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An Assessment of the Use of *Ceriodaphnia,* Decapsulated Egg Yolk and Raw Egg Albumen in the Feeding of *Clarias gariepinus* Larvae

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Abstract: This study assessed the use of *Ceriodaphnia,* decapsulated egg yolk and raw egg albumen in the feeding of *Clarias gariepinus* larvae for a period of four weeks. *C. gariepinus* broodstock were induced to spawn using ovaprim at a dosage rate of 0.3ml/kg (female) and 0.1ml/kg (male). Latency period and approximate time of hatching were 10hrs 15min and 26hrs 25min respectively. Catfish larvae of mean weight 0.25 ± 0.01g and mean length 0.50 ± 0.01cm were stocked at the rate of 50 larvae/tank into six aerated plastic aquaria tanks (10L capacity each). The larvae fed *Ceriodaphnia* recorded the best growth with a mean weight gain of 6.26 ± 0.05g, while the larvae fed decapsulated egg yolk and raw egg albumen recorded mean weight loss of -0.04 ± 0.03g and -0.15 ± 0.06g respectively. The best specific growth rate (SGR), 14.07 ± 0.03, was recorded in larvae fed *Ceriodaphnia,* with values of -0.83 ± 0.16 and -6.58 ± 0.46 recorded in larvae fed decapsulated egg yolk and raw egg albumen respectively. At the end of the feeding trial, 88, 0 and 0% survival were recorded for larvae fed *Ceriodaphnia,* decapsulated egg yolk and raw egg albumen diets respectively. Consequently, it is recommended that *Clarias gariepinus* larvae be fed with *Ceriodaphnia* for the first four weeks after hatching.

Key words: *Ceriodaphnia* ·Egg yolk · Egg albumen ·*Clarias gariepinus*

INTRODUCTION

The demand for fresh and frozen fish in the diet of Nigerians is increasing, particularly with the reduction of the traditional source of animal protein (cattle production) due to effects of drought, diseases and high cost of feeds. With the constant rise in population, fish supply from the wild has not been able to meet up with the ever-increasing demand for fish. In view of this large deficit in fish supply, there appears therefore an urgent need to increase the intensification of fish production in Nigeria. With the reduction in catch from inshore fisheries due to over-exploitation of most commercial marine species and the increased cost of offshore fishing, the alternative source of supply and meeting domestic demand for fish is aquaculture. However, one of the major constraints facing the development of aquaculture in Nigeria is the problem of providing feed that is of high quality and in adequate quantity. Nutrition plays a vital role in aquaculture; in the production of finfish and shellfish of any culture system, a major part of the operational costs is due to feeds. Fish culture is highly unimaginable without the artificial mass propagation of fish seeds of cultured fish species. The need for the production of quality fish seed for stocking artificial ponds and natural water bodies has been steadily increasing and hatchery-produced seeds through artificial propagation constitute the only practicable means of producing enough quality fish seeds.

The African catfish (*Clarias gariepinus*) is a remarkable and fascinating fish. Biologically, it has all the attributes of a premier aquaculture species [1]. Its biology and life-history is well known. Despite all these, total production of clariid catfish in Africa is relatively low and this could be pinned on market forces, inadequate and regional infrastructure and high production cost. Nevertheless, the potential for the production of *Clarias gariepinus* throughout its distributional range is immense. Due to the high densities at which catfish larvae are reared, it is essential that a reliable source of high quality larval feed, which satisfies all nutritional requirements, is always and readily available. Fish larvae require live feed organisms at the onset of exogenous feeding [2] and live feed organisms create a conducive natural environment

