E-ISSN: 2347-5129
P-ISSN: 2394-0506
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.549
IJFAS 2017; 5(3): 01-05

www.fisheriesjournal.com
Received: 01-03-2017
Accepted: 02-04-2017

Cassius Aruho
National Fisheries Resources Research Institute, Kampala, Uganda

Mathew Tenywa Mwanja
National Fisheries Resources Research Institute, Kampala, Uganda

Akisoferi Owori Wadunde
National Fisheries Resources Research Institute, Kampala, Uganda

Kamahoro Immaculate
Ministry of Agriculture Animal Industry and Fisheries, Kampala, Uganda

Mujibu Nkambo
National Fisheries Resources Research Institute, Kampala, Uganda

Richard Ddungu
National Fisheries Resources Research Institute, Kampala, Uganda

Constantine Chobet Ondhoro
Buginyanya Zonal Agricultural Research and Development Institute

Correspondence
Cassius Aruho
National Fisheries Resources Research Institute, Kampala, Uganda

Growth performance and survival of African catfish (*Clarias gariepinus*) fed on different diets

Cassius Aruho, Richard Ddungu, Mathew Tenywa Mwanja, Akisoferi Owori Wadunde, Kamahooro Immaculate, Mujibu Nkambo and Constantine Chobet Ondhoro

Abstract

Two trial experiments were conducted to assess the performance of a commercial dry feed D in combination with de-capsulated *Artemia* (AD), *Moina* (FD) and dry feed alone on African catfish larvae *Clarias gariepinus* for 14 days. The trials were conducted sequentially, separated by two months at the same facility to validate the consistence of the weaning effect of the feed on the growth of catfish larvae. Results showed that the final larval mean total length TL (cm) of larvae weaned using a feed combination AD (Trial 1, 1.50±0.013 1; Trial 2, 1.44±0.011), significantly performed better in both trials than that of larvae weaned on the other two diets, FD (Trial1, 1.37±0.011; Trial 2, 1.3510±0.0091) and D (Trial 1, 1.39±0.0141; Trial 2, 1.3150±0.009). There was no significant difference in the final mean total length of catfish larvae weaned on feed combinations FD and D ($P>0.05$). Specific growth rate (daily length % increment) ranged between 4.2% and 5.1% in all trials with the highest noted in feed combination AD. Although, weaner feed combination AD performed better than other feeds, there were no significant differences in larval survival in all the trials ($P>0.05$). In spite of the good performance of the combination diet (AD), results from other feed (diet) combinations were fairly good as well. Feed D (57% crude protein CP) is an imported commercial feed that has been recently introduced in the country and can be popularized as a starter feed without the need to culture tedious live feeds or use of expensive *Artemia* combinations.

Keywords: African catfish, growth performance, Dry feed

1. Introduction

Seed production still poses a challenge to commercialization of African catfish *Clarias gariepinus* industry in Uganda. Although many factors affect the growth of fish larvae, weaning is one of the key factors that define the survival and good growth of larval fish [1]. The process is regularly referred to as a changeover of the feed from live feed to dry feed [2]. Introducing a new correct starter compound feed type to the larval fish at a particular larvae developmental stage is a key challenge in intensive fish culture [3, 4] and it is only possible at a developmental stage when the digestive system is able to assimilate and digest the compound feed [5]. Although the fish may have basic developmental phases, complexity of development of the digestive tract and timing may defer as the larvae matures, characterizing varying nutritional requirements at different stages and periods in different fish species [6, 7]. First feeding when the fish begins taking feeds is the most critical period as delays or early feeding may affect larval growth and survival [8, 9]. In some cultured species, dry feeds have been successfully introduced as starter feeds at first feeding without using live feeds [1, 2, 10]. Additionally, the type of weaner feed given will influence the growth and the survival of the larvae differently because of different nutritional content in the different diet formulations.

