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Use of Live Food and Artificial Diet Supply for the Growth and Survival of African Catfish (*Clarias gariepinus*) Larvae

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Abstract: The effects of different feeding levels on growth performance and survival of African cat fish (*Clarias gariepinus*) larvae with the newly hatched *Artemia* nauplii and artificial feed was investigated in this study. Over 12 days of experiment, the increase of feeding level slightly increased the growth of fish larvae. At the feeding level g=0.3 it decreased suddenly but increase even further at the highest feeding level (g =0.4). The growth rates were maximized at a feeding level 0.25 with the highest specific growth rate of 22.87%/day over a 12 days period. As expected, the growth of fish at early stage for short culture periods was high in all feeding levels at the beginning of the experiment and decreased faster. Food conversion ratio (FCR) of *Artemia* nauplii at the g=0.3 for the first 3 days of the experiment were lower than the FCR of the artificial food from day 6 to 12. Fish larvae tend to use *Artemia* more efficiently than artificial food. The lowest food conversion recorded were 1.88 at the feeding level of 0.2. The highest fish survival rate recorded were 97.07 % with the feeding level of 0.25 which corresponds also to the highest growth rate of fish. Fish mortality at feeding levels 0.2; 0.3; 0.4 were not significantly different; nevertheless, the highest feeding level offered the highest mortality rate. It can be concluded that optimum feeding level should be maintained to achieve better survival and FCR. But less feeding might be result in less survival rate and less growth. Because of the dependence of feed conversion ratio on feeding level, fish farmer should choose the optimum FCR which can offer better growth and less mortality. Thus feeding level of g=0.2 over 12 days of experiment is recommended for catfish larvae culture.

Key words: *Artemia nauplii* · FCR · SGR · Larviculture

INTRODUCTION

Fingerling production is one of the many challenges faced by those interested in promoting industrial production of emerging marine and fresh water species. In spite of huge efforts to use artificial feeds, the culture of fish larvae during the primary nursing phase still depends heavily on natural food. Live feeds include rotifers, *Artemia* and other tiny organisms are often the first foods in the aquaculture food chain. The fact that *Artemia* cysts can be stored in cans for longer period and only 24h of incubation make them the most convenient, least labour intensive live food available for aquaculture. *Clarias gariepinus* is generally considered to be one of the most important tropical catfish species for aquaculture and since the 1970's, it has been considered to be a fish of great promise for fish farming in Africa. Its growth rate is high; it is very resistant and appreciated in a wide number of African consumers.

Larval nutrition and live feed culture like *Artemia* and rotifers is one of the most important and obligatory matter for successful fish culture. Feeding with live prey for fish larvae are most essential because during first few days of their life they have no complete develop digestive tract, especially their digestive enzymes. Moreover, live prey increases feeding by predatory larvae, resulting reduce cannibalism of some species like *Clarius gariepinus* and enhancing larval production. *Clarius gariepinus* is generally considered as predator or omnivorous and also commercially important fish for aquaculture because they are able to tolerate to extreme environment conditions and worldwide demand. The larvae of African catfish are fed on live food *Artemia* nauplii during their first developmental stage until weaned on artificial dry diets. Various external and internal factors are also controlled the larval growth.

In Bangladesh, no attempts has been made on this type of study. However, few works have been carried out

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in many parts of the world. In feeding trials a formulated diet was evaluated for the intensive rearing of *Clarias gariepinus* larvae by Appelbaum and Damme [1]. Studies on the nutritional physiology of larval fish provide the basis for defining the length of the larval period and for understanding the quantitative and the qualitative feed requirements of the larvae. The capacity of the larvae to acclimate physiologically to different nutritional conditions seems to be limited [2]. Soybean meal replacement by roquette (*Eruca sativa* Miller) seed meal as protein feedstuff in diets for African Catfish, *Clarias gariepinus*, fingerlings studied by Fagbenro [3]. Awaiss and Kestemont [4] studied the suitability of the freshwater rotifer *Brachionus calyciflorus* as starting food for the larviculture of African catfish, *Clarias gariepinus.* Martins *et al.* [5] carried out a study to quantify the consistency of individual differences in growth, feed intake/efficiency and feeding behaviour. The satiation time, stomach capacity, gastric evacuation rate and return of appetite were investigated in *Clarias gariepinus* larvae was studied by Haylor [6]. Growth of larval sharptooth catfish *Clarias gariepinus* fed live *Artemia nauplii*, a specially prepared dry feed (MN-3), a commercial dry salmon starter feed (Silver Cup 3600), or a combination of 50% live *Artemia* and 50% MN-3, under conditions of either light or dark for 21 days was studied by Appelbaum and Mcgeer [7].

