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Full Length Research Paper

Oil content and physicochemical characteristics of some wild oilseed plants from Kivu region Eastern Democratic Republic of Congo

Kazadi Minzangi[1]*, Archileo N. Kaaya[2], Frank Kansiime[3], John R.S. Tabuti[3] and Bashwira Samvura[4]

[1]Laboratory of Phytochemistry, Department of Biology, CRSN/Lwiro, Bukavu, Democratic Republic of Congo.
[2]Department of Food Science and Technology, Makerere University, P. O. Box 7062 Kampala, Uganda.
[3]Institute of Environment and Natural Resources (MUIENR), Makerere University, P. O. Box 7062 Kampala, Uganda.
[4]Department of Chemistry, Insititut Supérieur Pédagogique de Bukavu, Democratic Republic of Congo.

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Seeds were collected from *Carapa grandiflora, Carapa procera, Cardiospermum halicacabum, Maesopsis eminii, Millettia dura, Myrianthus arboreus, Myrianthus holstii, Pentaclethra macrophylla, Podocarpus usambarensis, Tephrosia vogelii* and *Treculia africana* from Kahuzi-Biega National Park and the surrounding areas in D.R. Congo. Oils were extracted using ethyl ether in Soxhlet extractor. Physicochemical characteristics were determined using the methods of the American Oil Chemists Society. The seed oil content obtained ranged from 17.2 to 64.4%; the highest was obtained from *P. usambarensis* and the lowest from *T. vogelii*. The oil specific gravity varied from 0.8050 to 0.9854; the oils melting point ranged from -12 to 32°C; the oil saponification values from 182.5 to 260.9 mg KOH/g; the oil acidity index from 1.74 to 5.31 mg KOH/g and the unsaponifiable matter from 0.54 to 2.25%. The plant seed oils content reported in this study are comparatively higher than some food crop plants such as soybean and olive. Five of these oils have oil melting range as that of edible oils. *C. grandiflora, C. halicacabum, M. eminii* and the two species of *Myrianthus* are in the range of common cooking oils by their specific gravity values. *P. usambarensis* seed oil with its relatively high unsaponifiable matter content can have efficacy as cosmetic.

Key words: Physicochemical characteristics, oil content, oilseed plants, Kahuzi-Biega National Park, edible oils.

INTRODUCTION

The source of oils and fats is diminishing, this means therefore, that there is the growing need for the search of new sources of oil as well as exploiting sources that are currently unexploited in order to supplement the existing ones (Ikhuoria et al., 2008). Especially in D.R. Congo, oil for nutritional use and derivate products like soaps, cosmetics and medicines have become more unaffordable for most people because, the sources of these products are very small and limited (ABC, 2003).

Lack of information on the characteristics and utilization of the many and varied indigenous oil seed plants, is more of a problem than the shortage of these oils (Ikhuoria et al., 2008). In previous studies conducted in and around Kahuzi-Biega National Park (KBNP) Eastern D.R. Congo, more than 40 oil producing plant species were identified (Kazadi, 1999, 2006). This study is therefore, aimed at revealing the potentials of unknown and less-known seed oils, from Congolese brush and forest, which could very well replace the popular vegetable oil. To characterize oils obtained, we have selected *Carapa grandiflora, Carapa procera, Cardiospermum halicacabum, Maesopsis eminii, Millettia dura, Myrianthus arboreus, Myrianthus holstii, Pentaclethra macrophylla, Podocarpus usambarensis, Tephrosia vogelii* and *Treculia africana*.

*Corresponding author. E-mail: minzangi@yahoo.fr. Tel: +243997765148, +256773046329.