The success of a fish farm enterprise is based on the availability of good quality fish seeds [11]. In recent past, fish fingerlings were sourced from the wild i.e. natural waters but these are unreliable production to support commercial fish farming [12]. Recent hatchery surveys [13] in Uganda indicated that, lack of better weaner feeds is one of the biggest hindrances to catfish production in the country and contribute to the high mortalities observed especially during the first two weeks. The report stated that the majority of the surveyed hatcheries did not nurse well the hatched larvae [13]. About 8% had the larvae transferred to the green water nursing ponds and the percentage survival was recorded below 10% in most regions.

The highest larval survival recorded two weeks after hatch in tanks was 13% from the Central region. All the hatcheries that nursed larvae in the tanks fed the larvae on fine crashed feed ingredients that were improperly formulated although some attempted to feed the larvae with other combinations including *Artemia* and live green cultures [13]. All the hatcheries indicated that the highest loses occurred in the first two weeks of larval hatching. African catfish fry have been nursed successfully using, live or frozen zooplankton, live or frozen nauplii (first larval stage) of brine shrimp *Artemia salina* and de-capsulated *Artemia* eggs as first feeds [14]. Although these are technically feasible to produce in the country, they haven't been fully adopted majorly because of socio-economic and technical considerations. Most farmers view live feed culture for cultured species as tedious, time consuming, costly and impractical in commercial larvae culture [10, 15, 16] and this requires simplified procedures as well [17]. The introduction of dry diet as a starter feeds is being viewed as a strategy to reduce the cost of weaning the larvae using such complicated procedures. In this study the performance of the imported commercial dry artificial feed was evaluated in combination with live cultures used in the country to ascertain its effects on growth and survival as a starter feed for African catfish larvae.

2. Methods

Larvae samples were obtained from the catfish brood stock through induced spawning technique. The collection of ovulated eggs and their fertilization was carried out using the dry-method described by Hogendoorn [16] and Woynarovich [17]. Experimental larvae for two trials were obtained from the same batch of spawning brood stock at different periods; first when the brood fish had reached an average weight of 700 ± 32g and in the second trial when the brood fish size was 800± 20g, two months after the first trial. About 54,000 two day old catfish hatchlings were randomly stoked at 100 larvae per litre in 9 rectangular tanks of 0.5M^3 by volume. They were stocked at the initial mean length of 0.77 ± 0.005 cm in the first trial and 0.64cm ± 0.006 (Total length, TL) in the second trial. Combinations of feeds were randomly applied to the tanks in three treatments as follows: de-capsulated *Artemia* and the dry feed (AD); *Moina* and the Dry feed (FD); and the Dry feed (D) alone as the control. The fortified dry feed was Raanan, of crude protein CP 57% made by Raanan feed company, Akko, Israel (Table 1). The larvae were fed to satiation up to the termination of the experiments at 14 Days after Hatch (DAH) for each trial. In feed combinations of AD and FD *Artemia* and *Moina* were alternated with the dry feed during the feeding i.e. if *Artemia* was given to the larvae at 8.00hrs the next feeding would be dry feed at 11.00hrs. The feeds were given 4 times a day at 8.00hrs, 11.00hrs, 14:00hrs and 18.00hrs. The three treatments were done in replicates adding up to nine tanks. The same experimental arrangement was repeated in the second trial two months later using the same batch of brood fish which had reached an average of 800±20g. In both trials the brood fish was conditioned with a locally manufactured Kajjansi feed (35% crude protein CP) for two weeks before spawning. In all trials the dissolved oxygen was maintained at over 4mlg $^{-1}$. The pH was maintained at between 7and 8 and the ammonia at ≤0.1mg/l. Experiments were conducted at a private farm, Kireka fish farm in Wakiso district (N00.35180, E32.64025) between November 2013 and February 2014.