Cycles of movement and feeding of African catfish, *Clarias gariepinus* fingerlings were studied using an infrared illumination and video recording system by Hussain *et al.* [8]. Haylor [9] studied the growth and survival of *Clarias gariepinus* (Burchell) fry at high stocking density. Dry diets containing either fish meal or dried fermented fish silage and soybean meal blend as the sole protein source, were fed to triplicate groups of juvenile *Clarias gariepinus* at 5% body weight per day for 70 days by Fagbenro *et al.* [10]. A comparative study of larval growth in the different species of the genus Clarias in different regions studied by Verreth *et al.* [11]. Al-Dohail [12] carried out an experiment to evaluate the effects of the probiotic, Lactobacillus acidophilus, on the growth performance, haematology parameters and immunoglobulin concentration. Sorgeloos *et al.* [13] and Verreth and Bieman [14] studied the use of artemia in African catfish larviculture.

Understanding the major causes of growth variation is crucial for the success of fish farming since its reduction contributes to maximize production efficiency, reduce food waste and improve water quality. Many progresses have been made so far on the development of aquaculture, however, larval rearing remains the bottleneck in *C. gariepinus* production. The use of *Artemia* nauplia at the earlier stage of fry development seems to be one of the solutions to improve the production. The objectives of this experiment was to know the effects of different feeding levels on growth performance and survival of African cat fish (*Clarias gariepinus*) larvae with the newly hatched *Artemia* nauplii and artificial feed.

MATERIALS AND METHODS

The larvae of the *Clarius gariepinus* bought from the farm Fleuren-Nooijen in Someren, Netherlands and they were acclimatized to the culture condition in the laboratory of Aquaculture and *Artemia* Reference Center. Fish larvae were introduced into 16 tanks, each of 20 L water capacity (by 4 groups, each group maintained 4 tanks). Before introducing the larvae in the tanks we set up biofilter of 20 L volume against each rearing tank which consists of good recirculation system whereas water was continuously recirculated by air water lift with a rate of 1L/minute. A 150 μm rectangular screen filter was used in each tank to prevent loss of larvae and feed. Each tank contained 1040 catfish larvae that were randomly distributed in four treatments of feeding levels with four replicates of each. Feeding was given for each group 3 times per day at 8.00, 13.00 and 18.00 hrs. Every 3 days later, each group was sampled, whereas 40 fish larvae from every replicate were taken to measure the wet and dry weight (100°C, 4 h) by electric balance. Based on the measurements and survival rate, the feed are adjusted for the next three days. First 4 days of the larval experiment, larvae exclusively fed *Artemia* nauplli, next 3 days co-feeding with *Artemia* nauplli and rest of the experimental period only artificial feed were supplied. Water temperature has been checked regularly from both biofilter and larval tank and other water quality parameters specially NO_3^- and NO_2^- were tested with Merck test kits 2/3 days per week. Water loss due to evaporation from the larval tanks was replaced with some fresh warm water to maintain/minimize the stress of the larvae.

RESULTS AND DISCUSSION

Growth performance of catfish larvae was evaluated in different feeding level groups in terms of survival and mortality rate, specific growth rate, food conversion ratio etc.

