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PERFORMANCE TEST OF NILE TILAPIA (*OREOCHROMIS NILOTICUS*) SEEDLING RESULTING FROM RECIPROCAL HYBRIDIZATION BETWEEN THE PANDU AND KEKAR STRAINS IN MEDIA WITH VARYING SALINITY

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ABSTRACT

Nile tilapia (O. niloticus) is a key commodity with euryhaline characteristics, making it suitable for cultivation in various salinity environments. A decline in genetic quality due to inbreeding can reduce the fish's growth performance and adaptability. One approach to genetic improvement is through hybridization. This study aims to determine the effect of crossbreeding combinations between the Pandu and Kekar strains on the growth of tilapia fry in a 15 ppt salinity environment and to evaluate the resulting heterosis. The study was conducted using an experimental design with a Completely Randomized Design (CRD) consisting of four treatments and three replicates: A (♂ Pandu × ♀ Pandu), B (♂ Pandu × ♀Kekar), C (♂ Kekar × ♀ Pandu), and D (♂ Kekar × ♀ Kekar). The 30 days after hatch weighing 1.51 ± 0.109 g, were reared for 30 days in water with a salinity of 15 ppt after undergoing a one-day acclimation period at 3 ppt. The parameters observed included total feed intake (TFI), Feed Utilization Efficiency (FUE), specific growth rate (SGR), survival rate (SR), heterosis value, and water quality.. The results showed that differences in parental strain combinations had a significant effect ($P < 0.05$) on TFI, FUI, SGR, and SR. Treatment D produced the highest TFI at 76.16 ± 1.97 g, while treatment C showed the highest FUE at 97.69 ± 0.64% and SR at 100%. The heterosis values indicate that treatment C (♂ Kekar × ♀ Pandu) is a superior cross combination compared to its parents, as it produced better growth performance, FUE, SGR, and SR than the average of both parents.

1. INTRODUCTION

Nile tilapia (*Oreochromis niloticus*) is one of the leading aquaculture commodities, characterized by high economic value, rapid growth rates, and a broad adaptability to various environmental conditions. The success of tilapia aquaculture is heavily influenced by the quality of the fry used. One of the current challenges in tilapia hatchery operations is the decline in the genetic quality of the fry. This decline can result from the repeated use of the same broodstock over an extended period without targeted breeding management. This situation has the potential to lead to inbreeding, which results in a decline in genetic diversity within the population. The massive spread of tilapia in recent years has caused an uncontrolled decline in quality due to inbreeding (Wicaksono et al., 2016).

2. MATERIALS AND METHODS

2.1. Materials

The equipment used in this study included a 50 × 30 × 30 cm aquarium for tilapia rearing, a digital scale, a millimeter block, and aeration equipment such as an aerator, an aeration hose, and an aeration stone used to supply oxygen to the rearing aquarium. Other equipment, such as a scoop net, was used to easily transfer fish, as well as a bucket used as a temporary holding container for fish to be weighed or moved. Additionally, water quality measuring instruments were used, including a refractometer to measure the salinity of the rearing water, a pH meter to measure the water's pH level, and a dissolved oxygen (DO) meter to measure the level of dissolved oxygen in the water as well as the water temperature. Materials used in this study included 30-day-old tilapia (O. niloticus) fingerlings weighing 1.51 ± 0.109 grams, which were the result of reciprocal hybridization between the Pandu and Kekar strains conducted at PBIAT Janti. Freshwater and seawater with a salinity of 24 ppt were used as the rearing media for the hybrid tilapia fry of the Pandu and Kekar strains, along with commercial feed bearing the brand name PF 1000, which has a minimum protein content of 39%, to be provided throughout the rearing period of the tilapia fry.

2.2. Methods

This study used a completely randomized design (CRD) with 4 treatments and 3 replicates. The fingerlings used in the study were sourced from PBIAT Janti and were the result of reciprocal hybridization between the Pandu and Kekar tilapia strains; they were 30 days old and weighed 1.51

