

Study of the nutritional value of *Coula edulis* kernels from Sembé (Republic of Congo)

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Abstract

Coula edulis Baill., is a non-timber forest product of great importance from a food, cultural and economic point of view for the African countries where this species grows. It belongs to the order *Olacales* and the family *Olacaceae*. Almonds extracted from *Coula edulis* nuts are consumed thanks to the nutrients they contain. Thus, the present study, which has the general objective of promoting *Coula edulis* almonds with a view to contributing to their better knowledge, could play a capital role in the fight against malnutrition. We therefore used the standards established by the AOAC to determine the nutritional value of these almonds, namely: the oven to determine the water content, the Soxhlet method to extract the fat, the Kjeldahl method to determine the total protein content, the muffle furnace to know the ash rate and finally we deducted the carbohydrate content. Thus the characterization of these macronutrients led to the following results: a humidity level of 9.21%; the lipid content of 25.91%; protein content of 8.67%; the ash content of 1.55%, the fiber content of 3.5% and finally the carbohydrate content of 54.66%; which allowed us to find from these results, an energy value of 486.51 Kcal/100g. Compared to the results obtained in this study, we can say that these almonds have a very appreciable richness. Thus, *Coula edulis* almonds can be used as an excellent raw material in the production of fats or as a good source of carbohydrates in the agri-food sector. The consumption of its almonds by the Congolese population should be encouraged.

Keywords: Nuts; Sembé; Biochemical Composition; Congo.

1 Introduction

Malnutrition is a pathological state resulting from the deficiency, relative or absolute excess of one or more essential nutrients. In 2009, the Food and Agriculture Organization of the United Nations (FAO) estimated the number of people suffering from severe undernutrition at more than a billion worldwide. According to the same source, nearly 1.02 billion people suffer from undernutrition, a serious form of malnutrition, 99 % of whom live in developing countries [1]. This undernutrition is also due to vitamin and mineral deficiencies. Among the people suffering from these deficiencies, there are approximately 200 million children under the age of 5 whose symptoms are physical and mental disorders [2].

Despite the diversity of listed and unlisted plant species in the Republic of Congo, followed by its geographical assets, the level of food and nutritional security leaves much to be desired.

Indeed, there are underexploited forest or wild fruits that can play an important role in food security and improving the nutritional status of populations: this is the case of *Coula edulis*.

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Coula edulis is a plant that belongs to the family *Olacaceae* and the order *Olacales*. This plant is widely distributed in the forest zone of West and Central Africa from Sierra Leone to the Democratic Republic of Congo [3].

The numerous vernacular names [4]; [5] which designate *Coula edulis* in Ivory Coast, Nigeria, Cameroon, Gabon, Congo and the Democratic Republic of Congo demonstrate both the extent of its distribution area and its importance for local populations of West and Central Africa. However, few studies on the chemical characterization of *Coula edulis* kernels exist in the Republic of Congo. It is in this perspective that the present study was carried out with the aim of contributing to the better knowledge of *Coula edulis* almonds coming from the sub-prefecture of Sembé in the Sangha department.

Generally speaking, this study aims to promote almonds extracted from *Coula edulis* seeds. More specifically, it involves identifying the macronutrients contained in these almonds and determining the energy value contained in these almonds.

2 Materials and methods

2.1 Plant material

The plant material used for this study consisted of almonds extracted from the seeds of *Coula edulis*, coming from Sembé in the Sangha Department, harvested in April 2022.



Figure 1 *Coula edulis* seeds

2.2 Methods

After extracting the seeds from the shells, the almonds were then weighed using a precision balance. The weighed almonds were placed in the oven set at a temperature of 70°C. These almonds were kept in the oven until their masses became constant. The almonds taken out of the oven are cooled in the open air for an hour then crushed using a porcelain mortar.