C. grandiflora Sprague (Meliaceae) called in Eastern D.R. Congo: Ewechi, is a tree that grows up to 30 m (Burkill, 1995). In D.R. Congo, it is found in the forests of Kivu and Ituri (Adriaens, 1944). Its oil is used as a substitute for Vaseline by local people in Bwindi (Uganda) (Naluswa, 1993). *C. procera* DC. (Meliaceae) is a very important species prized for a number of non-timber forest products (Raquel, 2002). Its name in Eastern D.R. Congo: Ewechi, English name: Tallicoonah oil tree. In some countries, the seeds are used to produce oil used medicinally for various ailments (Burkill, 1995; Butler, 2006). *C. halicacabum* Linn (Sapindaceae), Mubogobogo (Mashi) in Eastern D.R. Congo. English name: Balloon wine is a woody perennial climbing plant. It is used in several tropical applications and has been found to have anti-arthritic effect (Babu and Krishnakumari, 2006). *M. eminii* Engler (Rhamnaceae) Omugaruka (Mashi) in Eastern D.R. Congo is a large African forest tree introduced to many parts of the tropics and grown as a fast growing timber tree (Binggeli and Hamilton, 1993).
M. dura Dunn (Fabaceae) called Nshunguri in Eastern D.R. Congo is a small tree up to 13 m tall (ICRAF, 2008). Its fruits are reported as elephant food in Kibale National Park, Uganda (Rode et al., 2006). *M. arboreus* P. Beauv. (Cecropiaceae) called Bwamba in Eastern D.R. Congo, is a tree that grows to about 20 m high (Aluka, 2008). *M. holstii* Engl. (Cecropiaceae), common name in Eastern D.R. Congo: Chamba is a medium sized tree that grows up to 10 m which fruits are reported as food of chimpanzees (Basabose, 2002; Rothman et al., 2006). *P. macrophylla* Benth (Mimosaceae), Lubala (Kirega) in East of D.R. Congo, Bean tree in English, is a tree which seed is relished as a food in West African countries (ICRAF, 2008). *P. usambarensis* Pilger (Podocarpaceae), Omufa (Mashi) in Eastern D.R. Congo, is a large evergreen tree, up to 60 m high (Katende et al., 1995). *T. vogelii* Hook. (Fabaceae) Mukulukulu in Eastern D.R. Congo is a source of rotenone, useful in killing undesirable fish (Blommaert, 1950 and Lambert et al., 1993). *T. africana* Decne (Moraceae), Bushingu in Eastern D.R. Congo, is a large evergreen tropical food tree species (Onyekwelu and Fayose, 2007). Its common name, in English: African Breadfruit and wild jackfruit (Katende et al., 1995).

MATERIALS AND METHODS

Plant materials

Oilseed plant samples collected and analyzed are those eleven species listed above. Plants were collected from KBNP and surrounding areas located in South–Kivu Province, Eastern D.R. Congo at coordinates of 2°30'S 28°45'E. Seed samples were taken to laboratory where they were sun dried before drying in the oven at 105°C. After this, shelling was made by hand and the seeds were crushed to produce fine seed flour from which oils were extracted. To crush the seeds, a coffee-mill (model Corona 01 Landers and CIA. SA) was used. The oil content and physical and chemical characteristics that is, specific gravity, melting point, saponification value, percentage of unsaponifiable and acidity were carried out following the American Oil Chemists Society (AOCS) Official methods (AOCS, 1993). The analyses were performed for all criteria with 3 replicates.

Extraction of oil from plant oilseeds and determination of seed oil content

Oil samples were extracted by petroleum ether of boiling range between 40 - 60°C using the Soxhlet's procedure (Barthet et al., 2002). Oil from fine oilseed flour was extracted by repeated washing (percolation) with petroleum ether. After 8 h, the flask was removed, the hot oil dissolved in petroleum ether solvent filtered on filter paper and the solvent evaporated under vacuum using rotary evaporator. The remaining solvent traces were removed by heating the flask containing oil in water bath. The oil obtained was thereafter stored up in hermetically closed bottles and kept in a refrigerator till further analysis. As for seed oil content determination, oil was extracted as described above and the percentage of oil in the initial sample calculated using following formula:

$$\%\ Oil\ = \left(\frac{P}{M} \right) x100$$

where P = mass of obtained oil in g and M = mass of seed flour used.

