Advanced Science Letters
Vol. 23, 6465–6467, 2017

Daily Growth Rate of Weight, Length and Its Ratio of Milkfish (*Chanos chanos*) Within Silvicultural Pond

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Cultivation of Milkfish had been expanding as the increasing silvofishery application in aquaculture. The objectives of this research are to study the growth rate and to analyze the weight/length growth rate ratio of Milkfish cultivated in sylvicultural pond. This research was conducted through experiment involving 9 silvicultural pond embankments occupying various settings of mangrove plantation. Observation was conducted in 3 periods with observation interval of 1 month. Observations were conducted to measure length and weight of Milkfish which were used to calculate the daily growth rate of Milkfish and weight/length growth ratio. Statistical analysis was conducted with t-test to evaluate the differences of milkfish growth and growth ratio between the first and second periods. The result showed that there were decreases on Milkfish growth rate including daily length growth rate from 1.27 mm/day to 0.38 mm/day and daily weight growth rate from 0.17 g/day to 0.14 g/day. While growth ratio increased from 0.1290 g/mm to 0.3724 g/mm. Statistical analysis showed there were significant differences on the daily length growth rate and growth rate ratio, while daily weight growth rate was not significantly different. Decreasing growth rate of Milkfish was suggested as the impact of decreasing natural feed availability, while increasing growth ratio was suggested as the common trend of Milkfish growth pattern.

Keywords: Growth Ratio, Growth Rate, Milkfish, Silvofishery.

1. INTRODUCTION

Milkfish (*Chanos chanos*) is an economically important and mostly cultured fish species in South East Asia.[1] Milkfish is one of the most cultivated fish species in the coastal ponds instead of shrimps.[2] The cultivation of milkfish is increasing due to the decreased coastal ecosystem suitability for shrimp culture. Degradation of coastal ecosystem were caused by aquaculture activities in the past decades and the development of coastal area for industrial purposes.[3] Production of Milkfish is being emphasized to fulfill the market demand needs through sustainable aquaculture development.[4] The application of silvofishery in aquaculture had been proposed to overcome the impact of aquaculture to the environment.[3]

Milkfish has proportional length and weight growth.[1] Weight/length ratio of Milkfish was higher at early stages than the larger ones. The growth rate of Milkfish was much affected by food supply.[5] The natural growth pattern of fish varied among species. Fish larvae and juveniles tend to have higher biomass gain than matured fishes.[6] A research showed that the growth of several fish species are initiated by linear pattern followed by logarithmic pattern, while some other species are initiated by exponential pattern followed by logarithmic pattern.[7] The logarithmic pattern indicated that the growth rate is decreased and at maximum size the rate would be as near as zero. The length growth rate of fish tends to decrease as the increasing fish length.[8]

The growth rate of milkfish is affected by various factors such as salinity and feeding ratio. Various environment factors might affect the growth of fish such as temperature, salinity and feeding regimes.[9] Milkfish is better grown in saline environment.[10] Cultivation of milkfish at salinity level of 25 ppt resulted weight growth rate as 0.56 g/day, while the growth rate at salinity of 10 ppt was only 0.27 g/day. Another research showed the growth rate of Milkfish was 0.52 g/day at rainy season and 1.21 g/day at dry season.[11]

Animal growth consist of several phases.[12] Hence, the estimation of growth pattern could be separated into respective phases. The growth of fish usually expressed in length–weight relation occupying log linear (power) estimation. The weight growth rate of fish is usually faster than its length growth rate. The rate is usually expressed in allometric pattern including positive allometric where weight growth rate is faster than length growth rate, negative allometric where length growth rate is faster than weight growth rate, and isometric where length and weight growth has

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linear correlation. Even though, the relation of length and weight of particular fish species is not always similar among environment condition and food abundance.[13] Every organisms such as fish has its growth limit. But, before it reaches its growth limit there would be an inflection point where the growth rate would be decreased leaving gradual growth until it reaches its limit.[14] At this point, the growth rate would be decreased.

Cultivation of Milkfish in silvicultural pond had been conducted since the development of silvofishery system applied in aquaculture. But, the growth rate of Milkfish within silvicultural pond is not well understood. The objectives of this research were to study the growth rate and to analyze the ratio of weight/length growth rate of Milkfish cultivated in silvicultural pond.