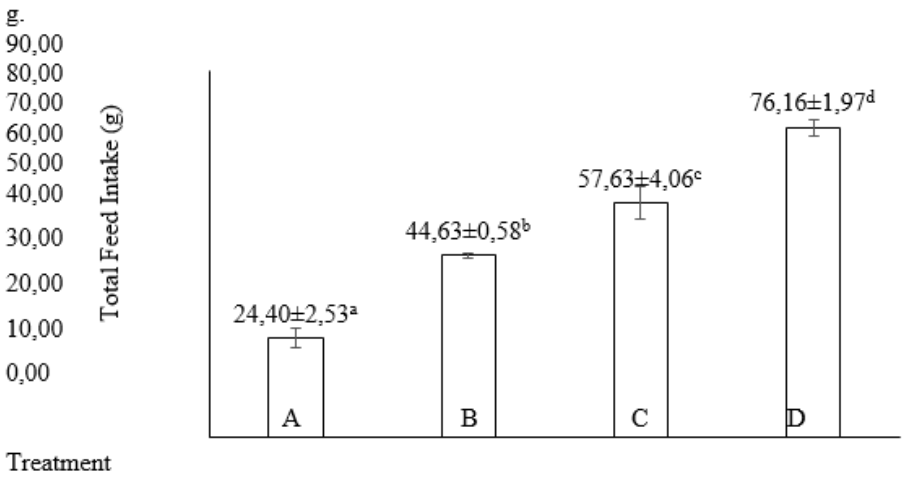
± 0.109 grams. The fry were selected at random but were uniform in size. The fry were

subjected to the treatments during a 30-day rearing period in aquariums measuring 50 × 30 × 30 cm, with 25 fry per treatment. The fry obtained from each treatment were as follows:
A: Tilapia fry resulting from the inbreeding of a ♂ Pandu and a ♀ Pandu B: Tilapia fry resulting from the crossbreeding of a ♂ Pandu and a ♀ Kekar C: Tilapia fry resulting from the crossbreeding of a ♂ Kekar and a ♀ Pandu D: Tilapia fry resulting from the inbreeding of a ♂ Kekar and a ♀ Kekar Before being released into the experimental tanks, tilapia fry first undergo a process of acclimatization to environmental conditions, particularly salinity. Tilapia fry are able to balance osmotic pressure inside and outside their bodies with minimal energy expenditure (Laudin et al., 2023). The adaptation process is carried out by first releasing the fry into a medium with a salinity of 0 ppt, or freshwater. Next, the salinity of the medium is gradually increased by 3 ppt every 24 hours. The adaptation process lasts for 6 days. According to research by Aziz and Barades (2021), adapting by increasing salinity by 3 ppt per day resulted in a Survival Rate (SR) of 100%. The osmoregulation process is carried out until the culture medium reaches a salinity level of 15 ppt. According to Sarker et al. (2023), tilapia can survive with a Survival Rate (SR) of 100% at a salinity level of 15 ppt. Feeding of hybrid tilapia fry is conducted twice daily on a routine basis. According to Laily et al. (2023), tilapia fry are fed using the at satiation method. The at satiation method allows for easy assessment of feed energy utilization, thereby ensuring the highest growth rate and feed efficiency.

3. RESULT AND DISCUSSION

3.1. Total Feed Intake (TFI)

The results of the feed intake calculations showed that the highest TFI value was observed in treatment D, at 76.16 ± 1.97 g, while the lowest was observed in treatment A, at 24.40 ± 2.53

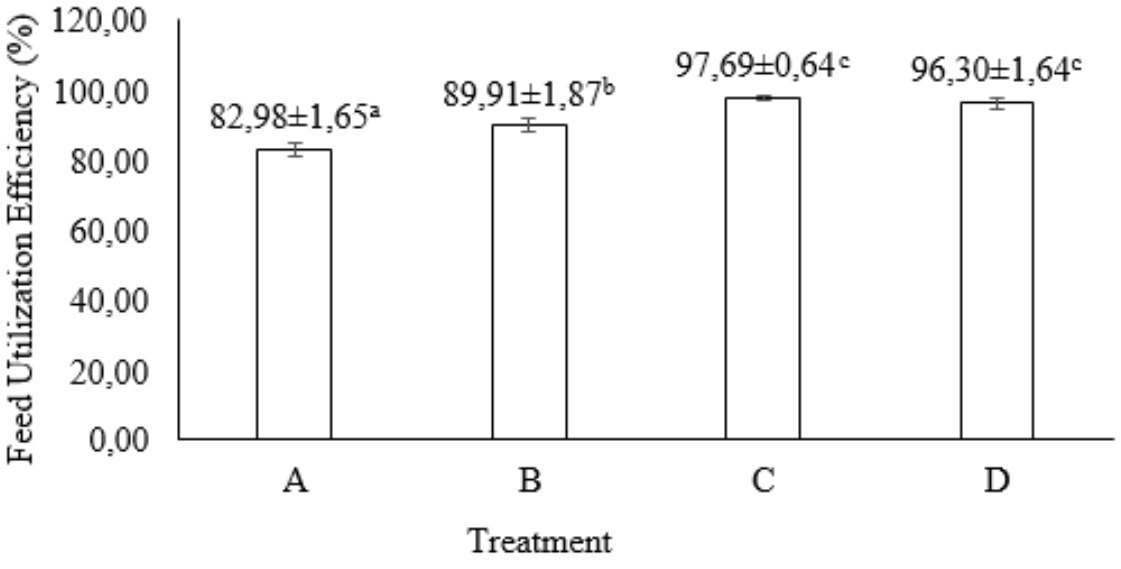


Picture 1. Total Feed Intake.

