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Feeding with mixture of inert diet and live prey improves zootechnical performances in *Heterobranchus longifilis* larvae

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Abstract:
The availability of supply of fingerlings of Heterobranchus longifilis (H. longifilis) is a major constraint caused by its larvae dependence on live Artemia and starter dry feed which are expansive for fish breeders of developing countries. Otherwise, to establish the best diet strategy to enhance growth performance and survival of catfish larvae is not easy. Zooplanktons are able to be used as feed for Catfish larvae. However, there is no information on the zootechnical performance of H. longifilis larvae fed on a mixed diet (live prey and inert feed). Three days old larvae of H. longifilis (initial mean weight = 2.88 ±0.13 mg) were stocked at 10 fish /L in aquaria tanks and were fed with live prey (zooplankton freshly collected from ponds), inert diet and a mixture of both during 28 days. Feeding was done ad libitum during the first week. They were fed at 75 and 50% respectively during the second and the last two weeks. Every week, larvae from each replicate were counted and weighed as a batch to 0.1 mg and the feed amount was adjusted accordingly. Survival rate was significantly higher in fish fed on live prey diet (76 ± 4 %) and the mixed diet (78.5 ± 3.5 %) versus inert diet (41.5 ± 6 %). The highest specific growth rate was recorded in larvae fed mixed diet (15.23 %.day^{-1}) compared to those fed on inert diet (12.40 ± 0.13 %.day^{-1}) and live prey (12.45 ± 0.10%.day^{-1}). However, feed conversion ratio was significantly lower in fish fed the mixed diet (3.44 ± 0.31) in comparison of live prey (4.47 ± 0.43) and inert (4.38 ± 0.28) diets fed fishes. This study showed that the mixture of live prey and inert diets allowed to better survival and growth of H. longifilis larvae. Live prey led to high survival rate in H. longifilis diet but it allowed to poor growth.

***Key Word**: Catfish larvae, growth, co-feeding, zooplankton, inert diet.*

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I. Introduction

Heterobranchus longifilis (*H. longifilis*) belongs to the catfish family of Clariidae. This species of catfish is found widely in rivers and other freshwater habitats of sub-Saharan Africa, as well as the Nile (1). *H. longifilis* is one of the most important fish for aquaculture business all over the world (2). *H. longifilis* is a good candidate of aquaculture because this omnivorous fish has fastest growth potential and can be reared in unfavorable environmental conditions (3).

In Côte Ivoire the lack of juveniles of *H. longifilis* is the major constraint. Indeed, larvae of this species are exclusively dependents on live *Artemia* (4) which is costly, time consuming and not always available for fish breeders of developed countries (5). Starter dry feeds have also been developed for fish larvae to substitute Artemia (5). Those feeds are not always accessible because of their expensive costs. In addition, formulated feeds generally do not meet total nutritional requirements of fish larvae.

Zooplankton are an essential food source for many aquatic animal species especially in their larval stages. Live zooplanktonic prey contains nutrients such as essential amino acids, fatty acids, carbohydrates, vitamins and minerals (6). According to the importance of zooplankton in fish natural feeding, many investigations were conducted and shown that zooplanktons are able to be used as feed for Catfish larvae (7; 4).

There is no information on the zootechnical performance of *H. longifilis* larvae fed on a mixed diet (live prey and inert feed). To establish the best diet strategy which can enhance growth performance and survival of *H. longifilis*, the present study was carried out to compare zootechnical performances of this catfish larvae fed on live prey, inert diet and a mixture of both.

II. Material And Methods

Heterobranchus longifilis larvae origin

Larvae were obtained by artificial reproduction as described by (8). This reproduction was carried out at the research station on inland fisheries and aquaculture in Bouaké (Côte d'Ivoire).

Experimental diets

Heterobranchus longifilis larvae were fed with three experimental diets:
1- Live prey constituted of zooplanktons freshly collected from ponds;
2- Inert diet was a commercial diet developed for fish larvae which contained 55 % of protein;
3- Mixed diet that contained live prey and inert diet.

