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RESEARCH ARTICLE

EFFECT OF SOLVENT AND PRESS EXTRACTIONS ON PHYSICOCHEMICAL PROPERTIES OF OIL EXTRACTED FROM *DACRYODESEDULIS* FRUIT

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ABSTRACT

Effect of solvent and press extractions on physicochemical properties of oil extracted from *Dacryodesedulis* fruit were investigated. These oils were obtained through different extraction methods (press-extraction, maceration and extraction by soxhlet). Indeed, press extracted oil has a better yield compared to the others. Analysing the physicochemical parameters, oils obtained from maceration and press of kernels and pulp have an acid value less than 2 mg of KOH/kg of oil; whereas those resulting from extraction by Soxhlet have an acid value greater than 2 mg KOH/kg of oil. The peroxide value of the extracts oils by maceration and press of the kernels and pulp are in agreement with the standard of the *codex alimentarius* (≤15 mEq O_2/kg of oil), while those obtained by soxhlet method are higher values than the norm. These oils have an iodine value which ranges from 90 to 120 g of iodine/100 g of oil, with a saponification value from 100 and 210 mg of KOH/g of oil and a rate of unsaponifiable matters between 1 and 3%.Also, refractive index measured for these different oils varies from 1.455 to 1.490 and their density is between 0.885 and 0.932 mg/mL. Moreover, fatty acid profiles of studied oils highlighted the presence of major fatty acids such as palmitic acid, oleic acid (**ω**-9) and linoleic acid (**ω**-6). Results of the study indicated that safou oils could be used in cosmetics and also in human nutrition for prevention against arteriosclerosis and cardiovascular diseases.

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INTRODUCTION

The needs of the oilseed market and the detection of new features have led to the search for new oil species. Many investigations have shown that the fruits of *Dacryodesedulis* has oilseeds with good potential (Kengue *et al.,* 2002). *D. edulis* commonly called Africanpearis a plant whose fruits (safou) are veryrich in oil. Indeed, safou oil contains 17 to 46% of palmiticacid, 21 to 40 % of oleicacid, 12 to 23% of linoleic acid and 4 to 14% of stearic acid (Ajayi *et al.,* 2006). Therefore, safou oil extracted from pulp and kernel are used in food and cosmetics (Tabuna and Tanoe, 2009). On the food level, safou oili sused for culinary receipts composition. In addition, it is used for the hair maintain and also for body pomade in cosmetics (Kapseu, 1993; Poligui *et al.,* 2013). These oils are generally extracted by soxhlet. According to Hesham *et al.* (2016), heat contribution during the soxhlet extraction would destroy the thermo sensitive compounds. However, there are other extraction methods such as maceration and extraction by press which do not require heat contribution. This present work aims at showing the impact of the various extraction methods on the quality of safou oil. To achieve this, physicochemical parameters and fatty acid profile of the oils from the pulp and safou kernel were determined.

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MATERIALS AND METHODS

Plant material

Fruits of *D. edulis* used as plant material were collected from village of Azaguie-Beda, Agboville Sub-prefecture, south of Côte Ivoire. The samples were sent to the Laboratory of Industrial Processes, Synthesis, Environment and New Energies (LAPISEN) of Yamoussoukro (Côte Ivoire). The safou pulp was separated from the kernels with a stainless knife. The kernels and pulps were dried during 3 days at room temperature. The kernels and pulp dried are then crushed and preserved.

Methods

Extraction of oil from pulp and kernel

Extraction with soxhlet: 30 g of crushed pulp and ground kernels were put in two different cartridges. These cartridges are then closed with cotton and inserted into two different Soxhlet. At the same time, 250 mL of hexane are put into two different ground-necked flasks and heated on a heating cap at 110 ° C during 6 hours. The flasks are then separated from the extractors. The extracted oil is collected by distilling the oil-hexane mixture under a rotary evaporator (RII BUCHI, Switzerland) (BIPEA, 1976). The yield of extracted oil was calculated using the equation below:

$$\text{Yield}\,(\%) = \frac{\text{Weight of oilextracted}}{\text{Weight of sample}} \times 100$$

Extraction by maceration: In 1000 mL Erlenmeyer flask, 100 g of sample (crushed pulp and ground kernels) was macerated, under magnetic stirring, with 300 mL of n-hexane for 6 hours at 30 ± °C. After that, the mixture was filtered using the whatman filter paper. The liquid phase containing the oil is then collected and dried over $MgSO_4$. Finally, the oil was obtained by removing the hexane on a rotary evaporator (RII BUCHI, Switzerland). The calculation of oil yield was done as in the case of Soxhlet extraction.

