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Traditional Pathway of Oil Extraction from *Quassia undulata* Seeds and Its Chemical Characteristic

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Abstract

In Africa, traditional vegetable oil extraction often involves the use of plants in the manufacturing process. *Quassia undulata* oil is thus traditionally prepared. An expedition went to Kédougo (a region in southeastern Senegal involving women of the Bassaris community) in June 2018 to study the *Q. undulata* oil traditional extraction mode. Thus, the objective of this study is to follow the traditional extraction of *Q. undulata* oil and to perform the physico-chemical analysis of the obtained oil. Oil samples taken after the survey allowed the oil physico-chemical characterization. The traditional oil extraction made by four women from Eganga, Ethiolo, and Ebarack's villages reveals oil clear that is solid at room temperature. The study of the established chart revealed the use of *Pilliostigma thonnintigi* leaves during the oil preparation. The oil shows characteristics comparable to shea butter, and the oil stability can be compared to the corn and peanut oil one. The physicochemical analysis showed oil solid at room temperature with an acid value between 1.223 ± 0.013 and 7.333 ± 0.465. The saponification value was between 190.489 ± 3.083 and 199.732 ± 3.107, and the peroxide value between 4.453 ± 0.042 and 8.644 ± 0.285. The iodine values were between 21.455 ± 2.440 and 38.068 ± 0.082, and the refractive index 1.462 - 1.463. *Q. undulata* oil offers several technological perspectives. However, it would be interesting to study the impact of *P. thonnintigi* leaves during extraction. The fatty acid profile should also be determined.

Keywords

Quassia undulata, Traditional Extraction, Physico-Chemical Characterization

1. Introduction

Senegal, located in the west of Africa, is full of many potentialities. In the most remote areas of the country, the local population exploits the forest resources in their daily lives ranging from firewood to wild fruits [1]. In the Sahelian and Sudanian regions, *Adansonia digitata L.*, *Balanites aegyptiaca L.*, *Tamarindus indica L.* are commonly used [2] meanwhile genus *Carapa* (Meliacéa) in the south and east are useless [3] [4]. Such non-conventional forest resources have many potentialities which are important to study. In the department of Salemata, women exploit seeds of *Q. undulata* to extract oil [5]. A survey made in the central area of Senegal (Bassin arachidier) shows that *Q. undulata* is used as food (fruits) and in wood production [1]. The *Q. undulata* seeds are known to have potential nematocidal activity on Meloidogyne javanica juveniles [6] [7]. In Nigeria, *Q. undulata* leaves were effective for the management of cognitive disorders [8]. Elsewhere, *Q. undulata* aqueous leaf extracts were proved to prevent scopolamine-induced amnesic effects in rats [9]. Only the investigations of Miraílles *et al.*, 1988 [10] dealt with fatty acids found in the oil of *Q. undulata*. The traditional production of this oil reveals the enhancement of local know-how. Traditional oil extraction is made by women and used as a skin ointment and as a medicine against earache. However, there is no booked information about this typical extraction. Thus, an expedition was organized in Kédougou, and physicochemical analysis has been done to complete previous studies of Miraílles *et al.*, 1988 [10].

2. Materials and Methods

2.1. Survey Process

The investigations were carried out into three villages: Eganga, Ethiolo, and Ebarack, located in the department of Salemata in Kedougou-Senegal in June 2018 (**Figure 1**). The process monitoring was done at the level of 04 women: 02 in the Eganga's village, 01 in the Ethiolo's village, and 01 in the Ebarack's village.

The survey consisted of recording the oil process made by women. The objective is to watch the women making the oil process as they do in their daily lives and then identify all the involved steps. After each procedure, oil and oilcake samples were taken for further analysis. Six oil samples were obtained and distributed as follow:

1) In Eganga, two oil samples were obtained prepared by two women: one sample per woman;

2) At Ebarack, two oil samples were obtained made by the same woman. The first one was prepared following the normal diagram process, and the second one was prepared without modifications;

3) At Ethiolo, two oil samples were obtained prepared by the same woman: one of the oil extraction was made in 2017, and the second one was prepared in our presence.

