Aquaculture Research

Aquaculture Research, 2010, 1–4 doi: 10.1111/j.1365-2109.2010.02709.x

SHORT COMMUNICATION

Effect of feeding regimes on growth and survival of *Clarias gariepinus* larvae: replacement of *Artemia* by a commercial feed

Michaël Vandecan, Amara Diallo & Charles Mélard

Aquaculture Research and Education Center (CEFRA), University of Liège, Tihange, Belgium

Correspondence: C. Mélard, Aquaculture Research and Education Center (CEFRA), University of Liège, Chemin de la Justice 10, B-4500 Tihange, Belgium. E-mail: c.melard@ulg.ac.be

The African catfish, *Clarias gariepinus* (Burchell 1822) is one of the most important species currently being farmed. *Clarias gariepinus* is a native species of tropical and subtropical fresh waters. It has been widely farmed in heated waters outside its natural range (Hecht & Appelbaum 1987), mainly in intensive culture in recirculating systems. The rapid growth even at high density, ability to breathe air and to withstand poor water quality and low food requirement make *C. gariepinus* an excellent fish for aquaculture. In recirculating systems, larval rearing is the bottleneck in *C. gariepinus* production (Verreth 1994), although great progress has been made on the development of larval diets (Hecht, Ollermann & Verheust 1996). Larvae of African catfish are generally weaned with natural food organisms that seem to be a prerequisite for the early larval rearing, and *Artemia* is often described as a reference diet in larval nutrition studies. Using natural food is costly, time consuming and not always available for the fish breeder. Production of live food also needs adapted structures. Recently, an alternative to *Artemia* live food was developed for the marine hatchery market. This new generation of starter feed is described as more digestible, metabolizable and with better formulation (Gemma micro®, Skretting, commercial prospectus). The objective of the present investigation was to assess the possibility to replace partially or totally live food (*Artemia* nauplii) by a commercial artificial food.

Larvae of *C. gariepinus* were obtained by artificial reproduction with captive breeders reared in the Aquaculture Research and Education Centre of the University of Liège. Larvae were reared in 50-L aquaria in a recirculating system at 28.0 ± 0.1 °C, pH = 7.6 ± 0.2, with constant aeration ($O_2 = 5 \pm 0.8$ ppm) and renewal rate (0.5 L min^{-1}). Concentrations of total ammonia and nitrites were 0.68 ± 0.26 and 0.22 ± 0.26 mg L^{-1}.

The experiment was conducted in two phases: during the first 13 days post first feeding (feeding begin 48 h post hatching), larvae were fed with or without *A.* nauplii and with different feed (six feeding regimes in duplicate, Table 1) at 500 fish/50-L aquaria. Two commercial larval feed were used: 'Gemma micro®', Skretting (particles size 150–300 μm), a marine larval feed or 'Lucky Star®' (particles size 150–300 μm), a freshwater larval feed. Compositions are presented in Table 2. Fish were fed *ad libitum* six times a day from 09:00 to 17:00 hours. When necessary, excess feed was removed from the aquaria at the end of the day.

In the second phase, from D13 to D32, larvae weaned with the different regimes were reared at 200 fish/50-L aquaria and fed with the same feed (Lucky Star®, particles size 300–500 μm) to evaluate the effect of first feeding regimes on growth and survival after the weaning period. At the end of each phase, biomass was measured and 50 fish were individually weighed. Specific growth rate SGR, food conversion ratio FCR and survival rate were calculated according to the formula: $SGR = 100 (\ln W_2 - \ln W_1) (t_2 - t_1)^{-1}$ where W_2 and W_1 are mean body weight (g) at day t_2 and t_1, $FCR = C$ $(final\ biomass - initial\ biomass)^{-1}$ where C is total food

Table 1 Feeding regimes for *Clarias gariepinus* larvae from D1 to D32 post first feeding