Fig. 1 reveals that the wet weight of the different groups was not the same. This means that the growth of different larvae groups was different . Group 4 used high feeding level than others and that why their growth larval was higher than another groups. Comparatively, the larval

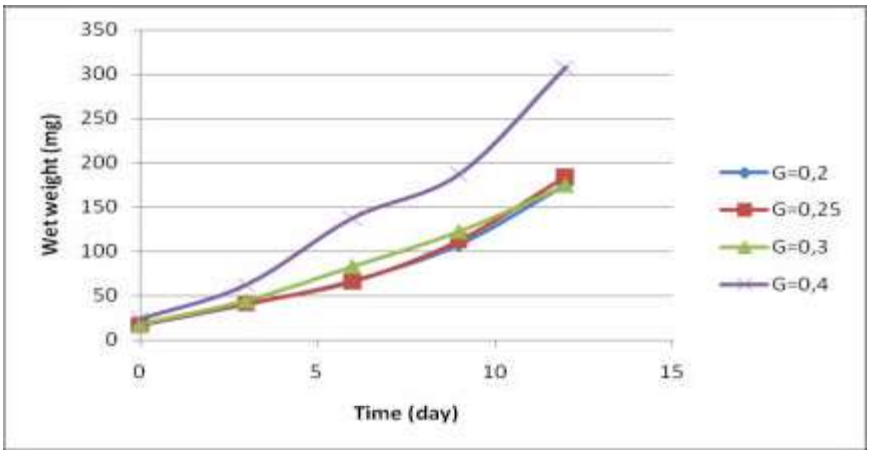

Fig. 1: Wet weight of groups over time

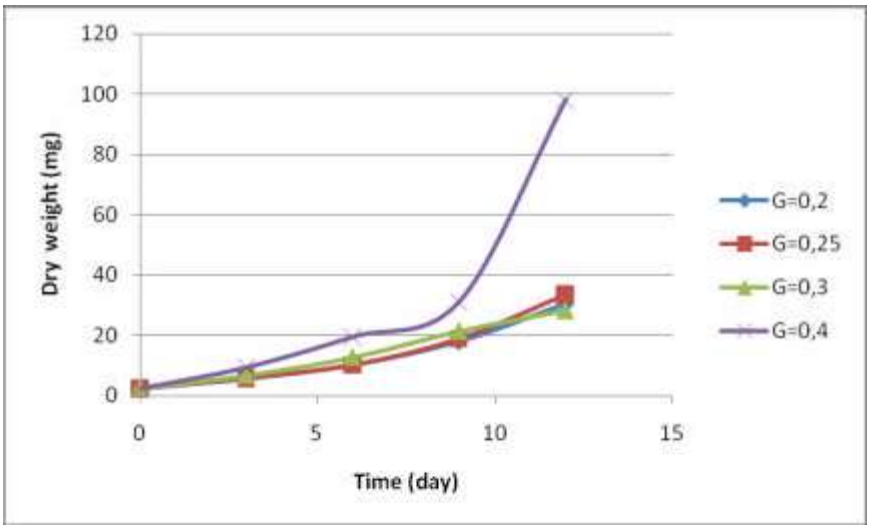