Extraction by press: The crushed pulp and ground kernels are put in a clean tissue and crushed under a crank press. Then, the extracted oil is left to decant and the supernatant (oil) is collected and conditioned in a bottle.

Determination of the organoleptic characteristics of the various oils extracted: The color of the pulp and kernel oil was determined by observing with naked eyes, smell and flavor through the olfactory sense (Muther, 2015).

Determination of the chemical parameters of the oil

Iodine value: The iodine value was determined according to AFNOR standard T60-203 (1984). To get this value, 0.5 g of oil was dissolved in 15 mL of chloroform. Then, 20 mL of Wijs reagent were added. The whole was then stirred slightly and then sheltered from the light for 1 hour. After that, 10 mL of 10% KI solution and 150 mL of distilled water were added to the mixture. The whole was titrated with 0.1 N of a solution of sodium thiosulfate ($Na_2S_2O_3$) in the presence of starch stain as a colored indicator. Keeping the same conditions, a witness was made. The iodine value was determined according to the following formula:

$$IV = 1.269 \times (V_0\text{-}V) / w$$

IV: iodine value (in g of iodine / 100 g of oil); *Vo: Volume (in mL) of 0.1N sodium thiosulfatepoured into the blank*; *V: Volume (mL) of sodium thiosulfate poured into the test; w: Weight of the test sample (in g); 1.269: is the molar mass of iodine in g of iodine.*

Acid value: Acid value was estimated according to AFNOR standard T60 (1984). 1g of oil was dissolved in 10 mL of ethanol / ether (50/50, V / V). The solution obtained was titrated with a solution of alcoholic KOH (0.1 N) in the presence of phenolphthalein. A control was made under the same conditions. The acid value was determined according to the following formula:

$$AV = 56.1 \times N \times V / w$$

AV: acid value (in mg KOH / g oil); V: Volume of KOH (in mL) used to neutralize the free acids of the oil; w: mass of the oil (in g); N: Normality of ethanolic KOH (0.1 N); 56.1: is the molar mass of KOH in g / mol.

Peroxide value: Peroxide value was determined according to AFNOR NF 60-220 (1984). 2 g of oil are dissolved in 10 mL of chloroform. Then, 15 mL of acetic acid and 1 mL of potassium iodide solution (10%) are added. The mixture is capped immediately, then stirred during 1 min and protected from light for 5 min. Then, 75 mL of distilled water was added to the mixture. After the homogenization of the mixture, the resulting solution was titrated with 0.002 N of a sodium thiosulfate solution in the presence of starch poi. A control was made under the same conditions. Peroxide value was determined according to the following expression:

$$PV = 1000 \times (V\text{-}V_0) \times N / w$$

PV: Peroxide value expressed in milliequivalents equivalents of active oxygen per kilogram of sample (mEq of O2 / kg of oil); V_0: Volume in mL of the sodium thiosulfate solution used for the blank test; V: Volume in ml of the sodium thiosulfate solution used to assay the sample; N: Normality of the sodium thiosulfate solution used (0.002N); w: Weight in grams of the test sample (g).

