Productivity Of Snakehead Fish (*Channa striata*) And Tilapia (*Oreochromis niloticus*) Cultured In Policultural Systems At Tarpaulin Ponds

Hasni Yulianti Azis[1], Rustam[1], Muhammad Yusri Karim[1], Alimuddin[2] dan Nurfadilah[3]

[1)]Faculty of Marine Sciences and Fisheries, Hasanuddin University, Makassar, Indonesia
[2)]State Agricultural Polytechnique, Pangkep, Indonesia
[3)]Faculty of Fisheries, Cokroaminoto University, Makassar, Indonesia

[*]Corresponding Author: hasni_yulianti@yahoo.com

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ABSTRACT

Snakehead fish (*Channa striata*) is a freshwater fish commodity with important economic value. This study was aimed to analyze the survival rate, growth, and production of snakehead and tilapia fish reared by the polyculture system in tarpaulin ponds. This study used containers in the form of tarpaulin ponds measuring 4 x 3 x 1 m in length, width, and height respectively or 12 m^3 in area of 6 pieces. Of the 6 pools, 3 pools used a partition measuring 2 x 3 x 1 m. Each pond is equipped with aeration equipment and a water management system (inlet and outlet) and the bottom of the pond is covered with soil as a bottom substrate with a thickness of 20 cm. The test animals used were 54 snakehead fish weighing 12-13 g and 324 tilapia measuring 68 g and reared for 60 days. The feed used in this study was artificial feed (commercial pellets with 26-28% protein) and natural feed (phytobenthos and plankton). The study consisted of 2 treatments and each treatment had 3 replications, namely snakehead fish polyculture with tilapia in 1 pond together and stocked separately in 1 pond. The results of the t-test showed that the survival of snakehead fish and absolute growth of tilapia did not show significant differences ($p > 0.05$) between those reared cultured separately, whereas survival rate of tilapia, absolute growth of snakehead fish, and production of snakehead and tilapia showed significant difference ($p <0.05$) between those cultured separately. The survival rate of snakehead fish, the absolute growth of tilapia, and the production of snakehead fish and tilapia that were not blocked were higher than those that were protected.

Key words: snakehead fish, survival, tilapia, production

INTRODUCTION

Snakehead fish (*Channa striata*) is a freshwater fishery commodity with important economic value having albumin content of around 21% and complete essential amino acids, fats especially essential fatty acids, zinc micronutrients, selenium, minerals especially zinc/zinc (Zn) and several vitamins. which is very good for health (Gam *et al*., 2005; Pratama *et al*., 2020; Rosmawati *et al*., 2021). Therefore, snakehead fish has been associated as a poison, because of its content and has been clinically proven in several diseases. Clinically the snakehead fish protein concentrate intervention in supplement form has helped accelerate the healing of post-surgery patients, burns and strokes in hospitalized patients, and diabetes mellitus (Rahman *et al*., 2018; Sahid *et al*., 2018; Fatma *et al*., 2020).

So far, most consumers' need for snakehead fish is still obtained from wild catches which fluctuate. On the other hand, consumer demand for snakehead fish is increasing, especially its use as a food source of albumin for hypoalbumin sufferers and wounds, both post-operative wounds and burns, which has implications for the demands of its development. To overcome this problem, an effort is needed that aims to produce sustainable and environmentally friendly snakehead fish through the development of snakehead fish cultivation. One of the problems found among farmers is the high operational costs for purchasing feed. Therefore, a maintenance model with a species combination system (polyculture) of snakehead fish and tilapia is needed which is expected so that the tilapia fry can become snakehead fish feed.

Tilapia (*O. niloticus*) is a freshwater fish species that has a fast reproductive cycle (FAO, 2009; Shuai and Li, 2022). In the wild, tilapia begin to reproduce at a total length of 20-30 cm (150-250 g), but in captivity tilapia reach sexual maturity at 8-13 cm (Shoko *et al*., 2015). According to Subiyanto *et al*. (2013) with a length of 8-12 cm and a weight of 80-90 g, tilapia were able to go through the initial spawning with an average fecundity of 123 eggs. The same thing was found by Pillay and Kutty (2005) that the initial spawning of tilapia at a weight of 90-100 g with an age of 3 months under temperature conditions of 23-25 ^oC and produces a fecundity of 100-150 eggs. The larger the size of the tilapia broodstock, the greater the fecundity produced, at brood sizes of 600-1000 g the fecundity can reach 1,000-1,500 eggs (Pillay and Kutty, 2005) and the gonad maturation period for tilapia in each reproductive cycle is short (Mashaii *et al*., 2016; Orlando *et al*., 2017).

