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Physicochemical Potential of *Balanites aegyptiaca* Seed Kernel Oil from Northern Cameroon for Biodiesel valorization

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Authors' contributions

This work was carried out in collaboration among all authors. Author DFK performed the methodology, conceptualization, experiments, writing original draft preparation, reviewing and editing. Author ES did the conceptualization, validation, writing- original draft preparation, reviewing and editing, validation, writing- original draft preparation by author DIS. Authors ET and PMK reviewed, edited and supervised the work. All authors read and approved the final manuscript.

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ABSTRACT

This research work reports the physicochemical potentialities of *Balanites aegyptiaca* kernel oil for biodiesel valorization. Balanites seed was sampling from Pitoa, Maroua and Moutourwa localities located from North Cameroon and the kernel oil was extracted using Soxhlet apparatus. The physicochemical and the free fatty acid composition of kernel oils was determined. Among the three samples, those of Pitoa shows the higher oil yield (56.6 %). All the Refractive index of these oils were ranged in ASTM and their kinematic viscosities were small compared to the EN ISO 3104 standard. The Acid values measured were all less than EN 14104 standard and the iodine values were in accordance with EN 14111 standard, whereas, the saponification value for the samples of Maroua (139.5 ± 0.07) was higher than those of Pitoa (123.6 ± 0.04) and Moutourwa (131.5 ± 0.06)

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and the Peroxide values measured were lower than 10 meq/Kg. Unsaturated fatty acids were higher for the sample of Maroua (78.8 %) than those of Moutourwa (76.9%) and Pitoa (77.7 %). This research work indicate that *B.aegyptiaca* kernel oil obtainable from North Cameroon as higher yield (50.7-56.6%). The kernel oil shows good physicochemical properties and fatty acids profile which can be valorised as a feedstock for the production of biodiesel.

Place and Duration of Study: School of Chemical Engineering and Minerals Industries - Department of Chemical Engineering, University of Ngaoundere – Cameroon
work takes place between October 2020 and Jun 2021.

Keywords: Physicochemical; balanites aegyptiaca; seed kernel oil; biodiesel.

1. INTRODUCTION

The need for energy continues to increase due to continued population growth and industrial development [1,2]. In this context, fossil fuels remain the main source of energy [3]. However, the supply of these non-renewable resources is limited and their stocks are likely to be depleted over the next century [4]. In addition, fossil fuels as an unclean energy source greatly contribute to environmental pollution, global warming and climate change [5]. Despite its negative feedback, it remains the most important source of energy on earth with a large majority of the population depending on it. This can be attributed to the low availability of more sustainable energy sources in many areas, and as a solution to this fault in energy systems we must seek cleaner alternatives which must be environmentally friendly, sustainable and reliable [6,7]. Alternative sources, therefore, include the sun, wind, waves, biomass and heat that form earth's crust. Among these energy sources, biomass represents the most important potential feedstock that can be used to produce biofuels such as biodiesel [8,9]. Biodiesel is produced by the transesterification of vegetable oils or animal fats using emulsification or catalyst [10,11]. It is defined, by the ASTM D6751-03 as a fuel composed of mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats [12,13]. Biodiesel has attracted many attention because of his energy efficient, less smoke production and has particularly low carbon dioxide emissions, is nontoxic and ultimately biodegradable compared to diesel [14-16] In addition, a great advantage of this fuel is the raw materials used to synthesize it are renewable [8,14]. Significant works has been made using non-conventional oils obtained from raw materials as *Jatropha curcas*, sunflower, palm seed, or fish oil to produce biodiesel [16-19]. Numerous reports show that the physical and chemical properties of vegetable oil such as viscosity, density, flash point, and acid value affect the combustion performance of biodiesel and gas emission. These properties depend on the chemical and physical composition of the raw material [15,18]. *Balanites aegyptiaca* (*B.eagyptiaca*) which local Cameroonian name is Adoua or Tane, is a plant widely distributed on the African continent [20]. In Cameroon, it is mainly grown in the Northern regions where it is significantly appreciated for the subsistence of communities [21]. Thus, the leaves and fruits of B. aegyptiaca are used as food products and the wood is exploited as fuel [22,20]. Seed kernel is particularly known to be edible and therefore used for producing oil for human consumption, the production of cosmetics and traditional medicine [23]. The seed kernel has a high oil yield (35-65%) and total fatty acids content (98-100%) [24]. The unsaturated and saturated acid value have been established as the most predominant compounds of the fatty acid profile [23,24]. These fatty acids are important for biodiesel synthesis and have different composition depending on the influence of pedoclimatic factors [25,26]. However, research on the properties of the *B.aegyptiaca* kernel oil in the way to produce biodiesel remains unexplored in Cameroon. The objective of this paper is to determine the physicochemical properties and the free fatty acid composition of *B.eagyptiaca* kernel oil from North Cameroon. In the first part, we present the materials (samples preparation and oil extraction) and the methods used to characterize the physicochemical properties and free fatty acid composition of *B.eagyptiaca* kernel oil. Then, we expand on the different results obtained through the analysis of international standards. Finally, the conclusion and future prospects of the study are presented.

