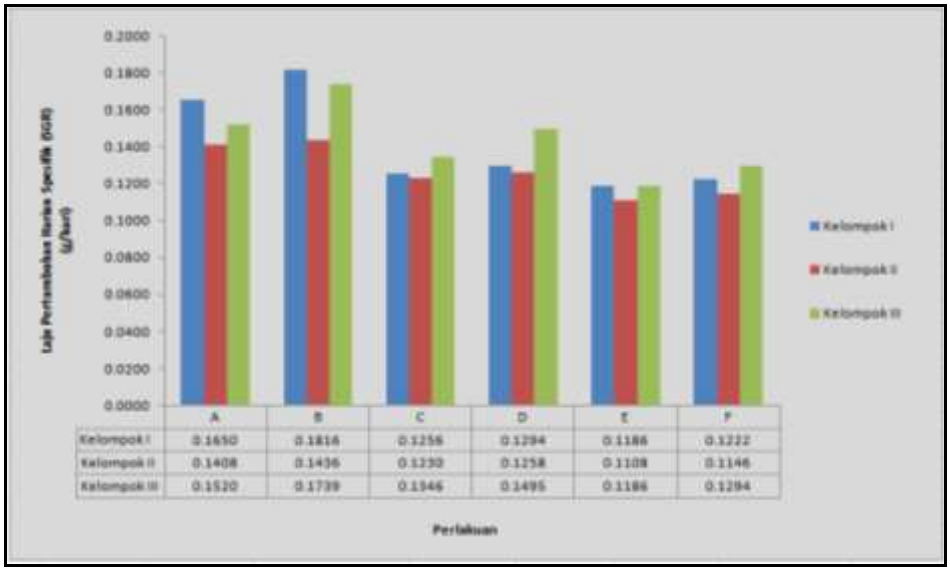

Figure 1. The Specific Daily Growth of L.vannamei

Survival rate (SR) of *L.vannamei* is ranged between 71,97% - 83,56% (Table 2). Lower stocking densities (100 shrimp-3) will be the survival rate higher if compared with high stocking densities (300 shrimp-3)[12]. That is showed cultured with higher stocking densities and the artificial substrate does'nt have a significant difference from the lower stocking densities and non-substrate. Survival rate only affects on the high stocking densities (300 shrimp-3), because the presence of artificial substrate will be eliminate influence of high densities. Artificial substrate can be increase the containers culture area so that the shrimp could be spread evenly[13]. Treatment C (300 shrimp-3) with high stocking densities and no artificial substrates is lower than the low stocking densities without substrate addetition[14].

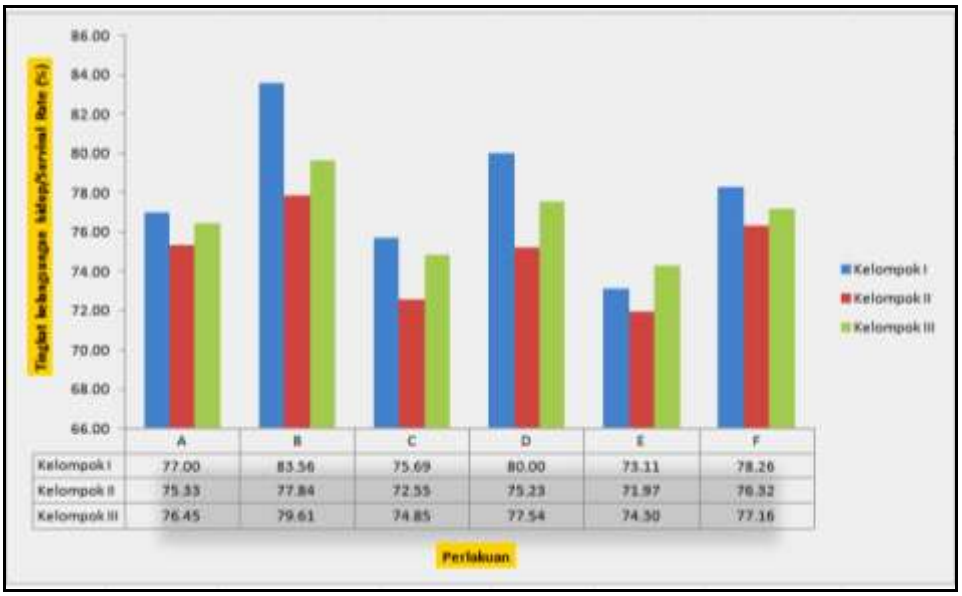

Figure 2. The Survival Rate of L.vannamei

Average of biomass production for 60 days the highest is obtained in F (300 shrimp-3 + substrate) with of 34,503 grams and the lowest A (100 shrimp-3) with of 14,529 grams. Production biomass will be increased along with the increasing time or age of the shrimp. This suggests that the duration of the culture affected the level of shrimp biomass, a longer culture will increase the weight or produce such positive effect on the growth, which in turn it will increase the biomass. The shrimp which is cultivated by using high stocking densities will inevitably produce high biomass, but otherwise, the shrimp cultivation which is carried out by using low stocking density will produce a low biomass[15]. The culture of *L.vannamei* by using artificial substrates will increase the biomass production although it is cultured with the same density[13].

