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Improving the food health and nutritional quality of populations through the production, development and consumption of crab (*Cardisoma armatun*) in Côte d'Ivoire

KOFFI Ahua René [1,*], KONE YELAKAN Clarisse Kinonton [1], KOFFI Affoué Carole [2], KOUADIO-N'GBESSO Ahou Charlotte Nadège [3] and DADIÉ Adjéhi [4]

[1] *Ecology Research Center, Microbiology and Biotechnology Laboratory, Universiy NANGUI ABROGOUA, Abidjan Côte d'Ivoire.*
[2] *Central Analysis Laboratory, Agronomic Forestry and Environment UFR of Man University, Man Côte d'Ivoire.*
[3] *Microbiology laboratory of Ocean Research Center, Abidjan Côte d'Ivoire.*
[4] *Microbiology and Biotechnology Laboratory, department of Food Science and Technology, University NANGUI ABROGOUA, Abidjan Côte d'Ivoire.*

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Abstract

Nutritional deficiencies in animal proteins and the absence of food hygiene are increasingly observed among low-income populations in West African countries, including Côte d'Ivoire. In order to contribute to the resolution of this situation which affects food security, this study proposes to promote the production and consumption of Cabe (*Cardisoma armatum*) by the Ivorian populations. Thus, one hundred male and female juveniles of *C. armatum* were captured in the Ebrié lagoon. After purification and reproduction, they were subjected to chemical and biochemical analyses. At the end of this study, about 2537 individuals of *Cardisoma armatum* respecting health and nutritional standards are produced per semester. The assay of minerals reveals, among other things, a respective phosphorus, sodium and iodine content of 343 mg; 402mg; and 100 µg per 100 g of crab. Riboflavin (B2) and panthoneic acid (B5) are remarkable with respectively 0.9 and 1 mg per 100 g of crab. Thus the populations who have adhered to this new nutritional practice, in addition to seeing their health improve, see their financial resources increase through the production and marketing of crabs.

Keywords: *Cardisoma armatum*; Animal protein; Food security; Financial resource

1 Introduction

Côte d'Ivoire has protected forest, savannah and maritime areas. These protected areas are the seat of an exceptional biodiversity which contains important flora and fauna resources, including crustaceans. Unfortunately, these resources are subject to many threats. However, they should be valued with respect for the environment and in particular for the benefit of local populations [1]. In this context, several possible solutions have been proposed. Of these, hairy crab farming appears to be the best. Indeed, in order to enhance other types of resources, hairy crab farming can respond to this problem of food and nutritional insecurity, while solving the problem of biodiversity management. One of the priorities that could arise from this breeding would be the anticipation of the disappearance of the species by repopulation.

* Corresponding author: Koffi Ahua René
Ecology Research Center, Microbiology and Biotechnology Laboratory, Universiy NANGUI ABROGOUA, Abidjan Côte d'Ivoire.

Several studies have been conducted on the genus *Cardisoma*. Data from these studies relate to their habitat, diet, movement, population density, sexual maturity, reproduction, fecundity and egg-laying [2]. On the African species *Cardisoma armatum*, found in Côte d'Ivoire, few works are mentioned in the literature. However, in recent decades, authors such as Koussémon and *coll*., [3] and Traoré [4] have worked on these species. Despite all this work, the "breeding" aspect has not been taken into account. In some countries of the world such as Vietnam, New Caledonia, Fiji and Martinique, crab farming plays a very important role in their economies ([5], [6] and [7]).

Crab farming could be one of the solutions to animal protein deficiencies in the diet of populations. Like fish and shrimp, certain species of crabs such as *Cardisoma armatum* constitute fundamental components that furnish culinary recipes in certain countries of the sub-region, in West Africa, particularly in Côte d'Ivoire. Most of these crabs are imported or come from traditional fishing. The domestication of crabs would allow their availability, their accessibility and above all could guarantee food security while raising the economic power and the health of local communities.

In Africa, the island of Madagascar and Benin are more advanced in the practice of crab farming. On the other hand, until 2021, Côte d'Ivoire has no crab farming sites known. This project has been developed to remedy this shortcoming. It aims first of all to create a crab farm and then to promote the consumption of crabs, in particular of the *Cardisoma armatum* species.