Physical and chemical characteristic of oils

Specific gravity

The specific gravity (SG) of the extracted oil was determined by the ratio of the mass of the specified volume in pycnometer to mass of an equal volume of water, both conditioned at the temperatures of 40°C in water bath. The formula used to calculate the SG was

$$SG_{\ t} = \left(\frac{c - a}{b - a} \right) xD_{\ o}$$

where a = empty pycnometer, mass, b = mass of pycnometer filled with distilled water, c = mass of pycnometer filled with oil and D_o = density of water at 40°C (0.9922 g/ml). Specific gravity decreases linearly with temperature according to following regression equation $SG_{t2} = -0.0006X + SG_{t1}$ (Wan Nik et al., 2007), where X is the variation of temperature in degrees. This linearity is more reliable around the interval of 10 degrees (Kabele, 1975). Using above equation, the experimental results obtained at 40°C are also converted at 30°C.

Melting point

The complete melting point (cmp) of the oils was determined using a fusiometer (Baur, 1995). The mpt is defined as the temperature at which a column of oil in an open capillary tube moves up the tube when it is subjected to controlled heating in a water bath (APOC, 2004). The cmp is recorded when the oil empty the capillary tube.

Saponification value

Accurately weighed 2 g of the oil sample were introduced in a flask with 30 ml of ethanolic KOH (0.5 M) and heated under a reversed

condenser for 30 min to ensure that the sample was fully dissolved. After this, the sample was cooled; 1 ml of phenolphthalein was added and titrated with 0.5 M HCl until a pink endpoint was reached. A blank was determined at the same time and condition. The saponification value was computed using the formula:

$$SV = \frac{C_1 - C_2}{M} X 28$$

where C_1 = number of ml of the hydrochloric acid 0.5 N used in blank, C_2 = number of ml of the hydrochloric acid 0.5 N used in essay with oil and M = mass in g of oil used.

Percentage of unsaponifiable matter

To determine the percentage of unsaponifiable matter (USM), the oil sample was saponified with alcoholic potassium hydroxide 0.5 M. The USM was extracted into diethyl ether in a separating funnel. After washing off the crude extract with water using separating funnel, the solvent was evaporated and the USM dried in oven at 105°C and weighed to calculate the percentage of USM using following formula:

$$\%Uns. = \frac{P}{M} x100$$

where P = mass of the extracted USM in g and M = mass of the oil sample saponified.

Acidity index (AI)

Five grams (5 g) of oil were dissolved into solvent mixture of 75 ml of ethanol 96% and 75 ml of diethyl-ether, 1 ml of phenolphthalein was added and the solution was thereafter, titrated with potassium hydroxide 0.5N until a pink endpoint was reached. The formula used to calculate acidity index was

$$AI = \frac{CXNX\,56.1}{M}$$

where C = number of ml of the potassium hydroxide used, N = Normality of potassium hydroxide used and M = mass of oil used.

Data analysis

The mean values and standard deviation (mean ± SD) were calculated. Analysis of variance (ANOVA) was performed for found characteristics of all species analyzed. The least significant differences of means (LSD) test at 5% probability level were also carried out. All analyses were done using the GenStat computer package programme, GenStat release 7.1 of 2003.

RESULTS

The obtained oil content in plant seeds and oils characteristics are shown in Table 1. Means of seed plant oil content and oil characteristics of the plants studied were statistically different ($p < 0.001$).

Plant seed oil content

The total oil content of the plant seeds ranged from 17.2 – 64.4% in the studied plant species. *P. usambarensis* had the highest oil content followed by *M. eminii* (56.67%) and *P. macrophylla* (55.79%) while *T. vogelii* had the lowest oil content.