Fig. 2: Dry weight of groups over time

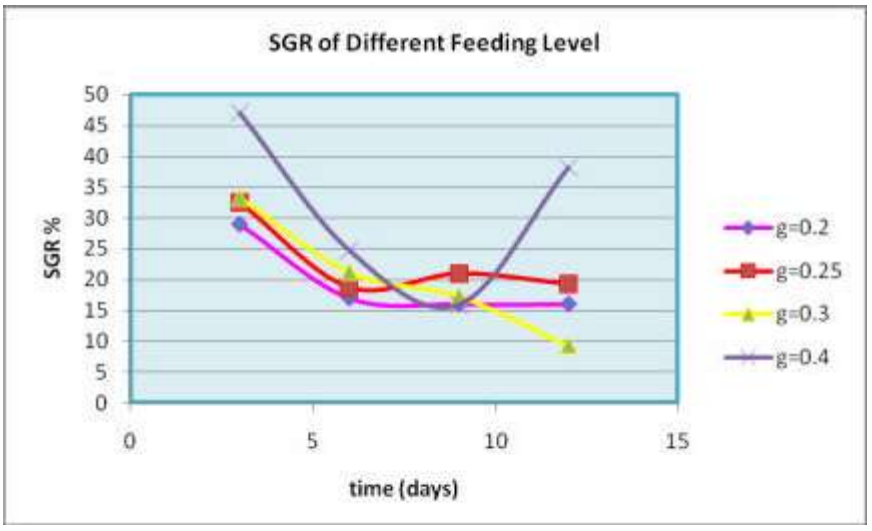

Fig. 3: SGR at different feeding levels with respect to time

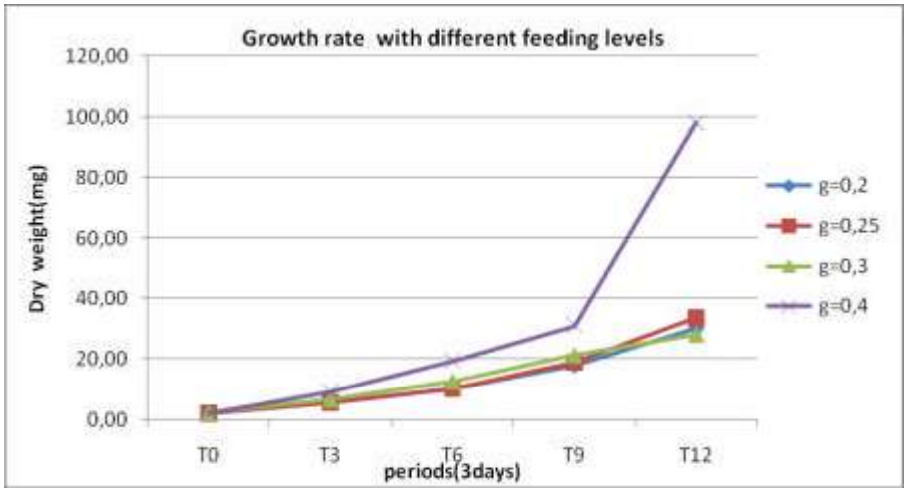

Fig. 4: Growth of fish larvae (dry weight) on different feeding levels over 12 days period

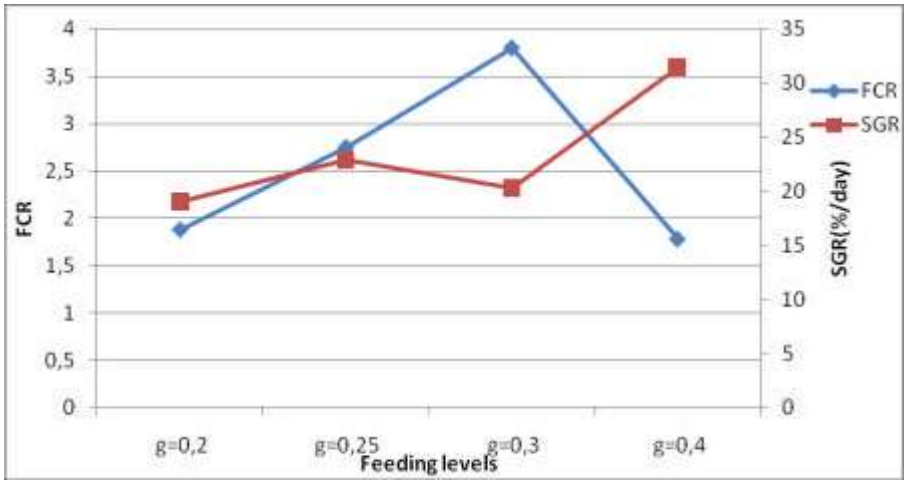

Fig. 5: FCR and specific growth rate on different feeding levels over a 12 days periods