Total Feed Intake (TFI) is the total amount of feed consumed by the fish during the rearing period. TFI is calculated by taking into account the weight of feed provided and consumed by the fish each day. Based on the research conducted, the fish were fed twice daily—at 7:00 AM and 4:00 PM—using the at satiation method. The at satiation feeding method involves providing feed in small increments until the fish are full and no longer respond to the feed. According to Nisa et al. (2024), the "at satiation" feeding method involves providing feed until the fish are full and no longer respond to the feed. The results of this study indicate that Treatment C yielded higher growth rates compared to Treatment B. This finding suggests the presence of a parental effect—that is, differing genetic contributions from male and female parents to the performance of their offspring. The use of male parents from the Kekar strain is believed to provide a greater genetic contribution to growth traits, resulting in fry with better nutrient utilization capacity. Kekar tilapia also exhibit excellent tolerance to varying salinity levels, which is one of the factors explaining why Treatment D had the highest TFI value. The higher growth performance observed in the treatment involving the Kekar strain indicates that this strain has better adaptability and energy-use efficiency under salinity conditions than the Pandu strain.

3.2. Feed Utilization Efficiency (FUE)

Feed Utilization Efficiency (FUE) values for tilapia (O. niloticus) in each treatment were as follows: Treatment A yielded 82.98 ± 1.65%, Treatment B yielded 89.91 ± 1.87%, Treatment C yielded 97.69 ± 0.64%, and Treatment D yielded 96.30 ± 1.64%.

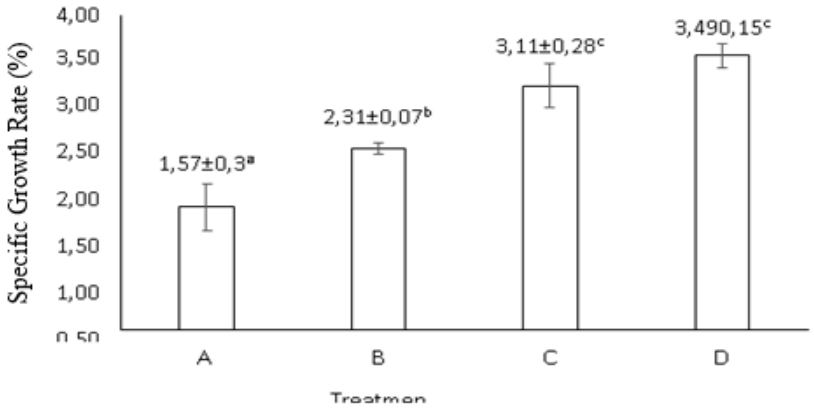


Picture 2. Feed Utilization Efficiency.

Feed Utilization Efficiency (FUE) is the percentage of feed successfully converted into meat or weight gain in fish during the rearing period. This value is used to indicate how well the feed is absorbed and utilized for the growth process. The FUE calculations showed that Treatment C yielded 97.69±0.64% and Treatment D yielded 96.30±1.64%, making them the best performers. Treatment A had the lowest FUE value at 82.98±1.65%. The higher the FUE percentage, the better the feed quality and the growth quality of the farmed fish. This is also consistent with the research by Asmaini et al. (2020), which found that a higher feed utilization efficiency value indicates that fish utilize the feed they consume more efficiently for their growth. Differences in FUE values among treatments also indicate the influence of genetic factors resulting from hybridization. Furthermore, the higher FUE values in Treatments C and D compared to A and B suggest the presence of a paternal effect influencing fish growth. This is also explained by Goldberg et al. (2020), who noted that the preference for male parents in fish breeding results in larger offspring that grow more rapidly. This phenomenon may be attributed to the high energy expenditure required to maintain the body's osmotic balance, which prevents all feed nutrients from being fully utilized for growth.