2. MATERIALS AND METHODS

2.1 Preparation of the *B. aegyptiaca* Seed Samples

The fruits of *B. aegyptiaca* used in the experiments were collected in Pitoa, Moutourwa,

and Maroua, three localities located in the North Cameroon in January 2020. In each locality, 50 kg of physiologically matured *B. aegyptiaca* seeds were gathered from farmers. The raw material sampling *criteria* were: the high productivity and the qualities of *B. aegyptiaca* fruits, the texture (hardness), degree of ripeness (yellow color) and appearance (not spotted). After collection, they were dried in direct sunlight and their shells were cracked using a steel hammer to obtain the kernel. Finally, the kernel were air-dried and then crushed into the cake using mortar and pestle to weaken the cell walls, releasing fats for extraction.

2.2 *B. aegyptiaca* Kernel Oil Extraction

Extraction of *B. aegyptiaca* kernel oils was carried out using the soxhlet apparatus. Hexane was used as the extraction solvent. 100g samples of *B. aegyptiaca* seed of each locality were prepared and introduced into the cartridges made from filter paper. 250 ml of hexane was poured into the 500 ml flask prepared for extraction. The device was brought at 70°C boiling point of n-hexane for 6 hours. The extract sample contained a hexane-oil mixture which was separated on a rotary evaporator at 70°C and 400 rpm, to obtain *B. aegyptiaca* kernel oil.

2.3 Physicochemical Characteristics of *B. aegyptiaca* Kernel Oil

The physicochemical characteristics of the *B. aegyptiaca* kernel oil determined were: oil yield, moisture content, pH, acid value, iodine value, calorific value, kinematic viscosity, refractive index, density, saponification value, peroxide value and free fatty acids composition of oil.

2.3.1 Moisture content

The moisture content was determined according to the method of the NFT 60-201 standard intended for fatty acid substances. 5 g of the sample oil for each locality was placed in an oven at a temperature of 105 ± 2 °C for 24 hours. After this time, the test sample is taken and weighed while hot. The heating and weighing operation are repeated until dry constant weight between two successive measures of sample is identical. The moisture content was calculated using equation (1) [23]:

$$T_m = \left[\left(\frac{m_1 - m_2}{m_0}\right)\right] \times 100 \qquad (1)$$

Where, m_0 is the mass (g) of the test sample, m_1 the mass (g) of the vessel and the test sample before heating, m_2 the mass (g) of the vessel and the test sample after heating, and T_m the moisture content.

2.3.2 Oil yield

The oil yield of *B. aegyptiaca* after extraction was calculated using equation (2) according to the procedure Am 5-04 (AOCS, 2009). The oil obtained from the extraction was transferred into a measuring cylinder which was placed over a water bath for 30 minutes at 70°C to ensure complete evaporation of the solvent. The oil volume was calculated using equation (2) [23].

$$Rd = \left[\left(\frac{P_1 - P_2}{M}\right) - T_w\right] \times 100 \qquad (2)$$

Where, P_1 is the weight of the empty flask (g), P_2 the weight of the flask with the oil extracted (g), M the mass of the test sample (g), T_w the water content of lipids, and Rd the *B. aegyptiaca* kernel oil yield.

2.3.2 PH

The pH was determined using the HANNA brand electronic pH meter instruments H18033. 100 ml of the oil sample was taken into a 200 ml beaker, after soaking and gently stirring the electrode in the sample, the pH value was read directly on the screen of the device.

