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The Use of Lyophilized Egg White as First Feed for *Clarias Gariepinus* Hatchlings

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Abstract

This study is based on the use of lyophilized egg white fortified with cod liver oil as first feed for the hatchlings of *Clarias gariepinus*. Proximate analysis and mineral composition of the diet samples were carried out. ANOVA statistical analysis was used to determine the level of significance ($p<0.05$) or ($p>0.05$) in the survival rate of hatchlings samples. A total of 1200 hatchlings of *Clarias gariepinus* of an average length of 0.2 cm were collected after an artificial propagation. These samples were allotted into eight plastic tanks of 1 m × 0.5 m × 0.5 m each with an average number of 150 hatchlings per tank and placed in a hatchery. Four different fish diets were used namely Lyophilized egg white, lyophilized egg yolk, Coppens Starter feed® and Artemia. Some were purchased from the market while others were prepared in the laboratory by a process of Lyophilization (Freeze-drying). The trial went on for 14 days (2 weeks) and feeding was done to satiation. After 14 days treatment period with the various test diets, fry total length range from 0.7 cm to 1.0 cm for samples fed with the lyophilized and egg yolk and 1.0 cm-1.6 cm for the control group which were fed with artemia and starter feed. Mortality rate was very low as compared with other feed diets used while the survival rate was 60%, Fry survival in the treatment sample group was 70% while in the control group, it was 100% i.e no mortality was recorded.

Keywords: Egg white; Lyophilization; Clarias gariepinus; Hatchling; Fry; Survival; Egg yolk; Artemia

Introduction

The future of aquaculture production, as in livestock production systems, is towards greater control of the physical, chemical and biological variables surrounding the production system. Larval nutrition is a key element underpinning this progress towards greater control and domestication. However, there is substantial work to be done if rearing of aquaculture species is to attain the level of control and understanding which are evident in the poultry, swine and ruminant industries.

The problems of effective feed and gastronomical palatability have posed major constraint in sustainability and survival of hatchlings of *Clarias gariepinus*. Nutrition and feeding of finfish in semi-intensive pond-farming systems is complex and poorly understood. Little or no information exists on the dietary requirements under farming conditions for many of the species cultured. To a large extent, this is due to the difficulties of quantifying the contribution of naturally available food organisms to the overall nutritional budget of pond-raised finfish or crustaceans [1].

Freshwater larvae are fed with live foods such as algae, zooplankton, rotifers and *Artemia*. In some cases, especially with rotifers and *Artemia*, the fatty acid profile is inadequate, especially with regard to the HUFA (Highly Unsaturated Fatty Acids) profile. The practice of enrichment has been developed as a means of overcoming this nutritional deficiency. Given that feed is the biggest source of nutrient input in fish and shrimp aquaculture production, clear understanding of its impact is essential for sustainable in either intensive or semi-intensive production system. This will help reduce negative impacts and improve predictability of environmental effects. Present knowledge and understanding of the environmental impacts of aqua feed needs further assessment; however, it is generally acknowledged that these impacts can be reduced by feeding fish with more environmentally friendly diets, developing better feeding strategies and by a sound farm management. The African catfish, *Clarias gariepinus*, is one of the most highly valued species in Africa (Egypt, Ethiopia, Ghana, Mali and Nigeria) and Asia (China, Indonesia, Malaysia, Philippines and Thailand). Recently, *Clarias gariepinus* has been introduced in some European and Latin American countries and its culture has increased in scale [2]. African catfish is considered one of the best suitable alternatives to tilapia for subsistence fish farming in Africa.

Yields of catfish from ponds could be higher than those of tilapia while using low grade feed composed of local agricultural by-products. Enrichment of feeds usually involves enhancing the docosahexanoic acid (DHA) of the natural feed through 'bio-encapsulation'. This involves feeding the live organism with a DHA/EPA enriched formulation to boost the levels in the tissues and then feeding the enriched organism to the larvae. Using Shrimp larvae, the use of enriched *Artemia* is restricted to the post-larval stages is due to the size of the first feeding stages of the *Artemia* [3]. A planned production of *Clarias* hatchlings can be realized through artificial reproduction, including hypophysation followed by stripping of the females and dissection of the testes of the males to fertilize the eggs making it easy to produce several millions of hatchlings in no time further demanding suitable foods or prepared first feeds.

Clarias gariepinus is refined for its high development rate, sickness resistance and its tolerant of an extensive variety of temperature, and also oxygen and high saltiness levels. The better execution of Clarias gariepinus looked at than different Clarias species regarding development rate has likely added to the way that C. gariepinus has been generally

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acquainted with regions outside its common extent.