Physical and chemical characteristic of oils

Specific gravity

The specific gravity (SG) in oil of analyzed plants species ranged from 0.8050 to 0.9854. *T. vogelii* had the highest specific gravity and *T. africana* the lowest. Five of plants analyzed had specific gravity less than 0.9000 and six other had specific gravity from 0.9059 and above.

Melting point

The melting point of the oils analyzed ranged from -12 to 32°C. The oil of most plants analyzed is liquid at room temperature. The oils of *Myrianthus* were liquids even below O°C. Contrary to this, *C. procera* and *C. halicacabum* had oils solid at room temperature and *P. macrophylla* and *C. grandiflora* oils were semi-solid at room temperature.

Saponification value

The saponification values of oils obtained from the different plant species were ranged from 182.5 to 260.9 mg KOH/g. *M. holstii, M. eminii and M. arboreus* oils had the highest values around 260 while *P. usambarensis* and *T. vogelii* had the lowest (182.5 and 184.3, respectively).

Percentage of unsaponifiable matter

The unsaponifiable matter percentage of oils ranged from 0.48 to 2.25%. *P. usambarensis* oil had the highest values while *M. eminii* had the lowest.

Acidity

The acidity index (AI) of oils ranged from 1.74 to 6.36 mg KOH/g. *T. africana* oil had the highest values around 260 while *M. holstii* had the lowest.

DICUSSION

Seed oil content of plant species

Determination of oil content in plants is important because it predicts the profitability of given plants as potential

Table 1. Plant oils contents and physicochemical characteristics of oil from oilseed plants of Kahuzi-Biega National Park and surrounding areas in D.R. Congo.

Plant name	% Oil	SG (40°C)	SG (30°C)	Mp (°C)	SV	AI	% Uns.
C. grandiflora	41.61 ± 0.62	0.9403 ± 0.0006	0.9371	21 – 25	194.1 ± 5.30	5.03 ± 0.45	1.33 ± 0.13
C. procera	47.91 ± 1.04	0.9311 ± 0.0003	0.9463	27 – 32	198.1 ± 1.85	3.81 ± 0.31	1.19 ± 0.08
C. halicacabum	38.89 ± 0.61	0.9239 ± 0.0003	0.9299	23 – 25	198.8 ± 3.70	4.02 ± 0.48	0.85 ± 0.04
M. eminii	56.67 ± 0.52	0.9059 ± 0.0008	0.9119	11 – 15	260.4 ± 1.40	2.79 ± 0.42	0.48 ± 0.02
M. dura	27.81 ± 0.22	0.9397 ± 0.0009	0.9457	3 – 7	222.1 ± 3.52	3.76 ± 0.42	1.58 ± 0.08
M. arboreus	52.38 ± 1.21	0.8793 ± 0.0007	0.8853	-5 – -2	260.9 ± 2.14	4.39 ± 0.40	0.54 ± 0.02
M. holstii	35.16 ± 0.90	0.8781 ± 0.0019	0.8841	-12 – -1	259.7 ± 1.85	1.74 ± 0.11	0.51 ± 0.03
P. macrophylla	55.79 ± 0.25	0.8615 ± 0.0006	0.8675	15 – 20	199.7 ± 2.14	5.31 ± 0.54	1.95 ± 0.05
P. usambarensis	64.40 ± 0.56	0.8324 ± 0.0009	0.8384	8 – 13	182.5 ± 4.50	2.43 ± 0.12	2.25±0.33
T. vogelii	17.23 ± 0.30	0.9854 ± 0.0013	0.9914	2 – 6	184.3 ± 1.76	3.72 ± 0.28	0.84 ± 0.05
T. africana	30.96 ± 0.04	0.8050 ± 0.0033	0.8110	1 – 5	200.9 ± 2.52	6.36 ± 0.43	1.08 ± 0.07
LSD (5%)	1.133	0.002242			5.154	1.009	0.1998
CV%	1.6	0.1			1.4	7.6	10.3

