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# Feed of crustaceans for a durable development of the aquaculture: shrimps feeding: A review

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**Abstract**
Aquaculture is an important part of agriculture because it generates products of same nature than those issued from natural marine and continental fisheries. Indeed, the particular interest toward aquaculture nowadays results from a decrease in natural reserves in fishes, crustaceans and others, provoked by an uncontrolled overfishing. It is important to notice the global increase in fish farming is not the same compared to crustaceans rearing and algae culture. The rearing of crustaceans is so less developed in Africa, especially in Southern Sahara though it's almost absent because shrimp feeding poses different problems according to species and culture methods especially. The aim of this work is to make a bibliographical synthesis on the feed of the crustaceans (shrimps) about their physiology of digestion, their diet and their nutritional need in order to promote studies on the feed of shrimps. The promotion of the breeding of shrimps will bring a beneficiation on the African western aquaculture about the economic, scientific, social and of food safety.

**Keywords:** feed, crustaceans, shrimp, aquaculture

## 1 Introduction
Aquaculture is an important part of agriculture because it generates products (fishes, crustaceans, mollusks, algae) of same nature than those issued from natural marine and continental fisheries. As marginal in relation to natural fishery volume until 1970s, aquaculture has developed explosively from middle 1980s and now represents the agricultural production with the highest growth rate during the last fifteen years on the world scale (14% yearly between 1990 and 2000 against 2.8 % for terrestrial animal productions in the same period) [1, 2]. According to the United Nations Food and Agriculture Organization [3], over the 148 million tons of fishes, mollusks and crustaceans consumed worldwide, 59.9 million were issued from aquaculture. The continental aquaculture remained in the same trend during the last four years though worldwide continental aquatic production varied from 3.5 million tons in 1970 up to 44 million tons in 2011 [4]. Indeed, the particular interest toward aquaculture nowadays results from a decrease in natural reserves in fishes, crustaceans and others, provoked by an uncontrolled overfishing [5, 6]. It's worth a production of supplementary 40 million tons of fishes and crustaceans in 2030 due to worldwide population increase and the transformation of the 50% of fishery products in oil and flour serving to animal feeding [7, 8].
Besides, it is important to notice the global increase in fish farming is not the same compared to crustaceans rearing and algae culture. The rearing of crustaceans is so less developed in Africa especially in Southern Sahara though it's almost absent [9]. Now, crustaceans especially shrimps are more rich in nutritional elements than fishes with a very high economical value [10, 11, 12]. Several technical, scientific and technological parameters hurt the development of shrimps rearing in the world, especially in Africa. Indeed, shrimp feeding poses different problems according to species and culture methods especially. Nutritional needs and particularly proteins vary strongly from a species to other and nutrition still constitutes a limiting factor to shrimps rearing especially in intensive systems.
The aim of this work is to make a bibliographical synthesis on the feed of the crustaceans (shrimps) about their physiology of digestion, their diet and their nutritional need in order to promote studies on the feed of shrimps.

## 2 Crustaceans generality

The crustaceans constitute one of the classes of the branch-line of the Arthropods, which regroup the animals with the segmented body.

### 2.1 Systematic position

The class of crustaceans has approximately 45000 species which can find in the watery or terrestrial ecosystems. They free and mobile either are fixed on an inert or alive support. Some crustaceans are parasitic or commensals on other animals. They are divided into seven groups (figure 1):

