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Fatty Acid Profile of *Quassia undulata* Oil Traditionally Extracted in Senegal

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ABSTRACT

This study examines the influence of *Piliostigma thonningii* leaves on the composition and physicochemical properties of *Quassia undulata* oil traditionally extracted by Bassari women in southeastern Senegal. Oils were produced with and without the presence of *P. thonningii* leaves following local extraction methods. Infrared spectroscopy (FT-IR) and gas chromatography (GC-FID) were used to determine their chemical composition and fatty acid profiles. The results show that both oils are predominantly composed of oleic acid (≈61–62%) and stearic acid (≈19%), with minor amounts of palmitic, linoleic, and linolenic acids. The total content of polyunsaturated fatty acids remains low (≈6%), indicating high oxidative stability. The oil extracted without *P. thonningii* leaves contained more double bonds, reflecting a higher degree of unsaturation. No statistically significant differences were found between the two samples, although a slight reduction in polyunsaturated fatty acids was observed in the oil obtained with *P. thonningii*, likely due to heat exposure during the purification step. Overall, *Q. undulata* oil is characterized by a high monounsaturated fatty acid content, good oxidative stability, and a solid texture at ambient temperature, making it a potential candidate for food, cosmetic, and pharmaceutical applications.

Keywords: *Quassia undulata*, *Piliostigma thonningii*, fatty acid profile, FT-IR, GC-FID.

INTRODUCTION

Quassia undulata (GUILL. & PERR.) belongs to the Simaroubaceae family which includes 32 genera divided into 170 species of trees and shrubs exclusively distributed in tropical and subtropical zones[1-3]. *Piliostigma thonningii* leaves are used in the traditional production of *Quassia undulata* seed oil by Bassari women in the Kedougou region of Senegal [4, 5]. In fact, In our previous studies, the use of leaves of *Piliostigma thonningii* have shown an impact on the oil ‘parameters: a decrease in the iodine index was noted, reflecting a decrease in the degree of unsaturation. It was also noted, an increase in the index of acid reflecting an increase in free acidity when the oil was extracted without the presence of *Piliostigma thonningii* leaves. Thus in this study we propose to determine the fatty acid profile of *Quassia undulata* oil traditionally extracted with and without the presence of *Piliostigma thonningii* leaves. An analysis by infrared spectrophotometry will also be made.

MATERIAL AND METHODS

Materials

The analyzes were carried out on the oil of *Quassia undulata* extracted traditionally with (1) and without (2) the presence of the leaves of *Piliostigma thonningii*. The oil extraction method is presented in our previous studies [4, 5]. The sample prepared in the presence of the *Piliostigma thonningii* leaves was traditionally extracted in Ethiolo/Senegal and the process includes a slight modification. This is a rapid heating done on the collected oil to remove impurities [5].

Infrared Analyzes

The analyzes were carried out using a Varian 10000 FT-IR device.

Fatty Acid Analysis

Apparatus: GC system 7890A from Agilent Technology. DB-WAX column, L 60 m, d 0.20 mm x 0.50 µm. Injector, 250°C, split mode: 1:50. Carrier gas: hydrogen. Detection by FID (Flame Ion Detector).

The fatty acid profile was determined by using transesterification according to the standardized production method for FAME (Fatty Acid Methyl Esters). The results were then analyzed with Statistica software.

RESULTS AND DISCUSSION

Infrared Oil Analysis

The vibrational spectrum of a molecule is considered as a unique and characteristic physical property of the molecule. Thus, the infrared spectrum can be used as a fingerprint for the identification of compounds by comparing the spectra of an "unknown" sample with reference spectra [6]. The infrared spectrum is formed due to the absorption of electromagnetic radiation at frequencies which correspond to the vibration of all the specific chemical bonds inside the molecule. Infrared analysis thus allows a qualitative analysis of the functional groups of compounds [7].

