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Effect of Different Water Culture System on the Aquaculture of the Bull Frog (*Rana adpersa*) Tadpoles: A Review

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Abstract: This study evaluated the effect of different water culture system on the growth performance of the bull frog *(Rana adpersa)* tadpoles. *Rana adpersa* tadpoles were raised in three different water culture media; continuous flow, semi-continuous flow and static water culture system for 70 days. At the end of the experiment trials, tadpoles reared in static culture system had the best weight gain (2.23 g), specific growth rate (5.43%) and feed conversion ratio (3.95) which were significantly different ($p<0.05$) from the other treatments. Survival ranged between 52.57-59.90% and were not significantly different ($p>0.05$) between treatments. The static water culture system is therefore suggested for the culture of the premetamorphic tadpoles of *Rana adpersa* for maximum yield in breeding farms.

Key words: Tadpoles, static, *Rana adpersa*, continuous flow, growth, survival

INTRODUCTION

Water quality along with adequate nutrition is recognized as one of the most important requisites for successful cultivation of any aquatic species (Alabaster and Lloyd, 1982; Boyd, 1990). In an aquaculture environment (i.e., a pond or a tank), water quality is expressed as a combination of several abiotic factors which in turn are related to the intensity of culture and the management strategy employed. Wild frog tadpoles of many anuran species live in lentic waters where the environmental conditions are often unstable.

A major constrain to commercial frog culture is because rearing these aggressive but fragile amphibian through a complete life cycle is technically difficult. According to Muir (1982), higher rate of water turn over is vital to maintain a healthy environment for culture of aquatic organism in intensive aquaculture system since, the rate of accumulation of metabolites is high. In captivity, tadpoles of the several species of the genus Rana including *R. adpersa* have been commonly cultured under semi-static, controlled conditions with variable results (Cairns *et al*., 1967; Mohanty and Dash, 1986; Culley, 1991).

The increasing West African demand for frogs may be an indirect sign of a decrease of other natural resources and deserves more attention (Ntiamoa-Baidu, 1987). The decline or even potential loss of frogs in particular areas may have direct and indirect effects on rural communities such as increasing mosquito populations, less bio-control of agricultural pest species or negative effects on freshwater ecosystems such as temporary ponds (Mohneke and Rodel, 2009). There is the need for commercial production of edible frogs in other to reduce over dependence on the ever increasing exploited wild population.

The present study was carried out to determine the performance of premetamorphic tadpoles of *R. adpersa* under three water management regimes by measuring the growth performance. This will help to determine the appropriate water regime for their commercial culture in breeding farms which will not only be of socio-economic advantage but also help to reduce over dependence on the wild stock population.

MATERIALS AND METHODS

Experimental design: *Rana adpersa* tadpoles were collected from a natural spawn and transported in polythene bags filled with oxygen and transported to the hatchery where they were incubated. After a 2 weeks acclimatization period, tadpoles in stage 25 (Gosner, 1960) were randomly distributed in nine indoor plastic tanks each 40×20×30 cm (Water column = 15 cm) at a stocking

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rate of 2 tadpoles L^{-1} using borehole water. The experimental design consisted of three treatments each with three replicates. Treatment 1 (T-1) is a continous flow through system. Treatment 2 (T-2) is a semi contionously flow through system in which water is only allowed to flow continuously between 6-8 h daily. Treatment 3 (T-3) is a static system where water was added to the tank only as needed to replace loss from siphoning. All the treatment tanks were constantly aerated.

Experimental diet: Tadpoles were fed daily at a rate of 13% body weight with moist dough following the recommended feeding regime of Lopes-Lima and Agostinho. Feeding was carried out early in the morning by placing the dough directly at the bottom of the tank in the centre. Protein of plant origin (Fontanello *et al*., 1988; Culley, 1991) was supplied daily in each tank at midday after siphoning with 0.2 L of multi-species micro-algae culture from outdoor tilapia tank.

Aeration and water flow were stopped in all the treatments for approximately, 1 h at feeding time to allow for better grazing and food consumption by tadpoles. Every day, unconsumed food and faeces were removed from the tanks by siphoning the bottom. Proximal composition of the moist dough used for tadpole feeding is shown in Table 1.

Growth performance: Every 2 weeks, all tadpoles from each tank were removed carefully with a dipnet which was passed over a paper towel to remove excess water and bulk weighed to the nearest 0.01 g and counted. All tanks were inspected daily for metamorphosed frogs. Quantity of feed were also adjusted based on the weight. Growth parameters were estimated using the following equation (Fig. 1):

$$\text{Weight Gain (WG)} = (W_f - W_i)g \quad (1)$$

Where:
W_f = Final weight of tadpole
W_i = Initial weight of tapole

$$\text{Specific Growth Rate (SGR)\%} = \frac{\text{Log } W_f - \log W_i \times 100}{t} \quad (2)$$

where, t is experimental period in day.

$$\text{Survival rate (\%)} = \frac{N_i - N_f \times 100}{N_i} \quad (3)$$

Where:
N_f = Final No. of tadpole at the end of experiment
N_i = Initial No. of tadpole at beginning of experiment

Table 1: Proximate composition of the moist dough for tadpole feeding

Ingredients	Percentage as fed	Composition	Percentage
Whole powdered milk	15	Moisture	64.00
Boiled egg yolk	25	Crude protein	2.300
Boiled potatoes	58	Ether extract	4.530
Vitamin premix	2	Crude fibre	0.660
		Ash	1.350
		NFE	27.16