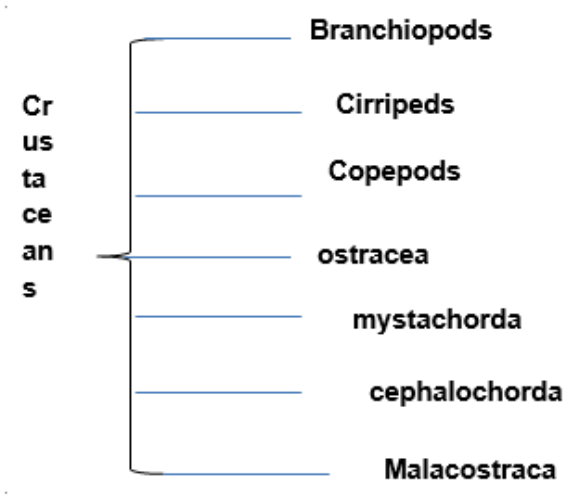


**Fig 1:** Different groups of crustaceans

### 2.2 External anatomy of crustaceans

The body of Crustaceans, although it has undergoes various reductions and fusions, is composed of a head with five pairs of appendices and of a trunk with many segments. Each segment is connected to different by articular membranes and carries a pair of articulated appendices. Their body is locked up in a chitin carapace encrusted with inorganic salt [13]. This external structure, the (external skeleton), is used as protection and support. It is periodically replaced in order to allow the growth. The crustaceans are distinguished from the other classes by the presence of two pairs of antennas and by the possession of many appendices and specific devices like the gills to extract oxygen from water. The crustaceans basically consist of three areas segmented: the cephalon (head) the pereion (thorax) and the pleon (abdomen).The body ends in an additional segment which is telson. However, at certain groups, one or more thoracic segments are incorporated in the head to form the cephalothorax.

### 2.3 Breathing in crustaceans

The breathing apparatus consists of plates or gills filaments locked up in a cavity which enable them to make to circulate water and thus to filter it to draw there oxygen necessary [13, 14]. The gills are in relation to the circulatory apparatus to carry out the gaseous exchange. This circulatory system is complex with a heart as well as a network of veins and arteries [15].

### 2.4 Digestion in crustaceans

The digestive system is complete with a mouth, an oesophagus, an intestine and an anus. The crustaceans have a complex stomach: the gastric mill, which is often subdivided in two parts called cardiac stomach and stomach pyloric. It is prolonged by the intestine average and accompanied by a significant hepatopancreas. Digestion is extracellular, but the chemical processes take place especially in the average intestine.

### 2.5 Reproduction in crustaceans

In crustaceans, the sex is generally separated, except at Cirripeds which are hermaphrodites. The genital glands, located above the intestine, form two long cords bent laterally and linked on the level of the heart by a transverse strip from which leave the evacuation channels the genital products at Malacostraca: spermiducts at the males and the oviducts in the females [16]. The crustaceans are oviparous animals; the genital openings are located between the legs walkers. There are coupling after its sloughing.

### 2.6 Locomotion in crustaceans

The external skeleton and the presence of articulated appendices give to crustaceans a large locomotors advantage compared to other species. On the one hand, the external skeleton gets rigidity necessary to the movement provides solid points of fastener for the muscles and the points of support for movements of lever. In addition, the appendices make it possible the animal to move. The articulations allow movements only in one plan, on the other hand their appendices are composed of several units whose articulations are directed in various plans what makes it possible to move the end of the appendix in all the directions.

### 2.7 Nutrition in crustaceans

Generally, the crustaceans are carnivorous or omnivorous, sometimes détritivorous. The larvae of all the species feed plankton by filtration of water. Cirripeds are species which feed plankton during all their life. Malacostraca nourish primarily preys dead or alive.

### 2.8 The moult in crustaceans

The crustaceans are protected by a chitinous carapace. When they grow, their carapace becomes too small; they leave it and produce some another. The frequency of the moults decreases with the age. A new soft carapace develops under the old one. Then, in a few minutes, the crustacean leaves, with move back, of its old carapace. At the time of the moult, all the chitinous parts are renewed, of the carapace to the smallest sensory hairs, while passing by the external part of gills [17].

## 3 Generality on shrimps

### 3.1 Systematic position and morphology of shrimps

#### 3.1.1 Systematic position of shrimps

The shrimps belong to the branch of the arthropods, the class of crustaceans and the order of the decapods. The decapods constitute the most significant order of crustaceans by the number of the species and contain all the eatable species (shrimps, lobsters, lobsters, crawfish, crayfish, and crabs).

| | | |
|---|---|---|
| Branch | : | Arthropoda |
| Super- class | : | Crustacea (*Pennant, 1777*) |
| Class | : | Malacostraca (*Latreille, 1806*) |
| Order | : | Decapoda (*Latreille, 1803*) |
| Suborder | : | Dendrobranchiata (*Bate, 1888*) |
| Family | : | Penaeidae (*Rafinesque-Schmaltz, 1815*) |
| Genus | : | *Penaeus* (*Fabricius, 1798*) |

#### 3.1.2 Morphology of shrimps

The morphology of shrimps (figure 2) does not differ from

that of other decapods. According to *Durand et al.* 1981, one observes in decapods:

- ❖ A cephalothorax, being able to be prolonged ahead by developed rostrum Apart from the eyes, it carries five (5) appendices divided into two (2) groups:
- 2 pairs of appendices in the adult playing the role of chemo-receivers, proprio- receivers and tactile:
- 3 pairs of oral appendices (oral) allowing crushing and chewing feed:
- 8 pairs of thoracic appendices of which:
- 3 pairs of jawbone legs. They make it possible to apprehend feed and constitute a support for the gills;
- 5 pairs of appendage being used for the locomotion.
- ❖ An abdomen (pleon) carrying six (6) pairs of abdominal appendices; five the first (5) pairs called the pleopods ensure the stroke in full water; the last is the uropod.