The problem in cultivating tilapia in conventional ponds is slow growth, requiring a long cultivation period to obtain market-sized tilapia (200–400 g/head). Its fast reproductive nature and the incubation of its eggs in the oral cavity until they hatch causes high larval survival so that it has a significant impact on tilapia populations in ponds (Koe and Shu-Chien, 2011; Longrie *et al*., 2013). Thus, there is competition between the parents and their offspring in terms of feed availability and use of water space in the pond and accelerates the decline in water quality. This condition causes the productivity of conventional tilapia ponds to be relatively low. Therefore, the implementation of snakehead fish polyculture with tilapia is expected to increase the total pond productivity and reduce the cost of using feed for snakehead fish.

This study was aimed to analyze the survival, growth, and production of snakehead and tilapia fish reared by the polyculture system in tarpaulin ponds.

II. RESEARCH METHODS

This study used containers in the form of tarpaulin ponds measuring 4 x 3 x 1 m in length, width and height respectively or 12 m^3 in area of 6 pieces. Of the 6 pools, 3 pools use a partition measuring 2 x 3 x 1 m. Each pond is equipped with aeration equipment and a water management system (inlet and outlet) and the bottom of the pond is covered with soil as a bottom substrate with a thickness of 20 cm.

The test animals used were 54 snakehead fish weighing 12-13 g and 324 tilapia measuring 68 g. The snakehead fish seeds were obtained from the snakehead fish breeding in Ompo, Lalabata District, Soppeng Regency, South Sulawesi, while the tilapia seeds were obtained from the Ompo Fish Seed Center. Maintenance of these fish lasted for 60 days.

The feed used in this study was artificial feed (commercial pellets with 26-28% protein) and natural feed (phytobenthos and plankton) which were grown in the research ponds by means of fertilization (organic and inorganic). The feed dose given was 5% of the fish biomass with a frequency of feeding 2 times a day, namely in the morning at 07.00 and in the evening at 17.00.) Growth sampling (weight) was carried out every 10 days with the aim of adjusting the feed dose.

The study consisted of 2 treatments and each treatment had 3 replications. Thus, this study consisted of 6 experimental units. The treatments tried were:

A. Polycute of snakehead fish and tilapia in 1 pond together
B. Polyurethane of snakehead fish and tilapia in 1 pond are stocked separately in 1 pond (blocked with bamboo slats)

The parameters observed in this study were survival rate, growth, and production of snakehead and tilapia fish.

Survival Rate

The survival rate of snakehead fish and parent of tilapia fish, is calculated using the following formula:

$$SR = (N_t/N_o) \times 100$$

Note:
SR = Survivability of snakehead fish and parent tilapia (%)
N_t = Number of live fish at the end of rearing (tails),
N_o = Number of fish at the start of rearing (heads)

Absolute Growth Weight

The absolute weight growth of snakehead fish and brood tilapia is calculated using the following formula:

$$W = W_t - W_o$$

Note:
W = Growth in absolute weight of snakehead fish and tilapia broodstock (g)
W_t = Average weight of fish at the start of rearing (g)
W_o = average weight of fish at the end of rearing (g)

Production

Production of snakehead fish and total production of tilapia (large and small sizes) were calculated at the end of the study using the following formula:

$$P = N_t \times B_t$$

Note:
P = Production of snakehead fish and tilapia (g)
N_t = Number of live fish at the end of rearing (tails),
B_t = average final weight of fish at the end of rearing

As supporting data, during the research period several water quality parameters were measured for snakehead and tilapia rearing media including: temperature, pH, dissolved oxygen, and ammonia. Temperature was measured using a thermometer, pH with a pH meter, dissolved oxygen was measured with a DO meter, and ammonia was measured using a spectrophotometer. Temperature, pH, and dissolved oxygen were measured twice a day during the study, namely in the morning at 6 am and in the afternoon at 5 pm. The ammonia was measured every week.

Data obtained in terms of survival, growth, and production of snakehead and tilapia between unscreened and unscreened were analyzed using the t test.

III. RESULTS AND DISCUSSION

Result

Average survival and absolute weight growth of snakehead fish and tilapia reared in the polyculture system are presented in Table 1 as follows:

Table 1. Survival rate and absolute weight growth of snakehead fish and tilapia both at pools that are not blocked or that are blocked

Treatments	Survival Rate (%)		Absolute Weight Growth (g)	
	Snakehead Fish	Tilapia	Snakehead	Tilapia
Not Blocked	100 ± 0.00[a]	100 ± 0.00[a]	59.67 ± 3.51[a]	124.67 ± 3.79[a]
Blocked	92.67 ± 4.35[b]	89.67 ± 4.04[b]	36.00 ± 3.60[b]	122.33 ± 9.29[a]

Note: different letters in the same column indicate differences significant between treatments at 5% level ($p < 0.05$)

The results of the t test showed that the survival rate and the absolute growth of the tilapia did not show a significant difference ($p > 0.05$) between those that were not blocked and those that were not partitioned. However, survival rate for tilapia and absolute growth for snakehead fish showed significant differences ($p < 0.05$) between those that were not partitioned and those that were not partitioned.