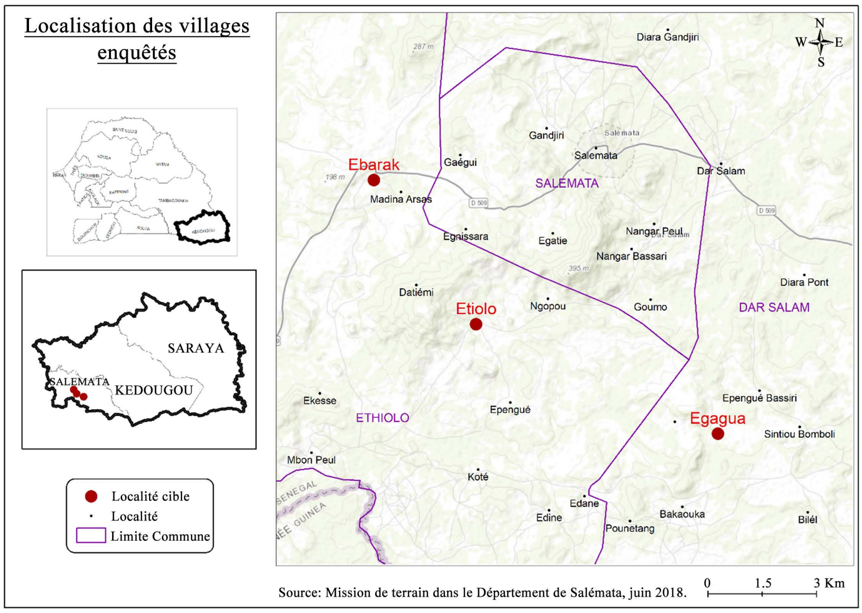

Figure 1. The villages' location where the surveys were conducted.

2.2. Physicochemical Analysis

The six samples were subjected to chemical analysis. All the analysis was done in duplicate, and the results were given as mean ± standard deviation. The acid index was determined according to the standard method NF ISO 660, while the Iodine index was conducted according to the standard method NF ISO 3961. The standard method NF ISO 3657 method was used to determine saponification index and NF ISO 3960 for peroxide index. The refractive index was determined on the perfectly anhydrous and filtered sample according to standard method NF ISO 6320 with a refractometer.

3. Results and Discussion

3.1. *Quassia undulata* Seed Oil Process Diagram

The oil production began with the crushing step. The seeds of *Quassia undulata*, also called "Agnarka" in the Bassari language, were separated from their hulls (**Figure 2(a)**). This step was complicated and took a lot of time because the crushing is done with the teeth. After that, seeds were crushed, pounded, and sieved. During the third step, a decoction of *P. thonningii* leaves was produced. *P. thonnintigi* was poured into the water, and as soon as the boiling' began, the leaves were removed (**Figure 2(b)**). The seed's powder was then added to the decoction (**Figure 2(c)**). The Boiling continued until oil appears (fourth step). As soon as the quantity of oil was large enough, it was recovered using a spoon (**Figure 2(c)**). The last step was optional and consisted of a slight heating (**Figure 2(d)**) of the oil to eliminate traces of water in order to allow better conservation.

After oil recovery, the oilcake was processed to obtain pasta named "*Enangue*". The oilcake was first poured into a large basket with holes (**Figure 3(a)**). It

(a)

(b)

(c)

(d)

Figure 2. Panoramic of different steps of oil extraction from *Q. undulata* seeds. (a): *Q. undulata* seeds with hulls, (a1) and without hulls (a2); (b): Preparation of *P. thonningii* decoction; (c): Boiling step and oil recovering (the *Quassia* seeds powder is poured inside *Pilliostigma* decoction and boiled till oil formation); (d): Oil boiling step to remove water.

(a)

(b)

Figure 3. Pictures showing *Quassia undulata* oilcake process. (a): The washing step of the oilcake with *P. thonningii* decoction; (b): Water washing and dewatering step of the oilcake (left picture shows *Lannea vellituna* leaves added to the bottom of the small basket before poring the oilcake inside, and the right picture shows oilcake in small baskets).

was washed with a decoction of *P. thonningii* and then with water. During the second step, the oilcake was poured into small baskets with holes having *Lanea velituna* leaves at the bottom (**Figure 3(b)**). Water was then gradually poured onto the oilcake and was drained (dewatering step). Finally, after water draining, the baskets were left in the open air to dry the oilcake at normal environment temperature. When the oilcake was completely dewatered, the obtained dough called "*Enangue*" (Bassari language) was consumed with sugar or salt.

The monitoring of manufacturing processes by the four women from Eganga, Ethiolo, and Ebarack's villages gave rise to the diagram in **Figure 4**.

