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# Effect of solar-induced water temperature on the growth performance of African sharp tooth catfish (*Clarias gariepinus*)

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**Abstract:** The effect of solar-induced temperature on the growth performance of African sharp tooth catfish (*Clarias gariepinus*) was studied based on a completely randomized design (CRD). Fishes with an average initial weight of 4.07±0.58 g were cultured for 90 days in 3 treatments with 3 replications, outdoor plastic lining ponds (treatment 1), outdoor cement ponds (treatment 2) and indoor cement ponds (treatment 3). The study investigation revealed that water temperature was significantly different among treatments ($p<0.05$) and the highest value was observed in treatment 3 (30.91±1.60 °C), followed by treatment 1 (29.19±1.54 °C) and treatment 2 (27.58±1.58 °C), respectively. Results of the experiment further showed that the differences in temperatures affected the growth and survival rate of the fishes. After 90 days of culture, fishes in treatment 1 had significantly higher weight (298.75±4.32 g/fish), growth rate (3.32±0.05 g/day) and survival rate (95.0±2.0) than treatment 2 (198.40±5.25 g/fish, 2.20±0.06 g/day and 89.0±2.0) and treatment 3 (198.40±5.25 g/fish, 2.20±0.06 g/day and 87.6±2.1) ($p<0.05$). The results indicate that the application of plastic greenhouse to increase the temperature is an alternative that could be applied for aquaculture, especially during winter when temperature is unsuitably lower.

**Keywords:** Catfish, Plastic Greenhouse, Temperature, Solar Energy

## 1. Introduction

Careers aquaculture has gained attention in Thailand. Freshwater fish have continued to expand in 2010, Thailand has an area of 1,007,709 acres of freshwater fish to produce 496,599 tones 532,487 farms with a total farm value of approximately 23,544,932 million Thai-baht, which is tilapia and catfish around 16,392 million [1]. At present, the catfish have much successful business due to the development of improved varieties. Because, these fishes that have good growth and resistance to disease. So each year the yield is getting higher.

However, in the Northern part of Thailand, an area where the temperature is relatively low. In winter, the air temperature drops below 15°C and the temperature difference between day and night about 15-20 °C. Farmers must manage multiple methods, such as the cost of food. Farmers have to manage the environment in the pond, water quantity and quality. The effects of season, temperature will affect the animals directly. Low water temperatures will affect the culture and productivity of aquatic. Maxwell [2] studied the water temperature in the pond. By using greenhouses could help to raise the temperature of water in the pond. And can raise the temperature of water in ponds up to 3.1-5.7 °C raising fish in the winter, with growth rates well above the pond. A study by Tiwari et al. [9] reported that catfish in ponds that control the water temperature in the range 30-32 °C using Solar-Heat compared which an uncontrolled water temperature. The water temperature is in the range of 25-29 °C was cultured in the winter and rainy seasons. Found the fish in controlled water temperature pond have a growth rate better than uncontrolled water temperature pond clearly. The growth higher rate of about 1.6-1.7 times, however have a high cost.

The purpose of this research to get knowledge and detailed information of using solar energy as a source of low-cost energy to keep the water temperature increases using plastic greenhouses to raise the temperature. This is another way to increase productivity of fish and potential to develop and usage of solar power to benefit and enhance the growth rate of fish in the winter.

## 2. Materials and Methods

### 2.1. Preparation of Ponds

The experiment was divided into three units including outdoor plastic lining ponds (treatment 1) measuring 25 sq., outdoor cement ponds (treatment 2) measuring 25 sq. and indoor cement ponds (treatment 3) measuring 25 sq. Added water to depth 1.5 m, then spread a poly cage net, nets 2 cm. in size 1x1x1.5 meters (length x width X height) which was conducted at the School of Renewable Energy, Maejo University.