Feed used in commercial catfish production must contain all essential nutrients at adequate levels to meet total nutritional requirements of catfish for normal growth and development. The use of lyophilized egg white as a "complete" feed for *Clarias gariepinus* hatchlings is hereby encouraged. Egg white is the common name for the clear liquid (also called the albumen). The egg yolk consists mainly of about 76% proteins dissolved in water.

Lyophilization is a process more commonly known as freeze-drying. The word is derived from Greek, and means "made solvent-loving". Lyophilization is a way of drying organic matter or food items that minimizes damage to its internal structure. It is a relatively complex and expensive form of drying which is limited to those materials which are sensitive to heat and have delicate structures and substantial value. It keeps biological properties of proteins, and retains vitamins and bioactive compounds [4]. Lyophilization is a drying method whereby the solvent is frozen prior to drying. This process avoids collapse of the solid structure, leading to a low density, highly porous product, able to regain the solvent quickly. In biological materials, lyophilization is regarded as one of the best methods to retain the initial biological properties of the materials or foods. It is a process which extracts the water from foods and other products so that the foods or products remain stable and are easier to store at room temperature (ambient air temperature).

- Lyophilization helps to maintain food quality because the food remains at a temperature that is below the freezing-point during the process of sublimation; the use of lyophilization is particularly important when processing lactic acid bacteria, because these products are easily affected by heat.

- Some foods which are lyophilized can usually be stored without refrigeration, which results in a significant reduction of storage and transportation costs.

- Lyophilization greatly reduces weight, and this makes the products easier to transport. For example, many foods contain as much as 90% water. These foods are 10 times lighter after lyophilization process.

As a result of its porosity, most freeze-dried foods can be easily re-hydrated. Lyophilization does not significantly reduce volume; therefore water quickly regains its place in the molecular structure of the food.

Objectives of the Study

- To optimize nutrient utilization, development and survival.

- To determine the effective use of Lyophilized egg white in feeding hatchlings of *Clarias gariepinus*.

- To compare lyophilized egg white with Artemia feed in terms of length (cm) and weight (g) using statistical analysis.

Literature Review

Some live foods provide an excellent source of nutrition, there are several drawbacks associated with their use. Specific algal cultures require considerable expertise to maintain in peak nutritional condition and facilities for mass production can be expensive to operate. Rotifers also require considerable expenditure in time and effort to maintain, especially if they, in turn, need to be provided with live feed. Live *Artemia* nauplii undergo inconsistent supply and quality as they are obtained from cysts collected in the wild environment (this is a significant problem). The bulk of cysts come from the Great Salt Lake in Utah in the US where annual fluctuations have been shown to cause wide fluctuations in yield. As a result, price and quality can vary unpredictably [5].

The findings of Wang and Zirong [5], who found that the addition of different bacterial strain (photosynthetic bacteria (PSB) and lyophilized *Bacillus* sp. (B) and their mix) in common carp basal diets improved growth performances, feed utilization and digestive enzyme activities compare to the control diet. In the same trend, bacterial probiotics have been found to influence positively on growth rate in juvenile carp *Cyprinus carpio* L [6]. Lara-Flores et al. observed that, yeast produced the best growth performance and feed efficiency in Nile tilapia *Oreochromis niloticus*. Kennedy et al. showed that the addition of a gram-positive probiotic bacterium to diets increased survival and growth rate of marine fish larvae (snook, red drum, spotted seatrout and stripped mullet). In contrast, Gildberg et al. and Efthimiou found that there was no effect of probiotics on growth performance was observed in Atlantic salmon fry and dentex, respectively. Also, Shariff et al. and McIntosh et al. [7] found that treatment of *P. monodon* and *Litopenaeus vannamei* with a commercial Bacillus probiotic did not significantly increase ($p \geq 0.05$) either survival or growth. improved growth efficiency in catfish in the current study could be due to the synthesis of a range of relevant digestive enzymes (amylase, protease and lipase). These enzymes would enhance growth performance as a result of higher nutrient digestibility, which could explain the better growth and feed efficiency seen with the supplemented diets. Also, probiotics have been shown to have effects on digestive processes by promoting the population of beneficial micro-organism, microbial enzyme activity, improve intestinal microbial balance, consequently improving digestibility and absorption of food and feed utilization [8]. Another possible reason for improving growth performance and feed efficiency may be due to the role of probiotics by inhibit the colonization of potential pathogens in the digestive tract by antibiosis or by competition for nutrients and space and alteration of microbial metabolism.

Probiotics can also improve nutrition by detoxifying the potentially harmful compounds in feeds, by denaturing the potentially indigestible components in the diet by hydrolytic enzymes including amylases and proteases, by producing vitamins, such as biotin and vitamin B12 [4,7], by producing inhibitory compounds [6] and by stimulating host immunity [9].