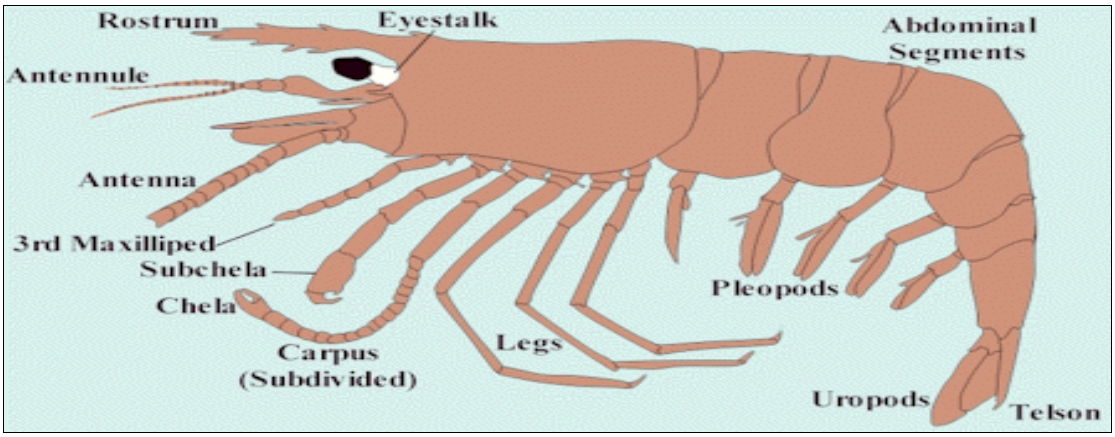


**Fig 2:** External morphology of shrimp

### 3.2 Physiology of the nutrition in shrimps

The digestive tract of the decapods can be subdivided in 3 parts: anterior tract digestive, intestine average and intestine posterior (Figure 3). The digestive tracts anterior and posterior, of ectodermal origin, are covered with a fine cuticle which is renewed with each moult. The average intestine is of endodermal origin [15].

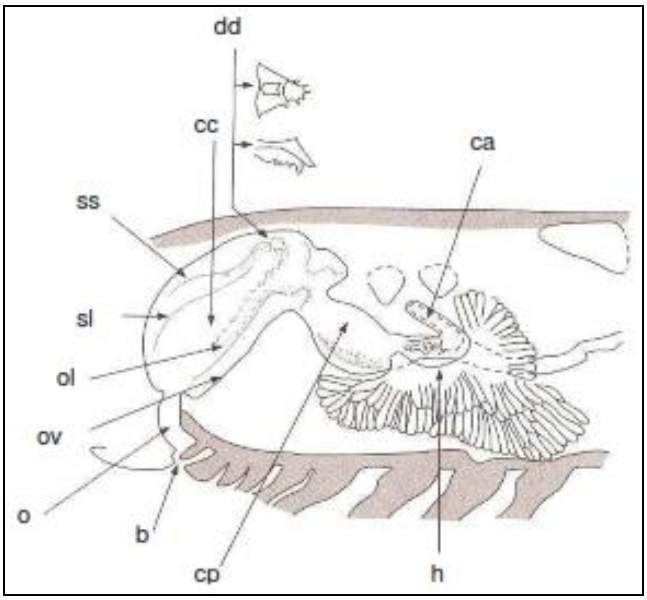


**Fig 3:** digestive system of shrimp. b: mouth; ca: anterior caecum; cc : cardial chamber; cp: pyloric chamber; dd, dorsal tooth; h: hépatopancreas; o: oesophagus; ol: lateral ossicules; ov: ventral ossicul; sl: lateral furrow; sv: ventral furrow

#### 3.2.1 Anterior digestive tract

The anterior digestive tract of the decapods crustaceans is made of 3 distinct parts: the mouth, the oesophagus, and the stomach.

- The mouth (figure 4) is surrounded by several pairs of appendices specialized in chemo-apprehend and gripping.


