



(RESEARCH ARTICLE)



## Chemical analysis and nutritional study of shrimp powder (*Penaeus notialis*, Peneids, Decapods) from Côte d'Ivoire freshwater in rats (*Rattus novegeus*, Wistar).

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Publication history: Received on 17 February 2020; revised on 06 March 2020; accepted on 19 March 2020

Article DOI: <https://doi.org/10.30574/wjarr.2020.6.1.0046>

### Abstract

Shortage and high cost of conventional proteins (meat and fish) in our developing countries means that we have to find new sources of protein. The shrimp (*Penaeus notialis*), produced in large quantities worldwide and particularly in Côte d'Ivoire, is a track to be exploited. This study was conducted to assess the nutritional quality of this unconventional protein from freshwater. Overall chemical characterization in grams per 100g / dry matter of the powder of this animal was carried out by standard methods (AOAC). The macromolecule content (carbohydrate, fat and protein) gave 44.4%, 7.86% and 34.21% respectively. Nutritional parameters that are the total dry matter ingested (MSTI), the total protein ingested (PTI) in grams/ day and the food efficiency coefficient (CEA), the protein efficiency coefficient (CEP) and the weight of these animals were evaluated on the basis of animal experimentation carried out in the animal physiology laboratory. Second consumption experiment gave an MSTI of 8.8 g / day respectively with a PTI of 0.82 on the one hand. On the other hand, a CEA of 0.20 and a CEP of 1.91 for the shrimp diet. All these values show no significant difference with that of the control diet (Casein) and the fish diet. The growth determined by the weight variation of rats fed the shrimp diet remains greater compared to that of the control and fish diets. This study showed that proteins from the shrimp diet (*Penaeus notialis*) may well be a nutritional alternative alongside conventional meat. Additional studies may be conducted to more specifically determine the micronutrient composition of this animal protein.

**Keywords:** Protein efficiency; Côte d'Ivoire; Nutritional quality; Proteins; Shrimp (*Penaeus notialis*)

### 1. Introduction

Protein-energy malnutrition places functional nutrition disorders at the forefront [1] (FAO, 2012); [2] (IFPRI, 2016). This remains a serious challenge for food security [3] Svanberg et al, (1997). Malnutrition in all its forms (under nutrition, micronutrient deficiency, overweight and obesity) still plagues all over the world and more particularly in developing countries such as the Ivory Coast country of Africa. 'Where is malnutrition, whatever form it reveals, results from a poor diet or eating habit, from a nutrient deficiency, from a lack of knowledge of our available resources. These are all factors that have underlying causes [4] Shetty and Phersonn (1997); [5] Aristya et al, (2008); [6] Satmala et al, (2017). Malnutrition is a real obstacle to the sustainable development of our developing countries, whether it is to guarantee food security and maintain satisfactory nutrition [7] (WHO, 2010).

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; In addition, the exponential growth of the world population and that of the developing countries entail an increasingly high demand for foodstuffs rich in proteins. Access to different sources of traditional animal protein (meat and fish) is becoming increasingly difficult and expensive. In view of this situation, it is imperative to find new sources of unconventional animal proteins which may constitute an interesting alternative. With a total production of 13,720 tonnes in 2016. Shrimp (*Penaeus notialis*) from the Pénéaeidae family could replace the various conventional resources [8](FAO, 2003).

This animal species in Ivory Coast has several vernacular names. These are, among others, "Gagabo" (Bété), "N'zécéré" (Baoulé), "Zonzon" (Malinké), "Séé" (Gouro), "Gnagalo" (Dida), "Alé" (Akyé). This animal has a high nutritional value with a pulp of exceptional good quality ([9]Hinard, (1984);[10]AOAC, (1980). This is generally used in making seasoning cubes. Unfortunately, few studies have been done on the nutritional properties of the proteins in its freshwater crustaceans. A valuation study of the nutritional quality of the protein of this animal species was initiated with a view to popularizing the consumption of this animal encountered on our different markets in Cote d'Ivoire.

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## 2. Material and methods

### 2.1. Animal material

The dried prawns (*Penaeus notialis*), once purchased (Locodjro Abidjan market) were then sorted and disposed of all kinds of waste.

They were crushed using a kitchen mortar to obtain the dried shrimp powder and stored in clean jars in the freezer at 5°C.