The problems with live foods have led to the development of diets specifically formulated for their replacement. However, the development of formulated larval diets to completely replace live foods has been an elusive goal, despite considerable effort [10]. The use of formulated larval feeds as partial replacements for micro-algae is common in commercial hatcheries, total replacement of algae has proven to be more difficult. Complete replacement has only been achieved using ocean quality seawater that is partly filtered to retain the natural bacterial community [11] and reports of complete replacement in commercial hatcheries appears restricted to those located in the oceanic waters of the Pacific islands [10]. Alabi et al. [11] also showed that total replacement requires the establishment of a balanced bacterial community from either the filtered seawater or following conditioning by micro-algae. As a result Jones et al. suggested the inoculation of a single dose of live algae (SDLA) before use of artificial feeds to condition hatchery water when it is taken from coastal water of variable bacterial quality.

Use of Different Feeds

Wouters and Van Horenbeek as reported by summarized the various types of commercial larval feeds available in the market. These include microbound diets, flakes, granulated feeds, microencapsulated feeds; liquid feeds (lipid-walled capsules). Microbound feeds using a variety of different binders and produced as a small particle, or as a pellet, cake or flake, which is then crumbled to the appropriate size. Dietary ingredients are added to water to obtain a dense soup. An appropriate binder is added and the resulting suspension is sprayed onto a steam-drum dryer. Temperatures can exceed 100°C and significant nutrient loss can occur unless passage times are kept short. Large flakes can be crushed and passed through an appropriate mesh screen immediately prior to use. They are generally used for the post-larval stages of the shrimp. Granulated feeds are produced using liquid binder and water sprayed onto the feed mix, resulting in granules with a raspberry-like structure. Microencapsulated feeds have an outer coat (capsule) that retains the ingredients inside the particle.

They can be designed to have a slow release of the material or to totally prevent leaching of water-soluble nutrients. Some techniques encapsulate using a cross-linked protein-wall that can be digestible yet capable of withstanding drying.

Goat testes meal

Some Frys of *tilapia spp* were fed ad-libitum with two diets having a total length ranged from 2.5-2.9 cm for the group fed with goat testes meal (GTM) and 3.0-3.5 cm for the control group, which were fed with coppens starter diet. Fry survival in the treatment test group was 65%, while in the control group (group fed with coppens) it was 100%, that is, no mortality was recorded. With the 70% survival rate it shows that with Goat testes meal a desirable level of survival can be achieved in the indoor culture, contrary, to the opinion of Popma [12] who reported a survival of 40% and concluded that higher level of survival might not be visible in the indoor culture.

Coppens starter diet had 56% in terms of it crude proteins content while the goat testes meal was 47.33% CP. However to be able to use GTM as starter meal, some level of supplementation is required to boost its composition. Supplemented GTM would hold a lot of promise for the hatchery business with the difficulty being experienced with live fish foods in Nigeria [13-16].

The use of probiotic strains

Nogami and Maeda [16-18] isolated a bacterium from a crustacean culture pond. The bacterial strain was found to improve the growth of crab (*Portunus trituberculatus*) larvae and repress the growth of other pathogenic bacteria, especially Vibrio spp., but would not kill or inhibit useful micro algae in sea water when it was added into the culture water. Among the bacteria population present in the culture water of the crab larvae, the numbers of Vibrio spp. and pigment bacteria decreased or even became undetectable when the bacteria was added into culture water. The production and survival rate of crab larvae were greatly increased by the addition of the probiotic bacteria into the culture water. It was suggested that the bacterium might improve the physiological state of the crab larvae by serving as a nutrient source during its growth [19]. This bacterium may have a good effect in the crab larval culture as a bio-controlling agent in the future isolated two bacterial colonies present in a formulated fish feed from poultry egg albumen and the effect of these bacterial cells on the survival of *Clarias gariepinus* larvae. The two strains are *Staphylococcus aureus* and *Staphylococcus epidermidis* respectively. The feeding trials carried out using the live cells of *Staphylococcus aureus* did not have adverse effect on the fry as no death was recorded and the fry were still active at the end of the feeding trial. The colony forming units of *Staphylococcus aureus* were 0.23×10^6 cfu/ml on the first day of the feeding trial; it was increased to 3.90×10^6 cfu/ml on the fifth day and finally 9.86×10^6 cfu/ml. After feeding the fry with increased number of cells of the test organism, the frys were discovered to have responded well to the live cells. Despite being fed with increasing density of the live cells of the test organism, the fry were able to survive on the live cells that they were fed with 9.86×10^6 cfu/ml density of bacterial cells. A survival of 80% *Clarias gariepinus* larvae was recorded which indicates that feeding with live cells of *Staphylococcus aureus* promoted growth. It was suggested that previous focus on procedures to limit or remove the presence of bacteria from the culture water of a system for production of fish larvae may, in fact, have been a bias that led to culture failures [20-23].