About 150 fish larvae were sampled from each nursing tank and the total lengths TL were measured using a Vanier caliper to the nearest 0.1mm. Specific growth rates (SGR) were calculated as SGR=Final length-initial length /culture days x 100. Larval survival was estimated as a Percentage function of the difference between number of individuals at the termination of experiment and the initial population at stocking. Differences in mean larvae lengths between treatments due to the weaner feeds were determined using One way analysis of variance followed by Duncan's Multiple Range tests at $P<0.05$ level of significance. Variations in percentage survival between treatments were compared using student's t- test in IMB SPSS statistical version 20 software. Values were recorded as means ±SE (Standard Error).

Table 1: Composition of the imported commercial feed D

Nutritional value		Vitamins		Ingredients	Min	Max
Moisture	9.5 % max.	Vitamin A	30,000 IU/kg	Fish meal	**55%**	**75%**
Crude protein	56 % min.	Vitamin D	3000 IU/kg	Krill meal	**5%**	
Crude fat	15.0 % min.	Vitamin C (stabilized)	2000 mg/kg	Wheat and by products	**7%**	**18%**
Crude fiber	0.6 % max.	Vitamin E	400 mg/kg	Fish Oil	**6%**	
Ash	11.0 % max			Vitamins and minerals	**1.0%**	
Protein % from marine sp.	80 % min.					
Fat % from marine sp.	90 % min.					
Phosphorus	1.0 % min.					
Digest. energy	3500 kcal/kg min.					

Source: Raanan fish Product certification

3. Results

Results indicated that final mean length (TL cm) of feed combination AD was significantly higher ($P<0.05$) than FD combination and D alone in both trials. However, final mean length for feed combination FD and D alone were not different in both trials (Table 2 & 3.). Clear differences in mean length between feed combination AD and other feeds FD and D began to be noticed at Day 6 in the First trial and Day 7 in the second trial and the trend continued up to the end of the experiment (Table 2 & 3; Fig. 1& Fig. 2). Specific growth rate (mean length % increment per day) was 5.14%, 4.29% and 4.50% in trial 1 and 5.71%, 5.14% and 4.93% in trial 2 for AD, FD and D respectively (Table 3). The percentage mean length daily increment (SGR) was notably higher in feed combination AD than other feeds in both trials. Over all SGR for all feeds in trial 2 was generally better than those in the trial 1.

Student t-test results indicated that differences in mean survival % were not significant between feeds within each treatment ($p>0.05$) (Table 3). However, the percentage survival of de-capsulated Artemia + dry feed (AD) was better than other feeds in both trials and the second trial registered an improved mean % survival in all feeds compared to the first trial (Fig. 3).

Table 2: Showing mean differences (±SE) for the three weaning diets; AD, FD and D in Trial 1

Day	Mean AD	Mean FD	Mean D
D1	0.7791^{a}±0.005	0.7680^{a}±0.004	0.7750^{a}±0.004
D2	0.8191^{ac}±0.005	0.8010^{b}±0.004	0.8097^{bc}±0.005
D3	0.8729^{a}±0.007	0.8431^{b}±0.006	0.8472^{b}±0.006
D4	0.9741^{a}±0.006	0.9486^{b}±0.007	0.9622^{ab}±0.008
D5	0.9993^{a}±0.005	0.9908^{a}±0.005	1.0476^{a}±0.068
D6	1.1059^{a}±0.007	1.0711^{b}±0.007	1.0620^{b}±0.007
D7	1.1881^{a}±0.008	1.1312^{b}±0.009	1.1131^{b}±0.011
D8	1.2168^{a}±0.009	1.1345^{b}±0.012	1.1622^{b}±0.010
D9	1.2655^{a}±0.011	1.2126^{b}±0.010	1.2323^{b}±0.010
D10	1.3316^{a}±0.010	1.2660^{b}±0.008	1.2655^{b}±0.013
D11	1.3990^{a}±0.010	1.3152^{b}±0.010	1.2885^{b}±0.010
D12	1.4037^{a}±0.011	1.3077^{b}±0.012	1.3296^{b}±0.012
D13	1.4548^{a}±0.010	1.3420^{b}±0.010	1.3306^{b}±0.010
D14	1.4952^{a}±0.013	1.3696^{b}±0.011	1.3973^{b}±0.014