2.3.3 Iodine value

The Hübl method of the standard was used to determine the iodine value of the kernel oil of *B. aegyptiaca*. 0.2g of the oil sample was placed in a 250 ml conical flask, then 10 ml of chloroform and 30 ml of iodine solution were added. The flask was closed and the solution was stirred in the dark for 40 minutes and 10 ml of 15% potassium iodine solution was added and shaken. 100 ml of distilled water was added and the mixture was titrated solution against 0.1 M sodium thiosulfate solution until a yellow color formed and 3 drops of starch solution was added after a blue solution has been formed. The titration continued until the blue color disappeared while the volume of $Na_2S_2O_3$ at the end point was recorded. The iodine value (noted I_i) was calculated using equation (3) [27].

$$\mathrm{I_i} = \frac{12.69 \times \mathrm{C} \times (\mathrm{V_1} - \mathrm{V_2})}{\mathrm{m}} \qquad (3)$$

Where, *C* is the Concentration of $Na_2S_2O_3$ used, V_1 the volume of $Na_2S_2O_3$ used for the blank, V_2 the volume of $Na_2S_2O_3$ used for sample and *m* the mass of the sample.

2.3.4 Acid value

The acid value was determined according to the NFT 60-204 standard. It gives an estimation of the number of free acids. In others words, it is the number of milligrams of potassium hydroxide needed to neutralize the free acidity in one gram of this body. In a dried 250 ml conical flask, were placed 2 g of the oil sample followed by 25 ml of absolute ethanol and 3 drops of phenolphthalein indicator. The mixture was heated in a shaking water bath for 5-6 minutes. When hot, it was titrated against 0.1 M KOH until pink color appeared. To ensure complete mixing, dynamic agitation was performed when the end point was approached. The volume of 0.1 M KOH consumed by an acid was recorded. The acid value (noted *AV*) was calculated using equation (4) [27].

$$AV = \frac{56.1 \times V \times M}{m} \quad (4)$$

Where, *V* is the volume of KOH used, *M* the molarity of KOH and *m* the mass of sample.

2.3.5 Saponification value

The saponification value is the mass of potassium hydroxide expressed in mg, necessary to neutralize the free fatty acids and saponify the combined fatty acids contained in 1 g of this substance. It was determined according to the AFNOR T60-206 standard. A 2g sample of the oil was weighed into a 250 ml glass conical flask, and 10 ml of mixture of ethanol ether was added to the same flask followed by 25 ml of 0.5 N ethanolic potassium hydroxide. The flask was fixed to a reflux condenser using a boiling water bath for 30 minutes. To the warm solution were added 3-4 drops of phenolphthalein indicator which was titrated against 0.5 M HCl to the end point. The same procedure was used for the other samples and the blank. The expression of the saponification value (noted *SV*) was calculated using equation (5) [27].

$$SV = \frac{56.1 \times M \times (B - R)}{m} \quad (5)$$

Where, *B* is the volume of the solution used for blank test, *R* the volume of the solution used for determination, *M* the Molarity of the HCl used and *m* the Mass of the sample.

2.3.6 Peroxide value

The peroxide value was determined according to the official ISO 3960: 2001 test method. The peroxide value expressed in mill equivalents of active oxygen per kg of fatty acids. A 2 g sample of the oil was put into a 250 ml Erlenmeyer flask, 1 ml of potassium iodide and 20 ml of glacial acetic acid/chloroform (3/2 by volume) were added and the mixture was boiled for a minute. The hot solution was transferred into a flask containing 20 ml of 5% potassium iodide. 3 drops of starch solution were added to the mixture and the latter was titrated with standardized 0.1 M sodium thiosulphate and the peroxide value (noted *PV*) was determined using equation (6) [27].

$$PV = \frac{V \times M \times 100}{W} \quad (6)$$

Where *V* is the volume of $Na_2S_2O_3$, *M* the molarity of $Na_2S_2O_3$ and *W* the weight of oil sample (g).

2.3.7 Refractive index

The refractive index (noted *IR*) at 25°C was determined according to the ISO 6320: 2000 using the Sopelem refractometer. This device measures the refractive index by measuring the critical angle of total reflection. A few drops of the sample oil were carried into the glass slide of the refractometer. Water at 25°C was circulated round the glass slide to maintain its temperature uniform. Through the refractometer room, the dark part viewed was adjusted to be aligned with the intersection of the cross. In the absence of parallax error, the pointer on the scale pointed to the refractive index. The refractometer was calibrated using distilled water where the refractive index of water at that temperature was obtained [27].