Feeding days	1	2	3	4	5	6	7	8	9	10	11	12	13	13 → 32
Regime 1	*Artemia*			Co-feeding *Artemia* + 'Lucky Star®'										'Lucky Star®'
Regime 2	*Artemia*			Co-feeding *Artemia* + 'Gemma micro®'										'Lucky Star®'
Regime 3	*Artemia*			Co-feeding *Artemia* + 'Lucky Star®'			'Lucky Star®'							'Lucky Star®'
Regime 4	*Artemia*			Co-feeding *Artemia* + 'Gemma micro®'			'Gemma micro®'							'Lucky Star®'
Regime 5	'Lucky Star®'													'Lucky Star®'
Regime 6	'Gemma micro®'													'Lucky Star®'

Table 2 Composition of the larval feed

Ingredient composition (%)	Gemma micro®	Lucky Star®
Fish Meal	71	45
Squid meal	*	20
Phospholipids	>12	*
Lecithin	12	*
Wheat gluten	4	*
Cereals	*	10
Yeast	*	5
Vitamins	4	5
Mineral premix	4	5
Starch	2.5	*
Fish oils	<5	*
Betain	1	*
Analytical content (%)		
Protein content	55	56
Fat content	15	8
Fiber	5	1.4
Ash	13.5	13
Moisture	7	10
Phosphorus	2	*
Copper	3	*
Vit A (IU kg^{-1})	40 000	*
Vit D3 (IU/kg^{-1})	2800	*
Vit E (IU/kg^{-1})	400	*
Total n-3 HUFA	13.3	*
DHA	4.3	*
EPA	7.1	*

*Not given.

distributed during the experimental period and survival Rate = final number/initial number.

Statistical analysis (one way analysis of variance) of growth parameters (final weight between duplicate and among treatments) was performed using STATISTICA software. Significant ANOVAs were followed by an LSD multiple comparison test to identify differences among treatments. Mortality data were compared with the Chi-square (χ^2) test. Level of significance was accepted at $P<0.05$.

In the first phase of the experiment (D1 to D13), growth (final body weight: 66 ± 3 mg) and survival (92 ± 4%) of larvae fed with the 'Gemma only' regime were significantly higher ($P<0.05$) than with the other regimes. All mixed regimes (Artemias+artificial feeding) showed better growth and survival with 'Gemma' than 'Lucky Star®' (Table 3).

In the second phase (follow-up from D14 to D32 after weaning period, same feed for all groups), no growth difference was observed in term of SGR (37.5 ± 0.6% day^{-1}), or for the FCR (0.7 ± 0.1) between groups (Table 4). Body weight at D32 was higher for fish fed previously with regimes including 'Gemma': 993 ± 55 mg vs 820 ± 82 mg for other regimes. Survival of larvae fed previously with regimes including 'Gemma' was higher than the other regimes (83 ± 4% vs 71 ± 7%) (Figs 1, 2). No external

Table 3 Growth parameters of clarias larvae during the 13-day feeding experiment with different regimes

	A13+L	A13+G	A6+L	Ar6+G	L	G
Initial weight (mg)	3	3	3	3	3	3
Final weight (mg)	21 ± 0^a	52 ± 4^b	22 ± 6^a	37 ± 0^b	16 ± 1^a	66 ± 3^c
SGR (% day^{-1})	22.3 ± 0.0	29.9 ± 0.6	22.5 ± 2.3	27.1 ± 0.0	19.8 ± 0.8	31.9 ± 0.3
Survival (%)	69 ± 2^a	75 ± 6^a	64 ± 4^a	75 ± 7^a	72 ± 8^a	92 ± 4^b

Means indicated with a different letter are significantly different ($P<0.05$).
A, *Artemia* (during 6 or 13 days); L, Lucky Star®; G, Gemma micro®; SGR, specific growth rate.