### 2.2. Experimental Design

The experimental design was randomized (Complete Randomized Design; CRD).Catfish of farms in Chiang Mai average weight 4.07 ± 0.58 g/fish. Take catfish to adapt in cages measuring 15 sq. for 24 hr. Counting and weighing catfish before start experiment 100 fish/cage in the pond (three treatments and three replicates). The amount of food eaten was recorded during the 90-day trial period (Figure 1).


***Figure 1.*** *Experiment ponds, plastic lining ponds (A), outdoor cement ponds (B), indoor cement ponds (C).*

### 2.3. Food and Feeding Food

Used in the experiment was floating food. Protein no has less than 30 percent to 2 times daily at 09.00-10.00 am; and 04:00- 05:00 pm; to satiation throughout the trial period of 90 days. The water discharge 10 percent of the water every 10 days.

### 2.4. Temperature

Temperature used Thermometer Model TA318 depth of 30 cm of water in each treatment. The storage temperature of the pond outside distance was away from each pond 50 cm. Storage time 2 times a day at 09.00 am and 05.00 pm. Data was recorded every day until 90 days reached.

### 2.5. Data Collection

Data collection was done every 15 days for each dietary treatment. Fish length and weight were determined to monitor fish growth. Daily feed consumption, growth performance, feed conversion ratio, survival rate and yield productivity were also determined.

### 2.6. Statistical Analysis

Data are analysis of variance ANOVA for CRD and compare the difference of averages by Duncan, s New Multiple Range test at a confidence level of 95 % confidence level. All statistical analyses were performed using SPSS version 11.5.

## 3. Result and Discussion

### 3.1. Temperature Difference

Changes of water temperature inside ponds and external ponds during 09.00 am and 05.00 pm., outdoor plastic lining ponds (treatment 1), outdoor cement ponds (treatment 2) and indoor cement ponds (treatment 3) for a period of 90 days, However, the highest recorded mean the water temperature at 09.00 am was difference is significant different ($p < 0.05$). The water temperature at indoor cement ponds (treatment 3) 29.89 ± 0.97 °C, outdoor plastic lining ponds (treatment 1) 27.00 ± 1.53 °C and outdoor cement ponds (treatment 2) 26.46 ± 1.24 °C, respectively. However the water temperature in experiment at 05.00 pm was difference is significant different (p<0.05). Show that, indoor cement ponds (treatment 3) 31.93 ± 1.40 °C, outdoor plastic lining ponds (treatment 1) 29.20 ± 1.46 °C and outdoor cement ponds (treatment 2) 28.93 ± 0.98 °C , respectively (Table 1, Figure 2 and 3).

Effect of temperature in outside ponds at 09.00 am was difference is significant different (p <0.05), the temperature outside ponds the highest indoor cement ponds (treatment 3) average 34.23 ± 3.20 °C and the temperature outside ponds outdoor plastic lining ponds (treatment 1) and outdoor cement ponds (treatment 2) the same temperature average 30.71 ± 3.20 °C. And temperature outside ponds at 05:00 pm. was difference is significant different (p <0.05) the temperature. external ponds highest indoor cement ponds (treatment 3) average 41.40 ± 4.48 °C and the temperature outside ponds outdoor plastic lining ponds (treatment 1) and outdoor cement ponds (treatment 2). The same temperature average was 35.71 ± 2.88 °C (Table 1, Figure 2 and 3). Young [7] presented that the water temperature in the greenhouse increased 4.67-5.83 °C compared to the water temperature outside the greenhouse. The temperature of water as a result of the covering of the greenhouse which is consistent with literature information [8] that were tested in the greenhouse pond or pond-based plastics that can cause water temperatures to raise 2.8-4.4 °C.