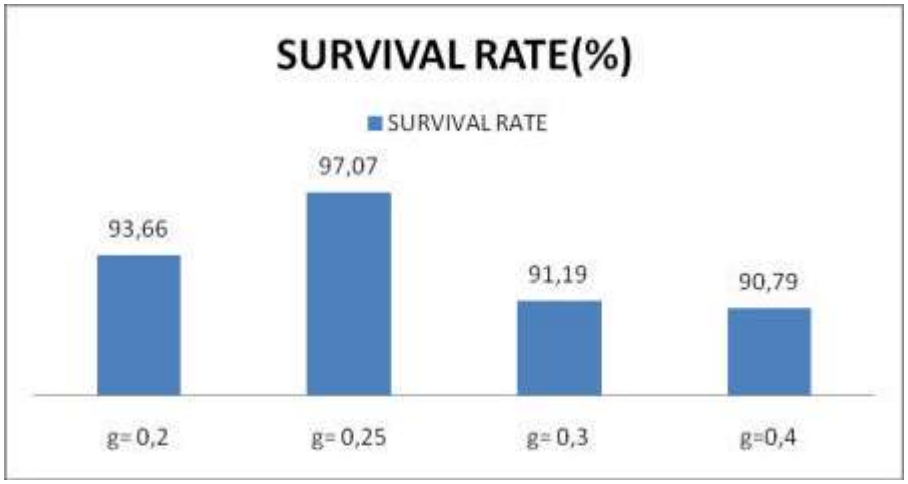

Fig. 6: Fish survival on different feeding levels over a 12 days period

growth of group 3 is lower than group 1 and 2, because they used higher feeding level, so it was concluded that higher growth depends on good quality higher feeding level.

Fig. 2 shows that the growths were also depend on higher feeding level. We also see that the larval growth of group 4 are higher than other groups because of the higher feeding level. Although, remarkable that the initial growth of group 4 was lower. Fig.1 and Fig. 2 indicate that the larval weight were dependent on the amount of food, higher amount of feed lead to higher growth.

Above graphs also, showing that low amount of food with better FCR can be obtain from *Artemia* than the artificial feed. The increased amount of artificial feed increased the FCR, but decreased the growth rate of fish.

Fig. 3 shows that in the case of all groups the initial growth was decreasing. During experiments 1 and 2 the larval growth was not increasing, the feeding level 3 showed continuously decreasing and in feeding level 4, growth firstly decreasing and at the end of this experiment, it again increased. According to the feeding level the specific growth rate of groups 2 and 4 were better than groups 1 and 3. Group 3 used more feed than group 2, but SGR of group 3 was decreased.

Figure 5 shows that all specific growth rates were differing by different feeding levels. In case of group 1, low FCR with a little bit high SGR is obvious. Iin group 2 approximately same results for both FCR and SGR were obtained. In the case of group 3, high FCR but low SGR was clear and finally group 4 had low FCR with high SGR. FCR and SGR ratio was positive but group 4 was different. Group 3 was complete unsatisfactory even as compared to group 2.

According to the Fig. 5, the best growth rates were found in group 4 with high amount of feed (feeding level-0.04) while giving low FCR. We observed that the feeding level of 0.3 (group 3) has shown high FCR but low growth rate, possibly there may be some errors occurred. In the feeding levels 0.2 (Group 1) , the amount of food increases, FCR decreased and the specific growth rate increased than feeding level 0.25 (Group 2). It would be possible to get better growth rate of fish larvae if the water quality parameters were maintained with high amount of feed. During this experiment we saw some cannibalism which indicated that there was not enough food for their growth and the larger one started feeding smaller one. So, for reducing cannibalism and healthy weighty fish we should avoid adding low amount of food, despite the moderate FCR while specific growth rate was high. By the above discussion, we can conclude that overall nice growths (both actual and SGR) depends on food quality and quantity, environmental condition etc. and in this case it was better if feeding level was maintained below 0.4.

Fig. 4 shows the increase of the mean body weight of fish larvae at different levels over a 12 days period. The figures clearly depicted that, an increasing of feeding levels leads to a slight increased of the growth rate of fish larvae from day 1 to 9. After day 12, the fish larvae growth rate at feeding level of 0.3 was lower than for other feeding levels. At the end of the experiment, the total growth of fish larvae was quite similar for the feeding level of g = 0.2, 0.2.5 and 0.3. This results lead to an evidence that the growth of fish at the highest feeding level (g =0.4) was higher and seems to be significantly different from other feeding levels.

The results of our study shows that the specific growth rate of fish larvae on different feeding levels dropped rapidly from day 0 to 3.After this period, it continues to gently drop up to the end of the experiment. However, at the highest feeding level of g= 0.4 growth rate suddenly increased from day 9 to 12 (Fig. 4). As it is shown in Fig. 5, an increase of feeding level lead to an increase of the growth of fish larvae. It was also noticed that the growth rate started to decrease with the feeding level of g= 0.3. The highest specific growth rate obtained at the highest feeding level g = 0. 4.