Thus the general objective sought is to contribute to promoting the local consumption of *Cardisoma armatum* (hairy crab) while contributing to the improvement of the food security of the populations. Specifically, these are:

- Create a hairy crab farm
- Ensure the health and nutritional quality of livestock products
- Locally train young people in the breeding of hairy crabs
- Sensitize rural and urban communities on the nutritional, therapeutic and economic values of hairy crab.

2 Material and methods

2.1 Material

2.1.1 Biological material

The study material consists on the one hand of individuals of male and female hairy crabs and on the other hand of a crab farming device consisting of an enclosure and food inputs.

2.1.2 Technical equipment

The technical equipment consists of standard microbiology and biochemistry laboratory equipment.

2.2 Methods

2.2.1 Breeding of Cardisoma armatum

Juvenile crabs (males and females) are captured in the lagoon and on the edge of the Ebrié lagoon. These juveniles are then weighed and introduced into a breeding shed for further growth. Individuals are fed twice a day. The quantities of food given are weighed before each meal. A container of drinking water is made available to them and regularly renewed. Veterinary care is given to the crabs to keep them healthy. This care consists of making them ingest natural antimicrobials (dried leaves and bark).

2.2.2 Microbiological and biochemical analyzes of Cardisoma armatum

Microbiological analyzes

- A count of faecal coliforms or bacteria indicating faecal contamination (E coli and Enterobacter cloacae) was carried out according to conventional microbiology methods [8]. After having prepared the stock suspension and carried out decimal dilutions, the inoculation of the preparations was done by inoculation of 1 mL of each suspension in sterile Petri dishes; then 15 mL of the VRBL solution supercooled at 45°C were poured into the Petri dishes containing the inoculum. Then, each preparation was homogenized by gentle shaking. After solidification, a second layer of 4 mL of the same medium (VRBL) was poured into the same Petri dishes. Incubation was done at 44°C for 24 hours).

- RAPID' E. coli agar was used for the detection and enumeration of *Escherichia coli* [9]. Seeding was done by spreading 0.1 mL of each suspension on the surface of agar previously poured and cooled in a Petri dish. Incubation was done at 37°C for 24 hours. -Mossel agar was used for the enumeration of Bacillus cereus. Inoculation was done by spreading 0.1 mL of each suspension on the surface of previously poured and cooled agar in a Petri dish. Incubation was done at 30°C for 24 hours.
- Staphylococcus aureus was counted on Baird Parker agar according to ISO 6888-1[10]. Inoculation was done by spreading 0.1 ml of the stock suspension and decimal dilutions on the surface of the agar previously poured and cooled in a Petri dish. Incubation was done at 37°C for 24 hours.
- Salmonella research was carried out according to the NF ISO 6579 standard [11].

Dosage of minerals and vitamins

The determination of the following different elements: water content; protein rate; lipid level; fatty acid level; mineral rate; vitamin content, made it possible to assess the nutritional quality of the crabs.

2.3 Statistical analysis

The data collected from the study was analyzed by SPSS 20.0 software. The statistical links between diet, health and nutritional quality were analyzed with a confidence interval of 0.05.

3 Results

3.1 Production of *Cardisoma armatum*

Crab production is an important activity that requires daily monitoring. The methodology used makes it possible to increase the survival rate of juvenile populations and to make production profitable. It is found that the rate of male juveniles is significantly higher during growth than that of females. However, a female juvenile is capable of producing nearly five hundred to a thousand eggs in one laying, thus making it possible to respond to an appreciable production (Table 1 and 2).

Table 1 Survival rate of juvenile populations of *Cardisoma armatum*

Cardisoma armatum	**initial number**	**Survival and growth rate (%)**
Male juveniles	100	55
Female juveniles	100	35

Table 2 Yield of the production of *Cardisoma armatum*

Cardisoma armatum	**initial number**	**Final output**	**Expected workforce**	**Yield (%)**
Female juveniles	35	2537	17500	14.5

3.2 Microbial load of *Cardisoma armatum*

The results of the microbiological analyzes showed that the hairy crabs analyzed contain high loads of faecal coliforms (3.98×10^4 to 7.36×10^4 CFU/ml), *Staphylococus aureus* (1.19×10^6 to 9.76×10^6 CFU/mL), *Bacillus* spp. (1.08×10^6 to 1.93×10^6 CFU/mL), and *E. coli* (5.20×10^4 to 8.30×10^4 CFU/mL) but no *Salmonella* load, table (3).