Materials and Methods

Experimental station

The study was carried out at a private farm located at Low Cost Housing Estate, Badagry Local Government Area of Lagos State.

Hatchlings collection

One thousand two hundred samples of newly hatched *Clarias gariepinus* (African Catfish) were collected from the parent broodstock after artificial propagation in the hatchery on 2nd March 2008. The samples were allotted to eight plastic tank of 1 m × 0.5 m × 0.5 m each and were placed inside the hatchery building. The hatchlings were left to adsorb their egg yolk in the yolk sac before the commencement of exogenous feeding (Figures 1 and 2).

Sample collection and diet preparation

The lyophilized egg white was prepared by careful separation of the egg yolk from the egg white in the laboratory into a very clean beaker. After which the egg white was fortified with 1% of cod liver oil and thoroughly homogenized before being taken to the biochemistry laboratory where the homogenized sample was introduced into the lyophilization tube and kept in the freezer for a minimum of 24 hrs so as to preserve its chemical composition (Figure 3).

Process of lypholization

There are three stages in the complete drying process. This includes:

- Freezing

Figure 1: Plastic culture tanks.

Figure 2: Culture tanks enclosed in a bath tub.

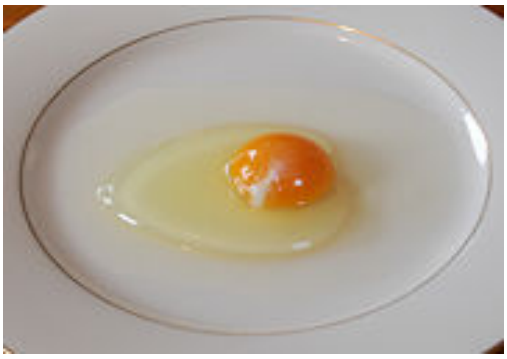

Figure 3: Egg white with egg yolk.

- Primary drying
- Secondary drying

Freezing: The freezing process consists of freezing the material so that the water in the food becomes ice. This was carried out in the Biochemistry laboratory by placing the material (egg white) in a freeze-drying flask and rotating the flask in a bath, called a shell freezer, which is cooled by mechanical refrigeration. On a larger-scale, freezing is usually done using a freeze-drying machine.

This step is important to cool the material below its eutectic point, the lowest temperature at which the solid and liquid phases of the material can coexist. This ensures that sublimation rather than melting will occur in the following steps. Larger crystals are easier to freeze-dry [24]. In order to produce larger crystals, the product should be frozen slowly or can be cycled up and down in temperature. This cycling process is called annealing. However, in the case of food, or objects with formerly-living cells, large ice crystals will break the cell walls (The freezing temperatures between -50°C and -80°C. The freezing phase is the most critical in the whole freeze-drying process, because the product can spoil if badly done [25].

Primary drying: The egg white was placed under a vacuum. During the primary drying phase, the pressure was lowered (to the range of a few millibars) and enough heat was supplied to the egg white for the water to sublimate. The amount of heat necessary can be calculated using the sublimating molecules' latent heat of sublimation. In this initial drying phase, about 95% of the water in the material is sublimated. This phase was slow (can be several days in the industry), because, if too much heat is added, the material's structure could be altered. In this phase, pressure was controlled through the application of partial vacuum. The vacuum speeds sublimation, making it useful as a deliberate drying process. Furthermore, a cold condenser chamber and/or condenser plates provide a surface(s) for the water vapour to re-solidify on. This condenser plays no role in keeping the material frozen; rather, it prevents water vapour from reaching the vacuum pump, which could degrade the pump's performance. Condenser temperatures are typically below -50°C (-60°F).

It is important to note that, in this range of pressure, the heat is brought mainly by conduction or radiation; the convection effect can be considered as insignificant.

Secondary drying: The secondary drying phase aims to remove unfrozen water (i.e. drawing off the water vapour) molecules, since the ice was removed in the primary drying phase. This part of the freeze-drying process was governed by the material's adsorption isotherms. In this phase, the temperature is raised higher than in the primary drying phase, and can even be above 0°C, to break any physico-chemical interactions that have formed between the water molecules and the frozen material. The pressure was also lowered at this stage to encourage desorption (typically in the range of microbars, or fractions of a pascal) Cabral [26,27].

