

## Some physico-chemical characteristics of *Carapa procera* (Meliaceae) oil produced in northern Côte d'Ivoire

Ouolouho Seydou COULIBALY <sup>1, \*</sup>, Souleymane SOUMAHORO <sup>2</sup>, Hyacinthe Attoh ANON <sup>2</sup> and Adama COULIBALY <sup>3</sup>

<sup>1</sup> Department of Biochemistry-Genetics, University Peleforo Gon Coulibaly (UPGC), Po Box 1328 Korhogo, Côte d'Ivoire.

<sup>2</sup> Institute of Agropastoral Management, Peleforo Gon Coulibaly University (UPGC), Korhogo, and Po Box 1328 Korhogo, Côte d'Ivoire.

<sup>3</sup> UFR Biosciences, University Félix Houphouët-Boigny, 22 PO Box 582 Abidjan 22, Côte d'Ivoire.

World Journal of Advanced Research and Reviews, 2022, 16(02), 771-776

Publication history: Received on 04 October 2022; revised on 15 November 2022; accepted on 17 November 2022

Article DOI: <https://doi.org/10.30574/wjarr.2022.16.2.1201>

### Abstract

The production and marketing of *C. procera* oil is still embryonic in tropical Africa. The general objective of this study is to promote and enhance this oil. The specific objectives were to evaluate the physico-chemical parameters of this vegetable oil. The evaluation of the oil of *C. procera* according to the AOAC and the AFNOR standards made it possible to find the following results: acidity: between  $6.66 \pm 0.75$  g of oleic acid/100 g of oil and  $8, 59 \pm 1.03$  g oleic acid/100 g oil; iodine value: between  $11.75 \pm 1.23$  g I<sub>2</sub>/100 g of oil and  $15.02 \pm 1.54$  g I<sub>2</sub>/100 g of oil; acid index: between  $17.79 \pm 0.64$  mg KOH/g of oil and  $22.64 \pm 0.97$  mg KOH/g of oil; saponification index: between  $179.89 \pm 0.77$  mg KOH/g oil and  $188.90 \pm 0.67$  mg KOH/g oil; peroxide index: between  $0.182 \pm 0.023$  meq O<sub>2</sub>/kg of oil and  $0.388 \pm 0.013$  meq O<sub>2</sub>/kg of oil; refractive index: between  $1.464 \pm 0.087$  nD, 20 °C and  $1.468 \pm 0.073$  nD, 20°C; Insoluble impurities: between  $0.12 \pm 0.06\%$  and  $0.30 \pm 0.04\%$ ; Density: between  $0.928 \pm 0.002$  g/ml and  $0.943 \pm 0.033$  g/ml; Humidity: between  $0.35 \pm 0.02\%$  and  $0.54 \pm 0.01\%$ ; Unsaponifiable: between  $1.05 \pm 0.03\%$  and  $2.47 \pm 0.06\%$ . Regarding saturated fatty acids, the highest contents of myristic acid, palmitic acid and stearic acid are respectively 28.40%; 13.59% and 1.51%. Regarding unsaturated fatty acids, the highest contents of oleic acid, linoleic acid and linolenic acid are respectively 7.25%; 0.24% and 3.81%. Ultimately, *C. procera* oil has physicochemical parameters similar to certain vegetable oils. Thus, it could be used in the industrial field.

**Keywords:** Unsaponifiable; Peroxide index; Iodine index; Fatty acid

### 1. Introduction

Africa is full of medicinal plants that allow the poorest to provide primary health care. Thus, among the 6400 species of plants listed in traditional medicine, more than 4000 have a therapeutic use and more than 80% of the population has recourse to traditional medicine [1], therefore to traditional drugs. Medicinal plants are important resources for the majority of the African population in rural areas [2]. *Carapa procera* is one of the African medicinal plants. It is an oilseed plant belonging to the Meliaceae family. This tree grows in the gallery forests of the Sudanian and Guinean zones of tropical Africa [3, 4]. According to Kenfack *et al.* (2008) [5], the genus *Carapa* includes about 27 species, 16 of which are of African origin. The *C. procera* tree can reach up to 15 meters in height. Species of the genus *Carapa* are of recognized socio-cultural and medicinal importance in all distribution areas [6]. Indeed, all parts of the *C. procera* tree are used by people in Africa. The seed is the most used, ahead of bark and leaf extracts. The seeds are used for the production of oil in a traditional way by simple processes for cosmetic and therapeutic purposes [7]. According to Gueye *et al.* (2009) [6],

