The combined effect of stocking density and feed types on growth and survival of mudskipper (*Pseudapocryptes elongatus*) fingerlings

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Abstract: The combined effect of feed types (commercial feed, live and frozen ongrown *Artemia* biomass), and stocking density (100; 200 and 300 ind./m^2) on growth performance and survival of mudskipper (*Pseudapocryptes elongatus*) was peformed. The aim of study was to find out the best stocking density and *Artemia* biomass for the best growth of fish obtaining. Natural mudskipper fingerlings, with length and weigh was 2.7 cm/ind and 0.51 g/ind, respectively, were nursed in 250 L plastic tank containing 100 L of 15‰ seawater. After 30-day of culture, the results showed that the survival of fish is not affected by feed type, but it is affected by stocking density. The significantly lower of survival was recorded in commercial-fed fish when compared to frozen *Artemia*-fed fish when reared at 200 and 300 ind/m^2. The growth of commercial-fed fish was better than fish in the *Artemia*-fed fish when stocked at 100 ind/m^2, but it was slower growth when reared at 200 and 300 ind/m^2. When comparing in the same feed type, fish were significantly larger size and weight than high density fish nursed when nursed at a density of 100/m^2. However, the the growth of fish was not affected by stocking density when provided *Artemia*. In general, both stocking density and feed type had a singular effect on the length and weight growth of the fish, but there was not interaction with each other on the growth of the fish. The results indicated that, *Artemia* biomass can be used to rear mudskipper.

Index term: *Mudskipper, Pseudapocryptes elongatus, live ongrown Artemia, frozen ongrown Artemia*

I INTRODUCTION

Mudskipper (*Pseudapocryptes elongatus*) is the brackish water species, they distributed in South East Asian countries and they utilize on phytoplankton, small crustacean, detritus, rice bran and commercial feed. In Viet Nam, mudskippers are superintensively reared in earthen ponds where it located in the Southern coastal provinces such as: Soc Trang, Bac Lieu, Ca Mau, Kien Giang…Among small crustacean species use as feed for shellfish and fish larviculture, *Artemia* nauplli known as the live feed with high protein content (Sorgeloos *et al*., 2001; Lim *et al*., 2001) and was reported as the excellent feed for fish and shellfish larvae (Bengtson *et al*., 1991). Beside the *Artemia* nauplii, *Artemia* ongrown is also used as potential feed for nursing of fish and shrimp larvae (Hoa *et al*., 2007) because it varies in size and suitable uses as feed for fish and shellfish larvae.

Artemia is exotic species in Vietnam, it has been introduced to culture for cyst production in Mekong Delta during the dry season (from Janaury to May). The massive biomass at the end of the crop has been harvested and used directly as feed for ornamental fish, marine snail *Babylonia tesselata*, *Scylla paramamosain*, tiger shrimp *Penaeus monodon* (Anh, 2011), snakehead fish *Channa striata*, Asian seabass *Lates calcarifer*, marble goby *Oxyeleotris marmorata* (Van *et al*., 2010), Asian swarp eel (Van and Toi, 2017), white-leg shrimp *Litopenaeus vannamei*, giant gourami *Osphronemus goramy* (Toi and Van, 2018). In addition, the use of *Artemia* biomass also increased the pigmentation and metamorphosis improvement by up to 20% (compared to 4% when using *Artemia* nauplii). However, the population density of *Artemia* in the pond is low during the raining season and the *Artemia* biomass could not harvested with large quantity for trading, normally on that time the farmers use *Artemia* biomass as feed for rearing some brackish and marine species on their own farms, but the use of *Artemia* biomass to rear mudskipper has been not reported. In the present study, a different *Artemia* biomass type were investigated to culture mudskipper at different stocking density.

II MATERIALS AND METHODS

2.1 Experimental design

Natural mudskipper fingerlings were purchased in Soc Trang province, Mekong Delta, Vietnam and shipped to Can Tho for the study. Fish were acclimated with a new condition for a week before running of the study.

Fish were nursed at 100, 200 and 300 ind/m^2 and provided with 03 food types (commercial diet, live *Artemia*, and frozen *Artemia*), corresponding with 09 treatments (T), triplicate for each treatment.