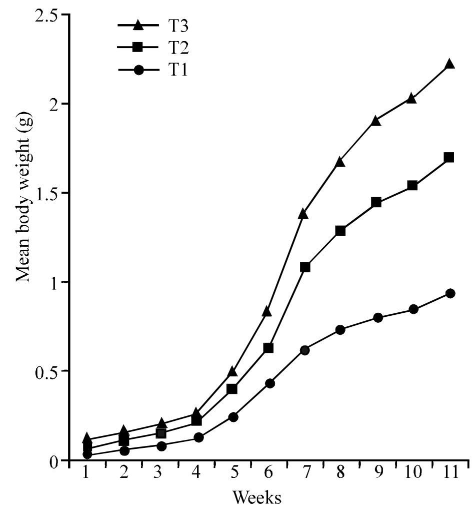

Fig. 1: Weekly weight increase of *Rana adpersa* tadpoles in the different water culture system for 70 days

Statistical analysis: Data on growth performance and survival were subjected to one-way Analysis of Variance (ANOVA) at 95% probability level. Mean differences between treatments were tested for significance ($p<0.05$) using Duncan's Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Table 2 shows the growth performance of the tadpoles in the different water culture system. Tadpoles in the three different culture system increased in weight generally during the experimental trial period. At the end of the experimental trial, tadpoles in T-3 had the highest weight gain (0.871 g) and specific growth rate (5.32%) which were all significantly different ($p<0.05$) from the corresponding values obtained in other treatments. Table 2 shows the growth performance of the tadpoles in the different water regimes.

Although, not significantly different ($p>0.05$), overall survival was highest in T-1 (59.9%), intermediate in T-2 (57.2%) and lowest in T-3 (52.6%). T-3 also had the best apparent food conversion ratio though not significantly different from T-2 while the least value was obtained in T-1 food. As water-exchange rate increased, there was a tendency for growth and metamorphic rate to decrease.

Table 2: Growth performance of the tadpole in the different water culture medium

Parameters	T_1	T_2	T_3
Survival (%)	59.900^a	57.240^a	52.570^a
Initial body weight (g)	0.049^a	0.045^a	0.052^a
Final body weight (g)	0.880^a	1.860^{ab}	2.320^b
Weight gain (g)	0.780^a	1.710^{ab}	2.230^b
Specific growth rate (%, day)	4.110^a	5.320^{ab}	5.430^b
Feed conversion ratio	5.840^a	4.080^a	3.950^a

Apparent food conversion ratio on a wet-weight basis was higher in tadpoles reared under T-3 than those from the semi-continous flow and the 100% day^{-1} water-exchanged system.

In aquatic culture systems with similar environmental conditions, better water quality would improve the growth and development of bullfrog tadpoles. However, it is clear from the results that the best water quality (O_2, TAN and nitrate) was recorded in T-1 but the best growth and development were in T-3 with the less desirable water quality. Lowest mortality and highest growth rates were observed in the static system while the reverse was true in the continous flow through system. Several factors determine the growth performance of tadpoles. In this present study, the stocking density used was relatively high as compared with other studies with *Rana catesbeiana* tadpoles (Culley, 1991). When tadpoles are reared in conditions of >1 L^{-1}, there may be a negative effect of density (Fontanello *et al*., 1988).

The continuous flow through system (T-1) were supplied with water via PVC pipes connected to shower system. However in nature, bullfrog tadpoles occur in lentic, non-disturbed waters. Continously flowing water could adversely affect their performance for example, by requiring higher metabolic energy to swim and maintain their position in the water column. Water flow in the culture system is one of the main factors to be controlled including flow velocity, associated, noise and type of agitation or stirring.

Another important consideration is feeding efficiency. The food conversion ratio did not differ significantly between treatment 2 and 3. However, SGR and weight gain per day were significantly higher in tadpoles reared under static conditions. In addition to the relationship between energy expenditure and water circulation, the tadpoles in T-2 and T-1 had less access to food, since both dough particles (with attached bacteria) and micro-algae added to the tanks were flushed out with water exchange.

In T-3 unconsumed feed particles remain on the bottom together with faeces, probably creating an important source of protein. Anuran tadpoles use several alternative feeding strategies including filter-feeding (Wassersug, 1972; Viertel, 1992), grazing (Dickman,1968) and coprophagy (Steinwascher, 1978). In culture conditions, tadpoles rely mostly on supplementary food but depending on the management practice, they may also filter-feed and practice coprophagy especially, if the supplementary food does not meet their nutritional requirements. Culley (1991) states that growth and development is enhanced in bullfrog tadpoles that have access to aquatic micro-flora in addition to supplemental diets. Even though, all tadpoles in this trial were provided with a dense volume of micro-algae, the 1 h break during which both aeration and continous flow were stopped to allow for better feeding may not have been enough for the tadpoles to make use of the algae which were then flushed out water flow was restarted. In T-3 micro-flora proliferated, covering the bottom and walls of the culture tanks, thus providing an additional and more balanced food source than was available in T-2 and T-1.

CONCLUSION

The present study shows that the continuos and semicontinous flow through culture medium did not provide a suitable environment for settling and proliferation of micro-algae. It has been reported that tadpoles are better suspension feeders when they are in the early metamorphic phase and as they approach stages 42-46 of Gosner they become surface grazers and tend to rely more on detritus. At the beginning of the experiment, the addition of phytoplankton to the tanks apparently supplemented the nutritional requirements of the tadpoles. When they approach more advanced stages they relied more on the bottom than other surfaces and the benthic flora and detritus became more important therefore those reared in the static system would have access to more feed than those in the more dynamic water systems.

It can then be observed that water exchange affects the condition of tadpoles with a direct effect in keeping the benthic flora from establishing and food particles from settling thus, restricting the availability of food resources. Therefore, cultivation of the tadpole stage of this species of edible frog is most suitable in static water culture system. This will help to improve both the survival and its availability under culture system and thereby reduces over dependence on the dwindling wild stock population.

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