**Fig 4:** mouth of shrimp

The oesophagus in the shrimp peneidae is relatively short and muscular consists of an internal wall of flexible chitino-proteinic nature. The stomach consists of a cardial chamber and a pyloric chamber. In the peneidae shrimps, the anterior-ventral part of the cardial chamber includes a peak furnished with a line of 14 ossicles calcified and articulated. These parts equipped with a special muscular constitute the gastric mill. Ossicles and tooth are renewed with each moult as well as the walls of the oesophagus and the stomach. The calcified formations are prolonged in the pyloric chamber. This chamber consists of folds, of calcified spines and of silks which are used as filter and let pass only the finest particles of the feed bowl. The particles having crossed this filter are directed towards the average intestine and the organ of absorption, the hepato-pancreas. At the majority of the species the pH of the contents stomach remains neutral or slightly alkaline. The organ does not comprise any gland or cell with acid or enzymatic secretion.

#### 3.2.2 Average intestine and hepato-pancreas

The average intestine which goes from the pylorus to the rectum is rectilinear. In his epithelium one distinguishes from the nervous cells, of the hemocytes as well as cells of the endocrine cells. This epithelium secretes mucus which coats solid waste resulting from the stomach and a chitin film which forms the peritrophic membrane of excretion [18].

The digestive gland or hepato-pancreas is in the shrimps peneidae a massive organ made up of two wrapped symmetrical conjunctive fabric lobes. It is located in the dorsal part of the cephalo-thorax under the heart. The light of each tubule is bordered of a wrapped unicellular epithelium of a double longitudinal and ensuring circular muscular fiber work of the peristaltic movements allowing the transport of the liquid phases. Histological studies showed four cellular types constitutive of the epithelium of these tubules. In crustaceans, there are not biliary salts but gifted compounds of comparable surface-active properties.

**3.2.3 Posterior digestive tract**

It is a tubular formation with longitudinal folds comprising of the circular muscles which ensure the defecation by peristaltic movements and the reabsorption of water in marine environment.

## 4 Feed of shrimps

### 4.1 Natural diet of shrimps

The shrimps are carnivorous, omnivorous, and omnivorous with carnivorous tendency but sometimes also detritivorous. The larvae of shrimps feed planktonique cells by filtration of water. The stomach content analyses of the majority of shrimps showed their highly omnivorous tendencies (planktivorous, insectivorous, piscivorous, detritivorous etc). The majority of crustaceans are able to support prolonged fasts [18].

In nature, it is rare to meet shrimps of less than 5 g on the bottom, they are very generally fixed on supports (roots of mangrove, herbarium…) in the search of preys and of waste. Although the behavior of shrimps tends to become more benthic in big shrimps, they also feed on the vertical substrates.

### 4.2 Feed of shrimps semi intensive system

When the shrimps lay out has the time of natural food, preys alive, vegetation, derived organics various, and of granules, it is difficult to estimate the quantity of granules which it is advisable to distribute. It is more difficult to determine the ideal theoretical composition of the feed which is used as complement with natural feed. In practice there is recourse either has covering feed as well as possible needs for the species (feed intended for the intensive breeding) that is to say with local food. The experiment shows that the distribution of this feed increases the growth of shrimps well, but without it being known if the granules are introduced directly by shrimps or if they are it initially by other cells or if they are degraded by bacteria [19].

### 4.3 Feed of shrimps in intensive system

The feed of shrimps not receiving any natural food poses problems of a scientific nature but also of a technical and even technological nature. Initially, for approaching the study of the nature and the percentage of different the nutriments which it is advisable to bring to shrimp, it is necessary to solve the problem of the appetence and especially of stability with water of the feed particles which one provides [18]. Indeed the latter are consumed only slowly, they undergo a more or less intense dissolution according to the nature of the components and this dissolution of granule can make completely illusory the theoretical composition of the mode, affecting its nutritional value considerably. To minimize these losses, two approaches are possible: one can first of all use binders having or not a nutritional value (e.g. gelatin, starches transform for the first category, CMC);one can also use a particular process of agglomeration of the particles: cooking-extrusion. The control of these proceed is a precondition to any manufacture of feed for shrimp of quality. To have thus effective granule feed for shrimps, it is necessary to take into account parameters such as the formulation of feed and the quality of the ingredients; manufacturing method and physical characteristics of the granule ; method and the mode of distribution; watery environment and production natural [20].