Table 1. Experimental design

Density \ Feed	Commercial feed	Live *Artemia*	Frozen *Artemia*
100 ind/m^2	T1 (100-CF)	T2 (100-LA)	T3 (100-FA)
200 ind/m^2	T4 (200-CF)	T5 (200-LA)	T6 (200-FA)
300 ind/m^2	T7 (300-CF)	T8 (300-LA)	T9 (300-FA)

Feed preparation and feeding

Ongrown *Artemia* from Vinh Chau salt pan was stored at -21^{0}C and called as frozen Arrtemia biomass. Ongrown live *Artemia* was prepared by rearing nauplii *Artemia* with *Chaetoceros* sp. and rice bran up to adult size. Before providing to fish, frozen *Artemia* were thawed, and live *Artemia* were washed with 15‰ seawater to get rid of dirty matter.

Commercial feed for fish from De Hues (40% protein; 0,6 mm in size) was used.

Pond management

Feed were given to fish 4 times/day at ad libitum.

Water was renewed everyday (30%) and uneaten feed and solid waste from fish was removed by siphoning before feeding.

Data collection

Enviromental factors

Temperature, pH was recorded twice/day at 7:00 and 14:00.

Total amonum nitrogen or TAN (NH_3/NH_4^+) and nitrite (NO_2^-) was tested every three days by Sera test-kit (made in Germany).

Biological factors

The length (L) and weight of fish (W) was measured at beginning day of study and every 15 days by measuring 30 fish per treatment.

Daily length gain (DLG; cm/day) = (Lf-Li)/day of culture

Daily weight gain (DWG; g/day) = (Wf-Wi)/day of culture

Specific growth rate (SGR; %/day) = 100 x (LnWf – LnW_i)/day of culture

Where: Lf: final length; Li: initial length; Wf: final weight, Wi: initial weight

Survival of fish was counted the alive fish per treatment at the end day of reared period.

Suvival (%) = 100 x (final number of fish/initial number of fish)

2.2 Statistical analysis

The evarage and standard deviation of survival, growth performance was caluated by Microsolf Excel. All datasets were analyzed using one-way analysis of variance (ANOVA) followed by Tukey´s honestly significant difference (HSD) at 0.05 level of probability.

III RERULTS AND DISCUSSION

3.1 Water quality

The results on pH water showed that the pH ranged from 8.5 – 9.2. According to Egna *et al*. (1997), pH water from 6.5 - 9 is suitable range for the growth of fish. Temperature of water in this study ranged from 25.8 – 29.9 ^oC. Boyd (1993), the suitable range of temperature for fish is 25 – 28^oC. However, the mudskippers are able adapt to the harsh environmental conditions, so under conditions of lighly fluctuating temperature they are still able to grow.

TAN (NH_3/NH_4^+) concentration in this study ranged from 0.4 – 0.8 mg/L, this level is suitable for fish (Boyd, 1993). Nitrite (NO_2) in this study was low in the treatment 3 (3.4 mg/L) and high concentration in treatment 8 (5 mg/L). NO_2 in water is product the convertion of NH_3 and NH_4^+ under the action of bacteria, a form of protein that has a toxic affect on aquatic animals. According to Boyd (2007), NO_2 is absorbed by fish and other aquatic animals, it can combine with hemoglobine of blood to form methemoglobine or the toxicity of NO_2, but NO_2 is less toxic to shrimp and fish cultured in brackish and saline water bodies than in freshwater environments.

3.2 Survival

After 30-day of culture, the survival of fish ranges from 53.8% - 85%. The highest survival is T9 (85%) in frozen *Artemia*-fed fish, nursed at 300 ind/m^2 and lowest survival is T4 (53,8%) in commercial- fed fish, nursed at 200 ind/m^2. When compared in stocking density, the survival of fish in the commercial-fed treatment was higher than that obtained in the rest treatments. When comparing at the same feed type, the survival of fish at 300 ind/m^2 was higher than the low stocking density treatments. These results indicated that the survival of fish is related to feed type, but it is not with stocking density. In addition, there is no interaction e bffect between density and feed type on survival of mudskipper (Table 2).