However, there are products that benefit from increased pressure as well. After the freeze-drying process is complete, the vacuum is usually broken with an inert gas, such as nitrogen, before the material is sealed. At the end of the operation, the final residual water content in the product is around 1% to 4%, which is extremely low (Figures 4 and 5). Once the ice is sublimated, the foods are freeze-dried and can be removed from the machine. The extract (the refrigerated sample) was then inserted into the lyophilizing machine for a period of 48 hrs. The lyophilized sample i.e. freeze dried extract were used as feed for *clarias gariepinus* hatchlings. The extract was in a powdery form after the process of freeze drying (Figures 6 and 7).

Feeding regime

Feeding regimes on growth and feed conversion of *clarias gariepinus* hatchlings were examined. Siphoning was always carried out before feeding in order to ensure an unpolluted environment. Aerators were available as well to ensure the availability of dissolved oxygen. The hatchlings were fed "ad-libitum" six times daily (at 4 hours interval) for a period of 14 days with the test feed samples after which results in response to the feeds were taken.

Figure 4: Homogenized sample (i) of egg in lyophilization tube.

Figure 5: Homogenized sample (ii) of egg in lyophilization tube.

Figure 6: Crumbles of lyophilized egg white.

Figure 7: Lyophilizing machine with lyophilizing tube containing samples.

Fish were allowed to eat as much as they would to achieve apparent satiation. Amounts of feed consumed by the fish in each were recorded daily. Back-up aeration, provided by a 1-horsepower aerator was used in each culture medium. pH were measured weekly during the growing season.

Chemical analysis

Proximate and Mineral compositions of feed samples were determined at University of Lagos, Akoka, Yaba, Lagos. Parameters Analysed include the moisture, crude fibre, ash, crude protein, lipid content, Nitrogen free extract and also the mineral composition such as Ca, Fe, Na, K were also determined.

Water analysis was also determined at Fisheries laboratory. These include the physico-chemical parameters of water like salinity, pH, DO, Turbidity, Colour, Biological Oxygen Demand, Total hardness, temperature and carbon dioxide.

Statistical analysis

Descriptive statistics was used to compute the proximate and mineral compositions of the samples and the data collected was used to determine the arithmetic mean and standard deviation values. T-test analysis and ANOVA (Analysis of Variance) were used to compare means by determining the standard error of mean, lower and upper limits of 95% Confidence Interval of the Difference to test level of significance ($p<0.05$) or ($p>0.05$) in the survival rate values observed for the experimental treatments replicates.

Results and Discussion

Some general observations were made based on patterns of individual treatment means. Data on production characteristics were subjected to ANOVA and the Fisher's protected LSD procedure using SPSS (Statistical Package for Social Sciences) version 15.0 software. Plastic tanks were used as the experimental unit and variation among these tanks within a treatment was used as the experimental error in tests of significance. A significance level of $P \leq 0.05$ was used (Tables 1-4 and Figures 8-13).

Physico-Chemical Parameters that were Determined

Dissolved oxygen

100 ml – Water Sample (Fixed with Reagents A and B)

8 drops –Starch (Indicator)

Nutrient (%)	Feed samples		
	Artemia	Lyophilized Egg White	Coppens Starter Feed®
Fat	8.87 0.152^{a}	8.39 1.692^{b}	7.39 ± 0.445^{a}
Ash	13.5 0.436 ^{a}	10.05 0.860^{a}	13.45± 1.211^{b}
Protein	85.10 ± 0.264^{a}	78.39 ± 1.695^{b}	74.56 ± 1.085
Fibre	0.06 0.015^{a}	0.03 ± 0.010^{a}	0.05 ± 0.02^{a}
Moisture content	6.46 ± 0.041^{a}	4.10 ± 0.100^{b}	9.77 ± 0.576^{b}
CHO(Carbohydrate)	13.20 ± 0.624^{b}	8.18 ± 0.174^{a}	6.54 ± 0.297^{a}
NFE (Nitrogen Free Extract)	4.21 ± 0.500^{b}	3.95 ± 0.278^{a}	3.47 ± 0.135^{a}

The above table shows that subscripts with the same alphabet along the same row are not significantly different while those with different alphabets significantly differ.

Table 1: Proximate composition of atremia, coppens starter feed and lyophilized egg white feed samples.

Parameters (Mg/kg)	Feed Samples		
	Artemia	Lyophilized Egg White	Coppens Starter Feed®
Mn	-	1.28 ± 0.081^{a}	0.31 ± 0.036^{a}
Fe	28.070 ± 0.420^{b}	74.21 ± 0.636^{a}	36.30 ± 1.014^{a}
Na	1400.230 ± 35.145^{b}	7545.86 ± 4.309^{a}	1105.620 ± 5.037^{a}
Ca	2342.500 ± 74.310^{b}	2046.03 ± 4.404^{a}	1952.00 ± 2.645^{a}
K	1156.00 ± 42.579^{b}	231.50 ± 2.930^{a}	715.20 ± 5.345^{a}

Table 2: Mineral composition of atremia and lyophilized egg white feed samples fed to hatchlings of clarias gariepinus.

