The performance analysis of hybrid seeds between catfish (*Clarias gariepinus* Burchell) semarang and sangkuriang strains

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Abstract. This study aimed to analyze the performance of hybrid seeds between catfish (*Clarias gariepinus* Burchell) semarang and sangkuriang strains by parameters of fecundity, length and weight gain and seeds survival rate. The material used in this study was the parent of catfish semarang and sangkuriang strains. The research method used was experimental method using Completely Randomized Design (RAL), consists of four treatments and three replications. Those were Treatment A (semarang/HH ♀ × semarang/HH ♂), Treatment B (semarang/HH ♀ × sangkuriang/SS ♂), Treatment C (sangkuriang/SS ♀ × sangkuriang/SS ♂) and Treatment D (sangkuriang/SS ♀ × sangkuriang/SS ♂). The results showed that fecundity of most catfish eggs were obtained from treatment A, B, C and D. The hatching rate of catfish eggs from various treatments was not significantly different. Performance of seeds with length and weight parameters showed that newly hatched larvae until the age of one-week-feeding catfish are not significantly, the difference in seed performance began to appear on the 14th day of feeding. The order of the best treatment result were C, B, D and A. The difference was more significant at 28 days of feeding.

1. Introduction

Catfish is one of the superior products of freshwater aquaculture because of its good taste, source of protein and preferred by all levels of society, especially in Central Java. This fish is suitable to be developed to increase food security as food demand will continue to increase along with the increase in population especially in Central Java [1]. The production of *Clarias gariepinus* catfish (Burchell, 1822) in Central Java is also continuously improved. The production of catfish in Central Java reached 62,686 tons and 75,236 in 2012 and 2013, respectively or increased by 20.02 % [2]. The production of catfish in Central Java in 2016 amounted to 122,292.16 tons [3]. The high demand for seeds has not been followed by improved seed quality. This condition is indicated by increase in length of fish harvesting time, as has been illustrated that in 1985 in the first year the developed catfish showed that seeds measuring 3–5 cm were stocked then within 60 days it was harvested. However, gradually there has been a decrease in growth, on 2000 when the 3–5 cm seeds size were stocked then the harvest time has reached 90 days [4].

One effort that has been made to improve the performance and increase the ability of catfish production is hybridization program. Hybrid excellence is showing a faster rate of growth than either parent, or has other characteristics, which are often economically significant to a better quality than that of parent [5].
For hybridization, cross-breeding is conducted between strains. This study used the parent of catfish semarang and sangkuriang strains reciprocally. The purpose of this research was to analyze the performance of cross-breeding seeds between the catfish of semarang and sangkuriang strains with the parameters consisting of egg fecundity, the length and weight gain and the seeds survival rate.

2. Materials and Methods

2.1. The test fish
The parent of catfish (C. gariepinus Burchell) sangkuriang strain. Sangkuriang strain was a result of catfish selection of individual and backcrossing so its growth was very well and have been released by the Ministry of Maritime Affairs and Fisheries, Republic of Indonesia through the Ministry of Marine and Fishery No. KP.26/MEN/2004 dated July 21, 2004. Whereas, the catfish of semarang strain has been located in semarang more than 27 years and done the simple selection: every time of spawning, it was taken the biggest in size. The body weight of catfish semarang and sangkuriang strains range between 1.10–1.45 kg.

2.2. Spawning pond
A 2 m² × 3 m² pond with a height of 0.60 m made of tarpaulin with 12 pieces of bamboo.

2.3. Experimental design
The experimental design used was Completely Randomized Design (RAL) with four treatments and three replications i.e. A (semarang/HH ♀ × semarang/HH ♂), Treatment B (semarang/HH ♀ × sangkuriang/SS ♂), Treatment C (sangkuriang/SS ♀ × sangkuriang/SS ♂) and Treatment D (sangkuriang/SS ♀ × semarang/SS ♂). In order know the growth of larvae to be a seed, every one week the length and weight of the body was measured. Food given to larvae was egg yolks for 3–5 days old larvae, silk worm for aged 5–15 days of larvae, fine pellets for seed aged 15–28 days.