2.3.8 Specific density

The specific density of *B. aegyptiaca* kernel oil was determined at 25°C. The oil was made using prewashed, dried and labeled density bottles. The density bottled was filled to the volume mark of the oil sample and the weight of the density bottle with the oil was evaluated. The density bottled was also full of water until the volume mark was reached, and the weight of the density bottle with the water was determined. The

density and the specific density of the oil was calculated according to equation (7) and (8) respectively [23].

$$\boldsymbol{D = \frac{W_1 - W_0}{V_0}} \quad (7)$$

Where D is the specific density, W_1 the weight of empty density Bottle + oil, W_0 the weight of density Bottle and V_0 the volume of oil.

2.3.9 Dynamic and Kinematic viscosity

The dynamic viscosity is the measure of the flow time by the gravity of a volume of liquid. It was determined according to DIN 53015 standard using a falling ball viscometer of the HAAKE brand at 25°C and HAAKE Water Bath and stopwatch by means according to equation (8) [28]:

$$\mu_B = K_{ball}(\rho_{ball} - \rho_B) \times t \quad (8)$$

The kinematic viscosity is the quotient of dynamic viscosity by density. It was determined using equation (9) [29]:

$$\gamma_B = \frac{\mu_B}{\rho_B} \quad (9)$$

Where ρ_B is the density of *B.eagyptiaca* oil (g/cm^3), ρ_{ball} the density of the ball (g/cm^3), K_{ball} the constant of the ball and γ_B the kinematic viscosity (m^2.s^{-1}).

2.3.10 Free fatty acids composition of oil

The composition of fatty acids of *B. aegyptiaca* kernel oil sample was analyzed using a GC-2014 Gas Chromatography (GC) model, Shimadzu, Japan. It was equipped with an FID –Flame ionization detector and capillary column with a column length of 30 m. The GC oven was kept at 70ºC for 3 min, heated at 10 °C/min up to 280 ºC, where it was held for 5 min, and analysis time was 26 min. The analytical gas used was Helium at 1.45 ml/min, column flow rate, and 33.5ml/min, total flow rate. The fatty acid esters were hydrolyzed and methylated simultaneously with a mixture of 100 µL of toluene and 0.6 mL of boron trifluoride/methanol (BF3/MeOH) for 95 min at 70 ◦C using reactor bath. 500 µL of distilled water and 500 µL of hexane were added after cooling. After shaking and settling, the hexane layer containing fatty acid methylated esters was transferred into GC and 1 µl of the sample solution was injected for analysis. The identification of the fatty acids was obtained by retention times when compared with standards solution with was in the computer program. The relative percentages of each fatty acids was determined based on peak area measurements [29].

3. RESULTS AND DISCUSSION

In this section, the physicochemical properties of *B.aegyptiaca* was presented and analysed in accordance with the different existing standards.

3.1 Oil yield

Fig. 1 presents the B.aegyptiaca seed kernel oil yield from Pitoa, Moutourwa and Maroua and Table 1 shows the measured physicochemical properties of the *B. aegyptiaca* kernel oils for each analysed zone, determined using standard tests. It is observed that, these physicochemical properties vary according to their origin. The measured percentage of oil content ranged from 51.7 ± 0.03 to 56.6 ± 0.04 %. The samples of Pitoa (56.6%) show the highest oil yield as compared to those collected at Moutourwa (50.7%) and Maroua (52.5%). The obtained values are higher than those obtained by Ahmed and Alshareef [30] (42.98 %) and Yau and al [23] (38.5%). In addition, the obtained oil yields are also superior than cotton seed oil (18-28%), soya been oil (11-25%) and rubber oil (21-25%) [27]. Indeed, the highest obtained of the seed oil yields of *B. aegyptiaca* in northern Cameroon could be explained by environmental influence, geographical location, ecologic factors, and the soil conditions specific to each locality. The highest values of oil yields shows that, the *B.aegyptiaca* from North Cameroon can be considered as a good potential source of vegetable oil for industrial or domestic purposes.