Feeding Period (wks)	Weight of Hatchlings Fed with *Artemia* (g)	Weight of Hatchlings fed with Lyophilized Egg white (g)	Weight of Hatchlings fed with Coppens Starter feed ® (g)
Week 1	0.08	0.07	0.09
Week 2	0.25	0.24	0.23
Total weight gain (g)	0.17	0.17	0.14
% Weight gain	17	17	14

The above table shows a similar weight gain for Artemia and Lyophilized egg white group but different when compared with commercial Coppens Starter diet®

Table 3: Weight-gain (g) of hatchlings fed with different experimental diets.

Feeding Periods (wks)	Lyophilized Egg white (cm)	Artemia (cm)	Coppens Starter Feed® (cm)
Week 1	1.28	1.34	1.33
Week 2	1.47	1.54	1.52
Total Mean Length	0.19	0.20	0.19
% Mean Length	19	20	19

Table 4: Length of hatchlings after 14 days of feeding in indoor plastic tanks.

2 ml – H_2SO_4

Titrate – Na_2SO_4

Observations:

Fixed water sample + H_2SO_4 = Golden Yellow

Fixed water sample + H_2SO_4 + 8 drops of starch = Blue black colouration

After Titration, the end point is colourless

1st Titration:

Initial reading = 35.30

Final reading = 42.70

Final reading – Initial reading = 42.70 – 35.30

= 7.40

2nd Titration:

Initial reading = 38.5

Final reading = 45.70

Therefore F.R – I.R = 45.70 – 38.50 = 7.20

Average Titre Value = Titre value 1 + Titre value 2

= 7.4+7.2 = 7.30

The oxygen levels of the 8 experimental treatments were positively correlated with the survival rates. This implies that as the oxygen levels in the treatment tanks increased, the survival rates of the hatchlings increases.

Discussion

Diet samples of lyophilized egg white, artemia and coppens starter feed was used to determine both the length and weight differences of *Clarias gariepinus* hatchlings. Proximate analysis and mineral composition were carried out on the diets respectively. This study revealed that lyophilized egg white 76% CP was higher than the optimum level of 57% CP recommended by Mc Gee [28]. Table 3 shows that total and percentage weight gain of hatchlings fed with artemia and lyophilized egg white are higher than that of coppens starter diet; this is due to the fortification of egg white and the natural composition or artemia diet. This is in agreement with Tal and Hepher [29], a balanced diet formulated with due consideration of the natural feed composition would bring good result in terms of weight gain.

The biological value of lyophilized egg white diet sample was improved after being fortified with only 1% cod liver oil in terms of fatty acids composition and protein-calorie ratio. Growing of fry, exclusively on finished feed is extremely difficult though but not impossible, as shown in this study. The aspects of feed preparation for commercial production of catfish were described by Lovell. Table 1 illustrate diet samples and their proximate values showing the significant difference in the diets ($P \leq 0.05$).

After the 14 days trial period, fry total length ranged between 1.30-1.70 cm with group fed with Artemia and 1.20-1.55 cm with group fed with lyophilized egg white while that of coppens starter feed ranged between 1.25-1.60 cm, it would seem that starter diet supported higher body length of fish than the lyophilized feed but lower than artemia fed group. However, the opposite is the case for body weight gain of fish. Fry survival in treatment sample group was about 70% while that in the control group was 100%. Table 3 shows from observation the Artemia (control group) has a total weight gain of 0.17 g and total mean length of 0.2 cm while that of lyophilized egg white has a total weight gain 0.17 g and mean length of 0.19 cm while that of coppens starter feed has 0.14 g with a mean length of 0.19 cm. This indicates that in the control group fed live food (Artemia), both growth and survival rates were impressive as to be expected when natural foods are used in culture system. Lyophilized egg white diet was fortified with cod liver oil whose component is made up of omega h3 and h6, important nutrient requirement of fish and growth in terms of weight with this group was similar to the control group fed artemia but the reason for the lower gain in length is not clear at this time.

From Figure 8, the feeding periods (days) and the corresponding weight (g) of hatchlings fed with Artemia, Coppens Starter feed and lyophilized egg white it can be observed that on the 10th day, the weight of hatchlings fed with lyophilized egg white and coppens starter feed were the same while that of artemia was higher.