Gonadosomatic Index (GSI) calculation fecundity, hatching rate (HR) and weight and length gain are measured as follows:

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\text{Gonadosomatic Index (GSI)} = \frac{\text{gonad mass}}{\text{total body mass}} \times 100\% \\
\text{Fecundity} = \frac{\text{No. of eggs in sub sample} \times \text{Gonad weight Fecundity (F1)}}{\text{Weight of sub sample}} \\
\text{Hatching Rate (HR)} = \frac{\text{Number of eggs hatched / Total number of eggs in a batch}}{\times 100\%}
\]

Growth in weight and length were measured for 28 days of breeding, while the growing size of the fish by using the formula of [8]:

- \( \text{Growth of Individual Weights / Absolute Weight (g/each)} = \frac{\text{the average final weight (g)}}{\text{the average initial weight (g)}} \)
- \( \text{Growth of Individual Length / Absolute Length (mm/each)} = \frac{\text{the average final length (mm)}}{\text{the average initial length (mm)}} \)

2.4. Data analysis
The data obtained as fecundity of obtained eggs, hatching rate (%), and performance hybrid seeds development were analyzed using the analysis of variance, as for the analysis tool of variance using the program MSUSTAT.

3. Results and Discussion

3.1. Fecundity of obtained eggs
As mentioned in the experimental material that the parent catfish used in this research is the parent catfish semarang strain with weight ranged from 1.1–1.45 kg, while the sangkuriang strain ranged between 1.1–1.35 kg.
The egg weights obtained from treatment A, B, C and D were 209.02 ± 30.45; 202.43 ± 19.49; 188.77 ± 17.14 g and 168.55 ± 19.81 g, respectively. Meanwhile, the fecundity were 146.314 ± 21.315; 141.701 ± 13.643; 132.139 ± 11.998 and 117.985 ± 13.867 eggs, respectively (table 1).

| Replication | Treatment | A   | B   | C   | D   |
|-------------|-----------|-----|-----|-----|-----|
| 1           |           | 218.7 | 201.25 | 174.8 | 183.6 |
| 2           |           | 174.9 | 182.85 | 183.6 | 175.95 |
| 3           |           | 233.45 | 223.2 | 207.9 | 146.1 |
| Total       |           | 627.05 | 607.3 | 566.3 | 505.65 |
| Average     |           | 209.02 ± 30.45 | 202.43 ± 19.49 | 188.77 ± 17.14 | 168.55 ± 19.81 |

The result of gonadosomatic index calculation at treatment A, B, C and D were 16.07 ± 0.15; 16.03 ± 0.12; 15.30 ± 0.10 and 15.23 ± 0.12 %, respectively (table 2). The analysis showed no significant differences between treatments.

| Replication | Treatment | A   | B   | C   | D   |
|-------------|-----------|-----|-----|-----|-----|
| 1           |           | 16.2 | 16.1 | 15.2 | 15.3 |
| 2           |           | 15.9 | 15.9 | 15.3 | 15.3 |
| 3           |           | 16.1 | 16.1 | 15.4 | 15.1 |
| Total       |           | 48.2 | 48.1 | 45.9 | 45.7 |
| Average     |           | 16.07 ± 0.15 | 16.03 ± 0.12 | 15.30 ± 0.10 | 15.23 ± 0.12 |

The results showed that the catfish both the semarang strain and the sangkuriang strain are sufficiently feed and healthy, *C. gariepinus* Burchell has gonadosomatic index (GSI) of 14.68 ± 4.86 indicating that the fish was healthy, feeding and the water temperature were quite sufficient [9]. In general, catfish *C. gariepinus* Burchell has a gonadosomatic index (GSI) of 15–20 % [10].

3.2. Hatching rate (%)
The percentage of hatching rate of cross-breeding eggs is shown in table 3. A treatment produced hatching rate of 80.48 ± 1.12 %, treatment B produced hatching rate of 80.55 ± 0.45 %, treatment C produced hatching rate of 82.26 ± 1.16 % and treatment D produced hatching rate of 79.93 ± 1.58 %.

| Replication | Treatment | A   | B   | C   | D   |
|-------------|-----------|-----|-----|-----|-----|
| 1           |           | 79.21 | 80.23 | 81.12 | 79.34 |
| 2           |           | 81.32 | 81.11 | 82.24 | 80.22 |
| 3           |           | 80.91 | 80.32 | 83.43 | 80.22 |
| Total       |           | 241.44 | 241.66 | 246.79 | 239.78 |
| Average     |           | 80.48 ± 1.12 | 80.55 ± 0.45 | 82.26 ± 1.16 | 79.93 ± 1.58 |

The results showed that fertilization and hatching results were not significant with high hatching rate more than 80 % due to enough parents’ weight, health and suitable environment. It is in accordance to an opinion [11], who stated that the heavier the parent catfish spawning produces the
higher hatching rate of eggs. High hatching rate of eggs indicates that nutritional content of oocytes in the gonads is enough for physiological processes of embryonic development for hatching. The time of oocyte growth, there will be an accumulation of the substance which is necessary for the early development of the embryo [12]. VTG absorption by the embryo explained that the yellow protein in the embryo covered by a synsytial layer or periblast, two coelemic mesoderm leaves, splanchnopleure and somatopleure and epidermis. Viteline vascular tissue develops in splanchnopleure and by using these networks, embryo can use protein stored in the egg yolks period. To break up the yolk globule, on the surface of periblast, there are viteolisis zones by the activity of thiol proteinase that is cathepsin L. The increase in activity of the enzyme causes yolk globula torn from the yolk period, so that the protein can be absorbed [13], and that has happened to yolk metabolism in embryos and larvae [14].