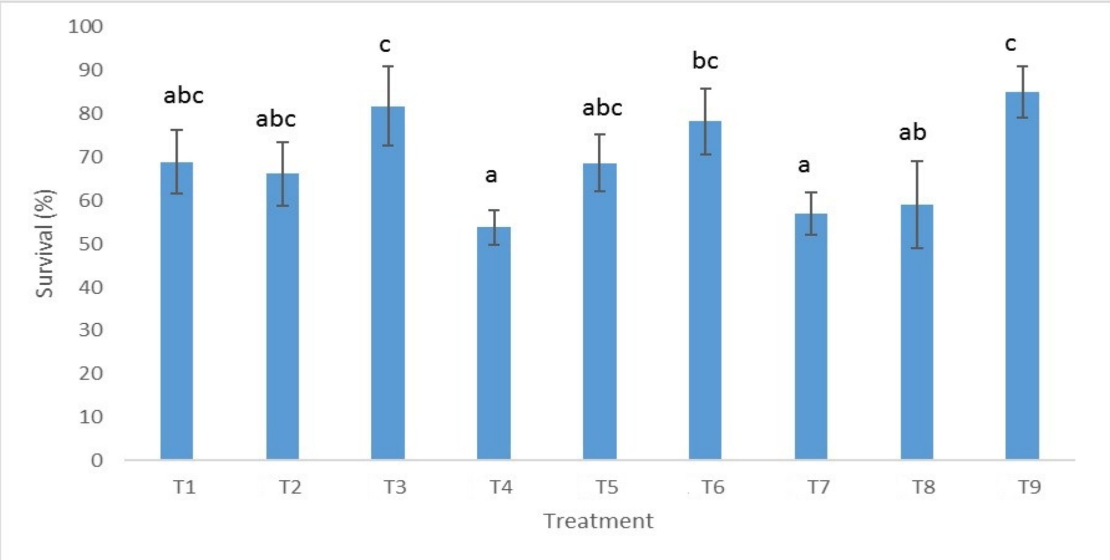

Figure 1: Survival of fish.

Table 2. P-value of experimental factors on survival of mudskipper

	P-value
Feed	0.0000***
Stocking density	0.18723
Feed*Stocking density	0.10603

(***: statistical difference p<0.001)

3.3 Effect of stocking density and feed type on growth performance

The initial length of fish is 2.7 cm/ind. After 30-day of culture, the length and DLG of fish (ranges from 4.73-7.75 cm/ind and 0.07-0.17 cm/day, respectively), the highest value of length was recorded in T1 (7.75 cm/ind) where stocked at 100 ind/m2 and provided by commercial feed, it was higher as compared to the rest treatments, except no significant (p>0,05) when compared to T4 (6.87 cm/ind). The survival of fish was not significant difference in feed types when reared at 100 ind/m^2 but survival of commercial fed-fish was significantly lower than frozen *Artemia*-fed fish when reared at 200 and 300 ind/m^2. When comparing at same feed type, the length of fish was higher value in the commercial-fed fish than *Artemia*-fed fish. These results indicated that both feed types and stocking density affected on the growth in terms of length. Fish have the highest value was recorded in the stocking at 100 ind/m^2 providing commercial feed, but there was significant difference was found when compared to fish stocked at 300 ind/m^2. Howerer, the length of *Artemia* biomass-fed fish was no significant difference when reared at different densities. There was interaction effect was recorded between feed type and stocking density on the growth of fish in terms of lenght (Table 3).