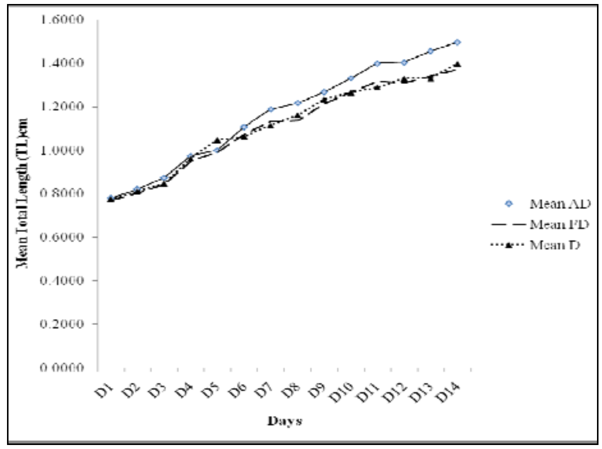

Fig 1: Mean Length increase due to feeds; AD, FD and D over a period of 14 days in trial 1

Table 3: Showing mean differences (±SE) for the three weaning diets; AD, FD and D in Trial 2

Day	Mean AD	Mean FD	Mean D
D1	0.6440^{a}±0.008	0.6300^{a}±0.006	0.6333^{a}±0.007
D2	0.7687^{a}±0.005	0.7427^{b}±0.006	0.7130^{b}±0.008
D3	0.8800^{a}±0.005	0.8807^{a}±0.005	0.8403^{b}±0.007
D4	0.9210^{a}±0.006	0.9095^{b}±0.005	0.8993^{b}±0.006
D5	0.9687^{a}±0.006	0.9313^{b}±0.006	0.9297^{b}±0.006
D6	1.0197^{a}±0.007	0.9968^{b}±0.005	0.9726^{c}±0.006
D7	1.0503^{a}±0.008	1.0180^{b}±0.008	1.0056^{b}±0.008
D8	1.0797^{a}±0.008	1.0473^{b}±0.008	1.0367^{b}±0.007
D9	1.1227^{a}±0.007	1.0907^{b}±0.009	1.0857^{b}±0.007
D10	1.1810^{a}±0.007	1.1460^{b}±0.008	1.1319^{b}±0.007
D11	1.2653^{a}±0.009	1.1947^{b}±0.008	1.1808^{b}±0.006
D13	1.3097^{a}±0.010	1.2447^{b}±0.008	1.2260^{b}±0.007
D12	1.3770^{a}±0.008	1.3000^{b}±0.008	1.2740^{b}±0.010
D14	1.4383^{a}±0.011	1.3510^{b}±0.009	1.3150^{b}±0.009

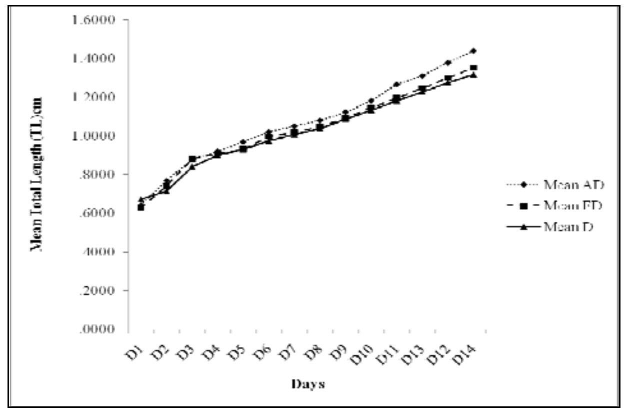

Fig 2: Mean Length increase due to feeds; AD, FD and D over a period of 14 days

Table 4: Daily mean percentage length increment and survival per feed combination; AD, FD & D