3.3. *Specific Growth Rate*

The specific growth rates of tilapia (*O. niloticus*) in each treatment were as follows: Treatment A yielded 1.57±0.3%, Treatment B yielded 2.31±0.07%, Treatment C yielded 3.11±0.28%, and Treatment D yielded 3.49±0.15%.



Gambar 3. Nilai *Specific Growth Rate.*

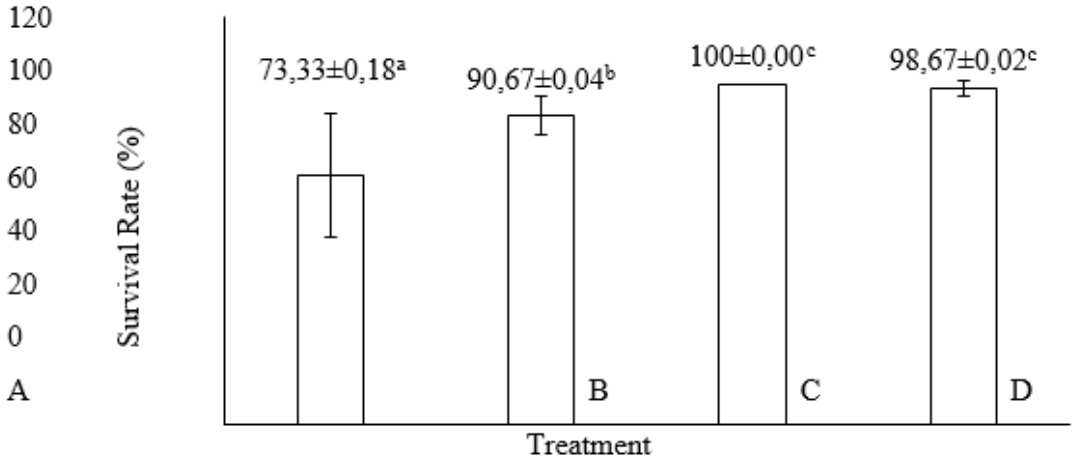
Picture 3. Specific Growth Rate.

Specific Growth Rate (SGR) is the average daily growth rate of fish based on their body

weight over a specific period. SGR calculations are used to determine the daily growth and increase in body weight of fish. Based on the research results, the SGR values of tilapia (O. niloticus) fry in different salinity treatments showed differences across each hybridization treatment. The SGR values for treatment A were 1.57 ± 0.3%, for treatment B 2.31 ± 0.07%, for treatment C 3.11 ± 0.28%, and for treatment D 3.49 ± 0.15%. These differences indicate the influence of genetic factors and physiological adaptive capacity to the salinity medium in each tilapia strain. Differences in SGR values among treatments also indicate the influence of hybridization on tilapia growth performance. Hybridization can produce a heterosis effect, or hybrid vigor, which is the emergence of superior traits in the offspring of a cross compared to their purebred parents. In this study, treatment C produced a higher SGR value than treatment B, indicating that the use of male parents from the Kekar strain contributed more dominantly to growth enhancement. This may be because the Kekar strain has rapid growth characteristics and better metabolic efficiency, enabling its offspring to optimally utilize nutrients in a salinity-controlled environment. This is also explained by Shaheen et al. (2017), who note that increased salinity can affect tilapia growth because metabolic energy is diverted to osmoregulation. Raising fish outside their natural environmental conditions also forces tilapia to undergo adaptive processes that can affect their feed utilization.

3.4. *Survival Rate*

The survival rates of tilapia (O. niloticus) in each treatment were as follows: Treatment A showed a survival rate of 73.33 ± 0.18%, Treatment B showed a survival rate of 90.67 ± 0.04%, Treatment C showed a survival rate of 100% ± 0%, and Treatment D showed a survival rate of 98.67 ± 0.02%.



Picture 4. Survival Rate.

According to SNI 6141:2009, a survival rate of ≥ 75% is considered good or optimal for tilapia fry. This is also noted by Hendriyana et al. (2023), who state that a good survival rate for tilapia fry is ≥ 75%. The survival rates (SR) in treatments B, C, and D fall within the "good" category for tilapia fry survival. The high survival rates in treatments B, C, and D are likely due to the fish's ability to adapt to salinity stress. Differences in survival rates across treatments also indicate that hybridization affects the survival of tilapia. Hybridization aims to produce offspring with a combination of superior traits from both parents, such as environmental tolerance, metabolic efficiency, and growth potential. This is also consistent with the objective of the study by Aulia et al. (2023), which states that the goal of tilapia hybridization is to produce superior varieties or strains. Differences in survival rates among treatments also indicate that hybridization affects the survival of tilapia fry. Treatment C yielded a higher survival rate than Treatment B. This suggests that the use of a male parent from the Kekar strain likely exerts a more dominant genetic influence on the survival of its offspring.