The infrared spectra of the oils are represented in **Figure 1**, **Figure 2**, and **Figure 3**. The analysis of the functional groups was carried out using references [6, 8-14]. 08 functional groups were identified in the oil sample (1) and 09 in the oil sample (2) (**Table 1**). Oil Sample (2) extracted without *Piliostigma thonningii* leaves contains more double bonds than the sample (1). This could reflect a higher percentage of unsaturated fatty acids. In addition, sulfur groups have been identified in very small amounts in the oil sample (2). These groups can come from sulfur amino acids such as methionine. Thus, it could be that the amino acids contained in the proteins of the seeds have passed into the oil.

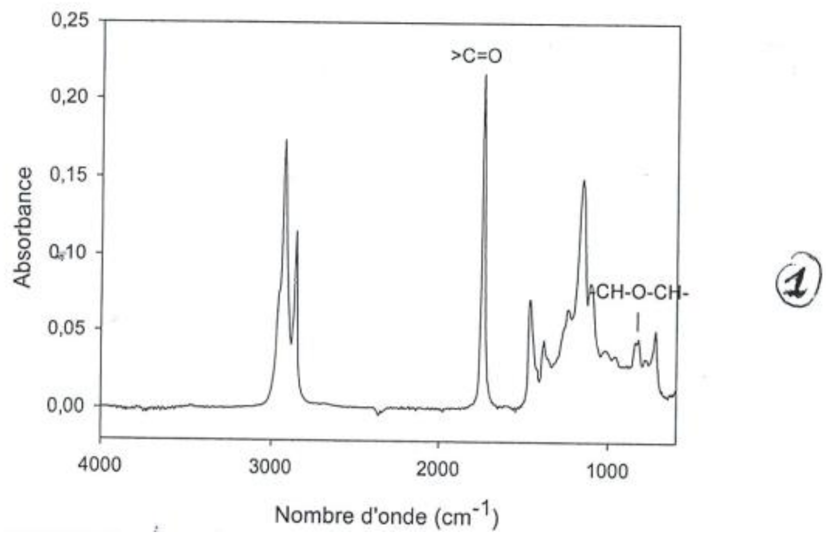

Figure 1: Infrared spectra of oil with *Piliostigma thonningii*

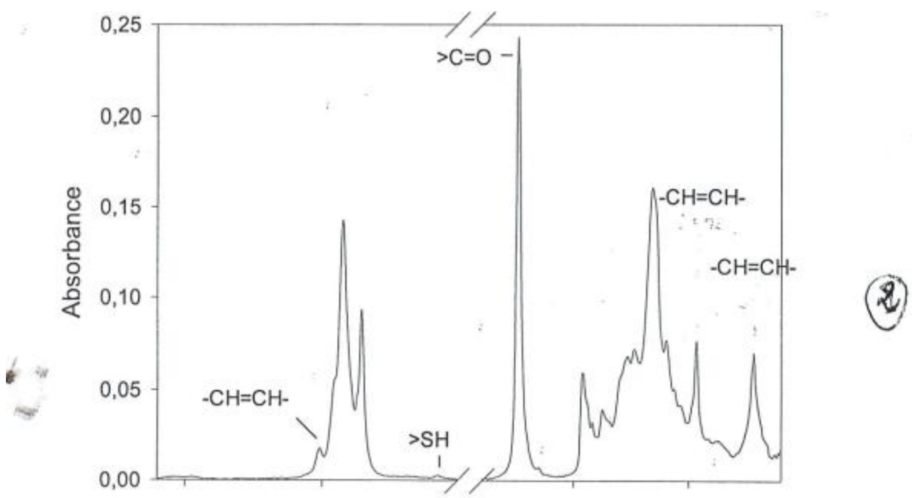

Figure 2: Infrared spectra of oil without *Piliostigma thonningii*

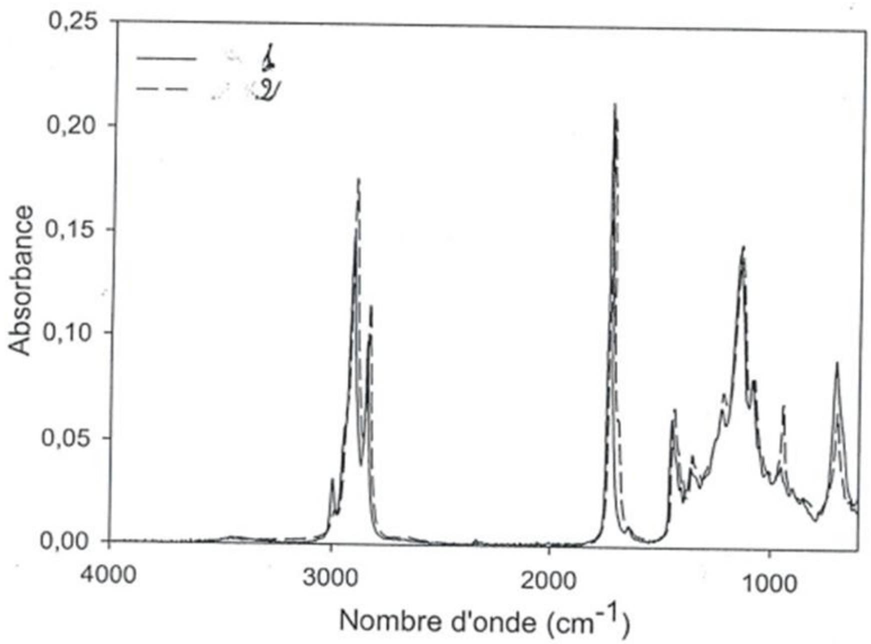

Figure 3: Combined Infrared spectra of oil with and without *Piliostigma thonningii*

Table 1: Functional groups identified in the oil samples

Numbers of groups	Sample (1)	Corresponding functional groups	Sample (2)	Corresponding functional groups
1	2800-3000	(C=C) doubles bond	3000-3100	(C=C) doubles bond
2	1700-1800	-C=O (Carbonyl or lactone or ester)	2800-3000	(C=C) doubles bond
3	1400-1500	Aromatic cycle	2400	SH
4	1100-1200	Cyclic compounds or ether cyclic	1700-1800	-C=O (Carbonyl or lactone or ester)
5	900	Ether cyclic or ether alkyl-substitutes	1400-1500	Aromatic cycle
6	600	disulfides	1100-1200	Ether cyclic or ether alkyl-substitutes
7	400	polysulfides	900	Ether cyclic or ether alkyl-substitutes
8	400	polysulfides	600	disulfides