3.2 Moisture Content

Moisture contents of *B.aegyptiaca* kernel oil in Table 1 are between 1.13 ± 0.03 % and 1.42 ± 0, 03 %. The sample from Pitoa (1.42% ± 0.01) shows the highest moisture content compared to those collected at Moutourwa (1.21% ± 0.03) and Maroua (1.13% ± 0.02). This result shows that the moisture content is lower than 1.5% and lower than those presented by Kabo and al [31] and Ahmed and al [32]. This result could be explained by the sahelian climate which is similar and typically hot and dry in the North Cameroon region [21]. The lower moisture content of the *B. eagyptiaca* kernel sampling from each locality is

an indication that the oil may be good to produce an important yield of biodiesel with less impurity.

3.3 Refractive Index

The *IR* is the ratio of the sine of the incidence angle to the sine of the refractive angle of light at a given wavelength. It is used to distinguish the family fat to which it belongs. The results of the refractive index of the sampling of *B.aegyptiaca* kernel oil in the three localities of North Cameroon indicated in Table 1 are 1.474, 1.471 and 1.476, for Pitoa, Moutourwa, and Maroua respectively. This result is included in the ASTM values $1.470 < IR < 1.478$ and is characteristic of the refractive index of unsaturated and polyunsaturated fatty acids rich in oleic and linoleic fatty acids [33]. The obtained values of *IR* are similar to those obtained by Mohamed and al [34] and are higher than those reported by Manji and al [35] and Yau and al [23]. This result indicated that these oils are semi-drying with a predominance of oleic and linoleic compounds, which must first undergo chemical synthesis to be used as biodiesel.

3.4 Kinematic Viscosity

The kinematic viscosities at 25°C of the *B.aegyptiaca* seed kernel oil reported in Table 1 are less compared to the EN ISO 3104 standard (38 mm^2/s). However, our measured values are close to those reported by Okia and al [36] and Alhassan and al [37]. This indicated that, the oil does not have good fluidity for direct use as a biofuel because of the presence of higher unsaturated and polyunsaturated fatty acids. Thus, it is flowability in the engines can be affected and can impact negatively the systems of the injection pump driver at low temperatures. However, viscosity can be significantly reduced by converting triglycerides into Fatty Acid Methyl Esters or biodiesel [38]. The *B.aegyptiaca* seed kernel oil of the three localities has densities located into EN ISO 3675 standard (0.91-0.93 kg/m^3). As the density is related to the viscosity, this indicate that oils are too dense to be used as fuel directly because of the presence of it is high-molecular ester compounds.

3.5 Iodine Value

The iodine value measures the degree of unsaturation of the molecular compound. The iodine values of *B.eagyptiaca* kernel oil of Maroua (120.7 ± 0.02 mg I_2/g), Moutourwa (119.7 ± 0.01 mg I_2/g) and Pitoa (116.7 ± 0.03 mg I_2/g) are between the values of the EN14111 standard ($100 < I_i < 130$ mg I_2/g). This result is closely similar (122.66 mg I_2/g) to that reported by Muhammad et al. [25] but higher than that reported by Manji et al. [31] and Okia et al. [36], who have obtained 76.8 and 98.28 mg I_2/g respectively. Thus, the *B. aegyptiaca* kernel oil can be considered as a non-drying oil. These oils have high iodine value which indicates that they contain higher level of unsaturated fatty acid that may be responsible for the stability of the oil.

3.6 Acid Value

The acid values of the *B.aegyptiaca* seed kernel oil of Maroua (1.8 ± 0.05), Moutourwa (1.4 ± 0.06) and Pitoa (1.6 ± 0.04) are all lesser than values recommended by EN 14104 standard (3 mg KOH/g), which reveals that, the oils are low in saturated fatty acid and have a characteristic of semi-dry oils. This result is in accordance with those obtained by Ahmed and Alshareef [30]. In addition, the result of the refractive index and the hydrogen potential (ranged between 6.54 ± 0.03 to 6.98 ± 0.06, thus close to 7) confirm that *B.eagyptiaca* kernel oils have low acid values, which is as characteristic of good purity and stability of oils at 25°C. Higher acid values may result from greatest amounts of fatty acids due to the method used in the seed treatment. The period of storage and drying of the seeds kernel can reduce the acid index. Acid index can be reduce due to geographic and climatic influence [27].