Trials	Feed combination	Mean Initial stocking TL (cm)	Mean Final length TL (cm)	Specific growth rate (SGR) % increase in length per day	Survival %
1	AD	0.78^{a} ±0.005	1.50^{a} ±0.013	5.14	75.6^{a}±1.6
	FD	0.77^{a} ± 0.004	1.37^{b} ±0.011	4.29	64.7^{a}±3.0
	D	0.77^{a} ± 0.004	1.40^{b} ±0.014	4.50	64.2^{a}±3.0
2	AD	0.64^{a}±0.008	1.44^{a}±0.011	5.71	79.4^{a}±5.0
	FD	0.63^{a}±0.006	1.35^{b}±0.009	5.14	74.5^{a}±4.1
	D	0.63^{a}±0.007	1.32^{b}±0.009	4.93	68.2^{a}±4.2

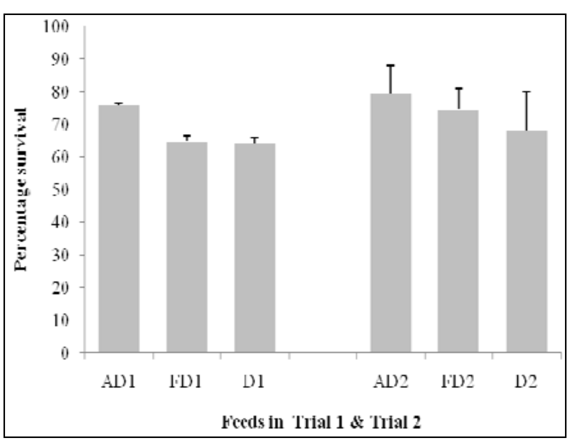

Fig 3: mean percentage larvae survival due to feed treatment AD, FD and D in Trial 1and 2

4. Discussion

Growth studies on catfish larvae rearing have indicated differences in performance of various starter feeds for African catfish. Studies recommend and emphasize incorporating live feeds as starter feeds for catfish larvae in the weaning protocol for better growth performance [10, 20, 21]. Over the years workers on a number of cultured fish species have shown growing concern of reducing the cost of weaning larvae by introducing early micro diets [15, 16]. This study illustrated successful weaning of the catfish larvae exclusively on dry feed alone. Despite the fact that a mixture of de-capsulated *Artemia* and Dry feed performed better than other feeds, the dry feed combination with moina and the dry feed alone performed equally well. The similar growth rates for both combination of dry feed + *Moina* (FD) and dry feed alone in both trials confirmed the possibility of using the dry feed exclusively in hatcheries. Use of dry feed alone were reported to have performed well as starter feeds in experiments done on *Clarias gariepinus* [22] and *Heterobranchus longfilis* [1]. These results uphold a positive concern that the weaning diets should be as simple as possible in order to reduce the cost of raising the larvae in hatcheries [17]. The current study proposes that the newly introduced Raanan feed or an equally well formulated diet could reduce the cost of mass production of catfish fry in hatcheries in Uganda and lessen the burden of preparing tedious live cultures. It is possible that the dry feed used contained relevant nutritive ingredients that could support first growth of larvae. Better growth performance on decapsulated *Artemia* cysts + dry feed combination has been attributed to increased High density unsaturated fatty acids (HUFA) [23]. However, this study did not analyze the fatty and amino acid profiles of the dry feed to establish specific nutrient composition of the feed that could confer similar attributes. Similar performance of the dry feed D used exclusively and the combination of the dry feed + *Moina* (FD) suggests that there was no indication of malnutrition associated with live feed nutrients for the larvae during the experimental period, thus further indicating that the micro diet used is an important feed for larvae weaning. In pike perch where the malnutrition was detected during the first feeding using the dry feed, compensatory growth was reported following improved development of the gut system [24]. In addition to using the dry feed exclusively as a starter feed to wean larvae in hatcheries, there is significant benefit of reduced disease incidence by direct weaning of larvae on micro diets. Live cultures in hatcheries have been observed to cause losses through introduction of disease causing agents in the larvae nursing systems during feeding [25, 26].