N (Replicate) = 3 for all species; LSD, least significant differences of means (5% level); CV%, coefficients of variation; **SG,** specific gravity; **Mp,** melting point; **AI,** acidity index; **% Uns.,** percentage of unsaponifiable matter; **SV,** saponification value

source of oil. High oil content in plant seed implies that processing it for oil would be economical (Ikhuoria et al., 2008). Thus, the oil yield found in the studied plants which ranged from 17.2 to 64.4% compares favourably well with the oil yield reported for some commercial plant oils such as cotton seed (36%), olive (17%), sunflower (44%), soybeans (18%) and corn 3.4% (Rossel, 1987).

M. dura oil content (27.81%) is close to that of related species *M. thonningii* (30.66%). No previous report on oil yield of *M. dura* seed. *C. grandiflora* oil content was (41.6%) which is higher than that (30%) reported by Adriaens (1944). For *C. procera*, there are divergent results reported in literature from 35 to 66% (Adriaens, 1944; Heckel, 1908; Kabele, 1975; Lewkowitsch, 1909; Oldham et al., 1993). As for the two species of *Carapa*, results of this study showed that *C. grandiflora* had less oil content than the *C. procera*. This is comparable to results reported by Adriaens (1944). It can be already used as criterion of distinction between these two species. Concerning the two species of *Myrianthus,* results showed *M. arboreus* to have oil content (52.38%) which was higher than that of *M. holstii* (35.16%).

Regarding *M. eminii*, seeds from India were reported to have oil content lower (Theagarajan et al., 1986) than the results obtained in this study. As far as the oil content of *P. macrophylla* is concerned, divergent results are reported in literature (Adriaens, 1944; Akindahunsia, 2004; Foma and Abdala, 1985; Ikhuoria et al., 2008; Kabele, 1975). The analyzed samples of *P. macrophylla* in this study contained more than the majority but were a bit close to those of Akindahunsia (2004) from Nigeria. The oil content found from *T. africana* is more than what was reported in previous studies (Dawodu, 2009; Foma and Abdala, 1985; Kabele, 1975). The percentage of *T. vogelii* from Western D.R. Congo was found to contain about 14% of oil in seed (Adriaens, 1944), which was slightly less than the findings of the current study (17.2%).

Physicochemical characteristic of oils

Specific gravity

Generally, oils are lighter than water. Some however, are heavier than water, especially those which contain larger amounts of oxygenated constituents of the aromatic series (StasoSphere, 2007). The remarkably high SG of *T. vogelii* oil (0.9854) may be explained from this fact because this plant is rich in rotenone (Lambert et al., 1993), a molecule that has many aromatic groups and oxygen atoms (Fang and Casida, 1999). Akindahunsia (2004) found from *P. macrophylla* Nigeria's sample the oil specific gravity (0.8600) exactly close to that reported in this study (0.8615 ± 0.0006). In the current study, result on specific gravity of *T. africana* (0.8050) is close to that found by Dawodu (2009) on samples from Nigeria (0.8363) but more lower than that (0.9078) found by Kabele (1975) on samples from Western D.R. Congo. For *C. procera*, a value of specific gravity obtained in this study was 0.9403, which is similar to that (0.9043) reported by Kabele (1975).

Most popular plant oils have specific gravity ranging from 0.9100 to 0.9400 and specific gravity of 0.92 is considered a pretty good number for any cooking oil (Elert, 2000). Some authors have stated that the specific gravity suitable for edible oils range from 0.8800 to 0.9400 (Toolbox, 2005) and for oils used for fuel from 0.8200 to 1.0800 at 15.6°C (CSG, 2008). Using the equation $SG_{t2} = – 0.0006x + SG_{t1}$ (Wan Nik et al., 2007), the above SGs intervals can be converted at 30°C and

they will change and become from 0.87136 to 0.93136 for edible oils and from 0.8114 to 1.0714 for biofuels. These SGs ranges compared to those of current study in Table 1 indicate that crude oils from *C. grandiflora, C. halicacabum, M. eminii* and the two species of *Myrianthus* are in the range of common cooking oils in regard of their SGs values (0.8714 to 0.9314). For fuel, oils that are denser contain more energy. Compared to fuel range of SGs properties, all oil plants analyzed, except that of *T. africana* have their SGs in the interval of SGs of fuels products (0.8114 to 1.0714).