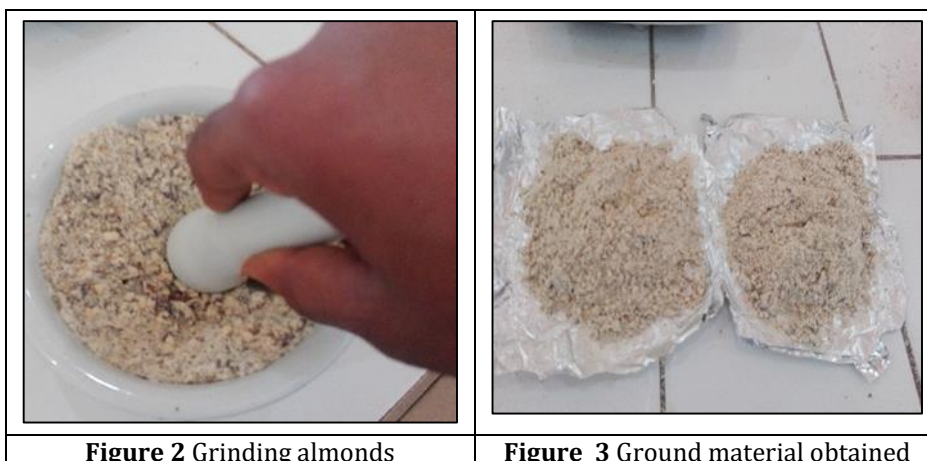


Figure 2 Grinding almonds

Figure 3 Ground material obtained

2.3 Characterization of almonds

2.3.1 Determination of water content

In a ventilated oven whose temperature is set to 70 °C, we placed the samples with an initial mass of 30 g per test. They were weighed successively until their masses became constant.

Knowing the mass of the fresh sample and its dry mass, we determined the water content using the formula below:

$$\% \text{ Water} = (m_f - m_s) / (m_f) \times 100$$

With: m_f = Mass of fresh almonds and m_s = Mass of dried almonds

2.3.2 Extraction of lipids by the Soxhlet method

In an empty 250 ml flask previously weighed (m_0), 200 ml of n-hexane were introduced. A cartridge containing a mass m equal to 30 grams of ground almonds to be analyzed was introduced into the Soxhlet extractor. The extractor was positioned on the flask containing the solvent (n-hexane). On the extractor, a refrigerant supplied with cold water was placed. The mounted device is positioned on a heating tank, set at a temperature allowing the solvent to boil. After extraction of the oil, the flask containing the solvent-oil mixture was recovered. The separation of the solvent from the oil was carried out using a rotary evaporator. Finally, the flask containing oil is weighed m_1 .

The lipid content is determined using the following formula:

$$\% \text{ lipids} = (m_1 - m_0) / m \times 100$$

With: m_0 = mass of the empty balloon; m_1 = mass of the flask with oil and m = mass of the crushed almonds.

2.3.3 Protein content by the Kjeldahl method

0.5 g of deoiled ground sample was introduced into a Matra. A spatula tip of mineralization catalyst and 10 ml of concentrated sulfuric acid were added with a few glass beads. The Matra was then placed on the mineralization ramp. The mineralization was carried out cold for 30 minutes then hot at 420°C for 2 hours. After cooling, 20 ml of ultrapure water and 30 ml of 0.1 N sodium hydroxide (until the solution turned brown) were added.

The ammonia was distilled using a distiller (in an excess of sodium hydroxide), then recovered in boric acid in the presence of a few drops of colored indicator (bromocresol green and methyl red) up to a volume of 125 ml. The nitrogen titration was carried out using N/20 sulfuric acid, until the indicator changed from green to pink.

The protein content was determined by the following formula:

$$\% \text{ N} = (V H_2SO_4 \times 0.07) / (\text{test portion})$$

Protein rate = $\% \text{ N} \times 6.25$ (which is the multiplication coefficient).

2.3.4 Ash content

2 g of samples were placed in the empty crucibles, previously weighed, then they were introduced into the muffle furnace. The incineration of the samples was carried out at 550°C for 8 hours, increasing the temperature every 30 minutes for 2 hours. After cooling, the crucibles containing the ashes were weighed.

Ash content was determined using the formula below.

$$\text{Ash content } (\% \text{MS}) = (m_2 - m_0) / (m_1 - m_0) \times 100$$

With: m_0 : mass in grams of the empty crucible; m_1 : mass in grams of the crucible loaded with the test portion and m_2 : mass in grams of the crucible loaded with the ashes.