The survival rates for all the feed combinations obtained in this study were consistent in both trials. The percentage survival values were quite deferring from those reported by previous workers [9, 13], ranging from 4.97% to 13.91%. Conversely these baseline percentage survival rates were much lower than the 64% obtained with the use of the dry feed exclusively. In a related experiment to evaluate performance of commercial dry feed as a starter feed on hybrid African catfish larvae (*Clarias gariepinus X. Heterobranchus bidorsalis*), percentage survival (33.3%) was still much higher than the indicated baseline values [10]. This implies that such micro diets are preferably better used than what the local hatchery operators use to wean catfish larvae. Although the improved percentage survival was largely attributed to the feed, other factors that ranged from brood stock conditioning, hygiene water quality management and larval handling were paramount to reducing the mortalities in the hatcheries [27]. The improved percentage survival rates in the second trial seem to affirm the need for continued vigilance and improvement of the nursing of the larvae that the hatchery operators should keenly adopt in the hatchery management business. In the second trial ardent preparations were made to ensure minimized mortalities in the hatchery illustrating how important simple procedures hatchery operators often ignored, could improve larvae production.

5. Conclusion and Recommendation

There was improved larvae production with the imported commercial dry feed whose performance was equally good as a starter feed alone without combining it with any live feed. Being comparatively cheaper than *Artemia* and the more tedious preparation *Moina* cultures, weaning the feed should be popularized among hatchery operators in order to improve larval production in Uganda. However, more efforts are required to develop and test locally formulated or manufactured feeds of the same or better ingredients of the feed used in the study to further reduce the cost of feeds in hatchery production.

6. Acknowledgement

We acknowledged funding from Association of Strengthening Agriculture Research in East and Central Africa (ASARECA) and technical support and facilities provided by National Fisheries Resources Research Institute (NaFIRRI). We thank the management of Kireka Fish farm for providing the experimental facility and their participation in this study.

7. References

1. Kerdchuen N, Legendre M, Corraze G, Bergot P. Larval rearing of an African catfish Heterobranchus longifilis (Teleostei, Clariidae): effect of dietary lipids on growth, survival and fatty acid composition of fry. Aquatic Living Resources. 1995; 8:355-363.
2. Fermin AC, Boliver ME. Weaning of the Asian catfish, Clarias macrocephalus Gunther, Larvae to formulated dry diet. In: C.B Santiago, R.M Coloso, O.M Millamena & I.G. Borlongan (Eds).Feeds for small scale aquaculture. Proceedings of the national seminar-on workshop fish nutrition and feeds Tigbauan, Iloilo, Philippines: SEAFDEC Aquaculture Department. 1996, 83-86.
3. Kolkovski S. Digestive enzyme in fish larvae – application and implications: A review. Aquaculture. 2001; 200:181-201.
4. Ostaszewska T, Wegner A, Wegiel M. Development of the digestive tract of Ide, leuciscus idus (L). During the larvae stage. Archives of polish fisheries 2003; 11:79-92
5. Navarro N, Sarasquete C. Use of freeze-dried microalgae for rearing gilthead sea*bream, Spar*usaurata, larvae. I. Gr*owth, histo*logy and water quality. Aquaculture. 1998; 167:179-193.
6. De Silva SS, Anderson TA. *Fish nutrition in aquaculture*. Chapman and Hall Landon. 1995, 319.
7. Jian GQ. Larval fish Nutrition and rearing technologies: State of the Art and future. In: Stephen H. S (Eds). Aquaculture Research trends. 2008; 3:113-148.
8. Zambonino-Infante J, Gisber E, Sarasquete C, Navarro I, Gutiérrez J, Cahu CL. Ontogeny and physiology of the digestive system of marine fish larvae. In: Cyrino J.E.O., Bureau D. and Kapoor B.G. (eds). Feeding and digestive functions of fish Science Publishers. Inc, Enfield, USA 2008, 277-344.
9. Chepkwemoi P, Bwanika GN, Kwetegyek J, Mbahizireki G, Ndawula L, Izaara AA. Fatty Acid Profiles and Growth of African Catfish Larvae Fed on Freshwater Cyclopoid Copepods and Artemia as Live Starter Feed. International Journal of Aquaculture. 2013; 3(22):126-132.
10. Adewolu MA, Akintola SL, Akinwunmi OO. Growth performance and survival of hybrid African catfish larvae (*Clarias gariepinus* x heterobranchus bidorsalis) fed on different diets. The Zoologist. 2009; 7:45-51.
11. Olumuji OK, Mustapha MK. Induced Breeding of African Mud Catfish, *Clarias gariepinus* (Burchell 1822), using Different Doses of Normal Saline Diluted Ovaprim. Journal of Aquaculture Research and Development. 2012; 3:133.
12. Shepherd CJ, Bromage NR. Intensive fish farming.