***Table 1.*** *Water and air temperature (X±SD) at 09.00 am. and 05:00 pm.*

| | Temperature(°C) | | | |
|---|---|---|---|---|
| **pond** | **In pond 09.00 am.** | **In pond 05.00 pm.** | **Out pond 09.00 am.** | **Out pond 05:00 pm.** |
| Outdoor plastic lining ponds | 27.00±1.53$^{b}$ | 29.20±1.46$^{b}$ | 30.71±3.20$^{a}$ | 35.71±2.88$^{a}$ |
| Outdoor cement ponds | 26.46±1.24$^{a}$ | 28.93±0.98$^{a}$ | 30.71±3.20$^{a}$ | 35.71±2.88$^{a}$ |
| Indoor cement ponds | 29.89±0.97$^{c}$ | 31.93±1.40$^{c}$ | 34.23±3.20$^{b}$ | 41.40±4.48$^{b}$ |

Values are mean of three replicates. Treatment means within a row followed by a different letter are significantly different (P≤0.05)

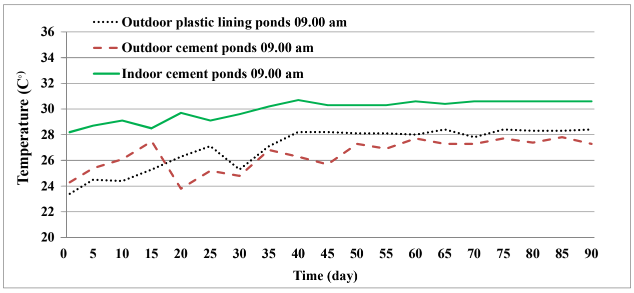


***Figure 2.*** *The temperature of different ponds (Indoor cement ponds, Outdoor cement ponds and plastic lining ponds) at 09.00 am from 0-90 days.*

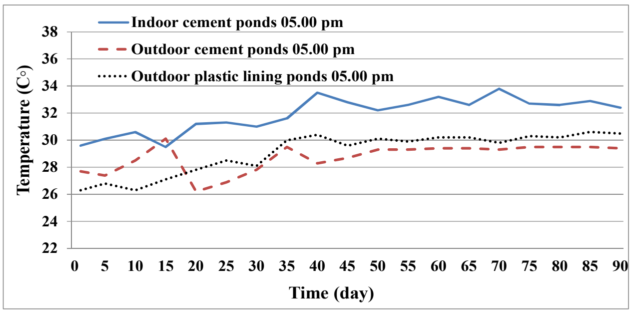


***Figure 3.*** *The temperature of different ponds (cement pond in the green house, cement pond and plastic pond) at 05.00 pm from 0-90 days.*

### *3.2. Growth Performance of African Sharp Tooth Catfish (Clarias Gariepinus)*

The average weight of African sharp tooth catfish (*Clarias gariepinus*) for a period of 90 days has increased is significant different (p <0.05). At 15 days has average weight 15.14 ± 2.15 to 8.49 ± 1.53 g/fish indoor cement ponds (treatment 3) was increased the average weight 15.14 ± 2.15 g, outdoor cement ponds (treatment 2) 10.91 ± 1.64 g and outdoor plastic lining ponds (treatment 1) 8.49 ± 1.53 g, respectively. However, at 90 day has increased is significant different (p <0.05) was in the range of 298.75 ± 4.32 to198.40 ± 5.25 g/fish, indoor cement ponds (treatment 3) the highest average weight 298.75 ± 4.32 g, outdoor plastic lining ponds (treatment 1) 200.79 ± 7.26 and outdoor cement ponds (treatment 2) 198.40 ± 5 g, respectively (Figure 4). The affects high temperature water the process of fish especially eating and digestion. The protease function effectively to the growth of fish [5] found that the increase water temperature has effect on the activity of digestive enzymes accelerate the digestion of nutrients, thus the growth of the fish. Elissa [4] reported that for cobia that are growing rapidly. Yorozu et al. [6] presented the nourish *Macrobrahim roesenbergii* in the winter using cover plastic ponds to maintain temperature that high growth rate of *Macrobrahim roesenbergii* than not cover plastic ponds.