Saponification value: Saponification value was determined according to standard AFNOR T 60-206 (1984) and 2 g of oil was solubilized in 25 mL of 0.5 N alcoholic KOH. The mixture was boiled in a water bath during 1 hour. After cooling, the excess of alcoholic potassium hydroxide was titrated with a solution of 0.5 N HCl in the presence of phenolphthalein until complete decolorization. A control was made under the same conditions. The saponification value was determined according to the following formula:

$$SV = 56.1\ (V_0\text{-}V) \times N / w$$

SV: saponification number in mg KOH / g oil; V: Volume in ml of the hydrochloric acid solution used to assay the sample; V_0: Volume in ml to dose the control; 56.1: is the molar mass in g / mol of KOH; N: Normality of the hydrochloric acid solution used (0.5 N); w: weight of the oil (g).

Unsaponifiable matter content: The determination of unsaponifiable matter content was estimated according to the AFNOR T 60-205 (1984) standard. A mixture of 5g of oil and 50 mL of alcoholic KOH (1N) was refluxed during 1h. After boiling, the solution was put in a separating funnel and then 50 mL of distilled water was added. This cold solution was extracted 3 times using 50 mL of hexane. The organic phases are combined and washed with 10% ethanol until pH reaches 7. After washing, the organic phase is dried over anhydrous sodium sulphate, filtered on filter paper and evaporated to dryness under reduced pressure. The resulting residue was dried in an oven at 103°C and then desiccated to constant weight. This residue constitutes the unsaponifiable fraction.

Unsaponifiable materials were determined through the formula below:

$$\text{Unsaponifiable matter (\%)} = \frac{\text{Weight of unsaponifiable}}{\text{Weight of sample}} \times 100$$

Determination of physical parameters

Refractive index: Refractive index was determined according to standard AFNOR T 60-212 (1984). A few drops of the oil were heated beforehand to 40°C in a water bath for analysis. Then, they were deposited in the refractometer mold. The refractive index is directly displayed on the screen of the device.

Density: 2 mL of oil (pulp and kernel) was weighed and the density was obtained by relating the mass of the oil extract to the volume of the oil at 20 ° C. The density was calculated using the formula below:

$$d = w / v$$

***d**: density of oil; **w**: Weight of the oil extract in g; **v**: Volume of the oil extract in ml.*

Determination of the fatty acid profile of safou oil: The fatty acid profile was determined using a Hewlett-Packard HP 5890 Series II gas chromatograph. The CPG was equipped with a flame ionization detector (FID). The capillary column used is a CP-Select CB, type WCOT Fused Silica 50 m long, 0.25 mm internal diameter and 0.25 mm thick. The vector gas used is helium with a flow rate of 1.2 mL/min. The temperature of the injector was 250 °C. The injection was carried out with a volume of 1µL.

Statistical analysis: Results were expressed as mean ± standard deviation of three replicate. Data were evaluated by one-way analysis of variance (ANOVA) using statistica 7.1 (Stat Soft, Inc, USA) solfware. Newman-keuls test performed to determine significant.

RESULTS AND DISCUSSION

Extraction yield of oil pulp and kernel: Table 1 presents oil yied of pulp and kernel of safou. The oil yied of the pulp obtained by press extraction (93.94 ± 0.7%) is higher than those extracted by Soxhlet (62.21 ± 0.17%) and maceration (52.34 ± 0.25%). As for the kernel, two oil extraction methods were used (Soxhlet and maceration). The yield of oil extracted by soxhlet (18.28 ± 0.24%) is higher than that of maceration (11.18 ± 0.15%). These results showed that pulp contains more oil than thekernel. Then press extraction is the best extraction method. This is due to the ability of the crank press to extract almost all of the oil contained in the pulp (Kandji, 2001). The oil yield obtained is similar. This oil yield is similar to that of some oleaginous seeds such as: peanut 50%, cottonseed 35 - 40%, corn germ 45 - 50%, soy 15 - 25%, palm: 35.5% (Karleskind and Wolff, 1992; Verleyen, 2002). Also, the yields recorded after chemical extraction of pulp oil are in agreement with those made in Cameroon (47.4 to 61.1%) (Kapseu *et al.,* 1999) and Congo-Brazzaville (49 and 70%) (Silou *et al.,* 2000). In addition, the efficiency of press extraction is higher than that obtained by Kengué (2002), which indicated an oil content ranging from 25 to 49%. Also, the oil yields of the safou kernel are low compared to those observed in Nigeria (27.3%) (Ajiwe *et al.,* 1997).