### 4.4 Nutritional needs for shrimps

The nutritional needs for shrimps are characterized by:

- High protein needs (compared to those of the terrestrial mammals, poultries and of some watery species) which must be covered by proteins of high quality in particular of proteins of animal and marine origin brought by crustaceans and squid, fish meals. The other proteins are of a vegetable nature [20, 21].
- Requirements in lipids relatively weak but specific in fatty acids poly-insaturated to long chain (which can be brought only by marine oils - fish oil), out of phospholipids and cholesterol.
- Requirements in vitamins and certain minerals (in particular phosphorus).

### 4.5 Nutritional value of the shrimp flesh

The shrimp flesh is primarily rich in proteins just like the fish (table 1), contains very small quantities of greases and glucide. It is also rich in mineral substances such as sulphur, chlorine, calcium, magnesium and phosphorus. But, this chemical composition of shrimps varies with the species, the stage of maturity, the feed and the habitat.

**Table 1:** compared values of flesh of shrimps and fish

| Species | Humidity (%) | Protein (%) | | lipid(%) | | ash(%) | |
|---|---|---|---|---|---|---|---|
| | | Min | Max | Min | Max | Min | Max |
| *Latex niloticus* | 12.7 | 63.8 | 73.1 | 7.8 | 9.0 | 18.5 | 21.2 |
| *Lutjanus guineensis* | 32.5 | 63.1 | 93.4 | 3.3 | 4.8 | 5.2 | 7.6 |
| *Ethmalosa dorsalis* | 17.0 | 59.3 | 71.4 | 8.4 | 10.1 | 19.4 | 23.4 |
| *Clarias scopoli* | 10.5 | 57.7 | 64.4 | 10.2 | 11.4 | 18.0 | 20.1 |
| *Penaeus* | 18.1 | 53.3 | 65.0 | 8.8 | 10.7 | 14.2 | 17.4 |

## 5 Problems of the feed of crustaceans

In breeding, the feed constitutes a parameter determining for the economic profitability of the livestock production [21]. It contributes to more than 60% of the loads of production. It is the same for the aquaculture or the feed constitutes a parameter determining for the profitability of the aquacole production. In sub-Saharan Africa the fish covers on average 22% of the protein contributions of animal origin [22]. However, the maintenance of the current level of fish consumption per capita obliges Africa to increase of almost

250% its halieutic production during next years [23]. But it is noticed that the interest carried to the aquaculture is especially concentrated on pisciculture. The breeding of shrimps misses practically in West Africa. Of all the aquacoles resources halieutics exploited in West Africa, the crustaceans in particular the shrimps are negligible. The consumed and exported shrimps are all resulting from the gathering then that no structure of production of fresh or salted water shrimps settled so far. This dependence of shrimps is only due to no control of the techniques of breeding of shrimps. The true problem in all procedures of domestication of a new species is the feed. The shrimps present characteristics concerning their morphologies and physiology of digestion. These characteristics make difficult their feed catches and require an adapted environment. Indeed, the granule are consumed only slowly, they undergo a more or less intense dissolution according to the nature of the components and this dissolution of granule can make completely illusory the theoretical composition of the mode, affecting its nutritional value considerably. The system of breeding quickly becomes polluted and does not answer any more the ideal environment of shrimps.

## 6 Implication for the development

The realization of a bibliographical synthesis on the feed of the crustaceans (shrimps) about to their physiology of digestion, their diet and their nutritional need aims to promote studies on the feed of shrimps. The provision of basic information on the feed of shrimps will support the investments in the breeding of shrimps. What will lead to the development of the techniques and technologies for the control in the field of the feed of the breeding of shrimps in West Africa. The promotion of the breeding of shrimps will bring a beneficiation on the African western aquaculture about the economic, scientific, social and of food safety.

## 7 Prospect

This work was completed with an aim of promoting the breeding of shrimps in West Africa. Studies will be undertaken on the peneidae biology and the ecology of shrimps. Nutritional requirements out of protein, lipid and glucide. The attempts of the artificial propagation of peneidae will be tested.

## 8 Conclusion

The aquaculture development is a solution for the durable development of developing countries. This development must be done by the diversification of aquaculture species. Separately the fish, other species as shrimps must be bred. The control of the feed of crustaceans in occurrence of shrimps (peneidae) is a solution in the field of feed and economic safety.