9	-	-	400	polysulfides

Fatty Acid Profile of *Quassia undulata* Oil

The results obtained are presented in

Table 2 and

Fatty acids	Oil extracted Without Piliostigma thonningii leaves	Oil extracted With Piliostigma thonningii leaves
Palmitic acid (C16:0)	8,76±0,02 [a]	4,62±0,02 [a]
Stearic acid (C18:0)	19,15±0.03 [a]	19,82±0.03 [a]
Oleic acid (C18: 1) (ω9)	61,79±0,05 [a]	62,07±0,05 [a]

Linoleic acid (C18:2) (ω6)	6,21±0.05 [a]	5,96±0.05 [a]
Linolenic Acid (C18: 3) (ω3)	0,65±0.02 [a]	0,47±0.02 [a]
Arachidic acid (C20:0)	2,77±0.02 [a]	2,82±0.02 [a]
Arachidonic acid (C20:1) (ω6)	0,41±0.01 [a]	0,44±0.01 [a]
Behenic acid (C22:0)	-	0.75±0.02

Table 3. It is noted that the oil of *Quassia undulata* is mainly formed of oleic acid (≈61-62%) followed by stearic acid (≈19%) . Linolenic acid (omega-3) is present in very small quantities (≈0.47-0.65%) and concerning omega-6, two have been identified. These are linoleic acid and arachidonic acid present respectively at levels of (5.96-6.21%) and (≈0.4%). Overall, there is a low presence of polyunsaturated fatty acids ≈6% of the total fatty acid content. This content is comparable to that of coconut oil (7.12%) [15]. Monounsaturated acids predominate in the oil with a prevalence of ≈62%, followed by saturated fatty acids with a rate ranging from 28 to 30% depending on whether the oil is extracted without the presence of *Piliostigma thonningii* leaves or not. The monounsaturated fatty acid content ois higher than that of palm oil (41.46%), mustard oil (49.57%) and sunflower oil (45 .5%) known for their high content of monounsaturated fatty acids [15]. The saturated fatty acid content is lower than that of palm oil and coconut oil but higher than most other vegetable oils [15].