Table 4 Growth parameters of clarias juveniles previously fed with different feeding schemes from days 14 to 32

	A13+L	A13+G	A6+L	A6+G	L	G
Body weight J14 (mg)	21 ± 0[a]	52 ± 4[b]	22 ± 6[a]	37 ± 0[b]	16 ± 1[a]	66 ± 3[c]
Body weight J32 (mg)	750 ± 50[a]	930 ± 70[b]	800 ± 80[a]	1030 ± 20[b]	910 ± 330[a]	1020 ± 10[b]
SGR (% day^{-1})	36.6 ± 0.4	37.6 ± 0.5	37.0 ± 0.5	38.3 ± 0.1	37.5 ± 2.1	38.1 ± 0.1
FCR	0.7 ± 0.0	0.6 ± 0.2	0.7 ± 0.1	0.6 ± 0.0	0.7 ± 0.0	0.6 ± 0.0
Survival (%)	70 ± 2[a]	85 ± 1[b]	79 ± 7[b]	78 ± 2[b]	65 ± 18[a]	86 ± 1[b]

Means indicated with a different letter are significantly different ($P < 0.05$).
A, *Artemia* (during 6 or 13 days); L, Lucky Star®; G, Gemma micro®; SGR, specific growth rate; FCR, food conversion ratio.

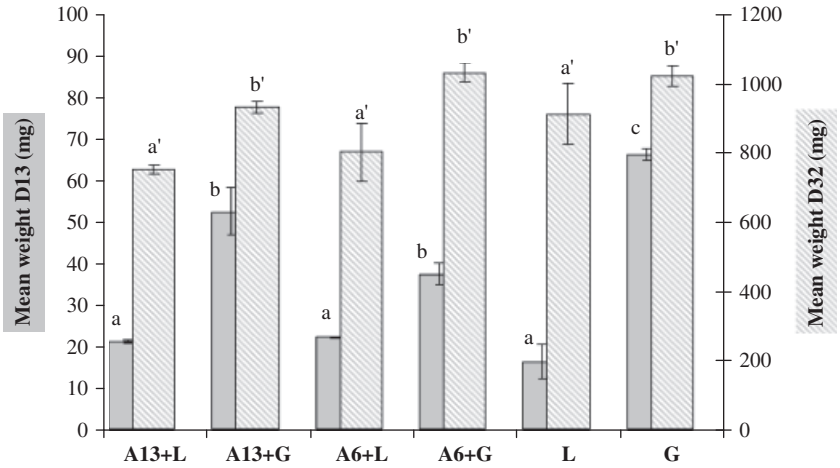

Figure 1 Body weight of clarias after 13 days (feeding regimes experiment) and 32 days (follow-up of growth after weaning period) experiment. A = *Artemia* (during 6 or 13 days); L, Lucky Star®; G, Gemma micro®. [a,a′, b,b′, c]Means indicated with a different letter are significantly different ($P < 0.05$).

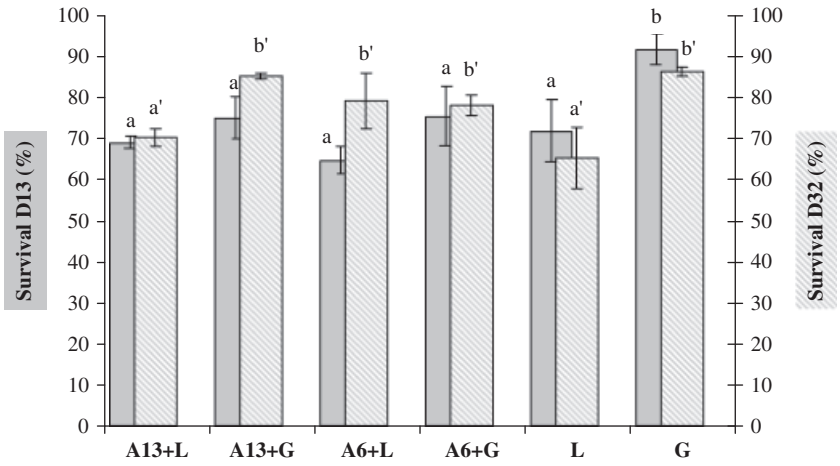

Figure 2 Survival of *Clarias gariepinus* after 13 days (feeding regimes experiment) and 32 days (follow-up of growth after weaning period) experiment. A = *Artemia* (during 6 or 13 days L, Lucky Star®; G, Gemma micro®. [a,a′, b,b′]Means indicated with a different letter are significantly different ($P < 0.05$).