Table 3 Distribution of microbial loads in hairy crab

Microbial loads (UFC/mL)					
Samples	***Bacillus* spp.**	***Staphylocoques aureus***	**Coliformes fécaux**	***Escherichia coli***	***Salmonella* spp**
Site A	$(1.93\pm0.54)10^{6a}$	$(1.19\pm0.075)10^{6a}$	$(7.36\pm1.368)10^{4a}$	$(8.30\pm1.04)10^{4a}$	0
Site B	$(1.08\pm0.13)10^{6b}$	$(9.76\pm0.05)10^{6b}$	$(3.98\pm1.27)10^{4b}$	$(5.20\pm0.90)10^{4a}$	0

Dans une même colonne, les valeurs affectées de la même lettre ne sont pas significativement différentes au seuil de 5% (P>0,05).

In the same column, the values assigned the same letter are not significantly different at the 5% level (P>0. 05).

3.3 Nutrient content of *Cardisoma armatum*

Cardisoma armatum is a nutrient-rich food source that should be valued. During this study, the results of analyzes revealed this resource with a protein content of 19.2 g (Table 4).

Table 4 Distribution of nutrients identified in *Cardisoma armatum*

Nutriments	**Crab /100 g**
Proteins	19.2 g
Carbohydrates	0.5 g
Sugars	0.0 g
starch dietary	0.0 g
fiber	0 g
Lipids	5.4 g
Cholesterol	71.0 mg
saturated fatty acids	0.7 g
monounsaturated fatty acids	1.4 g
polyunsaturated fatty acids	1.6 g
Water	71 g
Alcohol	g

3.4 Dosage of vitamins and minerals of *Cardisoma armatum*

Table 5 Proportion of vitamins dosed in *Cardisoma armatum*

Vitamin	**Content per 100 g**
Vitamin C	0.0 mg
Vitamin E	0.0 mg
Vitamin B1	0.1 mg
Vitamin B2	0.9 mg
Vitamin B3	1.5 mg
Vitamin B5	1.0 mg
Vitamine B6	0.2 mg
Vitamine B9 (folic acid)	20.0 µg

Table 6 Content of minerals present in *Cardisoma armatum*

Minerals	**Content per 100 g**
Phosphorus	343 mg
Sodium	402 mg
Iodine	100 µg

This nutrient-rich food resource is also rich in vitamins and certain minerals essential to the proper functioning of our body. The results of this study also show this (Table 5 and 6).

4 Discussion

The results of this study showed that it is possible to domesticate *Cardisoma armatum*, although the yield achieved was low compared to expected estimates. Indeed, according to Bakary and *coll*., 2015, in their work entitled the preliminary study on the description of the *Cardisoma armatum* crab farming system, there are ways to improve farming practices for this species. Similarly, the microbiological analysis of these crabs showed high loads of faecal or thermo-tolerant coliforms, *Staphylococcus*, *Bacillus* and *E. coli*. These results could be explained by the fact that the crabs live in an environment potentially contaminated by pathogens. Indeed, the environment in which crabs live is conducive to the presence and proliferation of microorganisms. Kosmala [12] has shown that these fishery products come from aquatic environments which have increasingly become the receptacle of all kinds of pollutants. The microbial loads obtained during this present work are similar to those obtained by several authors including Koussemon and *coll*. [13], who obtained coliform loads greater than 104 CFU/mL during their work on the study of the microbiological quality of a tropical species of crab. The high *Bacillus* loads observed in this study could be due to the capture and production environment of these species. Bacteria that occur naturally in the soil and produce spores can contaminate virtually all categories of food [14]. Furthermore, the presence of *E. coli* and faecal coliforms in crabs testifies to faecal contamination of the environment of crabs.

5 Conclusion

The implementation of this project has made it possible to promote the consumption of *Cardisoma armatum* and to have a new approach to this source of protein which was perceived as unfit for consumption by a large number of the population. It is also presented as another source of income for young populations, mainly in search of employment. Despite the presence of some telluric microorganisms, the consumption of *Cardisoma armatum* does not present a danger to the health of the consumer. Better still, these numerous nutritional resources make hairy crab an excellent food, one of the inexpensive links in food security.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest.

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