Chemical parameters: The chemical parameters of the different oils are shown in Table 3.

Acid value: Acid value defines the quality of the oils. It characterizes the stability of oils at room temperature. The acid values of the pulp and kernel oils obtained through maceration and by press are between 0 and 2 mg of KOH / kg of oil (Table 3). Whereas, those extracted with Soxhlet have an acidity higher than 2. Indeed, the extraction mode has strong influence on the acid index. However, these acid values remain lower than the normal (≤ 4 mg of KOH / kg of oil) allowed for edible fats (AFNOR, 1981).

Peroxide value: Peroxide value is related to storage conditions and extraction methods. This is a very useful criterion for assessing the oxidative deterioration of oils. The peroxide value of the pulp and kernel oils obtained by maceration and press are lower than the normal values (≤15 mEq O_2 / kg) (*Codex Alimentarius*, 2001). While those obtained by soxhlet have high peroxide values compared to the normal.

Iodine value: Iodine value shows the degree of unsaturation of the oils. The results indicate that oils extracted by soxhlet from pulp and kernel have an iodine value of 90.87 g iodine / 100 g and 94.79 g iodine/100 g, respectively. In addition, the iodine values of oils obtained by maceration and press range between 100 and 120 g of iodine / 100g of oil. These high values of iodine value indicate the presence of unsaturated fatty acids justifying the liquid appearance of these oils (Codex stan 210, 1999).

Saponification value: This index is useful to assess on the one hand the length of the fatty acid chains and on the other hand the potentiality to be used in soap making. All saponification value of oils extracted are ranged between 185 and 210 mg KOH / g, except pulp oil obtained by press extraction which is 119.28 mg KOH /g. These indices are higher than the average saponification value (≥109 mg KOH /g) (Codex stan 210, 1999). This indicates that these oils could be used as raw materials for soap making. *Unsaponifiable matter content:* Unsaponifiable content in the oils is used as raw material in cosmetics. Soxhelet oil extracted contains a weak unsaponifiable matter matter (varying between 0, 5 and 1,5 %). However, relatively high proportions were observed for the whole of other oils with a content bordering 3%. The chemical analysis of the results revealed that the oil of pulp, kernel, macerated and in press have a low acid value. It follows that extraction by maceration and press has the beneficial effect of limiting the formation of free fatty acids during extraction. In addition, there is a slight increase in the acid value of the oil resulting from extraction of the pulp and kernel at the soxhlet due to heat. Nevertheless, the low value of acid confers a good stability of the oils studied. Compared to commonly used oils, macerated and press extracted oil of pulp and kernel oils have an acid value which is lower than those of soybean oil (3 mg KOH / g), sunflower (4 mg KOH/g maximum) and olive which varies from 2 to 16 mg KOH / g of oil (*Alinorm 01/17*). The determination of the peroxide value showed that the lowest values are those of oils obtained by maceration and press. These peroxide values are below the standard set by the *Codex Alimentarius* between 10

Table 1. Yield of extraction of oil from the pulp and kernel

Extraction methods		Yield (%)	
		Oil of the pulp	Oil of the kernel
Solvent extraction	Soxhlet	62.21 ± 0.17[a]	18.28 ± 0.24[a]
	Maceration	52.34 ± 0.25[b]	11.18 ± 0.15[b]
Mechanical extraction	In press	93.94 ± 0.7[c]	nd

In each column the averages not followed by the same lowercase letter are statistically different at a threshold of 5% (P < 0.05). nd: not determined.