In Africa, different vegetable oils are extracted in traditional mode. Many of these methods include a mix of the seed powder with water at room temperature; for example, in Morocco, argan oil is traditionally obtained by crushing the seeds in a stone wheel, then the almond paste is added with water and mixed with the hand to express the oil [11]. Elsewhere the traditional oil extraction consists of oilseeds boiling with water to separate the oil from the ashes. It's the case of *Elaeis guineensis* and *Butyrospermum parkii* oil extraction [12]. The same

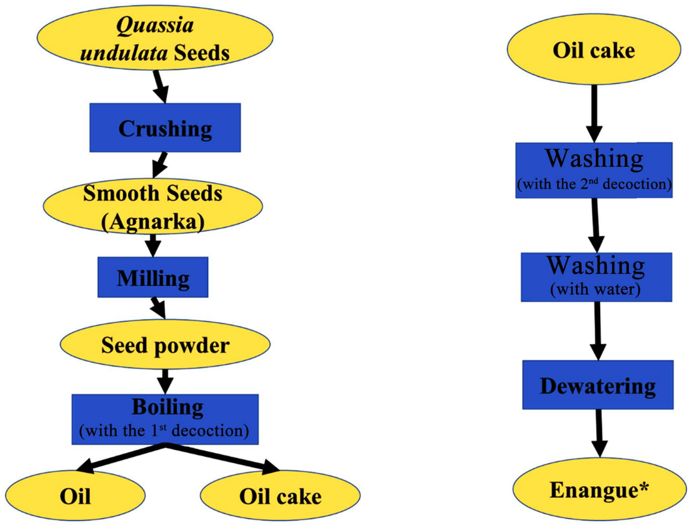

Figure 4. *Quassia undulata* oilseed and oil cake process (1st decoction refers to *Pilliostigma* leaves boiled with water and the 2nd decoction refers to the *Pilliostigma* milled leaves mixed with water at room temperature).

method is used for the traditional production of the *Carapa* (*Carapa spp. Meliaceae*) oil produced in West Africa, known to have a bitter taste [4]. However, Weber *et al.*, 2010, during this survey, show that some plant particles were added by some women (optional) during the boiling step [4]. The Bassaris women used the same process in Kedougou to extract the *Q. undulata* seed oil. Mirailles *et al.*, 1988 during their study about the *Q. undulata* fatty acid and quassinoids contents, used the Soxhlet mode with hexane as a solvent to extract oil from the seed. They obtain oil with a slightly bitter taste contrary to the oil obtained in this study using traditional extraction in the presence of *P. thonnintigi* leaves. Therefore, many questions arise about the *P. thonnintigi* key role during oil extraction. Are *P. thonnintigi* leaves responsible for the absence of bitter taste? Quassinoids are known as bitter principles [13], and Mirailles *et al.*, 1988, in their study, show that *Q. undulata* oil is rich in quassinoids compounds (Klaineanone, Glaucarubolone, and Chapparinone). Therefore in the future, more analysis can focus on the research of quassinoids contents of *Q. undulata* oil obtained after this traditional extraction using *P. thonnintigi* leaves.

3.2. *Quassia undulata* Seed Oil Physicochemical Characterization

Oil samples obtained during the survey were subject to different physicochemical analyses. The results are shown in Table 1.

Table 1 shows that **the peroxide indexes** are lower than 10 mEq/kg for all the oil samples, indicating low oxidation according to the WHO/FAO limits that considered that rancid oil peroxide value is between 20 and 40 mEq/kg [14]. The **refraction index** and saponification value are quite identique. **The refraction index** is about 1.46, showing that the *Quassia* oil is non-siccative oil. The **saponification value** is between 197 mg/g and 198 mg/g for Eganga's and Ebarack's samples and between 190 mg/g for the oil sample from Ethiolo. These differences

Table 1. *Quassia undulata* seed oil physical-chemical characterization summary.

Localities	Refraction value	Acid value (mg/g)	Saponification value (mg/g)	Peroxyde value (mEq/kg)	Iodine value (g/100g)
Eganga 1	1.46 ± 0.00	1.22 ± 0.01	197.64 ± 0.37	7.92 ± 0.57	38.07 ± 0.08
Eganga 2	1.46 ± 0.00	4.23 ± 1.77	199.73 ± 3.11	8.64 ± 0.28	36.17 ± 1.69
Ebarack	1.46 ± 0.00	3.07 ± 0.55	198.34 ± 2.26	4.45 ± 0.04	30.04 ± 0.07
Ethiolo	1.46 ± 0.00	2.32 ± 0.44	190.49 ± 3.08	5.64 ± 0.30	31.61 ± 1.66

can be explained by the boiling step used by the woman in Ethiolo after the oil recovering because the saponification value can decrease with the oil refinery step [15]. **The acid values of samples** are low and quite similar (1.22 - 4.21 mg/g). The small **iodine value** (from 30.04 to 38.07) may be due to *Quassia* oil small unsaturated acid contain [16]. This agrees with the results of Miraillles *et al.*, 1988 in their study about the *Q. undulata* oil fatty acid content where it is showed that the oil is rich in saturated fatty acid [10]. The *Quassia* oil sample in this survey is solid at room temperature of 20˚C - 24˚C.