The average production of snakehead fish and tilapia reared in the polyculture system is presented in Table 2 as follows:

Table 2. Production of snakehead and tilapia fish in not blocked and blocked ponds

Treatments	Production (g)	
	Snakehead Fish	Tilapia
Not Blocked	644.33 ± 27.68[a]	13.704 ± 668.99[a]
Blocked	398.00 ± 56.32[b]	6.233 ± 417.44[b]

Note: different letters in the same column indicate differences significant between treatments at 5% level ($p < 0.05$)

The results of the t test showed that the production of snakehead and tilapia fish showed a significant difference ($p < 0.05$) between those that were not blocked and those that were not blocked.

During the study, water quality parameters were measured for snakehead and tilapia rearing media including: temperature, pH, dissolved oxygen, and ammonia presented in Table 3.

Table 3. The range of water quality parameter values for snakehead fish and tilapia Culture media and parrot fish

Treatments	Parameters						
	Temperature (°C)		pH		O_2 (ppm)		Ammonia (ppm)
	Morning	Afternoon	Morning	Afternoon	Morning	Afternoon	
Not Blocked	27.32-27.35	30.76-30.81	7.43-7,45	8.53-8.57	2,80-3.20	7.00-7.30	0.01-0.02
Blocked	27,30-27,36	30.77-30.89	7.46-7,74	8.57-8.64	2.90-3.00	6.90-4.40	0.01-0.02

Discussion

Table 1 shows that the maintenance of snakehead fish polyculture with tilapia, both unscreened and screened, resulted in the same survival rate for snakehead fish. There was no difference in the survival rate of snakehead fish obtained in this study because the fish rearing environment was engineered to be as similar as possible to the natural environment so that it could adapt to the rearing environment. Meanwhile, the survival rate for tilapia obtained was higher for tilapia that were not screened than those that were screened. This is due to the very limited movement of tilapia in the blocked pond. In general, the survival rates obtained in this study were quite high, ranging from 92.67-100% for snakehead fish and 89.67-100% for tilapia. This survival rate is higher than several previous studies. Putra *et al.* (2015) obtained a survival rate of 79.1% for snakehead fish (*C. striata*) and 16.9% for tilapia (*O. niloticus*) reared in polyculture in tarpaulin ponds. Meanwhile Yi *et al.* (2000) rearing snakehead fish in a polyculture system with tilapia resulted in survival rates of snakehead fish ranging from 83.64 to 95.47%.

The growth in absolute weight obtained in this study did not show any difference between screened and unscreened tilapia. This is due to the availability of sufficient feed both in quality and quantity so that tilapia can grow well. In contrast to snakehead fish which showed a difference between those that were screened and those that were not screened where the highest absolute weight growth was obtained in the non-screened treatment. This is due to the wider space for the snakehead fish to move in an unscreened container compared to an unscreened one. In addition, the feed obtained by the snakehead fish in the partition is limited because of the partition so that the number of tilapia fry that can be natural food for the snakehead fish is limited. According to Hidayat *et al*. (2019) in its natural condition, snakehead fish are predatory and ferocious, because their main food is natural.

Research on the polyculture of snakehead fish with tilapia which examines the growth of absolute weight has been carried out by several previous researchers. Putra *et al*. (2015) who studied the cultivation of snakehead and tilapia fish with different stocking percentages in tarpaulin ponds obtained the highest absolute

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weight growth of 2.39 g, whereas in Umayah and Rustadi's research (2021) who examined the polyculture of snakehead and tilapia fish red tilapia with different stocking ratios obtained absolute growth in weight of snakehead fish ranging from 10.97-17.74 g and red tilapia ranging from 71.32-104.81 g.

Table 2 shows that the treatment between unscreened and partitioned gave a significant difference to the production of snakehead fish and tilapia. The production of snakehead and tilapia fish was determined by the weight growth and the number of live fish at the end of the experiment. The highest production of snakehead and tilapia was obtained in the unscreened treatment, namely 644.33 for snakehead fish and 13,704 g for tilapia. The production produced in the unscreened snakehead fish was 398 g and tilapia 6,233 g. The high production produced in both snakehead and tilapia fish which were not screened was due to the survival rate and the factual growth that was produced was higher in those that were not screened compared to those that were not partitioned.

The water quality values obtained during the study were temperatures ranging from 27.30-27.36ºC in the morning and 30.76-30.89oC in the afternoon, pH 7.43-7.74 in the morning and 8.53-8. 64 in the afternoon, dissolved oxygen 2.80-3.20 ppm in the morning and 6.90-7.30 in the afternoon, and ammonia around 0.01-0.02 ppm. The range of water quality parameter values is still suitable for the life of freshwater fish (Caldini *et al*., 2011; Macori *et al*., 2017; Setiadi *et al*., 2018).

CONCLUSION

The survival rate of snakehead fish and the absolute weight growth of tilapia reared both separately produced the same survival rates, whereas the survival rate of snakehead fish, absolute body weight growth of tilapia, and production of snakehead and tilapia were higher in captivity on the unscreened compared to the partitioned.

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