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THE ASSOCIATION BETWEEN WATER TEMPERATURE AND ACTUAL FEEDING ACTIVITY OF NILE TILAPIA (*OREOCHROMIS NILOTICUS*) UNDER CONTROLLED RECIRCULATING SYSTEM

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ABSTRACT

The Nile tilapia (*Oreochromis niloticus*) is one of the most important aquaculture species groups especially in South East Asia, Africa, South America and China. Therefore, it is necessary to analyze the environmental factor to the feeding activity of this species for the establishment of the culture technology for Nile tilapia because knowledge about the physiology. This study was used six fish with the body weight 60.9 g, 61.3 g, 64.5 g, 71.89 g, 73.3 g, and 75.4 g, respectively. The treatments were conducted under controlled recirculation system with different water temperature, which gradually increased and decreased 1^{o}C every two days. First period was the experiment with the increasing water temperature from 15 to 25^{o}C within 20 days (In-WT1) then increasing from 25 to 35^{o}C for 20 days (In-WT2), respectively. Each time data of feeding activity was stored into the data logger and monitored using computer to analyse the actuation of feeding activity. This study concluded that the best water temperature for Nile tilapia is 28 ^{o}C and the low water temperature seemed to give negative effect on feeding appetite. In addition, the change of water temperature from 15-25 ^{o}C was gave positive correlation between the changes of feeding activity and water temperature with coefficient correlation 0.96 and R square value was 0.93. Hence, the increasing the water temperature up to 35^{o}C has negative correlation with coefficient correlation -0.75 and weak contribution with R square value was 0.56. It means that each decreasing of feeding activity depends on the raising of water temperature.

Keywords: Nile tilapia, Feeding Activity, Water Temperature, Controlled Recirculation System

Introduction

A major determinant of successful growth and intensification of aquaculture production is on feeding supply and feeding technology. In 2015, global aquaculture production reached 106 million tons, and 76.6 million tons was increased during the period 1995-2015. Among them, the production of feed-dependent aquaculture increased over fourfold from 12.2 to 50.7 million tons, largely through intensification of production methods [1]. The use of aquatic species/species groups such as tilapias, carps, shrimp and salmonids with established aquaculture technologies provided firm market opportunities for increasing production and driving production efficiency and it was dependent upon the supply of external nutrient inputs provided in the form of fresh feed ingredients, farm-made feeds or commercially manufactured feeds.

The Nile tilapia (*Oreochromis niloticus*) is one of the most important aquaculture species groups especially in South East Asia, Africa, South America and China. Several species of tilapia are cultured commercially, but Nile tilapia is the predominant cultured species and its global production has reached to nearly 3.67 million tons in 2014. Including the production of Nile tilapia, cichlid fish production contributes about 5.6% of total aquaculture production [1]. The gross production of Nile tilapia increases year by year because of the strong worldwide demands for this potential freshwater fish as a food resource of human being.

Therefore, tilapia is likely to be higher rank in global aquaculture production next to carp production. According to previous study [2], tilapia is an ideal candidate for aquaculture, especially in developing countries because of rapid growth, omnivorous fish which can use high proportion of inexpensive plant sources in their feeds, high tolerance in wide range of environmental conditions, such as temperature, salinity, low dissolved oxygen, resistance against stress and diseases, and so on. In order to optimize the production of Nile tilapia, management system in aquaculture production such as the feeding technology and feeding nutrition are needed.

In most commercial fish farms at present, one of feeding technology such as scheduled automatic-feeding has been engaged to supply the delivering the diet. Alternatively, some studies have recently introduced self-feeding to fish farming [3,4]. The feed ratio is depends on feeding behavior and fish appetite, which the instrumental learning such as delivering food each time based on the learning ability of fish [4] is needed to observe the equal amount of feed and the best condition to supply the feed, hence the light intensity and water temperature give an important roles. Several studies have been carried out under this circumstance, such as European sea bass (*Dicentrarchus labrax*) [5] Yellowtail (*Seriola quinqueradiata*) [6], and seabream (*Sparus aurata*) [7]. The feeding behavior towards environmental condition differ in some species and further research is necessary for the establishment of the culture technology for Nile tilapia because knowledge about the physiology. Hence, learning the feeding behavior of Nile tilapia is necessary for a better understanding of the physiological mechanism and a better applying this feeding method for tilapia culture in the future.