Statistically there are no significant differences between the fatty acid contents of the oils extracted with and without the presence of *Piliostigma thonningii* leaves. However, the content of palmitic acid (C16:0) in the oil extracted without *Piliostigma thonningii* is almost twice that in the oil with *Piliostigma thonningii*. At the same time, behenic acid (C22:0) is only detected in oil with *Piliostigma thonningii* (0.75%). This has been observed in the fatty acid analysis results of avocado oil extracted with different extraction methods. Myristic acid has only been detected in Soxhlet-extracted oils [16]. It is also noted that the linolenic acid content is higher in the oil extracted without *Piliostigma thonningii* (0.65% against 0.47%). This can be explained by the fact that after oil extraction with *Piliostigma thonningii*, the oil was subjected to rapid heating to remove impurities. However, polyunsaturated fatty acids are sensitive to temperature [17]. Thus, this additional step could have led to the oxidation of the polyunsaturated fatty acids of the oil, thus reducing their content. Oxidative rancidity occurs by a process of initiation with a pro-oxidant giving a free radical from an unsaturated fatty acid. Then comes the stage of propagation in the presence of oxygen and finally the stage of termination, where an antioxidant gives hydrogen to give a non-radical product [18].

Table 2: Fatty acid profile of *Quassia undulata* oil traditionally extracted with and without the presence of *Piliostigma thonningii* leaves

Fatty acids	Oil extracted Without Piliostigma thonningii leaves	Oil extracted With Piliostigma thonningii leaves
Palmitic acid (C16:0)	8,76±0,02 [a]	4,62±0,02 [a]
Stearic acid (C18:0)	19,15±0.03 [a]	19,82±0.03 [a]
Oleic acid (C18: 1) (ω9)	61,79±0,05 [a]	62,07±0,05 [a]
Linoleic acid (C18:2) (ω6)	6,21±0.05 [a]	5,96±0.05 [a]
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Arachidic acid (C20:0)	2,77±0.02 [a]	2,82±0.02 [a]
Arachidonic acid (C20:1) (ω6)	0,41±0.01 [a]	0,44±0.01 [a]
Behenic acid (C22:0)	-	0.75±0.02

Table 3:Percentage of saturated and unsaturated fatty acids in Q.*undulata* oil

Fatty acids	**Oil extracted without *Piliostigma thonningii***	**Oil extracted with *Piliostigma thonningii***	**Bazongo et al., 2025 [19]**	**Mirailles et al.,1988 [20]**	**Iko et al.,2015 [21]**
SFA	30.68%	28.01%	28.59%	42.8%	35.07%
MUFA	62.2%	62.51%	63.65%	46.5%	52.06%
PUFA	6.86%	6.43%	7.76%	10.7%	11.37%

Statistically no significant difference is noted when comparing the fatty acid content of *Q.undulata* oil extracted with and without *Piliostigma thonningii* to that of Bazongo et al., Mirailles et al., 1988 and Iko et al., 2015 (**Figure 4**) [19-21]. The fatty acid contents found in our study are very close to those found for the species by Bazongo et al., 2025 [19]. However, the Monounsaturated fatty acid contents in traditionally extracted oils are higher than those found by Mirailles et al., 1988 and Iko et al., 2015 and those in stearic acid and linoleic acid are lower. This could be explained by the fact that the fatty acid content varies according to the varieties of the plant species, the growing conditions and the degree of plant maturity [22-27]. Indeed, the analysis of the fatty acid profile of 09 samples of palm oil from different cultivars of *Elaeis guineensis* from the same farm in Thailand gave palmitic acid and oleic acid contents varying respectively from 41.5 at 51.6% and 32.8–42.5% [28]. The same results were obtained with different varieties of Kenaf oil (*Hibiscus cannabinus* L.) [24]. On the other hand, Bouhlel et al., 2007 have shown that the fatty acid content of fish can vary depending on the season of capture [29]. The origin of the seeds could also justify these different levels obtained. Indeed, several studies carried out on the fatty acid content of palm and sunflower oils have shown that their percentage may vary depending on the origin of the seeds [15, 30, 31]. For example, for samples from Macedonia, Kostik et al., 2013 obtained for the SFA and PUFA contents of palm oil 76% and 1.25% respectively [30], while in Bangladesh, Chowdhury et al., 2007 obtained 46.34% and 11.84%; For MUFA contents, Kostik et al., 2013 obtained 31.5% for sunflower oil and Chowdhury et al., 2007 45.5%.