3.5. Heterosis Value

The heterosis value was obtained by comparing the phenotypic values of the measured variables from the observed tilapia seeds. The results of the heterosis value calculations are shown in **Table 1**.

Table 1. Heterosis Value.

Parameter	***Heterosis Value* (%)**	
	B	**C**
Total Feed Intake	-11,24	14,62
Feed Utilization Efficiency	0,3	8,98
Specific Growth Rate	-8,7	22,92
Survival Rate	5,43	16,26

Observations and research findings indicate that Treatment C exhibits better growth characteristics than its parent. Based on the heterosis value calculations, Treatment C showed higher heterosis values than Treatment B for nearly all observed parameters. Positive heterosis values for treatment C were observed for total feed intake (TFI) at 14.62%, feed conversion ratio (FCR) at 8.98%, specific growth rate (SGR) at 22.92%, and survival rate at 16.28%. This indicates that the offspring resulting from the cross in treatment C were able to achieve greater growth with relatively more efficient feed utilization compared to the average of their parents. These results support the hypothesis that the Kekar strain possesses superior

genetic potential for energy and nutrient utilization. These results indicate that the combination of a male parent from the Kekar strain and a female parent from the Pandu strain can produce offspring with better performance than the average of both parents (mid-parent value). The high heterosis value in treatment C indicates the presence of hybrid vigor—a phenomenon where the offspring of a crossbreed perform better than their parents. According to a study conducted by Joshi et al. (2018), dominance effects and heterosis significantly influence the growth and survival of tilapia. A combination of superior genetics and phenotypes in parent crosses will produce offspring with better genetic performance than their purebred parents. Based on the calculations and analyses performed, the heterosis values in this study indicate that Treatment C represents the best crossbreeding combination in saline environments, as it yields superior growth performance, feed conversion efficiency, and survival rates compared to the average of the original parent lines.

3.6. Water Quality

Based on the results of water quality observations during the study, the measured parameters including dissolved oxygen (DO), pH, and temperature for each treatment remained within ranges that support the survival and growth of tilapia (*Oreochromis niloticus*) fry. The results of the water quality observations are presented in **Table 2**.

Table 2. Water Quality Data.

Parameters	Treatment				Feasibility
	A	B	C	D	
DO (mg/l)	4,6 – 5,5	4,6 – 5,5	4 – 5,2	4,6 – 5,4	>5[a]
pH	6,8 – 7,5	6,7 – 7,5	6,8 – 7,3	6,9 – 7,4	6,5 – 8,5[a]
Temperature (°C)	24,4 – 27,8	24,6 – 27,5	25,9 – 27,3	24,6 – 27,5	25 – 30[a]

Description: a. SNI 6140:2009

The DO values for treatment A ranged from 4.6 to 5.5 mg/L with an average of 5.04 ± 0.173 mg/L; for treatment B, they ranged from 4.6 to 5.5 mg/L with an average of 5.02 ± 0.15 mg/L; Treatment C ranged from 4–5.2 mg/L with an average of 4.42±0.24 mg/L, and Treatment D ranged from 4.6–5.4 mg/L with an average of 5.02±0.15 mg/L. pH values ranged from 6.7 to 7.5, while the temperature during the rearing period ranged from 24.4 to 27.8°C. In general, these water quality parameters remained within the optimal range for tilapia aquaculture as specified by SNI 6140:2009. Dissolved oxygen is one of the key parameters supporting the survival of tilapia fry. Fish utilize the oxygen content in the water column for respiration, metabolism, and growth. Suboptimal dissolved oxygen conditions can

cause stress in fish, as the brain does not receive an adequate oxygen supply, which can lead to death due to body tissues not receiving oxygen in the blood (Francisca and Muhsoni, 2021).

4. CONCLUCIONS

Differences in the combinations of tilapia (*Oreochromis niloticus*) parent strains affected the growth performance, feed conversion efficiency, and survival rate of tilapia fry at a salinity of 15 ppt. The heterosis values in this study indicate that treatment C the cross between ♂ Kekar and ♀ Pandu is the best cross combination at a salinity of 15 ppt, as it produces better growth performance, feed conversion efficiency, and survival rates compared to the average of the two parent strains.

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