Material and Method

The experimental fish, Nile tilapia *Oreochromis niloticus* were obtained from local farmer. Before measured as animal tests, they were anesthetized with 0.01% ethyl m-aminobenzoate methanesulfonate (MS-222, Sigma-Aldrich Co., MO, USA) to weigh the initial body and 6 fish were individually kept in tanks. The body weight of fish in each tank was 60.9 g, 61.3 g, 64.5 g, 71.89 g, 73.3 g, and 75.4 g, respectively. Each fish was maintained uncer controlled recirculation system in 24*l* tanks (W24 cm x D40 cm x H25 cm) and was supplied with about 6-7 l/min of filtered and aerated water. The illumination was delivered by fluorescent lamps with an LD 12:12 photoperiod. The water temperature was maintained using a water cooler and heater at 25^{o}C during the experimental period. The automated feeding system with small tip was placed above each tank. The feed was commercial diets which cointained 32% CP. The treatments were conducted with different water temperature which gradually increased and decreased 1^{o}C every two days. First period was the experiment with the increasing water temperature from 15 to 25^{o}C within 20 days (In-WT1) then increasing from 25 to 35^{o}C for 20 days (In-WT2), respectively. Each time data of feeding activity was stored into the data logger and monitored using computer to analyse the actuation of feeding activity.

Results

Feeding Activity with Increasing Water Temperature 15-25°C

There was no feeding activity at the 1st day until the 3rd day of experiment, when the fish were reared under 15-17°C. The feeding activity was recorded at day four, when the second day of the temperature 17 °C, then the feeding activity raising progressively until day 9, at day 10 the feeding activity dropped 16 times/day when the water temperature reached for about 20-21°C. Hence, the number of feeding actuation become high until the end of experiment along with the highest total trigger actuation was 45 times/day at 25 °C (Table 1).

Table 1. Daily Feeding Activity under The Increasing Water Tempreature form 15 to 25 °C.

Day	Feeding Activity (time/day)	Water Temperature (°C)
1	0	16
2	0	16
3	0	17
4	7	17
5	9	18
6	9	18
7	10	19
8	18	19
9	23	20
10	16	20
11	14	21
12	20	21
13	29	22
14	26	22
15	27	23
16	33	23
17	41	24
18	41	24
19	45	25

The change of water temperature seemed to give the effect of feeding activity. Under experiment IN-WT1 (Increasing water temperature gradually from 15 to°), the feeding activity was raised when the water temperature increased. The starting point of intense activity was occurred since day 12 when the feeding activity reached 20 times/day at 21°C. This means the feeding profile of Nile tilapia could be high at temperature between 21°C and 25°C (Fig. 1).

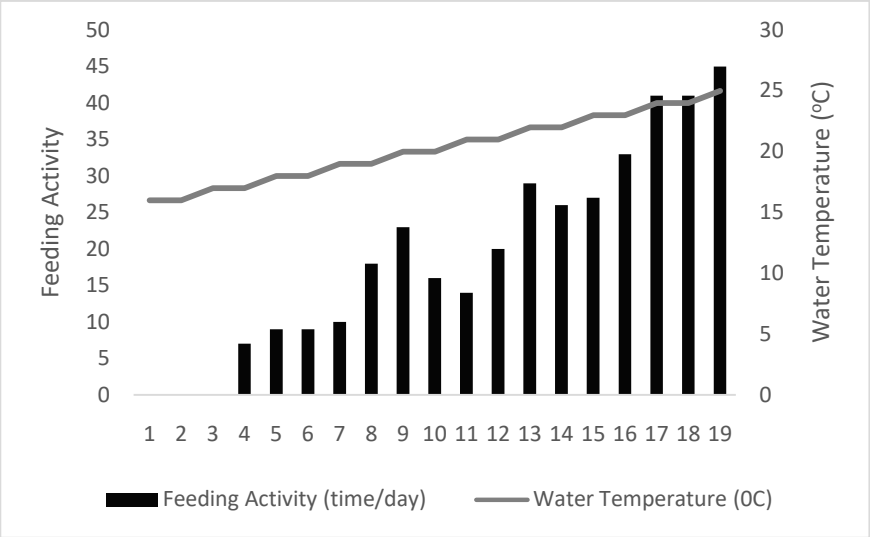

Figure 1. Changes the number of Feeding Activity of fish when the water temperature increased gradually from 15 to 25 °C under the controlled laboratory condition. Each bar indicates the mean value of daily number of feeding activity from six individuals. The change of water temperature represented by line is superimposed.

Feeding Activity with Increasing Water Temperature 25-35°C

The fish at the second experiment were used the same fish at the first experiment, the water temperature were continued to increase gradualy up to 35°C. At the first of experiment, the feeding activity was high when the total trigger actuation reached 53 times/day. Afterward, the feeding activity became unstable at the first week of experiment, but had its peak at day 6 with the number of total trigger actuation touched 73 times/day at 28 °C. But when the water temperature was getting warmer, the feeding activity decreased gradually to 12 times/day at the end of experiment when the water temperature was 35 °C (Table 2).

Table 2. Daily Feeding Activity under The Increasing Water Tempreature form 25 to 35 °C.