Temperature also plays an essential role and among the factors responsible for fluctuations in the fatty acid content of oils contained in oilseeds, temperature is certainly one of the major factors after genetic factors [32]. A correlation (R2=0.85) between temperature and the linolenic acid content of rapeseed oil was demonstrated by Baux et al., 2008. Indeed, the α-linolenic acid contents are higher when the temperatures are low [33]. Studies have shown that high temperatures favor oleic acid concentration at the expense of linoleic composition [34].

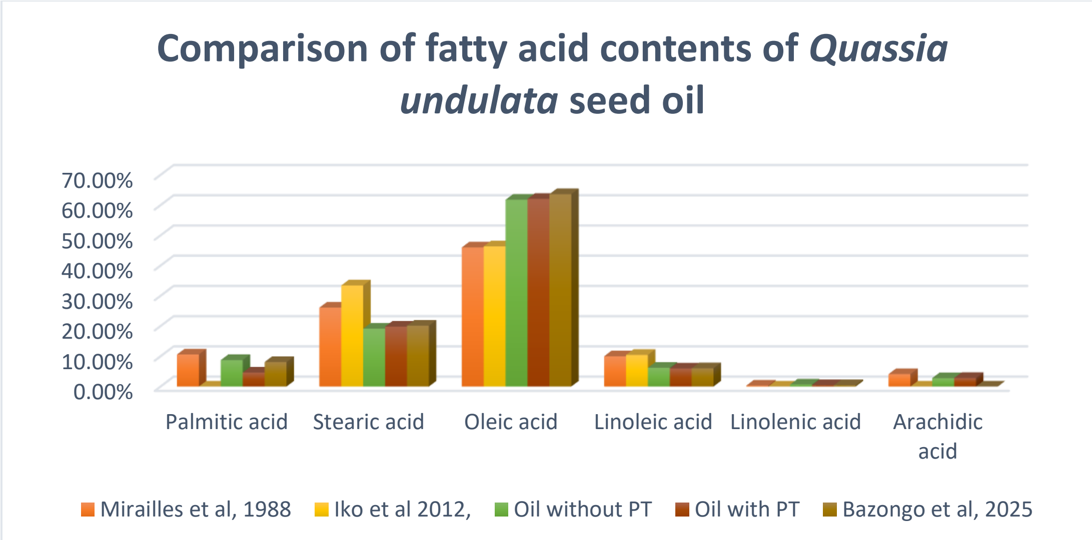

Figure 4: Comparison of fatty acid contents of *Q.undulata* oil

The high linoleic acid content of the oil without and with PT compared to that of Miraille s and Iko could be explained by the probable conversion of stearic and palmitic acids into oleic acid under the action of Δ-9 desaturase [35]. Desaturases are enzymes that allow the introduction of double bonds into the aliphatic chains of fatty acids. There are three types of fatty acid desaturases: acyl-CoA, acyl-ACP, and acyl-lipid desaturases [36].

CONCLUSION

The analyzes made in this chapter have made it possible to determine the fatty acid profile of the oils extracted with the traditional method. The oils exhibited high percentages of monounsaturated and saturated fatty acids which may explain the solid state of the oil at ambient temperatures of 20°-24°C. The low content of polyunsaturated fatty acids explains the low iodine indices obtained previously.

Conflict of Interest

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

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