\* Corresponding author: Ouolouho Seydou COULIBALY

Department of Biochemistry-Genetics, University Peleforo Gon Coulibaly (UPGC), Po Box 1328 Korhogo, Côte d'Ivoire.

the marketing of *C. procera* oil is still very embryonic in tropical Africa. In addition, *C. procera* oil, due to its bitterness, would be difficult to use in food. The general objective of this study is to highlight the advantages of *C. procera* oil through its physico-chemical characteristics. This could favor the varied supply of edible and/or industrial oils.

---

## 2. Material and methods

### 2.1. Plant material

The samples of *Carapa procera* oil were collected in the Savanes district, in the north of Côte d'Ivoire, from 5 women who produce and market this oil. These samples are stored in hermetically sealed sterile jars.

### 2.2. Methods

Measurement of physicochemical parameters of oils

#### 2.2.1. Acid number and acidity

It is the quantity of KOH in milligrams necessary to neutralize the acidity contained in one gram of fatty substance. This index is determined by following the AFNOR NF T 60-204 standard [8].

#### 2.2.2. Iodine index

The determination of the iodine value of the oil samples was carried out by the Wijs method described by [9]. This method consists of treating the fat with an excess of iodine trichloride in acetic acid (Wijs' reagent) and the excess reagent is then titrated with a sodium thiosulphate solution after the iodine has been released.

A mass of 0.3 g of oil is dissolved in 15 mL of chloroform. Two (2) mL of this mixture are taken and introduced into an Erlenmeyer flask. Five (5) mL of Wijs' reagent are added thereto. The Erlenmeyer flask is then capped, slightly shaken and placed away from light for 1 hour. After this time in the dark, 2 mL of a 10% potassium iodide solution and 50 mL of distilled water are successively added. The new mixture is then titrated with a 0.1 N sodium thiosulfate solution contained in a burette in the presence of starch paste until complete discoloration. A blank test is carried out under the same conditions.

#### 2.2.3. Saponification index

The saponification index was determined according to [10]. The method consists of treating the fat with an excess of hot alcoholic potash solution and then titrating the excess alcoholic potash with a hydrochloric acid solution.

Two (2) g of oil are dissolved in 25 mL of 0.5 N alcoholic potassium hydroxide. The mixture is then boiled in a boiling water bath for 1 hour under a reflux condenser. After cooling, the excess alcoholic potash is titrated with a 0.5 N hydrochloric acid solution contained in a burette, in the presence of 3 drops of phenolphthalein until the colorless change. A blank test is carried out under the same conditions.

#### 2.2.4. Peroxide index

The peroxide number of a fatty substance is the number of micrograms of active oxygen of the peroxide contained in one gram of oil or the number of milliequivalents of active oxygen per kilogram of fatty substance and oxidant of potassium iodide in the conditions of the NF T 60-220 method [8].

#### 2.2.5. Refractive index

The refractive index of extracted oils is determined using the method described by Pesce (1985) [11].

After calibrating the ABBE digital optical refractometer, a drop of oil heated to 40°C is placed between the prisms of the device. The value of the refractive index ( $n_D^{\theta}$ ) is displayed automatically after pressing the measurement button on the device.

#### 2.2.6. Unsaponifiable

The term "unsaponifiable matter" of a fatty substance means all the products present after saponification of the latter with an alkaline hydroxide, extraction with a specific solvent and elimination of the latter. This set is formed by natural constituents extracted from fats such as sterols, tocopherols, higher aliphatic alcohols, pigments and natural

hydrocarbons. The conditions for obtaining them and their dosage are carried out according to the AFNOR NF T 60-205 standard [8].

#### 2.2.7. Density

The method used to determine the density of oils is that described by [12]. It consists of measuring the mass, at a given temperature, of a volume of fat contained in a pycnometer previously calibrated at the same temperature.

#### 2.2.8. Water and volatile matter content

The water and volatile matter content is the loss undergone by the sample after heating to  $103 \text{ }^{\circ}\text{C} \pm 2 \text{ }^{\circ}\text{C}$ , under the conditions specified in the ISO 662 standard [8]. It is expressed as a mass percentage of the sample.