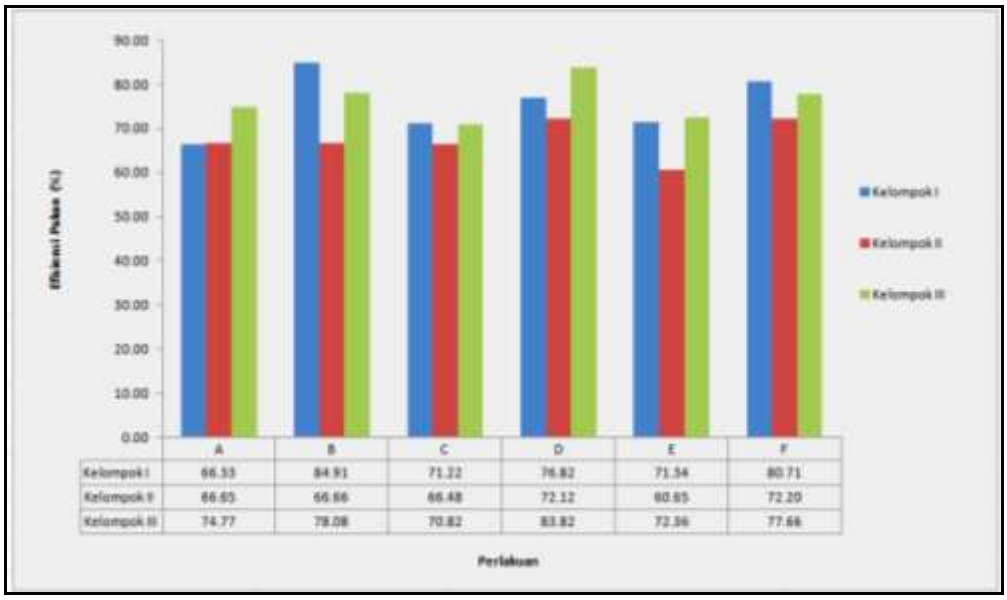

Figure 3. The Efficiency of L.vannamei feed

Feed efficiency by the end of the *L.vannamei* culture above indicates that the highest value of the feed efficiency is obtained in B (200 shrimp-3 + substrate) with a feed efficiency of 0,84,91% while the lowest is F (300 shrimp-3 + substrate) with the efficiency of 60,65%. The high feed efficiency value shows that the feed utilization is very good and optimal. High feed efficiency value is the inverse of the low feed conversion rate[12].Feed efficiency value in a cultivated organism is influenced by the increase in body weight during the maintenance period. Fish which are able to absorb food properly shows that the fish can completely digest their feed so they will experience an optimal growth[14]. Feed efficiency is also influenced by the substrate which is added to the media of cultivation. Therefore, after a longer time, the substrate will be covered by periphyton that allegedly can be used as a feed for the shrimp and as a water quality control factor in the cultivation media[13].