2. EXPERIMENTAL DETAILS

This research was conducted through field experiment, occupied silvicultural pond placed in Mangunharjo Village, Tugu District, Semarang City. The research was conducted from early June to mid August, including 3 observation periods with one month intervals. Observations were conducted in early fingerling cultivation and 2 following observations of defined intervals. Nine pond embankments were used in this research including various silvicultural settings, such as population and species composition of mangrove stands. Even though, these silvicultural settings were ignored and all observation plots were considered as replication.

Data collections were conducted in 3 periods. Acclimation of Milkfish was conducted one week before the observation to allow the fingerlings to adapt the environment. Parameters observed in this research was the daily growth rate, the length and weight of Milkfish. Total of 30 fingerlings from each plot were utilized as animal test. Since the fingerlings were randomly sampled, calculation on the daily growth rate as well as its ratio were conducted to its average values. Hence, there were only 9 observation data for each growth period. Daily growth rate of Milkfish fingerling and the ratio of weight/length was calculated with following formula:

$$DL = \frac{L_{t1} - L_{t0}}{t}$$

where DL = daily growth rate of fingerling length (mm/day), L_{t1} = final length of fingerling after t days (mm), L_{t0} = initial length of fingerling (mm), t = time interval (days)

$$DW = \frac{L_{t1} - L_{t0}}{t}$$

where DW = daily growth rate of fingerling weight (g/day), L_{t1} = final weight of fingerling after t days (g), L_{t0} = initial weight of fingerling (g), t = time interval (days)

$$GR = \frac{DW}{DL}$$

where GR = growth ratio (g/mm), DW = daily growth rate of fingerling weight (g/day), DL = daily growth rate of fingerling length (mm/day).

Data collected were including 2 periodic growth achieved from 3 field sampling of fingerlings length and weight measurements. Only growth ratio data would be shown for further analysis. Data analysis was conducted through paired sample t-test to analyze the significance of growth ratio difference. The confidence interval was set to 95%.

3. RESULTS AND DISCUSSION

The result showed that there were variations of weight/length growth ratio of Milkfish cultivated in silvicultural pond. Change on the growth ratio was also observed between first and second observation periods. Detailed information concerning the growth ratio of Milkfish is presented in Table I.

Daily growth rate of Milkfish cultivated in silvicultural pond showed decrease both on the length and weight. Average length growth rate at first period was 1.27 mm/day decreased to 0.38 mm/day, while weight growth rate decreased from 0.17 g/day to 0.14 g/day. T-test analysis showed that there was significant decrease of length growth rate of Milkfish between the first and second period, but there the weight growth rate was not differed significantly. T-test analysis showed t value of 5.9669 with probability level of 0,00 ($p < 0.05$).

Data processing on the growth ratio of Milkfish as presented in Table I showed that average growth ratio was lower in the first period. The growth ratio in the second period was much higher than in the first period. Average growth ratio of Milkfish in the first period was 0.1290 ± 0.0332 g/mm while in the second period was 0.3724 ± 0.1001 g/mm. It indicated that there was an exponential increase of biomass growth rate of Milkfish. Statistical analysis with t-test showed there was significant difference of Milkfish growth ratio between first and second period. Data transformation was conducted to achieve normal distribution of observation data involving logarithmic transformation. The analysis resulted t value of -20.8163 and probability of 0.00 ($p < 0.05$).

Average growth rate of Milkfish in this research showed a low value compared to Ref. [10]. The research resulted cultivation of Milkfish at salinity of 10 ppt showed growth rate of 0.20–0.27 g/day, while at 25 ppt was 0.41–0.56 g/day. That was still higher than the result of this research which was only 0.06–0.41 g/day (average 0.17 g/day) at first period and 0.05–0.27 g/day (average 0.14 g/day) at second period. Another research showed even higher growth rate, including 0.52 g/day in rainy season and 1.21 g/day in dry season.[11] The result suggested that the environment quality was not appropriate for Milkfish optimum growth.