Collection, identification and density of Zooplankton

Zooplanktons were collected from the 400 m^2 ponds of the inland fisheries and aquaculture research station using a plankton net. The opening diameter, length and mesh gap of the plankton net were respectively 40 cm, 150 cm and 35 µm. The plankton net was dragged horizontally in the water column over a length of 18 m. The identification of zooplankton was done according to (9), (10), (11) and (12). The density of zooplankton was determined with following formula (13): Zooplankton density (D) = (N / V1) X (V2 / V3) where N = number of individuals counted; V1= volume of the filtrate collected (3 mL), V2 = volume of the concentrated filtrate (sample volume), V3 = volume of filtered water = π x R2x d where d = The train distance of the plankton net in the water column (18 m), and R: the radius of the opening of the plankton net.

Experimental culture system

Seven hundred and towenty *Herobranchus longifilis* larvae were separated into tree batches according to the different feeding with tree replicates and stocked in to six aquaria tanks (10 L). Larvae (Initial mean weight = 2.88 ± 1.3 mg) were stocked at 10 fish / L in aquaria tanks and reared during 28 days. Feeding was done *ad libitum* during the first week. They were fed at 75 and 50% respectively during the second and the last two weeks. Left-over of feed, feces, and dead larvae were siphoned from the tanks every day before new feeding. Every week, larvae from each replicate were counted and weighed as a batch to 0.1 mg and the feed amount was adjusted accordingly. Average values of water quality parameter monitored in the tanks during the experiment were: pH, 6.87 ± 0.21; temperature, 28.14 ± 0.27 °C dissolved oxygen, 4.52 ± 0.13. The dry weights of rotifers, copepodites and copepod adults; copepod nauplii and cladocerans are 0.18, 0.47, 0.08 and 1.32 µg respectively (14).

Evaluation of growth performance, nutrients utilization and mortality

Mean weight gain, relative growth rate, specific growth rate, cannibalism and survival rate, coefficient of variation of individual weight and feed conversion ratio were used to express growth performances and mortality. Those parameters were calculated using the following formula:
Mean weight gain = (final weight – initial weight)/ Number of fish,
Specific growth rate = 100 [(ln final weight-ln initial weight) / Number of experimental days],
Survival rate (%) = 100 (final number/initial number),
Cannibalism rate (%) = 100 – [Survival rate (%) + Observed mortality (%)],
Coefficient of variation of individual weight (%) = Standard deviation of final weight × 100/mean weight,
Food conversion ratio = Feed intake (g)/Fish weight gain (g).

Statistical analysis

STATISTICA 7.1 software was used for Statistical analyses. Data were expressed as mean ± SD (n = 2). The effects of diet in the indices of *H. longifilis* larvae were tested with one way analysis of variance (ANOVA), followed by Tukey's test. Differences were considered significant when $P< 0.05$.

III. Results and Discussion

Composition of zooplanktons collected in ponds

The density of zooplanktonic population of the inland fisheries and aquaculture research ponds was 1356.73 ± 131.42 ind.L^{-1}. The zooplankton composition included Nauplii, Copepodites, adult copepods, Cladocerans and Rotifers. The densities of Nauplii, Copepodites, adult copepods, Cladocerans and Rotifers were

289.11 ± 19.5, 182.21 ± 24.04, 174.07 ± 9.34, 455.85 ± 44.76 and 255.47 ± 29.18 ind.L^{-1} respectively. The zooplankton density observed in the present study was higher than those observed in Lokpoho River (1217 ind/l) and Bandama (463 ind.L^{-1})/ according to (15). The high abundance of zooplankton could be explained by the fact that the ponds are rich in minerals (N. P. C) resulting from the decomposition of leftover and faces from fish. However, the density of zooplankton in the ponds of the inland fisheries and aquaculture research station observed in this study (1327 ind. L^{-1} was lower than that observed by (16) in the same ponds (1800 ind. L^{-1}). This low abundance could be explained by the fact that the ponds have been fertilized before sampling.