3.3. Performance hybrid seeds development
There was no significantly different of weight and length of newly-hatched larvae among treatments (figure 1). The absorption of the yolk by the embryo in very short time could not provide the significant different of larvae weight although there is some genetic differences.

Results of a study on the newly-hatched larvae found that larvae length ranged from 5.73 ± 0.71 mm to 6.47 ± 0.61 mm from various treatments. The newly hatched-larvae in this study is longer than that of reported in the previous study [15] which has total length of 3.5–4.0 mm.

The observation result of weight and length gains on the 3rd day or at the time the larvae begin to eat can be seen in figure 1 and 2. The weight and length of the larvae were not significantly different at the 3 days old. It is assumed egg yolk has not been used for weight gain but it has only used to develop the larvae for the completeness of its digestive system.

The observation of weight and length gains on the 7th day of feeding or the 10th day of larvae can be seen in Figures 1 and 2, it can be shown that the weight and length of the larvae of the various treatments showed no significant difference. It is assumed that the use of feed from the outside has not been able to significantly accelerate the growth, or the larvae still adapt from the intake of feed from the outside. Consequently the growth of the larvae of the various treatments is not significantly different.

![Figure 1. Weight gain and larvae and fingerling of catfish produced from the breeding of semarang and sangkuriang strains.](image-url)
The observation result of weight and length gain on the 14th and 21st day of feeding or the 17th and 23rd days of larvae age can be seen in figures 1 and 2. The weight and length of the larvae showed significantly different among treatments. It is assumed that the exogenous feed has been used for growth and the genetic factor has worked resulting a difference in growth among the treatments. The similar reason is also suitable for the weight and length of 28th old fingerling. The observation of weight and length gain on the 28th day of feeding or day 31 can be seen in figure 1 and 2. Weight and length of fingerling in various treatments showed significantly different.

The result of hybrid breeding between the female and the male catfish of sangkuriang strain showed the same result between female sangkuriang breeding with male sangkuriang. This result indicated that hybridization was able to improve the quality of the catfish of semarang strain. Hybrids can play an important role in increasing aquaculture production of several types of freshwater and marine fish [5, 6]. For example, hybrid catfish in Thailand, striped bass hybrids in the United States, hybrid tilapia in Israel and tilapia hybrids in Venezuela. Although the hybridization of catfish has shown an increase in production [17], but it is suggested that further research is required for large scale catfish hybrid production which can be used for commercial catfish culture.

![Figure 2](image-url)

**Figure 2.** Length gain and larvae and fingerling of catfish produced from the breeding of semarang and sangkuriang strains.

The result of the observation on the survival rate at 28th day of feeding or the 31st day of larvae age is presented in table 4. It can be shown that the best survival rate was obtained in treatment C successively followed by treatment B, treatment D and treatment A.
**Table 4. Survival Rate of fingerling of catfish produced from the breeding of semarang and sangkuriang strains.**

| Replication | Treatment |   |   |   |
|-------------|-----------|---|---|---|
|             | A         | B | C | D |
| 1           | 45.36     | 49.56 | 53.45 | 50.34 |
| 2           | 46.42     | 50.32 | 54.43 | 48.56 |
| 3           | 47.32     | 51.25 | 56.39 | 49.18 |
| Total       | 139.1     | 151.13 | 110.82 | 148.08 |
| Average     | 46.37     | 50.38 | 55.41 | 49.36 |

The low percentage of survival rate is assumed because of cannibalism as a result of uneven seed growth. Cannibalism begun to appear on the 14th day of feeding or 17-day-old seeds, and increased along with the age of seeds and the occurrence of difference in seed size. Therefore size grading was performed periodically from the 17th days-old. This results indicate that the grading of catfish size was crucial to avoid cannibalism, since adequate feeding was not appropriate to decrease the cannibalism [18, 19].

4. Conclusion
The breeding catfish between semarang and sangkuriang strain does not affect the fecundity and hatching rate. Hybrid seeds performance exhibit significant different after day 14 old of larvae. Breeding of sangkuriang/SS ♀ × sangkuriang/SS ♂ give a superior performance of fingerling, followed the fingerling produced by breeding of semarang/HH ♀ × sangkuriang/SS ♂.

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