#### 2.2.9. Determination of the content of insoluble impurities

It is determined by the standardized method NFT 60-202 [8]. A quantity of the oil sample is introduced into a conical flask. Technical n-hexane is added to the test sample. After stopping and shaking the vial, it is left to stand at a temperature of around  $20^{\circ}\text{C}$ , for about thirty minutes. The contents of the vial are then filtered through a paper filter. The paper is dried in the open air then in an oven and finally weighed. The content of insoluble impurities is expressed as a percentage by mass of the sample.

#### 2.2.10. Fatty acid composition

The analysis is carried out after derivation of the fatty acids into the corresponding methyl esters. Indeed, transesterification with methanol makes it possible to obtain these methyl derivatives after saponification of the glycerides of the fatty substance, then esterification of the fatty acids released, with methanol in the presence of boron. The protocol for this technique is operated according to the AFNOR NF T 60-233 standard [8].

### 2.3. Statistical analysis

Data and graphical representations were processed using the Microsoft Exel 2013 spreadsheet. For each parameter measured, three trials were performed and the average of the three trials was considered.

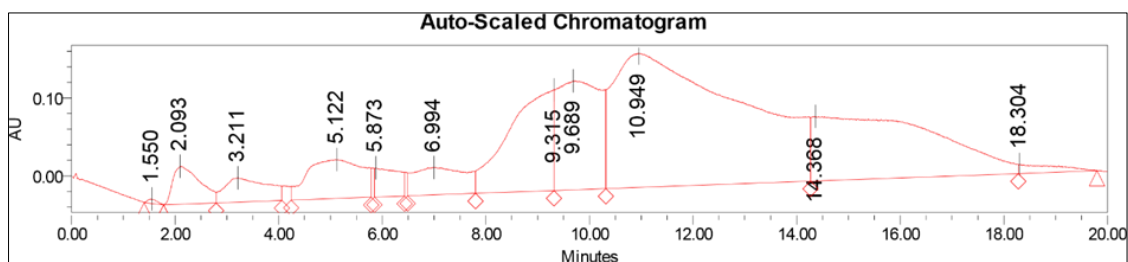
## 3. Results

The results of analysis of acidity, insoluble impurity, density, humidity, unsaponifiables and indices (iodine, acidity, saponification, peroxide and refraction) of the 5 *Carapa procera* oil samples are listed in **Table 1**.

**Table 1** Physico-chemical parameters of the 5 oil samples from *C. procera*

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Acidity (g of oleic acid/100g of oil)	8.10± 1.11	6.66 ± 0.75	6.72 ± 0.55	8.59 ± 1.03	8.18 ± 1.87
Iodine index (gI <sub>2</sub> /100g of oil)	14.36 ± 1.69	12.36 ± 0.59	13.78 ± 0.33	11.75 ± 1.23	15.02 ± 1.54
Acid index (mg of KOH/g of oil)	20.36 ± 0.92	18.92 ± 0.07	17.79±0.64	21.08± 0.88	22.64±0.97
Saponification index (mg KOH/g of oil)	187.96± 3.12	188.90± 0.67	180.24±2.07	179.89±0.77	183.82± 1.13
Peroxide index (meq O <sub>2</sub> /kg oil)	0.315± 0.011	0.249±0.008	0.388±0.013	0.205±0.005	0.182± 0.023
Refractive index (nD, 20 °C)	1.465±0.028	1.464± 0.087	1.466±0.009	1.467±0.066	1.468± 0.073
Insoluble impurities (%)	0.12 ± 0.06	0.21± 0.03	0.30 ± 0.04	0.17± 0.03	0.21±0.01
Density (g/mL)	0.928±0.002	0.930±0.012	0.943±0.033	0.928±0.004	0.932±0.024
Humidity (%)	0.35± 0.02	0.51± 0.05	0.54± 0.01	0.60± 0,02	0.50± 0.07
Unsaponifiable (%)	2.145± 0.05	1.05± 0.03	1.91± 0.05	2.47± 0.06	1.12± 0.03

Figure 1 gives an example of a chromatogram obtained during the determination of the fatty acids of sample 1