During the survey, it appears during the women's interview that the oil was used as a skin ointment after oil extraction. So, we compared Quassia oil's physico-chemical composition to shea butter, known as a high-quality skin ointment. The results are given in **Table 2**. *Quassia undulata* oil and shea butter are both solid at room temperature, and the iodine value and saponification value are similar. However, the peroxide value and the acid value of *Quassia undulata* oil are lower than the shea butter ones. According to that, *Quassia undulata* oil stability can be higher than shea butter.

On the other hand, Miraillles *et al.*, 1988 after their study on the fatty acid and quassinoid content, concluded that Quassia oil could be used as cooking oil (only after removing the Quassinoids from the oil). So, *Quassia* oil's physicochemical oil composition was compared with the peanut and corn oil (**Table 2**). It is noticed that *Quassia* oil iodine value is lower than the peanut and corn oil one. Besides, *Quassia* oil is solid at room temperature, contrary to corn and peanut oil at room temperature. It means that *Quassia* oil's unsaturated fatty acid content is lower than corn and peanut oil. The three oils have almost the same refractive index. The *Quassia* oil saponification value is higher than the peanut and corn oil ones. The 03 oil peroxide values are lower than 10 mEq/kg, showing that *Quassia* oil stability can be compared to the corn and peanut oil one.

Table 3 gives a comparison between *Q. undulata* produced in Senegal and *Q. undulata* made in Nigeria. It is noticed a difference between the results obtained in the 02 studies. The saponification value, iodine value, and refractive index are very different except for the peroxide and the acid value. This can be due to the production location; in the study of [20], the *Moringa stenopetala* oil saponification value and iodine value varied according to the sampling location. Besides, the peroxide value and the acid value were similar. On the other hand, the differences can be explained by the extraction mode. The *Q. undulata* oil characterized by Oko *et al.* [21] was extracted using a soxhlet extractor and hexane as

Table 2. Physicochemical comparison between *Quassia* oil, *peanut* oil and *corn* oil.

Physicochemical properties	*Quassia undulata* oil	*Peanut* oil [17]	*Corn* oil [18]	Shea butter [19]
Physical state at room temperature	Solid	liquid	liquid	Solid
Saponification value (mg KOH/g)	197 - 199	187 - 190	187 - 193	169 - 198
Iodine value (g I_2/100g)	21.5 - 38.1	118.2	127 - 133	28 - 30
Peroxide value (mg Eq/kg)	4.5 - 7.9	2.09	10 mEq/kg (max.)	14 - 17
Acid value (mg NaOH/g)	1.2 - 7.3	-	-	12 - 15
Refractive index	1.46	1.46 - 1.465	1.47	-

Table 3. Physico-chemical characterization of *Q. undulata* oil produced in Senegal and Nigeria.

Parameters	*Quassia undulata* oil characterization in this study	*Quassia unduluta* oil characterization by Iko *et al.* [21]
Physical state at room temperature	Solid	Liquid
Refractive index	1.46	0.7142
Iodine value (gI2/100g of oil)	21.5 - 38.1	132.78
Peroxide value (mg Eq/kg)	4.5 - 7.9	6.758
Acid value (mg NaOH/g of oil)	1.2 - 7.3	3.759
Saponification value (mg KOH/g of oil)	197 - 199	93.266

the solvent. During the survey, the oil production was done by boiling the seed in the *P. thonningii* decoction. It appears then the *P. thonningii* leaves play a key role during the oil extraction.

4. Conclusion

In this paper, the *Quassia undulata* traditional oil extraction process by the women of Salemata in Kedougou-Senegal was established. During the survey, it appears that the oil was obtained by boiling the seed in a *P. thonnintigi* leaves decoction. Clear oil is obtained. The physicochemical characterization shows that *Q. undulata* oil can be used as a skin ointment and may be used as oil for food consumption after treatment.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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