Table 2. Organoleptic characteristics of safou oil

Aspects	Characteristics	
	Oil of the pulp	Oil of the kernel
Consistency	liquid	liquid
Color	Darkyellow	Light yellow
smell and flavor	Pleasant	Pleasant

Table 3. Chemical properties of safou oils

Type of oils	Chemical properties				
	AV	PV	IV	SV	Uns.
HPM	1.35 ± 0.26[b]	13.50 ± 0.46[c]	103.64 ± 0.25[c]	207.56 ± 0.20[c]	2.45 ± 0.13[a]
HPS	3.74 ± 0.18[d]	25.08 ± 0.66[e]	90.87 ± 0.48[a]	201.3 ± 0.70[d]	2.38 ± 0.25[d]
HPP	0.56 ± 0.01[a]	6.32 ± 0.38[a]	115.28 ± 0.22[e]	119.28 ± 0.22[a]	1.39 ± 0.04[b]
HAM	0.61 ± 0.06[a]	8.33 ± 0.28[b]	108.75 ± 0.14[d]	196.49 ± 0.47[c]	2.35 ± 0.49[a]
HAS	3.33 ± 0.31[c]	15.50 ± 0.41[d]	94.79 ± 0.13[b]	188.46 ± 0.46[b]	1.30 ± 0.21[b]

In each column the averages not followed by the same lowercase letter are statistically different at a threshold of 5% (P < 0.05). AV: acid value in mg KOH / kg of oil; PV: peroxide value in mEq O2 / kg of oil; IV: iodine value in g of iodine / 100 g of oil; SV: saponification value in mg KOH / g oil;Uns: unsaponifiable. HPM: Oil of the macerated pulp; HPS: Pulp oil extracted with Soxhlet; HPP: Pulp oil extracted in press; HAS: Kernel oil extracted with Soxhlet; HAM: Macerated kernel oil.

Table 4. Physical properties of safou oils

Type of oils	Physical properties	
	Refractiveindex	Density
HPM	1.456 ± 0.007[a]	0.921 ± 0.045[a]
HPS	1.473 ± 0.054[a]	0.887 ± 0.036[a]
HPP	1.490 ± 0.052[a]	0.931 ± 0.017[a]
HAM	1.459 ± 0.001[a]	0.912 ± 0.026[a]
HAS	1.463 ± 0.002[a]	0.899 ± 0.021[a]

In each column the averages not followed by the same lowercase letter are statistically different at a threshold of 5% (P < 0.05). HPM: Oil of the macerated pulp; HPS: Pulp oil extracted with Soxhlet; HPP: Pulp oil extracted in press; HAS: Kernel oil extracted with Soxhlet; HAM: Macerated kernel oil.

Table 5. Fatty acid profile of the pulp oil and safoukernel

Fattyacids	Fatty acid content (%)				
	HPM	HPS	HPP	HAM	HAS
Palmiticacid (C16: 0)	46.84	45.34	44.07	41.16	43.62
Stearicacid (C18:0)	3.68	3.12	3.19	12.11	5.31
Arachidicacid (C20:0)	-	-	-	1.04	-
Oleicacid (C18:1)	30.96	13.06	31.28	19.02	18.26
Trans-vaccenicacid (C18 :1)	1.48	2.11	1.21	1.14	1.02
Linoleicacid (C18:2)	17.04	17.51	22.63	13.08	19.37

HPM: Oil of the macerated pulp; HPS: Pulp oil extracted with Soxhlet; HPP: Pulp oil extracted in press; HAS: Kernel oil extracted with Soxhlet; HAM: Macerated kernel oil.