3.7 Saponification Value

The saponification values of the *B.eagyptiaca* kernel oil of Maroua (134.5 ± 0.06), Moutourwa (123.6 ± 0.04) and Pitoa (139.5 ± 0.07) are ranged in the ASTM standard (120 - 170 $mgKOH.g^{-1}$). Lower saponification values indicate a high proportion of unsaturated fatty acids. The obtained results was lower than those reported by Chapagain et al. [39], Khalil and Khalil [40] who obtained 172.7 $mgNaOH.g^{-1}$ and 192.543 $mgKOH.g^{-1}$, respectively. This result indicates that the oil could be used in the transesterification process.

3.8 Peroxide Value

The peroxide values of the *B.aegyptiaca* seed kernel oils of Pitoa (7.3 ± 0.07 meq/Kg), Moutourwa (6.9 ± 0.04 meq/Kg) and Maroua (7.8 ± 0.02 meq/Kg) are lower than 10 meq/Kg, which is the characteristic of the majority of conventional oils [41]. These obtained values are lower than those reported by Yau and al [23] and

Ahmed and al [42]. Thus, a low peroxide value increases the oil suitability for long storage due to the low level of oxidative and lipolytic activities. This is also confirmed by the low obtained acid values.

3.9 Fatty Acids Composition

Table 2 shows fatty acids composition of the *B. aegyptiaca* kernel oil from North Cameroon. The most predominant fatty acids components, in order, obtained for the sample of Maroua was linoleic acid (53.7%), oleic acid (26.2%), stearic acid (10.4%), palmitic acid (8.3%) and linolenic acid (0.4%). The sample of Moutourwa found also linoleic acid (51.4%), oleic acid (25.5 %), stearic acid (10.7%), palmitic acid (9.5%) and linolenic acid (0.3 %). Finally the sample of Pitoa with obtained linoleic acid (52.3%), oleic acid (24.4%), stearic acid (10.6%), palmitic acid (9.4%) and linolenic acid (0.5 %). Small quantities of α-linolenic acid were found in each sample of the oils. The four major fatty acids in *Balanites kernel* oil constituted are ranged into 98.4 – 100% of the total fatty acids. Chapagain and al [39], Ousman-Bashir and Elhussein [43] found that the same four major fatty acids constitute 98 – 100% of the total fatty acids for *B. aegyptiaca* plants grown in Israel and Sudan, respectively. Unsaturated fatty acids (Linoleic acid and Oleic acid) are the main abundant constituents of kernel oil in the sample of Maroua which represents overall 78.8% than those of Moutourwa and Pitoa which are 76.9% and 77.7% of total fatty acids, respectively. The saturated acids (palmitic and stearic) which are significant lower were between 19 and 21%. These results are in good agreement with the reports of Mohamed and al [44], Ahmed and Ahmed [42], Ogala and al [27], who described that unsaturated acids are higher with slight dominance of linoleic over oleic acid than saturated acid (palmitic and linolenic acids) in *Balanites* kernel oil. Consequently, the samples oils of North Cameroon are more favorable to transesterification reaction than saponification synthesis because they contain little saturated fatty acids. This result confirms that the kernel oils can be used as potential raw materials for the biodiesel production.