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for cultured fish [3]. Fish larvae have been successfully reared on various species of zooplankton as reported for hybrid *Clarias* 'Heteroclarias' [4], *Heterobranchus* longifilis [5], the walking catfish *Clarias* batrachus [6] and the snakehead *Channa striatus* [7]. A typical live feed that can be used to feed fish larvae is *Ceriodaphnia;* a water flea that belongs to the crustaceans, a large group of jointed-limbed animals, most of which live in water and move through the water by a short hopping movement. They feed on bacteria, fine detritus and very small algae. Aside from live feed, egg is also regarded as one of the most nutritionally balanced food known for man and animals. The ability of yolk and white to remain separate during the cooking of unprocessed egg, plus the fine granular texture of boiled egg yolk have indeed provided aquaculturist with a practical artificial diet superior to most other artificial feeds [8]. Whole egg contains all the necessary nutrients needed during the first ten days of life of most species of fish and possesses all the characteristics desired in feed for very young fish. These characteristics include wholesomeness, consistency, water stability, low biological oxygen demand, long shelf life and ease of preparation. Egg yolk has been used in the rearing of larvae of *Helostoma temmincki* [9] and *Pangasius sutchi* [10].

In view of the immense production potential of the African catfish, *Clarias gariepinus* and the need to provide a reliable source of high quality larval feed, this study examines the nutritive values of *Ceriodaphnia,* decapsulated egg yolk and raw egg albumen as first feed in the feeding of the African catfish larvae.

MATERIALS AND METHODS

Larval Rearing and Experimental Set Up: One male (380g) and two female (average weight, 310g) broodstocks of *Clarias gariepinus* were obtained from SejFarms in Lagos, southwest Nigeria. The male and female brooders were injected with ovaprim at 0.1 and 0.3ml/kg body weight of fish respectively. The methods of Viveen *et al.*[1] were followed for the breeding, spawning and hatching of fertilized eggs. Hatching occurred between 24 - 36 hours after fertilization. Fertilized eggs hatched into larvae, which absorbed their yolk after 72 hours. The larvae were collected, weighed and distributed into six plastic aquaria tanks each of 10L capacity at a density of 5 larvae per litre. The stocking density was 50 larvae/tank, with a mean larval weight of 0.25 ± 0.01g. Two replicates were used for each dietary treatment.

Dietary Treatment: Using plankton net, live *Ceriodaphnia* sp. were collected from a stagnant pool of water in the Ojo area of Lagos, southwest Nigeria. Collection was not difficult because the zooplankton clustered together at the edges of the stagnant water. The *Ceriodaphnia* were rinsed thoroughly with borehole water and then inoculated into four concrete tanks which have been previously fertilized with cow dung manure at a rate of 250mg/L of water. In about the 7^{th} - 9^{th} day, there was population increase. Daily, *Ceriodaphnia* were collected from these tanks and fed to the larval fish. Fertilization of water in the tanks was done every week using half of the initial amount of the cow dung (125mg of cow dung/L of water). The egg diets were prepared on a daily basis. Raw egg albumen was separated from egg yolk and put in different bowls. The raw egg yolk was then whisked with a spoon. Warm water of a temperature of about 65°C was added to the whisked egg at a ratio of 1:1. The mixture was left to coagulate for some seconds and then whisked. This gave a milky suspension which was fed to the fish larvae.

Feeding Trial: Larvae of the African catfish, *Clarias gariepinus* were exposed to the three different dietary treatments. Two replicates were used for each dietary treatment. *Ceriodaphnia* was fed to larvae in tanks labelled T_1a and T_1b, while those in tanks T_2a and T_2b were fed with decapsulated egg yolk. Larvae in tanks T_3a and T_3b were fed with raw egg albumen. Feeding was done manually three times daily (07:00h, 12:00h and 17:00h) and the larvae were fed to satiation. Care was taken to remove all uneaten feed and faeces every morning before feeding was done. The average weight readings were recorded on a weekly basis. The weight was measured with a top-loading Mettler balance (Model PE1600) to the nearest 0.01g. The length of the larvae was measured every week on a measuring board to the nearest 0.01cm. Records of survival were taken on a weekly basis

Statistical Analysis: The following parameters were calculated from the data collected and the data collected were analyzed using the one-way analysis of variance (ANOVA). Significant differences among the treatments were tested using the Least Square Difference (LSD) Multiple Comparisons Test. The analyses were tested for significance at 5% level of significance and all the analyses were performed using the SPSS Version 13.0.