The Fig. 5 shows the evolution of food conversion rate of *Artemia* and artificial food at different period of the experiment. During the first 3 days period of experiment, FCR of *Artemia* nauplii at the feeding level g = 0.3 was 2.53, lower than FCR of artificial food (4.36) from day 6 to 12. After 12 days period of the experiment the FCR increased steadily with the increased feed level; It reached the maximum of 3.80 at the feeding level of g 0.3 then decreased suddenly at the highest feeding level (g=0.4).

Fig. 6 shows that overall survival rate was good. Feeding rate was very important for survival. Because if do not maintain proper feeding timely the larvae especially this Catfish larvae showed cannibalistic behavior. By looking above graph we show that group 2 has high survival rate comparatively using low feeding level than group 3 and 4. Though group 3 and 4 used very different feeding rate but their survival rate almost same, whereas group 1 used lowest feeding level than also their survival rate higher than group 3 and 4. For low survival rate of group 3 and 4 it might be due to canibilistic behabior of this fish. In feeding trials a formulated diet was evaluated for the intensive rearing of *Clarias gariepinus* larvae by Allelbaum and Damme [1]. After a 15-day feeding period, at a stocking density of 20/1, fish reached a mean total

length of 26.2 mm and a mean weight of 141.0 mg. Survival after 15 days was higher than 78 % in all densities. Cannibalism was the main cause of mortality and was responsible for losses of up to 28 % after 45 days. This study confirmed that the experimental dry food was a good starter feed which may satisfy the nutritional requirements of the larvae [1].

Over 12 days of experiment, the increase of feeding level increased the growth of fish larvae slightly. At the feeding level g= 0.3 it decreased suddenly but increased even further at the highest feeding level (g =0.4). The growth rates were maximized at a feeding level 0.25 with the highest specific growth rate of 22.87%/day over a12 days period. As expected, the growth of fish at early stage for short culture periods was high in all feeding levels at the beginning of the experiment and decreased faster. For instance, the specific growth rate of fish on feeding level g=0.3, decreased from 33.28 to 8.99 % / day within only 12 days period of experiment. Studies on the nutritional physiology of larval fish should provide the basis for defining the length of the larval period and for understanding the quantitative and the qualitative feed requirements of the larvae. The suitability of the freshwater rotifer *Brachionus calyciflorus* as starting food for the larviculture of African catfish, *Clarias gariepinus* Burchell, was investigated. The best results for survival were observed when rotifers were supplied during the first week of feeding, i.e. reaching 99.2 and 96.3%, respectively. The specific growth rate of larvae was largely dependent on the duration of preliminary feeding with the rotifers. A feeding with rotifers as a unique food source did not produce satisfactory growth during the first week of feeding. A precocious weaning showed that the highest growth rate and protein efficiency ratio (PER) can be obtained by feeding the larvae rotifers in association with a dry diet [4].

Food conversion ratio (FCR) of *Artemia* nauplii at the g= 0.3 for the first 3 days of the experiment (2.53) were lower than the FCR of the artificial food from day 6 to 12. Fish larvae tend to use *Artemia* more efficiently than artificial food. From our work it difficult to clearly give a conclusion concerning the rate of consumption of the two types of food used because live food and artificial feed were not eaten by fish larvae at the same periods of time. The lowest food conversion recorded were 1.88 at the feeding level of 0.2. From Fig. 5, we can see that an increase of feeding level lead to increase of food conversion ratio but with rather the slight increase of specific growth rate. While dry diets promoted higher growth rate than live *Artemia* nauplii alone, a combination of the two resulted in the fastest growth [7]. Cycles of movement and feeding of African catfish, *Clarias gariepinus* (Burchell 1822) fingerlings (113.48 ± 1.87 mm total length) were studied using an infrared illumination and video recording system. The fish were nocturnal and took over 70% of their daily ration at night when given access to food 24 h a day. When feeding was restricted to the light phase, feeding activity decreased, but nocturnal feeding was restored from the second day after a return to 24-h food access [8]. The growth and survival of *Clarias gariepinus* (Burchell) fry was investigated at high stocking density. Fry growth was negatively density dependent. Fry survival was in excess of 90% in all treatments. Increasing stocking density between 50 and 150 fish/l altered the pattern of mortality; non-cannibalistic deaths decreased significantly with increasing stocking density though cannibalism did not significantly increase. Periods of weaning fish onto larger feed particles were associated with temporarily increased rates of cannibalism [6]. Two day-old larvae swam horizontally, had sharp teeth, commenced ingesting rotifers and also artificial feed (small-size pellets) under both light and dark conditions; by then the larvae already had many taste buds. Three day-old larvae showed negative phototaxis and cannibalism by eating their conspecifics [5].