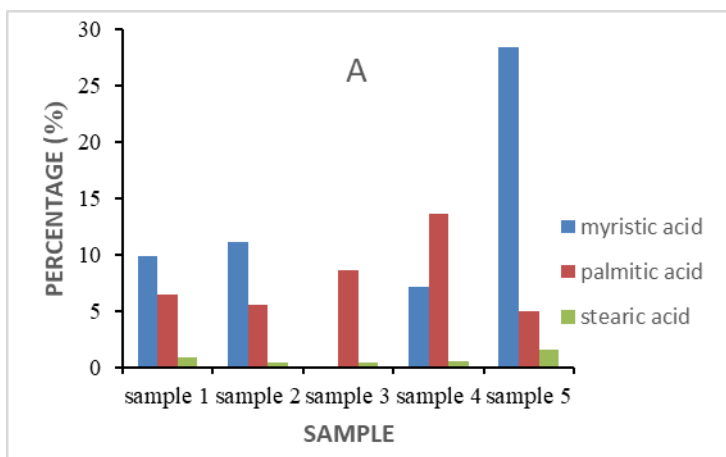


**Figure 1** Fatty acid chromatogram obtained by GPC of sample1

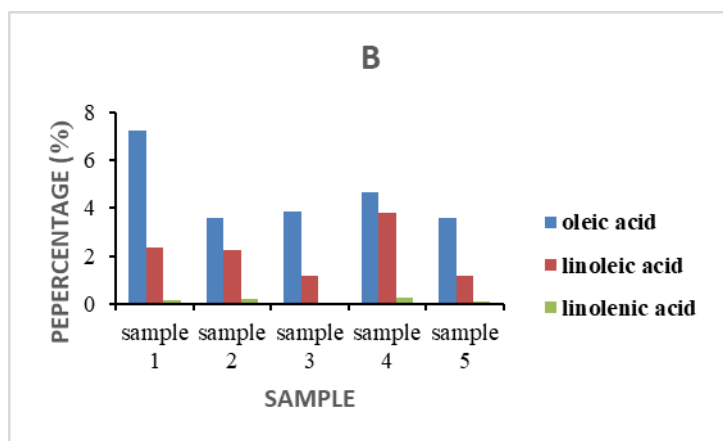
The saturated fatty acid and unsaturated fatty acid contents of the 5 samples of *Carapa procera* oil are respectively represented by figure 2 and figure 3.

In terms of saturated fatty acids, myristic acid is predominant with percentages varying between 9.87% and 28.40%. However, in sample 3, this acid was not detected. Then comes palmitic acid with contents ranging from 4.97% to 15.1%. Finally, stearic acid with lower proportions ranging from 0.37% to 1.51%.

Regarding unsaturated fatty acids, oleic acid, linolenic acid and linoleic acid are represented respectively with percentages ranging from 3.58% to 7.26%; 1.17% to 2.34% and 0.01% to 0.24%.



**Figure 2** Saturated fatty acid composition of oils of *C. procera*



**Figure 3** Composition in unsaturated fatty acids of the oils of *C. procera*

#### 4. Discussion

The acid number corresponds to the content of free fatty acids contained in the oil. This characteristic accounts for the state of degradation of the oil insofar as the free fatty acid is the product of degradation and more particularly of hydrolysis of the triglycerides, the main constituents of the oil. It is a good indicator for determining the alteration of a fatty substance [13]. The oil of *C. procera* has been studied for an acid number which varies between  $17.79 \pm 0.64$  mg of KOH/g of oil and  $22.64 \pm 0.97$  mg of KOH/g of oil, which is equivalent to an acidity which oscillates between  $6.66 \pm 0.75$  g of oleic acid/100g of oil and  $8.59 \pm 1.03$  g of oleic acid/100g of oil. The acid value of *C. procera* oil is higher than that of *Canarium schweinfurthii* Engl oil, which is  $11.16 \pm 0.25$  mg of KOH/g of oil, after 10 months of storage [14]. The high acid number of *C. procera* oil could be explained by a long period and poor storage conditions.