Weight gain (WTG) = Final weight - Initial weight
Length gain (LTG) = Final length - Initial length

$$\text{Specific growth rate (SGR)} = \frac{\text{Loge}W_2 - \text{Loge}W_1}{T} \times 100$$

Where W_2 = Final weight of fish
W_1 = Initial weight of fish
Log_e = Natural log to base e
T = Experimental period in days

$$\text{Survival (\%)} = \frac{N_o - N_t}{N_o} \times 100$$

Where No = Total number of larvae at the beginning of the experiment
N_t = Total number of dead larvae at the end of the experiment (28 days)

Physico-chemical Parameters: About 50% of water in the tanks was exchanged with fresh water every morning and aerators were used for adequate circulation of the dissolved oxygen. Water temperature was measured daily with a mercury-in-glass thermometer and the hydrogen-ion concentration with a pH meter (Jenway Model 9060). Other water parameters such as alkalinity, dissolved oxygen, dissolved carbon dioxide and ammonia levels were determined in accordance with the methods of APHA [11].

RESULTS

The weight changes in *C. gariepinus* larvae fed the different experimental diets are presented in Figure 1. There was a consistent increase in weight in larvae fed *Ceriodaphnia* diet, while larvae fed decapsulated egg yolk and raw egg albumen diets recorded slight weight increase in week 1, but decreased in weight in subsequent weeks. Fish larvae fed with *Ceriodaphnia* recorded the best final weight of 6.51 ± 0.02g, while those fed with decapsulated egg yolk and egg albumen recorded final weight values of 0.21 ± 0.04 and 0.10 ± 0.03g respectively. The growth performance results of *C. gariepinus* larvae fed with the three different experimental diets are presented in Table 1. There was a significant difference ($p < 0.05$) in the weight gains of the fish larvae. Larvae fed with *Ceriodaphnia* recorded weight gain of 6.26 ± 0.05g, while the larvae fed with decapsulated egg yolk and egg albumen recorded weight losses of -0.04 ± 0.03 and -0.15 ± 0.06g respectively. The best specific growth rate (SGR) value of 14.07 ± 0.03% was recorded with larvae fed *Ceriodaphnia.* The SGR value for larvae fed with decapsulaed egg yolk was -0.83 ± 0.16% and -6.58 ± 0.46% for egg albumen.

The survival records of larvae fed the different experimental diets showed that, at the end of the experiment, larvae fed *Ceriodaphnia* recorded a slight mortality of 12%, with a percentage survival of 88%. Larvae fed with decapsulated egg yolk and raw egg albumen recorded very high mortalities, such that by the 4^{th} week of the experiment, there was no record of surviving larva. The mean temperature, pH and alkalinity values in all the tanks were within the recommended range for the culture of catfish larvae, while there were marked differences in the dissolved oxygen (DO) and ammonia levels. For the DO, the tank with *Ceriodaphnia* diet recorded 7.62 ± 0.12mg/l, while tanks with decapsulated egg yolk and raw egg albumen recorded 3.37 ± 0.07 and 3.31 ± 0.14mg/l respectively. The mean ammonia level recorded in the tank with *Ceriodaphnia* diet was 0.03 ± 0.01mg/l, while the respective values for tanks with decapsulated egg yolk and raw egg albumen were 0.84 ± 0.01 and 0.93 ± 0.01mg/l.