Figure 9 explains a clear difference in proximate values of diet samples used whereby Artemia has the highest value of 70% CP followed by Lyophilized egg white 78.39% CP and Coppens starter diet 74.56% CP. This is due to artemia being a live food which has a very

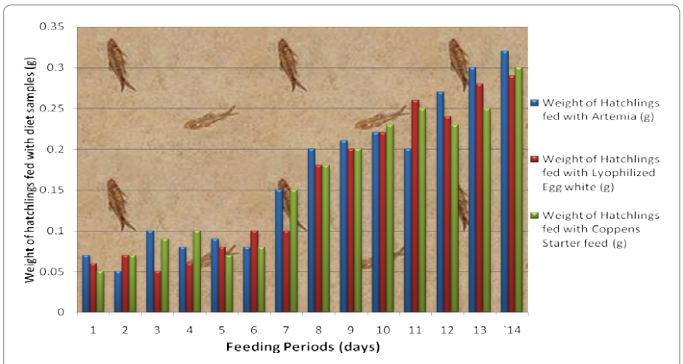

Figure 8: Feeding periods (days) and the corresponding weight (g) of hatchlings fed with artemia, coppens starter feed® and lyophilized egg white.

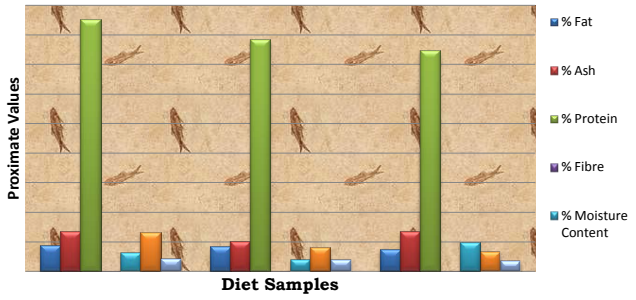

Figure 9: Proximate analysis of artemia, coppens starter feed® and lyophilized egg white.

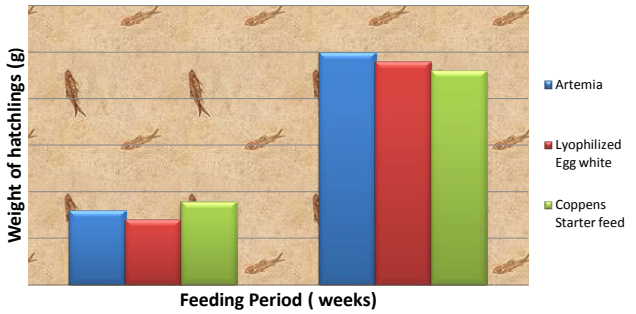

Figure 10: Weight of hatchlings fed with artemia, lyophilized egg white and coppens starter feed®.

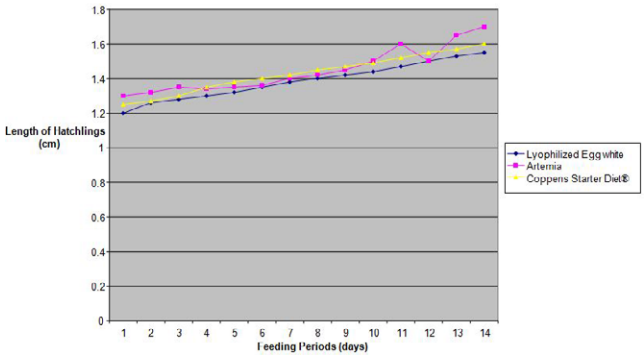

Figure 11: Feeding periods and length of hatchlings (cm) fed with lyophilized egg white, coppens starter feed® and artemia.

high percentage of protein while that of Lyophilized egg white was as a result of it's natural protein content and its fortification with cod liver oil which consist of omega h3 and omega h6.

This is in agreement with Joshi et al. [30] that reported effect. The increase in growth rates observed in control fish fed with coppens starter diet and the test hatchlings fed with lyophilized egg white agreed with the findings of Moriarty et al. [31] which showed in a controlled experiment that there was a very significant increase in growth rate *Litopenaeus vannamei* and *Litopenaeus stylirostris*. Water quality parameters of experimental set-up for both treatments were similar and within the optimum range recommended for culture of *Clarias gariepinus* [32]. Also, after the trial period of 14 days it was clear that a better performance was recorded with lyophilized egg white. This should be expected because of the higher protein level and fortification with cod liver oil. Though, artemia seems to be of better quality diet as a starter diet for fish to grow in their early stages of development. They require a lot of crude protein, which must be readily available. Artemia has 70% in terms of crude protein while the fortified lyophilized egg white was 78.39% CP. However, to be able to use lyophilized egg white as starter diet, some level of supplementation of egg white is required in order to boost the nutrient composition of the diet. Supplementation of lyophilized egg white would hold a lot of promise for the hatchery business with the difficulty being experienced with live fish foods in Nigeria. Lyophilized egg white therefore holds a lot of promise in Nigeria aquaculture industry. However, some fortification of egg white is needed to be established.