2.3.5 Carbohydrate content

Carbohydrate content (G) was estimated by the difference method [6].

According to the method mentioned, it was calculated by subtracting from 100, the sum of humidity (H), fat (MG), proteins (P) and ash (C) contained in the sample.

$$\%G = 100 - (H + MG + P + C)$$

With: H: Water Content; MG: Fat or Lipid Content; P: Protein content and C: Ash content.

2.3.6 Fiber content

In an empty flask, 2 g of delipidated ground material was introduced and 200 ml of 0.255N sulfuric acid were added, the mixture was heated to reflux for 30 minutes and filtered with distilled water. The residue was returned to the flask and treated with 200 ml of 0.313N sodium hydroxide. The mixture was heated for 30 minutes and filtered. The residue was washed three times with distilled water and 90°C alcohol. The washed residue was then transferred to a previously weighed dish (P₁) and then dried in an oven at 130°C for 2 hours, the dry residue was cooled in the desiccator then weighed (P₂). It was then calcined for 30 minutes at 600°C in a muffle furnace, cooled again in a desiccator and weighed (P₃).

The percentage of fibers was determined by the following formula:

$$\text{Crude fibercontent (\%)} = \frac{(P_2 - P_1) - (P_3 - P_1)}{\text{sample mass}} \times 100$$

With: P₁: crucible mass; P₂: crucible mass and dried sample; P₃: mass of the crucible at the end of incineration.

2.3.7 Energetic value

The total energy value was calculated according to the method of Manzi (1999) cited by Diallo Koffi *et al.* [6].

It is determined using the formula below:

$$\text{VE (Kcal/100g)} = (\text{CHO} \times 4) + (\text{CL} \times 9) + (\text{CP} \times 4)$$

With: CHO = % of carbohydrates; CL = % of lipids and CP = % of proteins.

3 Results and discussion

3.1 Characterization of chemical parameters of almonds

The results of the chemical composition of almonds extracted from *Coula edulis* seeds are presented in the table below.

Table 1 Chemical composition of the almonds studied

Chemical parameters	Average composition (%)
Water	9.21±0.56
Lipids	25.91±0.16
Proteins	8.67±0.21
Carbohydrates	54.66
Ashes	1.55±0.49
Fibers	3.5
Energetic value	486.51 Kcal/100g

3.2 Water content

After analysis, the almonds from *Coula edulis* seeds had an average water content of 9.21 ± 0.56%. The low water content of its almonds could be explained by the fact that the almonds used were already dried in the sun before the seeds arrived in the laboratory.

Compared to certain oilseed products, the water content obtained in this study is above those obtained by another study: 4.73% on the seeds of *Hibiscus sabdariffa* [7].

Miakayizila points out that to be stored at room temperature, the seeds must have a water content that ranges between 10 and 14% [8]. Hence the water content obtained (9.21%) in this study is a favorable factor for good conservation of these almonds at room temperature.

3.3 Lipid content

Soxhlet extraction of almond oil from *Coula edulis* seeds revealed that these almonds are rich in lipids, with an average content of $25.91 \pm 0.16\%$.

Compared to previous work, this value confirms that obtained by Moupela *et al.*, working on the same product and who obtained a content of 25.8% [9]. However, it is lower than the values found by other authors, working on boiled almonds of the same product in Ivory Coast and who found values ranging from 31.73 to 33.92% [10].

The values obtained by various authors on other almonds are quite high than those obtained in this study, notably 44.68% on *Pentaclethra macrophylla* almonds [11] then 64.24 to 65.45% [12] and 83, 51% by working on the seeds of *Irvengia gabonensis* [13].

However, the lipid content obtained in this study is greater than 13.6%, value found by certain authors, on the seeds of *Hibiscus sabdariffa* in Benin [7].

The result obtained from this study reveals that *Coula edulis* almonds constitute a good source of oil, hence the importance of characterizing it.

Lipids have two main roles in the body: an energy storage role in the form of triglycerides, particularly in adipose tissues, and a structural role in the form of phospholipids constituting cell membranes [14]. Thus, almonds of *Coula edulis* can be recommended as a raw material in the food industry for the production of vegetable oils and its derivatives.