## 9 References


1. El-Sayed AFM. Evaluation of soybean meal, spirulina meal and chicken offal meal as protein sources for silver seabream Rhabdosargus sarba. Aquaculture. 1994; 127:169-176.
2. Ramachandran S, Bairagi A, Ray AK. Improvement of nutritive value of grass pea (*Lathyrus sativus*) seed meal in the formulated diets for rohu, *Labeo rohita* (Hamilton) fingerlings after fermentation with a fish gut bacterium. Bioresource Technology. 2005; 96:1465-1472.
3. FAO, La situation mondiale des pêches et de l'aquaculture ; Département de Pêches et de l'aquaculture (Ed), Rome (Italie). 2010; 500:134.
4. FAO. La situation mondiale des pêches et de l'aquaculture. Rome, FAO, 2012, 241.
5. Naylor RL, Goldburg RJ, Primavera JH, Nils Kaustky M, Beveridge CM, Clay J et al. Effect of aquaculture on world fish supplies. *Nature*, 2000, 405.
6. Pauly D, Christensen V, Guénette S, Pitcher TJ, Sumaila RU, Walters CJ et al. Towards sustainability in world fisheries. *Nature*. 2002; 418:689-695.
7. Morin H. Menaces sur la pêche, l'aquaculture prend le relais. *Le Monde*, 2006, 20-21.
8. Subasinghe R. The State of world aquaculture. FAO Fisheries Technical Paper. FAO (Ed), Rome (Italie). 2006; 500:134.
9. Gangbe L, Agadjihouede H, Achoh M, Laleye P. Survie et croissance de la crevette géante d'eau douce macrobrachium vollenhovenii (Herklots, 1857) nourrie en captivité à base du tourteau du coprah, de la farine et du son de maïs. Afrique Science. 2016; 12(3):126-143.
10. Beard TW, Wickins JF. Breeding of Penaeus monodon Fabricius in laboratory recirculation systems. Aquaculture. 1980; 20:103-118.
11. Chamberlain GW, Lawrence AL. Effect of light intensity and male and female eyestalk ablation on reproduction of Penaeus stylirostris and Penaeus vannamei. World Maricuture Society. 1981; 12(2):357-372.
12. Jeckel WH, Aizpun de Moreno JE, Moreno VJ. Biochemical composition, lipid classes and fatty acids in the ovary of the shrimp *Pleoticus muelleri*. Biochemistry. Physiology. 1989; 92B:271-276.
13. Ceccaldi HJ. Anatomy and physiology of the digestive system. In: Crustacean Nutrition, Advances in World Mariculture Society of The World Aquaculture Society, Baton Rouge, LA, USA. 1997; 6:261-291.
14. Charmantier G. L'ionorégulation et l'osmorégulation chez les Crustacés : généralités, influences écologiques et physiologiques. Océanis, 5, fasc. 1979; 5:753-768.
15. Corbari L. Physiologie respiratoire, comportementale et morpho-fonctionnelle des ostracodes Podocopes et Myodocopes et d'un amphipode caprellidé profond. Stratégies adaptatives et implications évolutives. Thèse de Doctorat. Université Bordeaux 1. 2004, 134.
16. Charniaux-Cotton H, Payen G. Crustacean reproduction. In: Endocrinology of selected invertebrate types (Eds. by Laufer, H. and Downer, R.G.H.), Alan R. Liss, Inc. New York, 1988, 279-304.
17. Drach P, Tchernigovtzeff C. Sur la méthode de détermination des stades d'intermue et son application générale aux crustacés. Vie Milieu. 1967; 18:596-609.
18. Glencross BD, Smith DM, Thomas MR, Williams KC. The effects of dietary lipid amount and fatty-acid composition on the digestibility of lipids by the prawn, *Penaeus monodon*. Aquaculture. 2002; 205:157-169.
19. Keller R, Sedlmeier D. A metabolic hormone in crustaceans: the hyperglycemic neuropeptide. In: Endocrinology of Selected Invertebrate Types, (ed. Laufer H. and Downer R.G.H.), New York. 1988; II:315-326.
20. Fermon Y. La pisciculture de subsistance en étang en Afrique. ACF Internationale, 2006, 276
21. Tacon AGJ. Nutritional studies in crustaceans and the problems of applying research findings to practical farming sytem. Aquaculture Nutrition. 1996; 1:165-174.

22. Tacon AGJ, Cody JJ, Conquest LD, Divakaran S, Forster IP, Decamp OE. Effect of culture system on the nutrition and growth performance of Pacific white shrimp Litopenaeus vannamei (Boone) fed different diets. Aquaculture Nutrition. 2002; 8:121-137.
23. Nepad. Déclaration d'Abuja sur la pêche et l'aquaculture durable en Afrique, sommet du NEPAD du poisson pour tous. Abuja, Nigéria, 25 Août, 2005, 3.