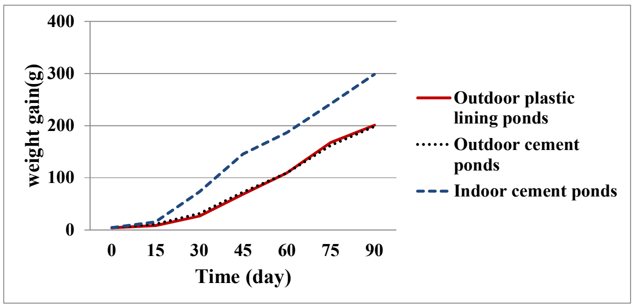


***Figure 4.*** *The weight gain (g) of catfish culture with different pond during 90 day culture period.*

### *3.3. Feed Conversion Ratio*

Feed conversion ratio (FCR) in African sharp tooth catfish (*Clarias gariepinus*) are not significantly different (P>0.05).

Outdoor plastic lining ponds (treatment 1), outdoor cement ponds (treatment 2) and indoor cement ponds (treatment 3) was 1.80 ± 0.04 1.83 ± 0.06 1.78 ± 0.06, respectively (Table 2).

***Table 2.*** *Growth parameters (Mean±SD) and feed intake of catfish for plastic lining ponds (T1), Outdoor cement ponds (T2) and Indoor cement ponds on 90 days.*

| pond | Temperature (⁰C) | SGR (%/day) | Feed intake (%/fish/day) | Survival rate (%) | FCR |
|---|---|---|---|---|---|
| Outdoor plastic lining ponds | 29.19±1.54$^{b}$ | 3.77±0.16$^{a}$ | 3.52±0.10$^{a}$ | 87.00±1.17$^{a}$ | 1.80±0.04$^{a}$ |
| Outdoor cement ponds | 27.58±1.58$^{a}$ | 3.76±0.16$^{a}$ | 3.58±0.09$^{a}$ | 89.00±1.17$^{a}$ | 1.83±0.06$^{a}$ |
| Indoor cement ponds | 30.91±1.60$^{c}$ | 4.16±0.16$^{b}$ | 5.61±0.07$^{b}$ | 95.00±1.17$^{b}$ | 1.78±0.06$^{a}$ |

Values are mean of three replicates. Treatment means within a row followed by a different letter are significantly different (P≤0.05)

### *3.4. Survival Rate*

Fish survival rate of African sharp tooth catfish (*Clarias gariepinus*) is significant different (P<0.05) after 90 days the highest is indoor cement ponds (treatment 3) 95.00 ± 1.17 %, outdoor cement ponds (treatment 2) 89.00 ± 1.17 %, and outdoor plastic lining ponds (treatment 1) 87.00 ± 1.17 %, respectively.

### *3.5. Water Temperature*

Significant different (p <0.05) in 3 treatment is values ranging from 30.91 ± 1.60 to 27.58 ± 1.58 °C, the average daily temperature indoor cement ponds (treatment 3) is maximum is 30.91 ± 1.60 °C, outdoor plastic lining ponds (treatment 1) average daily temperature was 29.19 ± 1.54 °C and the average daily minimum temperature is outdoor cement ponds (treatment 2) 27.58 ± 1.58 °C, respectively. [3] Studied the effects associated with the estimation of parameters related to greenhouse pond. Productivity of fish ponds in greenhouses showed a better performance compared to the open ponds. [9] Studied the water temperature in the culture ponds by using solar energy can control water temperature in the ponds and the fish are growing well compared to wells without temperature control.

## 4. Conclusion

This study raveled that the effect of solar-induced water temperature on the growth performance of African sharp tooth catfish (*Clarias gariepinus*). The results indicated that the application of plastic greenhouse to increase the temperature is an alternative that could be applied for aquaculture, especially during winter when temperature and indicate growth rate of African sharp tooth catfish (*Clarias gariepinus*); it show that the solar energy can be used to control the temperature of the water in the culture ponds.

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