3.4 Protein content

The analysis of the results of the kernels of *Coula edulis* seeds indicated a significant richness in proteins, with an average value of $8.67 \pm 0.21\%$.

This value obtained in this study is slightly lower than the values obtained by Some authors, on boiled almonds of the same product and who had obtained values ranging from 10.20 to 11.29% [10]. On the other hand, this 8.65% value is significantly close to 8.5%, a value found by other authors while working on *Irvengia gabonensis* almonds [15]. It is below 19.18% value obtained by certain authors on the seeds of *Hibiscus sabdariffa* [7]. This value nevertheless remains higher than 7.39% value found by other authors on the seeds of *Irvengia gabonensis* [13]. This being said, we can therefore affirm that the kernels of *Coula edulis* seeds contain a significant amount of protein.

3.5 Ash content

From this study, a low ash content in the kernels of *Coula edulis* seeds emerges, which is of the order of $1.55 \pm 0.49\%$. This value is less than 2.1%, a value found by Busson, while working on the same product [16]. However, it is included in the range of values obtained by certain authors who found values ranging from 1.45 to 2.37%, when working on boiled almonds of the same product [10]. It is also low compared to the values found by other authors on other almonds: 9.14% value obtained on *Tetracarpidium conophorum* [7]; 4.61% value found on *Pentaclethra macrophylla* [11]. On the other hand, this value is higher than 1.27% value obtained by other authors on the seeds of *Passiflora edulis* flavicarpa [17]. *Coula edulis* almonds therefore have a significant ash content.

3.6 Carbohydrate content

From this study it appears that *Coula edulis* almonds are rich in carbohydrates, with an average value of 54.66%. This value is on the other hand below 60.4%, a value found by Busson in Ivory Coast on the same product [16] but belongs to the range of values found by other authors working on boiled almonds of the same product [10].

Comparing with other almonds, the value obtained in this study is higher than 41.22% value found by Ossoko on *Pentaclethra macrophylla* almonds [11]. This indicates that *Coula edulis* almonds are a good source of carbohydrates.

3.7 Fiber content

Almonds extracted from *Coula edulis* seeds have an average fiber content of 3.5%. This value is much higher than those obtained by others on *Pentaclethra macrophylla* [11]. This being said, we can therefore affirm that *Coula edulis* almonds constitute a good source of dietary fiber.

Fiber is essential to facilitate intestinal transit. They also play a role in satiety and the absorption of certain foods [14].

3.8 Energetic value

Coula edulis almonds have an energy value of around 486.51 Kcal/100g.

This value is less than 585.72 Kcal/100g, the value obtained on *Pentaclethra macrophylla* almonds [11].

However, it remains higher than 398.04 Kcal/100g, a value found by certain authors, working on the seeds of *Passiflora edulis* f. *flavicarpa* [18]. We can therefore say that *Coula edulis* almonds constitute a good source of energy.

4 Conclusion and Perspectives

The main objective of the present study was to promote almonds extracted from the seeds of *Coula edulis*, coming from Sembé in the Sangha Department.

A chemical analysis of the almonds was undertaken and yielded the following results:

- Concerning the characterization of macronutrients, the humidity level is 9.21%; the lipid content is 25.91%; protein content of 8.67%; the ash content is 1.55%, the fiber content is 3.5% and the carbohydrate content is 54.66%;
- Finally for the energy value, 486.51 kcal/100g was obtained.

Thanks to the results obtained in this study, we can deduce that these almonds have a very appreciable richness. Thus, a valorization of almonds from *Coula edulis* seeds as a raw material in the production of fats and a good source of carbohydrates in the agri-food sector is possible. The consumption of its almonds by the Congolese population is something to be encouraged. This study also revealed that these almonds can be stored at room temperature.

The results obtained from this study are not exhaustive, they leave room for more in-depth work that can complete and best valorize this seed. This will be:

- Carry out a nutritional analysis of the oil extracted from almonds;
- Establish fatty acid and glyceride profiles;
- Determine the micronutrients present in the ashes from almond cakes;
- Define the vitamin profile of almonds;
- Define secondary metabolism.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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