**Figure 1** Shrimp and shrimp powder stored in a jar

### 2.2. Analyse chimique

Chemical analysis of food : the moisture content was determined by drying the fresh dish in an oven at 105°C until constant weight, ash by incineration in a muffle furnace at 505°C for 48h, proteins by nitrogen determination using the kjeldahl method and conversion of nitrogen to proteins by the 6,25, total lipids by extraction in a Soxhlet apparatus for 6h using petroleum ether as solvent fibers by successive digestion of the defatted sample with 0,26N, sulfuric acid and 0,23N potassium hydroxyd solution and carbohydrates by difference method [11]AOAC, (1998);[12] Abu and Eli, (2018).

### 2.3. Animal testing

The diets were distributed *ad libitum* once a day at 7 a.m. in the form of mash, to avoid wastage. Intakes were determined by weighing the feeders when they were put in and when they were removed. The quantities of fresh food consumed were obtained by the difference between the quantities distributed and the quantities remaining or refused. The water was served *ad libitum* and renewed every three days. The animals were weighed at the start of the experiment and then at three-day intervals. The last weighing took place at the end of the experiment. Growth was determined by the difference between the initial weight and the final weight.

## 2.4. Food and growth record

### 2.4.1. Experimental protocol

Diets were distributed *ad libitum* once a day at 7 a.m. in the form of mash, to avoid wastage. Ingests were determined by weighing the feeders when they were put in and when they were removed.

Quantities of fresh food consumed were obtained by the difference between the quantities distributed and the quantities remaining or refused. The water was served *ad libitum* and renewed every three days. The animals were weighed at the start of the experiment and then at three-day intervals. The last weighing took place at the end of the experiment. Growth was determined by the difference between the initial weight and the final weight.

### 2.4.2. Determination of consumption parameters, growth and food efficiency

The quantities of food ingested are converted into dry matter ingested. The percentage of protein in the food was evaluated based on the amount of food ingested.

It is expressed in grams (g) or grams per day (g/d). These quantities have been converted into ingested dry matter.

### 2.4.3. Total Dry Ingested Matter (MSTI) g/days

The amount of Total Ingested Dry Matter (MSTI) represents the total amount of food ingested as dry matter by the animal during the duration of the experiment.

MSTI (g/days) = sum of the quantities of dry matter (food) ingested during the experimental period over number of days of consumption.

### 2.4.4. Total Ingested Protein (ITP) g/days

Total Ingested Protein (PTI) represents the amount of dietary protein ingested during the duration of the experiment.

PIT (g/days) = MSTI x percentage of protein in the diet / number of days.

### 2.4.5. Food growth and efficiency

The growth, translated by the weight gain (GP), is obtained by the difference between the final weight and the initial weight it is expressed in g/d [13](Adrian *et al*, 1991).

GP (g/days) = Final weight - initial weight / number of days.

### 2.4.6. Food efficiency measure

Food efficiency coefficient (CEA)

It reflects the yield with which the food is assimilated. In other words, it is the weight gain favored by the ingestion of 1g of food. The CEA was calculated by relating the weight gain (g/days) to the amount of MSTI (g/days).

$$CEA = \frac{\text{Weight gain}}{\text{Total dry ingested matter}}$$

Uncorrected protein efficiency coefficient (CEP)

The CEP was obtained by relating the weight gain (g / d) to the ITP (g / d).

It reflects the efficiency of using the diet food.

$$CEP = \frac{\text{Weight gain (g)}}{\text{Total ingested protein (g)}}$$

**2.5. Statistical analysis**

Data were expressed as mean ± standard deviation. The data analysis was carried out by Anova using STATISTICA software (7.1). Comparison was made from the descriptive analysis test of the data collected, was made from the Newman Keuls test at the 5% threshold. The present graphics were made using GraphPadPrism 7.00 software.

**3. Results and discussion**

**Table 1** Overall chemical composition of shrimp powder

| Paramters               | Contents |
|-------------------------|----------|
| Humidity (g/100g MF)    | 9,66     |
| Dry matter (g/100g MS)  | 90,30    |
| carbohydrate(g/100g MS) | 44,40    |
| lipids(g/100g MS)       | 7,86     |
| Proteins(g/100g MS)     | 34,21    |
| Ash (g/100g MS)         | 13,53    |