Conclusion

The current state of knowledge of larval nutrition of *clarias gariepinus* contains many gaps. This is partly the result of the complexity and expense of conducting research into this area. However, given the increasing importance of domestication in catfish aquaculture particularly, there is a need for an increased focus on this area. The role of nutrition in larval production and maturation performance and in increasing larval survival and quality will be fundamental to obtaining optimal performance from domesticated stocks. Even in species where domestication is not an issue, the improvement of maturation performance and larval production remains a key goal in improving the efficiency of production systems. The complexity of the ontogeny of larval nutritional physiology may mean that technical success will be based on a compromise between the desire to provide a complete diet package and the need to strive for simplicity in formulation and

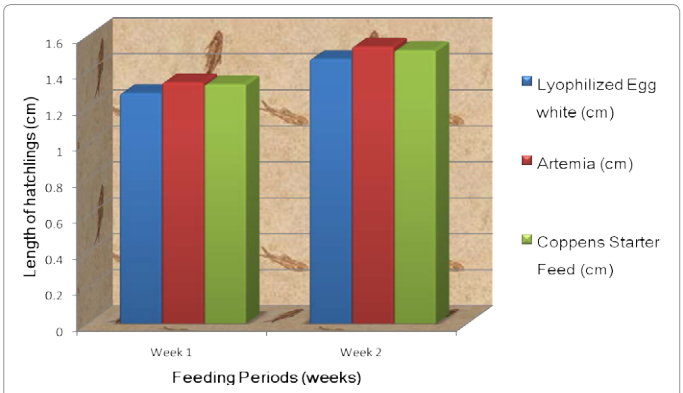

Figure 12: This table illustrates the length of hatchlings (cm) fed with the three diet samples and the feeding period (weeks).

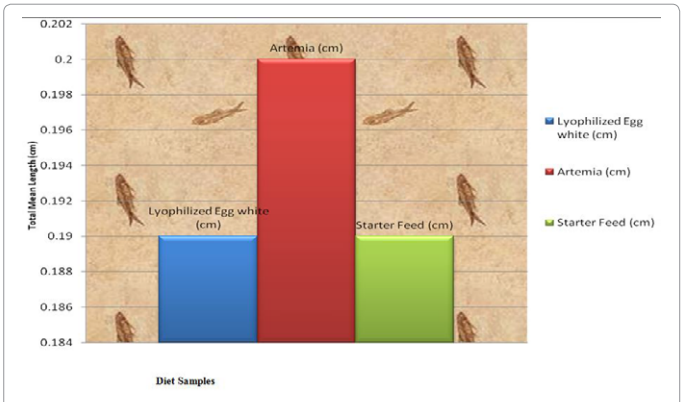

Figure 13: Total mean length of clarias gariepinushatchlingsunder a 14 day trial period.

manufacture. Over the last decade, the world has witnessed spectacular growth in the aquaculture industries of many developing countries. As a result, aquaculture has been contributing significantly to food security and poverty alleviation. It is anticipated that global aquaculture production will continue to increase and further contribute to these needs. The results of this study indicate that freeze-drying is a more reliable method of preserving samples so as to allow estimation of the relative contribution of different food sources to *Clarias gariepinus* nutrition. Nutrition and feeding play a central role in sustainable aquaculture and, therefore, fertilizers and feed resources continue to dominate aquaculture needs. Much of the increased aquaculture production in developing countries of Asia and Africa will likely be achieved through expansion of semi-intensive, small-scale pond culture, thus feed and fertilizer resource availability, as well as cost, could be the major bottlenecks for such development. In intensive aquaculture of marine carnivorous species, fish meal and fish oil will continue to be the major ingredients in the near future, although there may be scope for some use of animal by-products as alternative protein sources. With the expansion of intensive aquaculture, aquaculturists must carefully assess the impact of nutrient loading in the aquatic environment and use both science and judgement for reducing such impacts. Furthermore, a careful balance between environment, health/disease resistance and feed use should be maintained, so that the system does not deteriorate and negatively impact market value and consumer confidence. Utilization of detailed food and fishmeal has no reasonable future in semi-concentrated aquaculture in creating nations of the world. All things considered, further escalation of business aquaculture will occur, even in creating nations, for shrimp and meat eating freshwater species, with the same potential as said above for a general lack of customary food fixings. Option encourage fixings ought to be looked for in the meantime as change of lake administration and control of lake profitability. Employments of nutritiously finish planned eating methodologies will, on the other hand, keep on assuming an overwhelming part in incubation facility and nursery creation (Appendix).

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