The result indicated that the growth of the Milkfish was in its initial stage. The initial growth stage of Milkfish is considered to have exponential pattern. Even though the growth rate of Milkfish was decreased in the second period, but the growth rate ratio of Milkfish in the second period was much higher than the first period. It indicated that even though the growth rate of Milkfish was inhibited, the ratio still followed the common pattern. A contrary result showed on the Golden Spined Loach, where the growth rate at the second year increased intensely.[15] Naturally, the initial growth of some fish species has exponential pattern of its initial growth.[7] The exponential growth of fish could occur for several months, depend on the species. A research on the Catfish showed that the exponential growth occurred for 50 days followed by constant rate.[16]

Growth pattern of fish is expressed in length–weight relation. Milkfish commonly has positive allometric to isometric growth pattern. The growth rate of fish is affected by food conversion ratio.[13] Higher food conversion would affect faster weight growth rate of fish. Condition coefficient of fish growth showed allometry pattern of fish growth. Positive allometry is usually expected in aquaculture to gain faster fish growth and shorter culture period.[13] Milkfish has isometric growth pattern which showed

Table I. Growth ratio of weight/length of Milkfish cultivated in silvicultural pond.

	Length growth rate (mm/day)		Weight growth rate (g/day)		Growth ratio (g/mm)	
Replication	1st period	2nd period	1st period	2nd period	1st period	2nd period
1	1.48	0.35	0.22	0.13	0.1456	0.3611
2	1.28	0.58	0.17	0.23	0.1321	0.4002
3	1.41	0.19	0.19	0.07	0.1359	0.3976
4	1.01	0.14	0.12	0.05	0.1207	0.3367
5	2.10	0.47	0.41	0.27	0.1953	0.5844
6	1.29	0.25	0.19	0.08	0.1436	0.3238
7	1.09	0.24	0.12	0.09	0.1078	0.3983
8	0.71	0.54	0.06	0.11	0.0777	0.2030
9	1.01	0.66	0.10	0.23	0.1022	0.3466
Min.	***0.71***	***0.14***	***0.06***	***0.05***	***0.0777***	***0.2030***
Max.	***2.10***	***0.66***	***0.41***	***0.27***	***0.1953***	***0.5844***
Average	***1.27***	***0.38***	***0.17***	***0.14***	***0.1290***	***0.3724***
St. dev	***0.39***	***0.19***	***0.10***	***0.08***	***0.0332***	***0.1001***

proportionate length and weight growth.[1] To increase fish growth performance, such feeding treatments are usually applied.

Various factors had been suggested to affect the growth rate of fish. Even though, within the consistent environment condition and abundant food sources, each species would have its own growth pattern.[7] Environment stresses such as significant changes on water quality or lack of food availability might affect the growth rate of cultivated fish. The abundance of natural feed plays important role in supporting larvae growth.[17] Natural feed within silvicultural pond is supported by mangrove stands which produce nutrient for aquatic primary productivity, in this case for pond embankments. Each animal species has growth limit. At certain length, fish species would reach inflection point followed by gradual growth until it reach asymptotic length.[14]

Such suggested factors which effect the low growth rate of Milkfish in this research was food availability and closed system culture method. Silvofishery applies low input aquaculture method where ecosystem services are expected to provide supports for the cultivant food requirement.[3] Feed availability within silvicultural pond is limited.[18]

Decreasing growth rate of Milkfish was also considered to the effect of decreasing food abundance. The growth of Milkfish in the first period had caused to the increasing grazing rate to natural food sources which led to limitation of food abundance.[19] Hence, there was no sufficient food supply for Milkfish growth in the second period. It resulted the decreasing growth rate of Milkfish in the second period. The abundance and growth of fish could decrease plankton abundance through grazing activities.[20] This led to the decrease of food source. Low food availability caused to lower growth rate of cultivated fish and wider territory size which cause to higher competition.[21] Within a pond embankments where the extent of water surface is limited, it lead to higher competition among individuals which lead to decreasing growth rate. Additional food supply is needed to maintain optimum growth of Milkfish cultivated in silvofishery pond such as fertilization to improve plankton abundance or addition of artificial food such as pellet.[22]

4. CONCLUSION

The growth rate of Milkfish cultivated in silvicultural pond decreased between periods. Length growth was decreased from 0.71–2.10 mm/day (average 1.27 mm/day) to 0.14–0.66 mm/day (average 0.38 mm/day) while weight growth rate decreased from 0.06–0.41 g/day (average 0.17 g/day) to 0.05–0.27 g/day (average 0.14 g/day), indicated the decreasing abundance of natural feed for fish. Even though, ratio of weight/length ratio increased showing values of 0.0777–0.953 g/mm (average 0.1290 g/mm) at the first period to 0.2030–0.5844 g/mm (average 0.3724 g/mm) at the second period.

Acknowledgments: The authors acknowledge Biology Department, Faculty of Science and Mathematics Diponegoro University for funding support.

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Received: 5 September 2016. Accepted: 13 December 2016.