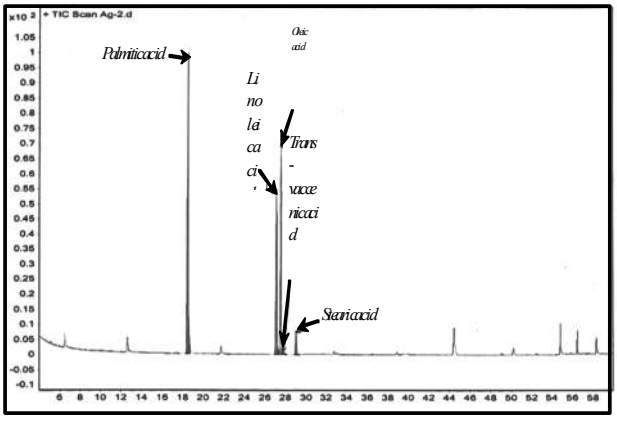

Figure 1. Gas chromatography of fatty acids from pulp oil from safou

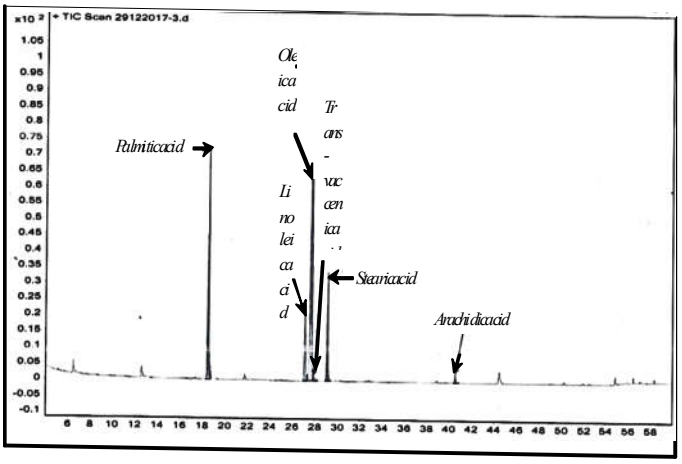

Figure 2. Gas chromatography of fatty acids from kernel oil from safou

and 15 mEq O_2/kg for unrefined oils (*Codex Alimentarius*, *1992*). These results reflect an undeveloped state of oxidation of oils obtained by maceration and press extraction. As to iodine value, the results show that the oils obtained by Soxhlet extraction are less unsaturated. They are comparable to the iodine values of peanut oil (80-107 g iodine / 100 g oil) and olive oil (75-94 g / 100 g iodine oil). On the other hand, the oil resulting from the macerated pulp, in press and that of the macerated kernel, are comparable to the cotton oils (100-115 g of iodine / 100 g of oil) and of sesame (105-120 iodine / 100 g of oil).

The high iodine value of safou oils indicates that they contain unsaturated fatty acids. For that, the consumption of these safou oils could allow the reduction of the blood cholesterol. As regards to the saponification value, it is related to the length of the constituent fatty acids of the oil. So the saponification value of the oils studied are comparable to palm oils (196-205 mg KOH / g oil), peanut (188-196 mg KOH / g oil) and olive (184 - 196 mg KOH / g oil) (*Codex stan* 210, 1999). The latter are mostly used in soapmaking. For this purpose, these different safou oils could be used in soapmaking. As to the extraction of the unsaponifiable fraction by hexane from the oil of the macerated pulp, extracted by Soxhlet and the macerated kernel, they give a value superior to that of the olive oil (1,5%) and sesame (1.69%) (Tir, 2005). As to the oil of the pulp extracted by press and the kernel extracted by Soxhlet, they indicate a low content. According to the literature, the unsaponifiable fraction represents 0.2 to 2% (*Alinorm* 01/17). As a result, the studied safou oils would contain bioactive compounds that would ensure their stability. They could therefore be used in cosmetics.

Physical parameters

The physical parameters of the different oils extracted were presented in Table 4. Refractive index and density of oil obtained by pulp maceration in n-hexane are 1.456 ± 0.007 and 0.921 ± 0.045 respectively. That of pulp oil extracted by soxhlet gives a refractive index of 1.473 ± 0.054 and a density of 0.887 ± 0.036. However, oil obtained by pressed extraction has a refractive index of 1.490 ± 0.052 with a density of 0.931 ± 0.017. As to kernel oil obtained by maceration, refractive index and density are 1.459 ± 0.001 and density 0.912 ± 0.026, Then refractive index and density that of kernel oil extracted by Soxhlet are 1.463 ± 0.002 and 0.899 ± 0.021, respectively. Results showed that refractive index measured for safou oils are not statiscally differents. These refractive index are similar to those of palm oil (1.449-1.456) (Hamilton and Rossell, 1986), sesame (1.465-1.469), sunflower (1.461-1.468) and soybean (1.466-1.470) (*Codex stan 210*, 1999). So, these safou oils could be considered as a reserved oil for seasoning and mild cooking. As to density, there is not statistical difference between all values obtained. Density of safou oils extracted are comparable to those of olive oil (0.910-0.916), sunflower (0.920-0.925) and soybean (0.921-0.924). (Ollë, 2002). Since these are recognized for their purity, then the oils studied are pure. except oil extracted by press where its higher density, could be explained by the presence of foreign matter.