Growth performance, nutrient efficiency and biological indices

The evolution of larval weight of *H. longifilis* is presented in figure 1. This figure shown that the growth of the larvae was identical in the three feed treatments during the first weeks of rearing.

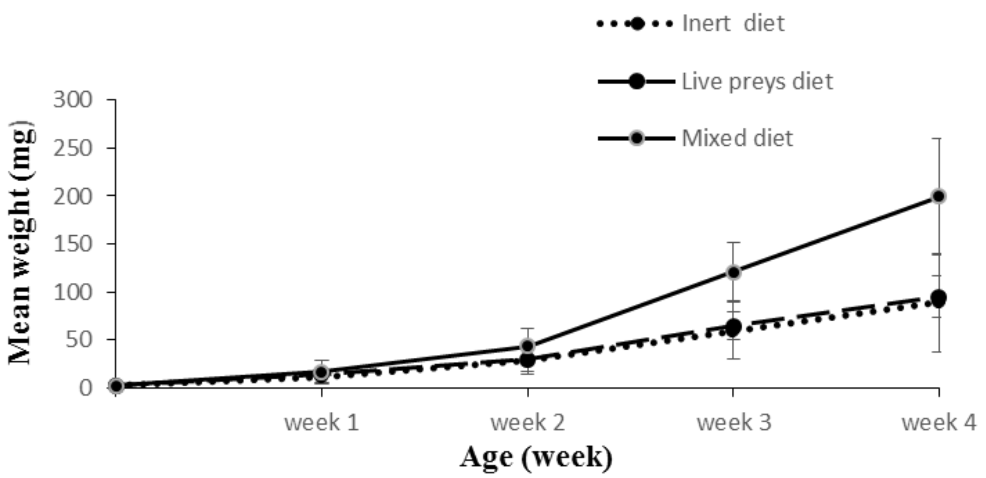

Figure 1 : Weight of *H. longifilis* larvae as a function of different experimental diets

From the second to the fourth week, the larvae fed on the mixed diet showed a statistically significant higher weight compared to the two other treatments. Furthermore, the larvae fed with zooplankton and dry diet showed an almost identical weight evolution during rearing period. The larvae fed the mixed feed increased from 2.87 to 199.38 mg. Those fed zooplankton and dry feed increased from 2.89 to 91.55 mg and from 2.88 to 90.22 mg respectively.

At the end of trial period, growth performance, nutrient efficiency and biological indices were significantly affected by experimental diets (Table 1). Survival rate was significantly higher in fish fed on live prey diet (76 ± 4 %) and mixed diet (78.5 ± 3.5 %) compered to inert diet (41.5± 6 %). Cannibalism rate were significantly lower in larvae fed with live prey and mixed diets (3.5%), and higher in those fed on inert diet (5.5 ± 0.5 %). The results of study reveal that growth performance, feed utilization and mortality rate of *H. longifilis* larvae were influenced by distributed diets. The low survival rate recorded in the fish that received the dry feed shown that this feed was not well palatable to the larvae. The low survival rate of fish fed the dry diet indicated that the dry feed was not palatable to the larvae. The high cannibalism rate, due to the high coefficient of variation, could be another explanation. Indeed, homogeneity of larval size greatly reduces cannibalism according to (17).

Table 1 : Growth performance and nutrient utilization indices of *H. longifilis* larvae fed experimental diets

Indices	Diets		
	Inert diet	**Mixed diet**	**Live prey diet**
IMW (mg)	2.88 ± 1.30	2.87 ± 1.30	2.89 ± 1.30
FMW (mg)	90.22 ± 51.68^{b}	199.38 ± 61.02^{a}	91.55 ± 22.79^{b}
MWG (mg)	87.34±50.28	196.5±59.67	88.66±21.51
FCR	4.38 ± 0.28^{b}	4.44± 0.31^{b}	4.47± 0.43^{b}