Table 1: Growth responses of *Clarias gariepinus* larvae fed different experimental diets

	Diet 1 Live *Ceriodaphnia sp.*	Diet 2 Decapsulated egg yolk	Diet 3Raw egg albumen
Initial weight (g)	0.25 ± 0.01	0.25 ± 0.01	0.25 ± 0.01
Initial length (cm)	0.51 ± 0.03	0.51 ± 0.02	0.50 ± 0.01
Final weight (g)	6.51 ± 0.02^c	0.21 ± 0.04^b	0.10 ± 0.03^a
Final length (cm)	4.07 ± 0.06^c	0.74 ± 0.03^b	0.55 ± 0.04^a
Weight gain (g)	6.26 ± 0.05^c	-0.04 ± 0.03^b	-0.15 ± 0.06^a
Length gain (cm)	3.56 ± 0.05^c	0.23 ± 0.01^b	0.05 ± 0.02^a
Specific growth rate	14.07 ± 0.03^c	-0.83 ± 0.16^b	-6.58 ± 0.46^a
Survival	88.00 ± 12.00^b	0.00 ± 47.70^a	0.00 ± 37.47^a

Figures in the same horizontal row with different superscripts are significant ($p < 0.05$)

Figures in the same horizontal row without superscripts are not significant ($p > 0.05$)

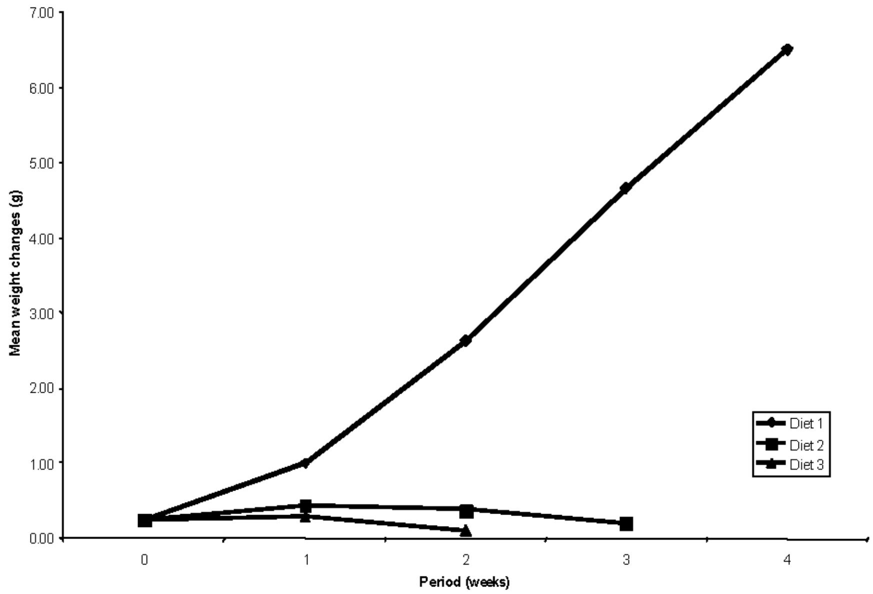

Fig. 1: Mean weight changes in *Clarias gariepinus* fed different experimental diets

DISCUSSION

A measure of the acceptability of any fish feed is the growth rate of the fish due to the feed. Weight gain of larvae fed *Ceriodaphnia* increased for the first three weeks, after which there was a slight decrease in the fourth week. It has been reported that live diets contain exogenous substances such as enzymes, gut neuropeptides and nutritional growth factors which enhance digestive efficiencies [12]. Also, *Ceriodaphnia* being a freshwater zooplankton can survive for many hours in water and this makes it more available than the egg diets which after some hours in water would deteriorate. The slight decrease recorded in the fourth week could be attributed to the need for a supplemental feed since the larvae had increased in size and were observed to respond more actively at feeding sites and within a short time consumed all the feed introduced into the water. Larvae fed decapsulated egg yolk and raw egg albumen recorded a slight increase in weight by week 1, but by the 2nd and 3rd weeks, a significant decrease was recorded. It was reported that *Corregonus fera* fry fed homogenized yolk registered no growth in the first three weeks [13], while the superiority of the diet combination of egg yolk and microworms over egg yolk alone in the feeding of *Helostoma temmincki* larvae was also reported [9]. The weight decrease recorded with the decapsulated egg yolk and raw egg albumen diets could be due to the fact that raw egg has a growth inhibitor (avidin) that must be deactivated before the egg can be fed to fish [8]. Deactivation of avidin is achieved by the application of heat on the raw egg. Since the egg diets used in this study were not treated to remove the growth inhibitor, this could have been responsible for the poor growth recorded with larvae fed the decapsulated egg yolk and raw egg albumen diets. Also, egg yolk is highly nutritious, but as a diet for young fish, its high energy-protein ratio could result in inadequate intake of protein necessary for maximum growth [8]. The poor growth of the African catfish larvae fed artificial diet has also been reported for other catfishes: *Chrysichthys nigrodigitatus* [14], *Clarias gariepinus* [15-17] and *Heterobranchus longifilis* [5]. This poor growth may be related to the texture of the dry feed, its digestibility and nutrient leach in water [4]. Furthermore, many fish larvae do not have enzymes for digesting artificial feeds and that digestion in these fish larvae is carried out by enzymes present in their live diets [18]. Thus, the lack of functional stomach, particularly the absence of proteolytic enzymes during the first few days of exogenous feeding, may also be responsible for the poor growth [5,19].