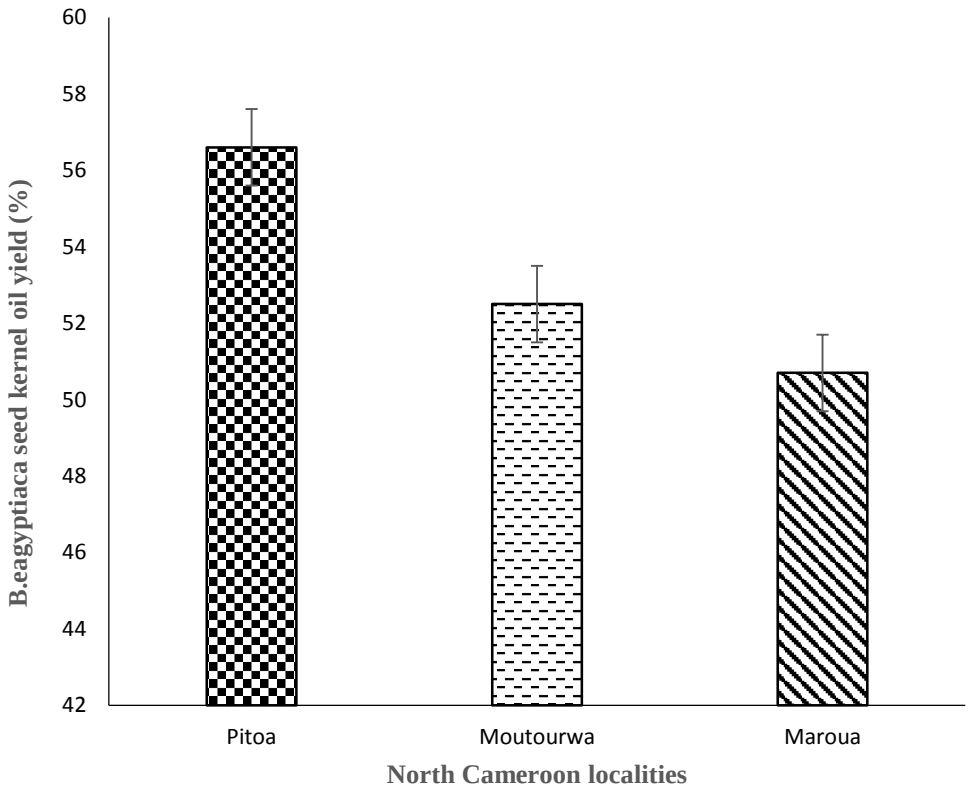

Fig. 1. *B. aegyptiaca* kernel oils yield from North Cameroon.

Table 1. Physicochemical characteristics of *B. aegyptiaca* oils of North Cameroon

Physicochemical Parameters	Seed kernel oils of each locality (mean ± SD*)			Standard Values	Standards
	Pitoa	Moutourwa	Maroua		
Moisture content (%)	1.42 ± 0,01	1.21 ± 0,03	1.13 ± 0,02	-	-
pH	6.89 ± 0,01	6.54 ± 0,03	6.98 ± 0,06	-	-
Refractive index at 40°C (St)	1.474 ± 0,06	1.471 ± 0,05	1.476 ± 0,07	1,470 < *IR* < 1,478	ASTM D6074
Dynamic viscosity at 25°C (mm^2/s)	34.1 ± 0,06	33.2 ± 0,06	35.3 ± 0,06		
Kinematic Viscosity at 25°C (mm^2/s)	37.2 ± 0,02	35.8 ± 0,01	34.9 ± 0,03	38-50	EN ISO 3104
Specific density at 25°C (g/cm^3)	0.917 ± 0,03	0.928 ± 0,05	0.922 ± 0,02	0,910-0,930	EN ISO 3675
acid value (mg KOH/g of oil)	1.6 ± 0,04	1.4 ± 0,06	1.8 ± 0,05	3.0	EN 14104
Iodine value (mgI_2/g of oil)	116.7 ± 0,03	119.7 ± 0,01	120.7 ± 0,02	100 < I_i < 130	EN 14111
Saponification value (mg KOH/g of oil	123.6 ±0,04	131.5 ± 0,07	139.5 ± 0,06	120-170	ASTM D5558-95
Peroxide value (meq/Kg)	7.3 ± 0.07	6.9 ± 0.04	7.8 ± 0.02	-	-

**Significant at p ≤ 0.05; otherwise not significant. SD is the standard deviation*

Table 2. Fatty acid of *B. eagyptiaca* kernel oil from North Cameroon

Localities	Palmitic (%)	Stearic (%)	Oleic (%)	Linoleic (%)	Linolenic (%)	TFA (%)
Maroua	8.3	10.4	26.2	53.7	0.4	99,6
Moutourwa	9.5	10.7	25.5	51.4	0.3	98,1
Pitoa	9.4	10.6	24.4	52.3	0.5	98,7

TFA: Total Fatty Acid

4. CONCLUSION

The aim of this paper was to investigate the physicochemical properties and fatty acid composition of *B.aegyptiaca* seed kernel oils from Pitoa, Moutourwa and Maroua, three localities from North Cameroon. The results showed that the locality of Pitoa has the highest oil yield (56.6 ± 0.04 %). All the kernel oil has good physicochemical properties and the most abundant fatty acids are linoleic acid, oleic acid, stearic acid and palmitic acid. Unsaturated acids (linoleic and oleic) are a major component of kernel oil fatty acids found in 98.2-100%. Therefore, *B.aegyptiaca* kernel oil from North Cameroon have good potential to be used economically as a raw material for biodiesel processing which will be done in other paper.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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