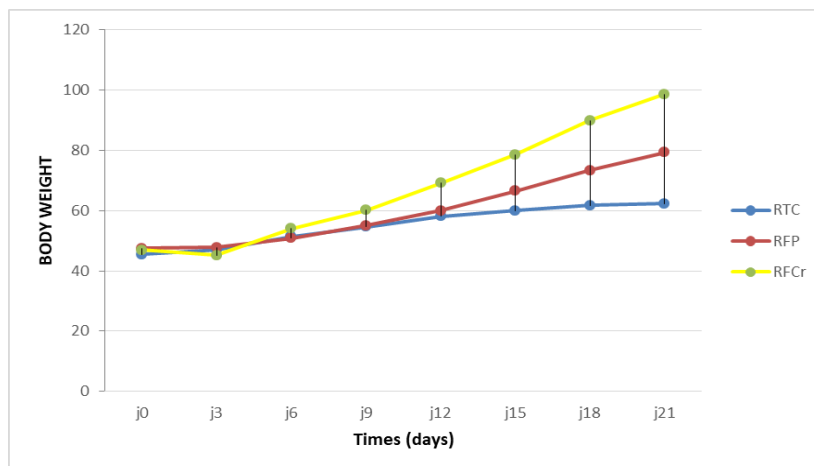
Each value is the mean±SEM of six rats.

**Table 2** MSTI; PTI, CEA and CEP of rats subjected to different diets

| DIETS        | RTC        | RFP        | RTCr       |
|--------------|------------|------------|------------|
|              | n=6        | n=6        | n=6        |
| MSTI(g/days) | 8,49±0,02a | 9,32±0,02a | 8,81±0,12a |
| PTI(g/days)  | 0,84±0,00a | 0,93±0,00a | 0,82±0,01a |
| CEA          | 0,09±0,02a | 0,16±0,02a | 0,20±0,03a |
| CEP          | 0,96±0,01a | 1,60±0,02a | 1,71±0,03a |

Each value is the mean±SEM of six rats

A, there is no significant in the table when designer by the same letter.  
 RTC: control diet (casein); RFP: diet of fich; RTCr: diet of shrimp powder



**Figure 2** Growth curves of young rats fed the RTC, RFP and RFCr diets

#### 4. Discussion

Dried shrimp powder is rich in essential nutrients that can contribute to the proper functioning of the body. This flour has a moisture content which is 9.66 g/ 100gFM. It is slightly lower than that found by [14] Edah and Adeyemi (2016): on the smoked *Penaeus notialis* shrimp which is 14.90 g/ 100gFM. This low content is due to the very pronounced drying of the shrimp. Indeed, this low water content of this food guarantees good preservation. Proteins represent 34.21 g / 100g DM, this protein content of the dried shrimp powder is lower than that found by [14] Edah and Adeyemi (2016): on the smoked *Penaeus notialis* shrimp which is 51.17 g/ 100g DM and also to that of smoked oyster which is 56.41 g/ 100g DM. This difference in protein can be explained by the fact that the shrimp purchased already dried underwent further drying which must have influenced this result. It is still higher than that found by [15] Salvini *et al.*, (1998). On the fresh *Penaeus notialis* shrimp which is 6.09 g / 100gMS and also higher than that of rabbit meat, chicken, veal and pork which are respectively 23.7 g / 100gMS, 22.2 g / 100gMS, 20.7 g / 100g DM and 19.9 g / 100gMS [16]FAO, 2003). However, these protein levels are higher than the official recommendations of [17]OMS, (1985) which indicates that the required protein level for a balanced meal is between 12 and 15%.

The essential function of a food protein is to meet the body's needs for nitrogen and essential amino acids [18] Azibuo *et al.*, (2008): as for the fat (lipids) obtained, they are 7.86 g/ 100gMS. This value remains lower than that of *Penaeus notialis* smoked in the work of [14] Edah and Adeyemi, (2016): which is 10.13 g/ 100gDM as well as those of rabbit, chicken and pork which are respectively 14.4 g/ 100gDM, 12.4 g/ 100gDM and 22.1 g/ 100g DM. However, it remains identical to that of veal which is 7 g / 100g DM and higher than that of the oyster 5.32 g / 100g DM. The factors for variation in lipid content in an animal are manifold and include age, sex, genotype, diet and breeding conditions. External, inter and intramuscular lipid deposits increase with the age of the animal. The lipids contained in shrimp contain, in fact, a majority of monounsaturated and polyunsaturated fatty acids whose protective effects on health are widely recognized.