Day	Feeding Activity (time/day)	Water Temperature (0C)
1	53	26
2	44	26
3	51	27
4	63	27
5	39	28
6	73	28
7	60	29
8	54	29
9	38	30
10	36	30
11	28	31
12	42	31
13	45	32
14	29	32
15	32	33
16	28	33
17	39	34
18	13	34
19	12	35

In-WT2 when the water temperature were gradually increased from 25-35°C, the feeding activity were decreased day by day dramatically since day 9 with feeding activity dropped from 54 times/day to 38 times/day when the water temperature raised to 30 °C up to 35 °C . This experiment has the opposite result with the result found in In-WT1.

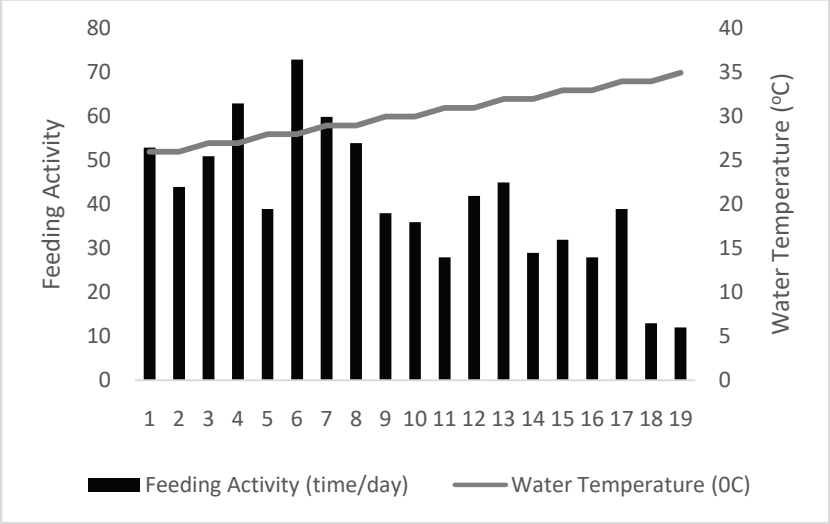

Figure 2. Changes the number of Feeding Activity of fish when the water temperature increased gradually from 25 to 35 °C under the controlled laboratory condition. Each bar indicates the mean value of daily number of feeding activity from six individuals. The change of water temperature represented by line is superimposed.

Corellation and Regression Analyses

Positive correlations between water temperature and feeding acativity was shown in In-WT1 with the coefficient correlation 0.96. Multiple regression analysis indicated that the frequency of fish feeding activity was significantly associated with water temperature with R square value was 0.93. In case of In-WT2, there are negative correlations result of In-WT1, when the coefficient correlation was -0.75 and multiple regression analysis indicated that every time the water temperature changes, the frequency of feeding activity changes by more than half with R square value was 0.56. It means that the water temperature was contributing much more in In-WT1 than In-WT2.

Discussion

The present study showed that Nile tilapia learned and adapted to feeding system quickly and most of the pellets distributed were consumed from the first day of experiment. The period of starting of feeding activity has been reported to be within several days in rainbow trout [8], European sea bass [9], and yellowtail [6]. Nile tilapia itself has been reported to require various lengths of time to activate the feeder [10,11].

Based on the results of this study, the higest daily feeding activity (73 times/day) occurred in In-WT2 at day 6 when the water temperature reached 28°C. This is along with previous study which used Nile tilapia with initial body weight of 100 ± 20 g under controlled water temperature (28°C) showed the best result of growth rate [12]. The feeding activity of Nile tilapia was observed very rare when the water temperature 17 °C, this is in line with the results of previous study of feeding activity of Nile tilapia which investigated in natural condition when the feeding behavior changed and decreased when the water temperature dropped to below 20 °C [11]. In In-WT2, the feeding activity dramatically decreased to 38 times/day when the water temperature reached 30°C. The study which investigated juvenile Nile tilapia under different water temperature conditions (24-34ºC) resulted range of SGR was 2.16-2.93%/day [13], other study also revealed that the best growth performance for Nile tilapia reared under controlled condition was 2.62%/day and in natural condition it would decreased when water temperature dropped below 20 °C [14].

Conclusion

In conclusion, the results of the present experiment clearly demonstrate that the nformation obtained from feeding activity experiment enables us to identify the influences of environmental changes on a physiological condition of farmed fishes through their expression of appetite. This study concluded that the best water temperature for Nile tilapia is 28 ^{o}C and the low water temperature seemed to give negative effect on feeding appetite. In addition, the change of water temperature from 15-25 ^{o}C was gave positive correlation between the changes of feeding activity and water temperature with coefficient correlation 0.96 and R square value was 0.93. Hence, the increasing the water temperature up to 35^{o}C has negative correlation with coefficient correlation -0.75 and weak contribution with R square value was 0.56. It means that each decreasing of feeding activity depends on the raising of water temperature.

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