Melting point

The high plant oil viscosities, compared to those of fuels, limits their direct use as bio-fuel. The viscosity of given plant oil decrease in proportion to its melting point. Thus, the low melting point suit best for bio-fuel use because it correspond to low oil viscosity (Krisnangkura et al., 2006). More common edible oils have cmp from -23 to about 2°C and butter and other fats from 28 to 48°C (Rossel, 1987). Thus, as indicated in Table 1, *T. vogelii, T. africana, M. dura, M. arboreus* and *M. holstii* have oils in melting range of edible oil. Oils of *C. procera* and *C. halicacabum* are solid at room temperature (21°C), thus, they are rather butter than oil. *C. grandiflora* and *P. macrophylla* oils being semi-solid at room temperature (21°C) can be easily fractioned (Grompone et al., 1994). Adriaens (1944) had reported melting range of 15 - 23°C from oil of *C. grandiflora* samples from Uganda. Lewkowitsch (1909) have found melting range of 15 - 46°C from oil of *C. procera* from Sierra Leone and Adriaens (1944) reported melting range around 37°C for samples from West D.R. Congo.

Saponification value

Many edible oils have saponification values between 193 and 200 (Pearson, 1981). Among the plant species studied, *C. grandiflora, C. procera, P. macrophylla*, *C. halicacabum* and *T. africana* oils have saponification values that are within this range. The oils having high saponification value (around 300) are useful for soap making (Alabi, 1993). No such oil was found in this study.

Chisholm and Hopkins (1958) found the *C. halicacabum* seed oil to have saponification value of 206. This is not far from the current study value (195-202). As regards *P. macrophylla*, Kabele (1975) reported 187, Akubugwo et al. (2008) 209.4 and Ikhuoria et al. (2008) from Nigeria also found 171.1. The result in current study (199.7) is more close to that of Akubugwo et al. (2008) from Nigeria. As for oil from *T. africana*, Dawodu (2009) had found in samples from Nigeria the saponification value of 112.5 and Akubugwo et al. (2008) 212.9. Kabele (1975) in samples from western parts of D.R. Congo has found 196.5-198. In the current study, the result (200.9) is near that of Kabele.

Percentage of unsaponifiable matter

The unsaponifiable matter of oil is a small portion of oil which is extracted by organic solvent after the oil is saponified by the alkali (Gunstone and Herslöf, 2000; Hartman et al., 1968). These minor substances of the oil contained in unsaponifiable matter have antioxidant and other health benefits in animals and in human subjects and useful in softening the skin (Goreja, 2004; Gunstone and Herslöf, 2000; Kochhar et al., 2001). Shea butter, avocado, sesame, soybean and olive oils have high unsaponifiable fractions and from this they are known in cosmetics as having efficacy on dry and damaged skins (Alvarez and Rodríguez, 2000; Dhellot et al., 2006; Mellerup et al., 2007). Tocopherols produced for sale are from soybean, sunflower, palm and other plant unsaponifiable matter, while the most of the world supply of corticosteroids and sex hormones is produced from soybean oil unsaponifiable matter (Clark, 1996; Gunstone and Herslöf, 2000).

Quantitatively, the value of unsaponifiable matter content of *M. eminii* is close to that of coconut oil. *M. holstii* and *M. arboreus* oils have unsaponifiable matter content comparable to that of groundnut oil and *T. vogelii* and *C. halicacabum* oils have unsaponifiable matter content comparable to those of cottonseed, palm and sunflower seed oils (Rossel, 1987). Unsaponifiable matter content of oils of *T. africana, C. procera, C. grandiflora* and *M. dura* fall in the range of unsaponifiable matter content of soybean oil, while those of *P. macrophylla* and *P. usambarensis* are near of the one of olive (Rossel, 1987).