The growth performance in terms of weight increased, it ranges from 4.13 – 5.76 g/ind at the end of study day. The growth of fish is affected by feed type and stocking density, fish provided by commercial feed and reared at low density was higher value than fish reared at high density and fish provided by *Artemia*. In addition, the figure of daily weight gain and specific growth rate again indicated that the highest value was found in T1 (0.17 g/day; 8.03 %/day, respectively), but there was no significantly higher than fish in the rest treatments when compared to corresponding stocking density, it was only significantly higher value when compared to *Artemia*-fed fish in 300 ind/m^2 treatment. The result on growth performance indicated that the growth of commercial feed-fed fish was better performance than *Artemia*-fed fish, and fish reared at low density had high value of performance compared to higher stocking density. In the past, live and frozen *Artemia* biomass was reported as the favourite feed for Snakehead (*Channa striata*), Bronze featherback (*Notopterus notopterus*), and Marble goby (*Oxyeleotris marmorata*), the survival rate and growth rate of *Artemia*-fed fish were significantly higher (p<0.05) trash fish-fed fish (Van *et al*., 2010). Moreover, powder of *Artemia* biomass can be used to replace fish meal in culture mudskipper (Anh, 2011). The reults in present study indicated that *Artemia* biomass can be the candidate protein source for mudskipper nursing.

Table 2: Growth performance of fish

Treatment	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**
L_i (cm/ind)	2.7 ± 0.37^{a}	2.7 ± 0.37^{a}	2.7 ± 0.37^{a}	2.7 ± 0.37^{a}	2.7 ± 0.37^{a}	2.7 ± 0.37^{a}	2.7 ± 0.37^{a}	2.7 ± 0.37^{a}	2.7 ± 0.37^{a}
L_f (cm/ind)	7.7 ± 1.16^{d}	5.83 ± 1.23^{abc}	5.43 ± 0.12^{ab}	6.87 ± 1.39^{cd}	5.15 ± 0.78^{ab}	5.37 ± 1.11^{ab}	6.17 ± 0.79^{bc}	4.73 ± 0.68^{a}	4.93 ± 0.65^{a}
DLG (cm/ind)	0.17 ± 0.06^{d}	0.10 ± 0.04^{abc}	0.09 ± 0.03^{ab}	0.14 ± 0.09^{cd}	0.08 ± 0.03^{abc}	0.09 ± 0.04^{ab}	0.12 ± 0.03^{bc}	0.07 ± 0.02^{a}	0.07 ± 0.02^{a}

The different superscript in the same indicate for significant difference ($p<0.05$)

Table 3. P-value of experimental factors on growth performance of mudskipper

P-value	Source of variation	
	Length	Weigth
Feed type	0.0000***	0.0001***
Stocking density	0.0000***	0.0000***
Feed type*Stocking density	0.3701	0.9018

(***: significant difference $p<0.001$; **: $p<0.01$; *:$p<0.05$)

W_i (g/ind)	0.51±0.17[a]	0.51±0.17[a]	0.51±0.17[a]	0.51±0.17[a]	0.51±0.17[a]	0.51±0.17[a]	0.51±0.17[a]	0.51±0.17[a]	0.51±0.17[a]
W_f (g/ind)	5.76±1.00[c]	5.55±1.30[abc]	4.86±1.06[abc]	5.29±1.22[abc]	4.56±0.92[abc]	4.15±0.84[a]	5.14±0.97[abc]	4.51±1.27[ab]	4.13±0.92[a]
DWG (g/day)	0.17±0.03[c]	0.17±0.04[bc]	0.14±0.04[abc]	0.16±0.04[abc]	0.13±0.03[abc]	0.12±0.03[a]	0.15±0.03[ab]	0.13±0.04[ab]	0.12±0.03[a]
SGR (%/day)	8.03±0.58[c]	7.87±0.80[bc]	7.44±0.72[abc]	7.71±0.82[abc]	7.23±0.69[abc]	6.93±0.64[a]	7.64±0.66[abc]	7.16 ±0.82[ab]	6.90±0.68[a]

IV CONCLUSION

Artemia biomass is favourite feed for mudskipper. The survival of mudskipper is related to stocking density, low survial in commercial fed fish when reared at 200 and 300 ind/m2. However, the survival of fish is not affected by stocking density.

The growth of *Artemia*-fed fish was not significant difference compared to commercial-fed fish. However, the slowly growth is obtained when fish is reared at high density and provided by commercial feed, exept for *Artemia*-fed fish.

The results indicated that *Artemia* biomass can be used to replace commercial feed in nursing of mudskipper.

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