Blackwell science Ltd. 1988, 404.
13. Mwanja M, Rutaisire J, Ondhoro CC, Ddungu R, Aruho C. Current fish Hatchery Fish Practices in Uganda. The Potential for future investment. International Journal of Fisheries and Aquaculture. 2015; 2(4):224-232.
14. Janssen JAL. Mass Production of Fry and Fingerlings of the African Catfish *Clarias Gariepinus* in: Seed Production UNDP, FAO, Nigerian Institute for Oceanography and Marine Research 1987, 3.
15. Gordon AK, Kaiser H, Britz PJ, Hecht T. Effect of Feed Type and Age-at-weaning on Growth and Survival of Clownfish Amphiprion percula (Pomacentridae). Aquarium sciences and conservation 2000; 2(4):215-226.
16. Liu B, Zhu X, Lei W, Yang Y, Han D, Jin J e al. Effect of different weaning strategies on survival and growth in Chinese longsnout catfish (Leiocassis longrostris Gunther) larvae. Aquaculture. 2012; (364-365):13-18.
17. Chatain B. Development and achievements of marine fish-rearing technology in France over the last 15 years. Hydrobiology. 1997; 358:7-11.
18. Hogendoorn H, Vismans MM. Controlled propagation of the African catfish Clarias lazera (C & V). II Artificial reproduction. Aquaculture 1980; 21(1):39-53.
19. Woynarovich E, Horvath L. The artificial propagation of warm water fin fishes, a manual for extension. FAO Fisheries Technical Paper 1980; 201:183.
20. Whyte JNC, Bourne N, Hodgson CA. Influence of algal diets on biochemical composition and energy reserve in patinopecten (Jay) Larvae. Aquaculture. 1989; 78:333-347.
21. Santiago CB, Pantastico JB, Baldia SF Reyes OS, Milk fish. (Chanos chanos) fingerling production in fresh water ponds with the use of natural and artificial feeds. Aquaculture. 1989; 77:307-318.
22. Appelbaum S, Van Damme P. The feasibility of using exclusively artificial dry feed for the rearing of Israeli *Clarias gariepinus* (Burchell1822) larvae and fry. Journal of Applied Ichthyology. 1988; 4:105-110.
23. Qin J, Fast AW, DeAnda D, Weidenbach RP. Growth and survival of larval snakehead (Channastriatus) fed different diets. Aquaculture. 1997; 148:105-113.
24. Hamza N, Mhetli M, Kestomont P. Effects of weaning age and diets on ontogeny of digestive activities and the structure of the pike perch (Sander lucioperca) larvae. Fish physiology and biochemistry. 2007; 33(3):121-133.
25. Food Agriculture Organization (FAO). Training Manual of Integrated Fish Farming in China. Fish diseases and control Chapter. 1985; 6:371.
26. Hecht T, Endemann F. The impact of parasites, infections and diseases on the development of aquaculture in sub-Saharan Africa. Journal of Applied Ichthyology. 1998; 14(3-4):213-221
27. De Graaf G, Janssen J. Handbook on The Artificial Reproduction And Pond Rearing Of The African Catfish *Clarias gariepinus* In Sub-Saharan. Africa FAO, Fisheries Technical 1996, 362 Rome.