As regards *C. procera* oil samples from Sierra Leone, Lewkowitsch (1909) reported unsaponifiable matter of 1.51%, that is, about the same as in current study (1.19%). Chisholm and Hopkins (1958) have found for the *C. halicacabum* seed oil the unsaponifiable matter of 0.4% which is about the half of what was found in current study (0.85). In oil of *P. macrophylla* samples from Nigeria, Odoemelam (2005) reported 3.6% of unsaponifiable matter, which is about two times the value found in current study (1.95). From all other 8 species, it seems to be no previous information.

Oil acidity

Oil that is low in acidity is suitable for consumption (Alabi, 1993). They must have acidity level less than 0.1 mg KOH/ g (FAO, 1993). Four of plant species (*T. vogelii, P. macrophylla, C. grandiflora* and *M. arboreus)* had oils with relatively high acidities close to that of crude palm oil while those of *M. holstii, P. usambarensis* and *M. eminii* oils are relatively low and close to that of crude soybean oil (Rossel, 1987). All these studied oils require refining to minimize their acidity before to envisage eventual food

use (Orthoefer and List, 2007).

Chisholm and Hopkins (1958) found the *C. halicacabum* seed oil to have AI of 11.7. This is higher than that found in the currently studied samples (4.02 ± 0.48). Regarding *P. macrophylla,* Akubugwo et al. (2008) and Ikhuoria et al. (2008) from Nigeria AI values of 2.81 ± 0.01 and 3.25 ± 0.20, respectively. The current studied result (5.31 ± 0.54) is much higher than all of these. As for oil from *T. africana* in samples from Nigeria, Dawodu (2009) has reported the oil AI of 1.96 while Akubugwo et al. (2008) reported very high AI value of 8.41. The result in current study (6.36 ± 0.43) is close to that of Akubugwo et al. (2008).

Conclusions

The seeds of all eleven plants analyzed had their oil content above that of olive seed; ten of them had oil content higher than that of soybean and six of them had it higher than that of palm walnut. With this comparison, it can be concluded that based on their oil content, these plants have the potential of being utilized as source of oil in D.R. Congo for economic purposes. Although the plant oils extracted and characterized had good structural values, it is not yet clear whether they can be consumed because of possible toxicity that has been associated with some oils such as canola or soybean oil. Refining could be one of the measures to improve utilization of these oils.

Therefore, according to oils physicochemical characteristics discussed here above, *T. vogelii, T. africana, M. dura, M. arboreus* and *M. holstii* have oils in melting range of edible oil. *C. grandiflora, C. halicacabum, M. eminii* and the two species of *Myrianthus* are in the range of common cooking oils by their specific gravity values. All these must be confirmed when analyzing fatty acids from all these oils. However, *T. vogelii* seeds contain poisonous substances and must be adequately refined before being used for food preparation. *C. procera* oil which was found to be more stable as deep frying oil and its melting point range is close to those of cocoa butter and coconut oil. The bitterness of oils from all *Carapa* species can limit its alimentary use if it can not be eliminated enough by refining. *P. usambarensis* seed oil with its relatively high unsaponifiable matter content can have efficacy on dry and damaged skins.

These plant oils may have good application as bio-fuels and the most promising are those of high density and relative low melting point as *T. vogelii, T. africana, M. arboreus, M. holstii, C. grandiflora, M. dura* and *C. procera.* In view of confirmation of the oil quality and to extend the range of use of the original plant oils analyzed, some further assessment may be undertaken. This may include analyzing the oil fatty acids, refining the oils and then, to determine and compare the characteristics and fatty acid composition of crude and refined oils.

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