As a result of the hardy nature of the African catfish, survival has never been a serious issue in its culture. Although a slight mortality was recorded with the *Ceriodaphnia* diet, the survival rate of *C. gariepinus* larvae fed *Ceriodaphnia* showed that the larvae fed on live feed performed better than those fed egg diets. Low survival rates of *Helostoma temmincki* larvae fed egg yolk alone has also been reported [9]. The slight mortality recorded with the *Ceriodaphnia* diet could be attributed to the shooters which could have fed on the smaller fishes; moreso when cannibalism is regarded as one of the problems encountered in the culture of the African catfish larvae. The 100% mortality recorded with the decapsulated egg yolk and raw egg albumen diets could be as a result of the growth inhibitor (avidin) in the raw egg. Another factor which could have caused the high mortality recorded with the decapsulated egg yolk and raw egg albumen diets is the low dissolved oxygen level recorded in tanks with the egg diets which were 3.37 and 3.31mg/l respectively, compared to 7.62mg/l of dissolved oxygen recorded in the tank with *Ceriodaphnia*. Thus, since the dissolved oxygen levels recorded in the tanks with egg diets were lower than the minimum dissolved oxygen level of 5mg/l recommended for the proper growth of catfish [1], this could have resulted in the release of toxic substances such as methane, nitrites and sulphides, into the water, which could have resulted in the death of the larvae. Also, the high but seemingly biologically unavailable protein in the egg diets could have resulted in the release of ammonia into the water, which indicated that the egg diets could have caused serious organic pollution of the water. Consequently, this could have resulted in the high ammonia levels of 0.84 and 0.94mg/l recorded with the decapsulated egg yolk and raw egg albumen diets respectively. It has earlier been reported that a level of 0.6 - 2.0mg/l ammonia is toxic to fish, thus the levels recorded with the egg diets are toxic to the fish larvae. Hence, the high mortality recorded with the decapsulated egg yolk and raw egg albumen diets could also be due to the high ammonia levels. The temperature range of 26.9 - 27.3°C recorded for all the diets fall within the optimal temperature range for *C. gariepinus* larval growth [1]. Also, the range of pH values (6.79 - 6.92) obtained for all the diets were also within the recommended 6.5 - 8.0 range [1].

On the basis of results obtained from this study, feeding live feed (*Ceriodaphnia*) to *Clarias gariepinus* larvae as first feed is probably an efficient feeding strategy in accelerating the growth of the fish when compared to the egg diets. *Ceriodaphnia* might eventually be used to replace the imported and expensive *Artemia nauplii* in the feeding of catfish larvae, since it is readily available in most freshwaters in Africa. Furthermore, since egg yolk has been reported to contain all the nutrients necessary for the growth of young fish for the first ten days of life, the use of processed egg yolk in combination with live feed could also be encouraged in the larval culture of the African catfish.

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