Fish growth reached its maximum at feeding level 0.25 and slight increase of feeding level to 0.3 conferred the decrease of growth rate. Giving more food to fish larvae increased the availability of food to larvae but can decrease their efficiency of using that food. High concentration of uneaten food and feces increase bacteria activity with the depletion of oxygen level and increased of Co_2 concentration level. This may lower the respiration efficiency and thus reduces appetite of fish. The excess and uneaten food was siphoned everyday and water quality daily checked to avoid such anaerobic effects. The ammonia concentration with g=0.3 was frequently higher than 0.05mg/l. This might seriously affect the growth of fish larvae. Dry diets containing either fish meal (C-FM) or dried fermented fish silage and soybean meal blend (1:1, ww^{-1}) (C-FS) as the sole protein source, were fed to triplicate groups of juvenile *Clarias gariepinus* (10.8 ± 0.3 g) at 5% body weight per day for 70 days. Catfish fed the C-FS diet showed reduced ($P < 0.05$) growth rate, feed conversion, protein efficiency and digestibility. Lower amounts of available amino acids in the C-FS diet resulted in inferior nutritive value for catfish growth than in the C-FM diet. *C. gariepinus* cannot metabolize protein from co-dried fish silage as efficiently as fish meal protein when used as the sole dietary protein [10].

A comparative study of larval growth in the different species of the genus Clarias in different regions revealed that in spite of strong differences in egg and larval size, the growth potential was quite similar. At the start of exogenous feeding, the larvae of *C. gariepinus* have an advanced digestive system with a functional pancreas, liver and nutrient absorption capabilities, but lack a functional stomach. Probably because of the rapid development of the digestive system, feeding live food organisms is mostly practiced for a few days only and is soon replaced by wet and/or dry diets. It was hypothesized that the requirement of live food or specific larval diets during the first days of exogenous feeding is related to the absence of pepsin digestion during this period [11].

The highest fish survival rate recorded were 97.07 % with the feeding level of 0.25 which corresponds also to the highest growth rate of fish. Fish mortality at feeding levels 0.2; 0.3; 0.4 were not significantly different; nevertheless, the highest feeding level offered the highest mortality rate (Fig. 6). In order to keep the mortality rate at the lower level, to minimize the fish stress and offers better environment for the growth of fish larvae, regular monitoring of water quality parameters were conducted for each tank before feeding in order to maintain the water quality at acceptance range. Despite the low variation in initial body weight (6.5%) and cumulative feed consumption (7.5%) over the experimental period, catfish exhibited high variation in final body weight (18.1%), specific growth rate (17.2%) and feed conversion ratio (27.9%), suggesting that individual variation in growth efficiency is important in determining growth rate. This individual variation may be related with individual differences in protein/fat deposition since faster growing fish deposited more protein and less fat than slower growing fish [5].

Over 12 days of experiment, the highest specific growth rate was observed at the feeding level (g = 0.25) whereas better FCR for the lower feeding level (g = 0.2). At feeding level of 0.25, fish larvae seemed to be overfed because food conversion ratio starts to increase and offered better growth. Above this feeding level, fish growth decreased suddenly. The highest survival rate was obtained at feeding level g = 0.25.

It can be concluded that optimum feeding level should be maintained to achieve better survival and FCR. But less feeding might be result in less survival rate and less growth. Because of the dependence of feed conversion ratio on feeding level, fish farmer should choose the optimum FCR which can offer better growth and less mortality. Thus feeding level of g=0.2 over 12 days of experiment is recommended for catfish larvae culture.

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