The value of the iodine index of our oil is between  $11.75 \pm 1.23$  gI<sub>2</sub>/100g of oil and  $15.02 \pm 1.54$  gI<sub>2</sub>/100g of oil. This value is much lower than that of palm oil (44-58 g I<sub>2</sub>/100g of oil) and shea butter (46-48 g I<sub>2</sub>/100g of oil) [15]. This value indicates that *C. procera* oil contains less unsaturated fatty acids than palm oil and shea butter. On the other hand, it is similar to the iodine index of *Griffonia simplicifolia* oil ( $13.38 \pm 1.59$  g I<sub>2</sub>/100g of oil) [13]. *C. procera* oil could be classified as a non-drying oil. Indeed, the iodine number makes it possible to classify vegetable oils into drying, semi-drying and non-drying oils.

The saponification index of the oil obtained varies between  $179.89 \pm 0.77$  mg KOH/g of oil and  $188.90 \pm 0.67$  mg KOH/g of oil. It is similar to that of *Griffonia simplicifolia* oil ( $186.59 \pm 0.63$  mg KOH/g oil), cottonseed oil (189-198 mg KOH/g oil) and sunflower oil (188-194 mg KOH/g oil).

The peroxide index of *C. procera* oil is in the range of  $0.182 \pm 0.023$  meq O<sub>2</sub>/kg oil to  $0.388 \pm 0.013$  meq O<sub>2</sub>/kg oil. The study by Kan *et al.* (2020) [16] on *C. procera* oil, obtains a value of  $2.89 \pm 0.04$  meq O<sub>2</sub>/kg of oil. The value of the present study is low, because less than 10 meq O<sub>2</sub>/kg of oil which characterizes the majority of conventional edible oils [17]. This reflects a non-advanced state of oxidation of our samples.

The value of the refractive index is between  $1,464 \pm 0,087$  to  $1,468 \pm 0,073$ . It is close to the value of the index of vegetable oils such as cottonseed oil (1,470- 1,473), palm oil (1,453-1,458) and sunflower oil (1,461-1,468) [18]. This index tells us about the purity of the oil.

The *C. procera* oil samples in this study have an insoluble impurity percentage above the recommended Codex standard of 0,05 %. The values of the oil density of *C. procera* of the present study is lower than that of water. The values obtained with the 5 samples of *C. procera* oil confirm those obtained by Kan *et al.* (2020) [16].

The water and volatile matter content of our samples is higher than the standard which sets the maximum content at 0.2% at a temperature of 105°C [17]. For better conservation of these oils, they must be dehydrated beforehand. This would prevent these oils from going rancid.

The chemical constituents of the unsaponifiables are most often varied in nature and in properties. They often give fatty substances certain pharmacological and cosmetological properties. *C. procera* oil has anti-inflammatory [19] and antifungal [16] properties. The unsaponifiable content of the samples analyzed is quite lower than that obtained by Dioum *et al.* (2013) [19].

The saturated fatty acid composition of *C. procera* oil is dominated by myristic acid, then palmitic acid and finally stearic acid. Unsaturated fatty acids are present with a preponderance of oleic acid. The linolenic acid and linoleic acid contents are relatively low. From an industrial point of view, the oil of *C. procera* could be used in soap making. Saturated fatty acids give oils a detergent and foaming power [20]. It has pharmacological properties. It could therefore be used for formulations of galenic compounds in cosmetics.

#### 5. Conclusion

The oil of *C. procera*, despite its importance in pharmacology, remains an underexploited resource. This present study is a contribution to the promotion and enhancement of this oil. According to the results obtained, the oil of *C. procera* has physico-chemical parameters close to certain vegetable oils. This vegetable oil, in view of these very interesting physico-chemical characteristics, could have several implications at the industrial level.

---

## Compliance with ethical standards

### Acknowledgments

The authors extend their sincere thanks to Dr Zoro Armel Fabrice and Dr Libra Michel Archange for their help in analyzing the data.