Fatty acid profile of oils: Figure 1 shows the fatty acid profile of safoupulpoil. This profile is similar to that of safou kernel oil (Figure 2). The rate of fatty acids identified in safou oils (kernel and pulp) obtained by using three extraction methods (Soxhlet, extraction by pressing and maceration) is presented in Table 5. The most abundant fatty acid identified, in pulp and kernel oils, is palmitic acid (41.16 to 46.84%) regardless to the three extraction methods used. The other fatty acids are oleic acid (31.28 to 13.06 %), linoleic acid (22.63 to 13.08 %), stearic acid (12.11 to 3.12 %) and *trans*-vaccenic acid (2.11 to 1.02 %).In the case of oilobtained by Soxhlet, after palmitic acid comeslinoleic acid, oleic acid, stearic acid and *trans*-vaccenic acid. The rates of palmiti cacid and stearic acid in safou oils are comparable to those of palm oil. According to Kapseu (2009), the rate of palmiticacid and stearicacid of palm oilwas 41.2% and 5.8%, respectively.

Also, the rate of linoleic acid of safou oils extracted is generally similar to that of peanut oil and rapeseed oil which is respectively 21% and 22% (FAO / WHO, 1977). Then, safou oils extracted are most richer in oleic acid than those of soybean (25%) oil and sunflower oil (23%). The presence of unsaturated fatty acids such as oleic acid and linoleic acid, in safou oils extracted, could be beneficial for consumers. Indeed, oleicacidlo wers LDL choleste rollevels by increasing HDL choleste rollevels (Brouwer *etal*., 2004). In addition, the presence of linoleicacid in safou oil participates in the formation of the impermeable barrier of the skin. It is believed to be one of the precursors of eicosanoid hormones (Raisonnier, 2010). Then, this fatty acid makesit possible to avoid deposition of cholesterol in various tissues (Guimarães *etal*, 2013). Also, linoleic acid is thought to be responsible for cardiovascular and immune balance. It acts on the regulation of the nervous system, on healing and against allergic and inflammatoryre actions (Eude, 2005, Guesnet *et al.,* 2005). Moreover, saturated fatty acids identified in safou oils such as stearic acid and palmitic acid are not hypercholesterolemic (Hunter *et al.,* 2010). These fatty acids are energy supply agents, cell membrane constituents and cancer cell inhibitors (Hunter *et al*., 2010). According to ANES (2011) and Lecerf (2008), *trans*-vaccenic acid is present at a tolerable level in safou oils. The threshold of presence of this type of fatty acid in consumer oils is 2%. Beyond this threshold, it would increase LDL-cholesterol and decrease HDL-cholesterol.

Conclusion

Three extraction methods were used in this study: press extraction, maceration and extraction by soxhlet. Results showed that oil of the pulp extracted by press has a higher oilyield (93%) presents a better physico-chemical propertyth another types of oils. Also, the oil from the pulp contains the highest proportion of oleic acid (ω-9) and linoleic acid (ω-6). The analysis of results also showed that oxidative stability of oil sextracted from safou and the fatty acid contents are better according to the following order of extraction: extaction by press> extraction by maceration> extraction by Soxhlet. However, the methods of extraction do not modify the physico-chemical properties and fatty acid composition. The safou oils extracted by press or maceration contains mainly palmitic, oleic and linoleic, stearic and trans-vaccenic acid in the same proportion as oils extracted by soxhlet.

Conflict of interests: The authors declare that there is no conflict of interests

Contributions of the authors: AARRA ensured the collection, handling experimental, the analysis of the data and the drafting of the manuscript.ENK, BABK and LOAA took part in the data analysis and the article correction. All the authors read and approved the final manuscript.

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