SGR (%/day)	12.40 ± 0.13^{b}	15.23 ± 0.14^{a}	12.45 ± 0.10^{b}
CV (%)	55.23 ± 12.26^{a}	30.36 ± 0.95^{b}	24.63 ± 3.21^{c}
CR (%)	5.5± 0.5^{b}	3.5± 0.5^{a}	3.5± 0.0^{a}
SR (%/j)	41.5± 6^{b}	78.5± 3.5^{a}	76± 4^{a}

Data are mean values ± SD (n=3); means in the same row with the same superscript are not significantly different (*P*>0.05). IMW: initial mean weight, FMW: final mean weight, MWG: mean weight gain, FCR: feed conversion ratio, SGR: specific growth rate, CV: coefficient of variation of individual weight, CR : cannibalism rate and SR : survival rate.

The survival rates recorded in *H. longifilis* larvae fed with inert diet (41.5± 6) was closed to that observed in the same species fed on commercial catfish feed (40.40 ± 6.22%) by (18). On the other hand, the survival of larvae subjected to zooplankton recorded was close to 78.5 and 81,5 % obtained by (4) in *H. longifilis* fed with freshwater zooplankton and *artemia* nauplii respectively. Regarding the mixed diet, similar survival rate (82%) was observed in *Clarias gariepinus* subjected to a mixed diet (19).

Thus, larvae of *H. longifilis* fed with mixed diet had significantly higher FMW (199.38 ± 61.02 mg), MWG (196.5±59.67 mg) and SGR (15.23 ± 0.14 %/days) compared to inert and live prey diets. Inert and live prey diets fed larvae shown significantly identical values of FMW, MWG and SGR. However, those indices were numerically higher in live prey diet fed fish than inert diet. As opposed to FMW, MWG and SGR, feed conversion ratio (3.44±0.31) was significantly lower in fish fed the mixed diet compered to live prey diet (4.47 ± 0.43) and inert diet (4.38 ± 0.28). Coefficient of variation of individual weight were also affected by dietary treatments. It was significantly higher in fish fed inert diet (55.23 ± 12.26 %) and lower in live prey diet fed fish (24.63 ± 3.21 %). Larvae fed with mixed diet (live prey and inert diets) shown the best growth performances, feed utilization and survival compared to those fed on live prey and inert diet. This difference could be related to the fact that mixed diet contained more nutrient (protein, fat, mineral, amino and fat acids and vitamins) sources than inert and live prey diets. Indeed, mixed diet contained nutrients sources from zooplankton and inert diet making it better than the two others. Similar results have been obtained by previous studies showing that combine nutrients like proteins sources was better than single protein source for fish diets, resulting from the synergism when various dietary protein sources are mixed in feeds (20; 21). Similar results were also obtained in *Clarias gariepinus* subjected to dry food, live prey and a mixture of both. Indeed, (19) showed identical growth in *C. gariepinus* larvae fed with zooplankton and dry food but inferior to that of fish subjected to a mixture of the two diets. This trend has been observed in another species such as *Oncorhynchus mykiss* (22). The specific growth rates, the values obtained in this study (12.40 to 15.23%/day) were lower than those reported by (4) Agadjihouèdé *et al*. (2012) in *H. longifilis* fed with *artemia* nauplii (17.2 %/day). However, they were higher than the values of 5.51 to 9.52%/day observed by (23) in *H. longifilis*. Otherwise, these values are comparable to those of (24) who obtained values between 10.1 and 14.2%/days. The differences observed in these specific growth rates may be explained by the quality of distributed diets, some abiotic factors such as temperature (25), the loading density and duration of rearing.

IV. Conclusion

The results of this study showed that the mixture of live prey and inert diets allowed to better survival and growth of *H. longifilis* larvae. Live prey led to high survival rate in *H. longifilis* diet but it allowed to poor growth. Nevertheless, subsequent research should evaluate if feeding *H. longifilis* larvae with mixture of zooplankton and inert diets is economically profitable.

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