Lipids, especially polyunsaturated fatty acids, are beneficial in controlling cholesterolemia and protecting against cardiovascular disease [19] Zannou, (2005). Physiological and nutritional studies were carried out on young rats growing with the casein (RTC), fish (RFP) and shrimp (RTC<sub>r</sub>) diets. The purpose of this study was to show the effectiveness or not of the shrimp diet in view of the analytical study previously carried out and which made it possible to determine some of their nutritional chemical characteristics. However, after six (6) days of consumption of the different diets (RTC, RFP and RTC<sub>r</sub>), the average weights of the rats (50-53 g) show no significant difference between the rats consuming the three diets  $p \geq 0,05$ .

This period could be compared to the adaptation phase to these different formulated regimes. From the 6th day until the end of the experiment (21st day), a much higher weight gain is observed in the rat fed the shrimp diet with 98.73 g followed by 79.38 g for the fish diet and finally the rats fed the 62.89 g control diet. [20]Dally *et al.*, (2010); [21]Beugré, (2008); [22]Trêches *et al.*, (1994) also made similar observations with diets and on monogastric animals. These results confirm the importance of proteins in building the body. Physiologically, the weight gain observed with the RTC<sub>r</sub> diet \*corroborates with the results obtained by [13] Adrian *et al.*, (1991) with rats fed a reference diet and which indicates a regular development of cellular metabolism with effective synthesis clean matter from rats. This weight growth is influenced by the large amounts of total dry matter ingested and total protein ingested, in these rats, for the different diets studied. Furthermore, it is not enough for a food to contain a required level of protein, it must also be well digested and contain the various essential amino acids in balanced proportions [23] Aremu *et al.*, (2006); [24] Taiwo *et al.*, (2008); [25] Bouafou *et al.*, (2007). Results of food consumption expressed in total ingested dry matter (MSTI) and total ingested protein (PTI) reveal that there is no significant difference between them  $p \geq 0.05$ .

These results show that the rats appreciated the different diets formulated. As well as the coefficient of food efficiency and the coefficient of protein efficiency which show no significant difference between the rats fed on the different diets. The overall observation that emerges from all of the measurement parameters (MSTI, PTI, CEA, CEP) is that there is no significant difference between these values of nutritional parameters studied  $p \geq 0.05$ .

The PTI values obtained are between 0.82 and 0.93 g/ d. These results are similar to those obtained on Ivorian diets by [21] Beugré, (2008). In addition, other authors such as [26] Dally *et al.*, (2014); [27] Onyeike and Achru, (2002) have clearly shown the advantage of the proteins administered to rats in front of protein-free diets. Indeed, [18] Azibuo *et al.*, (2008); further suggested that the nutrients essential for the harmonious growth of organs are major proteins and minerals, including calcium and zinc. However, chemical analysis of this animal species clearly shows that it has more. This content is beyond the standards recommended by the [17]OMS, (1985); which gives a recommended value in proteins between (12-15%) for a balanced meal.

The appearance of the growth curves obtained from the average values materialize more precisely the physiological and weight states of the growing rats fed the different diets formulated in this study and we can deduce the qualitative aspect of this dish made from shrimp powder.

On a physiological level, the weight gain observed during such a diet could indicate a regular development of cell metabolism with synthesis of the body's own matter [28] Fouabi *et al.*, (2017).

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## 5. Conclusion

This nutritional study conducted in the Abidjan markets showed the presence of a good quantity of fresh or dried shrimp and especially the genus *Penaeus notialis*. Chemical analysis of the powder shows a high proportion of essential macronutrients. Proteins with 34.21% fat from 7.86%. During animal experiments, the quantities of dry matter ingested and total protein ingested obviously affected the overall state of animal organisms fed by their weight gain. This animal species could constitute a favorable alternative in the substitution of our conventional proteins (meat and fish). Furthermore, more in-depth studies on the nature of the amino acid constituents of the constituent proteins can be studied, followed by hematological studies.

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## Compliance with ethical standards

### *Acknowledgments*

Thanks to the authors and managers of the laboratories who contributed to the development of this research work as well as to the managers of the national nutrition program for their support during this study.

### *Disclosure of conflict of interest*

There is no conflict of interest among the authors.

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### How to cite this article

Dally T, Diby YB, Kahoubi GP, Kouamé B, Ouattara H, Méité A and Kati-Coulibaly S. (2020). Chemical analysis and nutritional study of shrimp powder (*Penaeus notialis*, Peneids, Decapods) from Côte d'Ivoire freshwater in rats (*Rattus norvegicus*, Wistar). World Journal of Advanced Research and Reviews, 6(1), 82-88.

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