### Disclosure of conflict of interest

There is no declaration of conflict of interest

---

## References

- [1] WHO. WHO strategy for traditional medicine for 2002- 2005. 2002 World Health Organization, 47p.
- [2] Jiofack T, Fokunang C, Guedjo N, Kemeuze V, Fongnzossie E, Nkongmeneck B. Ethnobotanical uses of medicinal plants of two ethnobotanical regions of Cameroon. *Int. J. of Med and Med. Sc.* 2010; 2(3): 60- 79.
- [3] Weber N, Birnbaum P, Forget P M, Guèye M, Kenfack D. Carapa oil (Carapa spp. Meliaceae) in West Africa: uses and implications in the conservation of natural populations. *Fruits.* 2010; 65(6): 343- 354.
- [4] Forget P M, Poncy O, Thomas R S, Hammond D S, Kenfack D. A new species of carapa (Meliaceae) from Central Guyana. *Brittonia.* 2009; 61(4): 366-374.
- [5] Kenfack D. Systematic studies in Carapa (Meliaceae-Swietenioideae). Ph. D. Thesis, University of Missouri-St Louis. 2008; 265p.
- [6] Guèye M, Kenfack D, Forget P M. Socio-cultural importance, economic and therapeutic potential of Carapa (Meliaceae) in Senegal. In van der Burgt X, van der Maesen J, Onana J-M (Eds). *Syst and Conserv of African Plants.* Kew: Royal Botanic Gardens. 2009; P. 357- 365.
- [7] AFNOR. Collection of French standards, 5<sup>ième</sup> edition: fatty substances, oilseeds, derived products, Paris: 1993.
- [8] Delaney G. Sheabutter: connecting rural Burkina Faso women to international markets through fair trade. *Development in Practice.* 2006; 16(5): 465- 475.
- [9] AOAC. Official Method of Analysis, eighteenth edition. Association of Official Analytical Chemists, 2005, Washington DC, USA.
- [10] Anderson-Foster E N, Adebayo A S, Justiz-Smith N. Physico-Chemical Properties of Blighia sapida (ackee) Oil extract and potential application as emulsion base. *African Journal of Pharmacy and Pharmacology.* 2012, 6: 200- 201.
- [11] Pesce C. Oil palms and other oilseeds of the amazon –Reference publication, INC, Michigan. 1985; 28- 90.
- [12] IUPAC (International Union of Pure and Applied Chemistry). *Fat Analysis Method.* 6<sup>ème</sup> edition. Lavoisier Tec et Doc: Paris (France) : 1979. p190.
- [13] Novidzro K M, Wokpor K, Fagla B A, Koudouvo K, Dotse K, Osseyi E, Koumaglo K H. Study of some parameters and analysis of mineral elements, chlorophyll and carotenoid pigments of *Griffonia simplicifolia* seed oil. *Int. J. Biol. Chem. Sci.* 2019; 13(4): 2360-2373.
- [14] Dandjouma A A K, Tchieng C, Parmentier M. Evolution of some physicochemical quality parameters of *Canarium Schweinfurthii* ENGI pulp oil during storage. *Int. J. Biol. Chem. Sci.* 2008; 2(3): 249-257.
- [15] Dahouenan-Ahoussi E, Djenontin T S, Codjia D R M, Tchobo F P, Alitonou A G, Dangou J, Avless F, Sohounhloou D C K. Morphology of fruits and some physical and chemical characteristics of oil and cakes of Irvingia gabonensis (Irvingiaceae). *Int. J. Biol. Chem. Sci.* 2012; 6(5): 2263-2273.
- [16] Kan S G K, Yapi G Y, Ama V B I, Amon M A, Kouamé O C, Allico J D. Antifungal and antioxidant activities of *Carapa procera* oil and its physicochemical characteristics. *GSC Biological and Pharmaceutical Sciences.* 2020; 10(2): 130-137.
- [17] CODEX ALIMENTARUS. International Food Standards for Named Vegetable Oils CODEX STAN 201-1999. Adopted in 1999. Amendment: 2005, 2011, 2013, 2015. Revision: 2001, 2003. 2009. CODEX ALIMENTARUS.
- [18] Aissi V M, Soumanou M M, Tchobo F P, Kiki D. Comparative study of the quality of refined edible vegetable oils used in Benin. *Newsletter of the West African Chemical Society.* 2009; 6:25- 37.
- [19] Dioum M D, Seck M, Sy G Y, Faye J M, Sarr A, Faye B. Anti-inflammatory activity of the seed of *Carapa Procera* (Meliaceae). *Rev. CAMES-Sciences Struct. Mat.* 2013; 1: 17- 28.
- [20] Morin L, Dronne Y, Requillart V. Non-food demand for oils and fats. *OCL.* 1994; 1(3): 188- 191.