evidence of nutritional deficiencies was present after feeding with the same diet for 18 days. No cannibalism was observed in our experiment.

In our experiment, the growth and survival of the larvae of *C. gariepinus* are in accordance with previous results (Hogendoorn 1980; Verreth & Den

Bieman 1987; Appelbaum & Van Damme 1988; Verreth & Van Tongeren 1989; Appelbaum & Kamler 2000). Previous studies showed that total replacement of live food by commercial feed led to very bad growth and survival performances (Verreth & Van Tongeren 1989; Curnow, King, Bosmans & Kolkovski 2006). Authors assumed that the digestive system was not yet sufficiently developed before 4–5 days to enable good growth and survival. However, Appelbaum and Van Damme (1988) tested an experimental dry food with good growth performances (body weight: 141 mg after 15-days feeding), feed utilization and survival (78%). Our experiment using 'Gemma micro®' showed similar performances in term of growth (66 mg after 13-days feeding, 300 mg after 18 days), but a better survival (92% after 13 days).

Thanks to the development of high-quality larval feed, we demonstrated the possibility to totally replace live food by an artificial feed. Feeding only with the high quality feed without *Artemia* during weaning period showed best results in terms of growth and survival. Higher energy content of this artificial feed combined with a good supply in micro-nutriments (amino acids, phospholipids, vitamins, carotenoids) probably explains this result.

Acknowledgments

This study was supported by Electrabel-Suez and the Walloon government (APE project N° NM 02451).

References

Appelbaum S. & Kamler E. (2000) Survival, growth, metabolism and behaviour of *Clarias gariepinus* (Burchell 1822) early stages under different light conditions. *Aquacultural Engineering* **22**, 269–287.

Appelbaum S. & Van Damme P. (1988) The feasibility of using exclusively artificial dry feed for the rearing of Israeli *Clarias gariepinus* (Burchell, 1822) larvae and fry. *Journal of Applied Ichthyology* **4**, 105–110.

Curnow J., King J., Bosmans J. & Kolkovski S. (2006) The effect of reduced Artemia and rotifer use facilitated by a new microdiet in the rearing of barramundi *Lates calcarifer* (BLOCH) larvae. *Aquaculture* **257**, 204–213.

Hecht T. & Appelbaum S. (1987) Notes on the growth of Israeli sharptooth catfish (*Clarias gariepinus*) during the primary nursing phase. *Aquaculture* **63**, 195–204.

Hecht T., Ollermann L. & Verheust L. (1996) Perspectives on clariid catfishes culture in Africa. *Aquatic Living Resources* **9**, 197–206.

Hogendoorn H. (1980) Controlled propagation of the African catfish, *Clarias lazera* (C. & V.): III. Feeding and growth of fry. *Aquaculture* **21**, 233–241.

Verreth J. & Den Bieman H. (1987) Quantitative feed requirements of African catfish (*Clarias gariepinus* Burchell) larvae fed with decapsulated cysts of Artemia. I. The effect of temperature and feeding level. *Aquaculture* **63**, 251–267.

Verreth J. & van Tongeren M. (1989) Weaning time in *Clarias gariepinus* larvae. *Aquaculture* **83**, 81–88.

Verreth J. (1994) *Nutrition and related ontogenetic aspects in larvae of the African catfish Clarias gariepinus*. DSc thesis, Wageningen Agricultural University, Wageningen, 205 pp.

Keywords: *C. gariepinus*, larvae, feeding