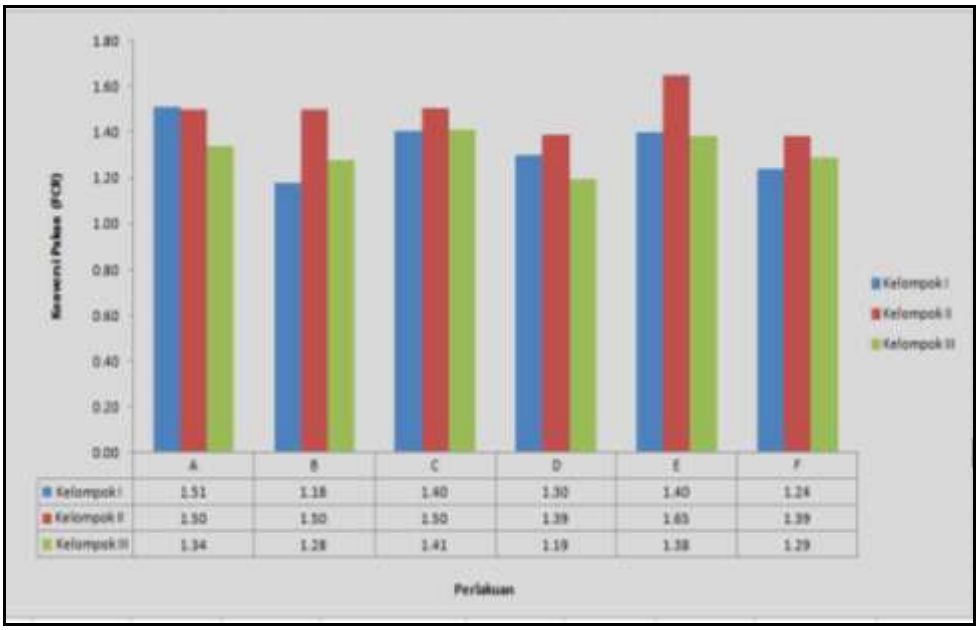

Figure 4. The Conversion of L.vannamei Feed

The best FCR result of *L.vannamei* cultivation in 60 days is obtained in treatment B (100 shrimp-3 + substrates) that is equal to 1,18 while the lowest FCR is in the treatment E (300 shrimp-3) which amounts up to 1,65. Result showed that the treatment of feed utilization in stocking density of 100 shrimp-3 with the addition

of artificial substrate is better when compared with others, especially when compared with E (300 shrimp-3). The cultivation of *L.vannamei* with artificial substrates and high stocking density will be able to lower the feed conversion rate (FCR) for which the stocking density of 100, 150 and 200 shrimp-3 without or with artificial substrates from 0,79 to 0,98[6]. The use of artificial substrates on the cultivation of *L.vannamei* in postlarval phase can lower the feed conversion rate[13] and eliminate the negative effects of high stocking density in the seeding phase[14].

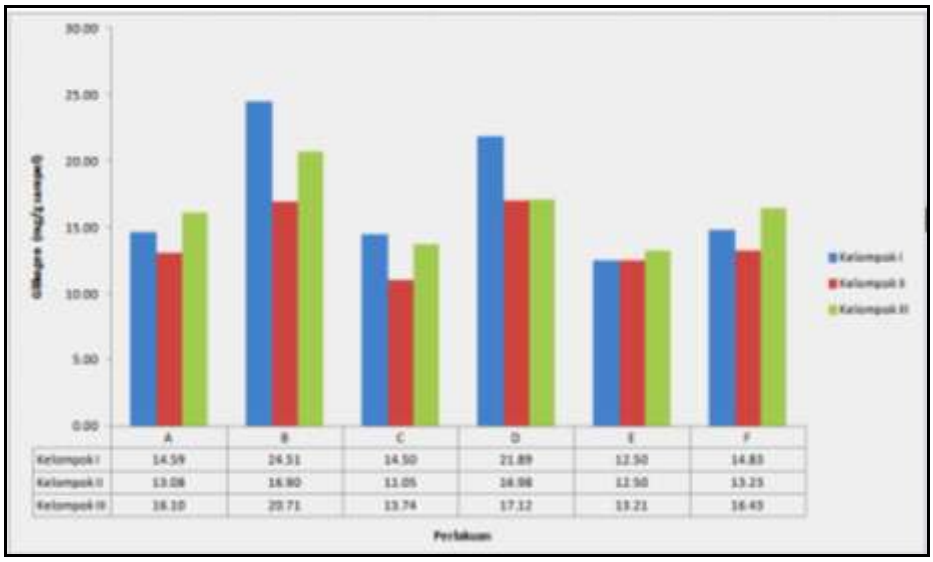

Figure 5. The glycogen of L.vannamei

Glycogen deposits for 60 days proves that the highest content of in *L.vannamei* is in B (100 shrimp-3 + substrate) in group I with 24,51 mg/g, and the lowest B (200 shrimp-3) in group II with 11,05 mg/g. These result if compared to the research of Aslamsyah et al.[6] by using an addition of carbohydrate by 30% -50% and feeding frequency by 2-6 times per day, this still resulted in a low level which is 16,469 – 34,545 mg/g. A continuous feeding on fish and shrimp with often frequency will be able to improve the utilization of carbohydrates. Along with this increased level of carbohydrate, generally the glycogen content of the liver in some fish species will increase as well[15].

Conclusion

Based on the result and the discussion above, it can be concluded that the KJA in Hurun Bay which is belong to the BBPBL (Balai Besar Perikanan Budidaya Laut) Lampung is qualified and suitable for *L.vannamei* culture development based on the water quality criterion. The highest result of the treatment on *L.vannamei* culture in floating cage is obtained in treatment B (100 shrimp-3 + substrate) with the addition of artificial substrate. In which, the survival rate, specific growth rate, utilization rate or feed efficiency, and feed conversion is better when compared with other treatments. The low stocking density of 100 shrimp-3 should be used in the floating cage of *L.vannamei* cultivation. The glycogen level in the floating cage of *L.vannamei* cultivation has the best result in treatment B (100 shrimp-3 + substrate) with a glycogen level of 24,51 mg/g sample. As an addition to that, a further research about the use of various models or methods of artificial substrates on *L.vannamei* farming in floating cage is needed to get a higher and more efficient productivity.

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