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Preliminary Chemical Characterization of Amashindwi (*Anisophyllea boehmii* Engl.) Kernels and Kernel oil

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Abstract

Our planet is facing a galloping demography and the satisfaction of the needs is continually increasing. Scientists call for the continuation of botanical exploration with a particular focus on the potential of socio-economic development of the biodiversity. This study is the first to focus on chemical composition of amashindwi (*Anisophyllea boehmii*) kernels and particularly on analysis of fatty acid composition of its kernel's oil. The purpose of this study is to optimize the uses of this species as a non-timber forest product, contributing in improvement of the socio-economic livelihoods of communities. Kernels were harvested from Buyogoma ecoregion in Burundi. Biochemical composition of amashindwi kernels is as follows: ash, 2.52 %; oil, 24.04%; protein content, 12.02 %; total carbohydrate, 48.48% and moisture, 12.92%. Mineral composition (mg/kg of kernels): potassium, 3872.33; phosphorus, 2670.03; magnesium, 860.13; calcium, 438.02 and iron, 23.08. Fatty acid analysis shows a high level of palmitic acid (41.74%) followed by oleic acid (19.16%), palmitoleic acid (18.40%), linoleic acid (12.75%) and vaccinic acid (5.68%); thus this kernel oil could be classified among palmitic fats. Kernel oil had a high content of tocopherol (2280.24 mg/kg) with predominance of α-tocopherol (93.46%). Those results show that kernels of amashindwi constitute an interesting lipid resource that could be exploitable as edible oil for food uses and this study revealed the oppportunity of amashindwi kernels valorization as non-timber forest products and interest of preservation and domestication of this species.

Keywords : amashindwi, umushindwi, *Anisophyllea boehmii*, kernels, oil, fatty acids.

1. Introduction

The strong human population growth results in increasing demand for its nutrition and reduction of forest areas [1]. Research on alternative and diversification of food resources should focus more in areas where food security is a challenge for population survival [2, 3]. Nowadays the global and individual consumption continue to increase especially those of lipids [2]. Since the 1930s, a net increase of 26% compared to carbohydrates and proteins was recorded and consumption of vegetable oils currently enhances to the detriment of animal fats [2, 4]. Moreover, oil needs is not defined only on the quantitative level because no oil can be sufficiently complete to all expected qualities [5]. Thus, given the quantitative and qualitative needs, the search for new sources of oil outside of the conventional is unavoidable [2] and rather, represents an opportunity and a contribution to socio-economic development.

The family of Anisophylleaceae, the order of Cucurbitales is divided in four genera distributed in South America, Madagascar, Malaysia and Africa [6]. The *Anisophyllea* genus accounts 25-30 species among which, *Anisophyllea boehmii* Engl. [6]. This species is named differently depending on the geographical zone: Mfungo, Mufungo, Nfungo from Zambia, Mufungu (Bemba), Mufuñu (Lunda) or Mnemvi, Mnyemvi from some Tanzanian languages. It is known as Umushindwi or Umushindwe in Kirundi (Burundian language) or Lusindwi, Mshindwi and its fruits, amashindwi (or ishindwi in singular), mashindwi, mashindwe or

amashindwe from related languages neighboring countries of Burundi [7, 8]. *A. boehmii*, umushindwi is widespread and indigenous in the eastern and southern regions of Africa and has been reported from Burundi, Tanzania, Zambia, Malawi, Mozambique, Angola and Congo DR [7–9]. *A. boehmii*, Umushindwi has a food interest and its fruits, Amashindwi are marketable [7-9]. Amashindwi are among most favorite of wild fruit consumers and are well marketed in the geographical distribution area of the species [7, 9]. It is a evergreen or semi-deciduous species, broad and rounded branches and dense crown, located in *Brachystegia* woodland or wooded grassland on sandy or rocky soils [10]. In Burundi, it is distributed in savannahs and fallows on lateritic soils and rocky mountains between 1525 and 1830m altitude [7, 11]; occasionally, trees are left deliberately on farms. Nzigidahera [7] reports that Umushindwi flowering begins from September to December and fruiting December to January. Nevertheless, according to our observations flowering goes from July to November and fruits are mature from middle-November to December.

The edible fruit part is the mesocarp and the thin exocarp fully joined together. Furthermore, in Burundi, after fruit harvesting period, children and herders usually extract from nuts (endocarp) and consume kernels which taste like peanuts. This taste is reminiscent of a composition that would include a larger fraction of lipid, making it interesting for the oil extraction in a country (Burundi) where the population diet is still deficient in lipid [12]. Moreover, the quantitative oil deficit of 78% requires imports to meet local market needs [13] causing currency expenditures. Therefore, the diversification of oil sources is opportune to meet the needs of communities and alleviate the economic impact of imports while promoting local non-timber forest products.

We undertook the study of the biochemical composition of amashindwi kernels and the composition and quality indices of the kernel oil. No-previous study has investigated the chemical composition of the kernels or kernel oil of amashindwi. The socioeconomic importance has already been demonstrated for the fruits. The kernel being less preferred compared to the fruit, the purpose of this study is to optimize the use of this species as non-timber forest products, improving livelihoods and incomes of communities. Specifically, we set five objectives : to (i) evaluate the chemical composition of the kernels and (ii) the oil production potential, (iii) to determine the quality indices of the oil and to (iv) define the fatty acid and (v) tocopherols composition.

2. Materials and methods

2.1. Plant material

Amashindwi (Figure 2. a) were handpicked at complete maturity and in perfect sanitary conditions in middle-december 2014 corresponding to the global ripening period of fruits from Cankuzo district in the savannahs of Buyogoma ecoregion, in Burundi (Central-East Africa) (Figure 1. a, b) at latitude 3°13’S; longitude 30°34’E ; altitude : 1736m. The climate is typically tropical.

A simple random sampling was conducted on a homogeneous area of about 2 ha. A total of about 1800 fruits collected from 6 trees (300 fruits per tree) constituted the sample. Fruits were sun-dried in open air for two weeks during harvesting period. Further drying was performed for a week in an oven at 45 °C and dried fruits were stored at room temperature in airtight jars. Before oil extraction and chamical analyses, kernels (Figure 2.c) were taken off after craking by secateurs to remove endocarps (Figure 2.d) strongly lignified. Kernels were ground using a coffee grinder.

2.2. Analytical methods

All analysis were performed in triplicate. The values of the different parameters were expressed as the mean value ± standard deviation (SD).

2.2.1. Chemical analysis of powdered kernels

The moisture was determined by drying about 2 g of amashindwi kernel powder (Figure 2.e) in oven at 105 °C till weight stability (around 24 h). The moisture was expressed as percentage of the powder weight reduction.

To determine ash and minenral contents, about 2 g of kernel powder were placed in nacelles and put in the muffle furnace at 450 °C for 24 h for incineration. The results were expressed as percentage of dry weight.

The ash was digested with HNO_3 for 3 h and filtered. The obtained solution was used to analyse minerals (K, Ca, Mg and Fe) using the atomic absorption spectrometer (Perkin-ELMER model AAnalyst 400). The phosphorus content (P) was determined by the spectrophotometric molybdovanadate method using a spectrophotometer (Shimazu UV-1205) at 420 nm.

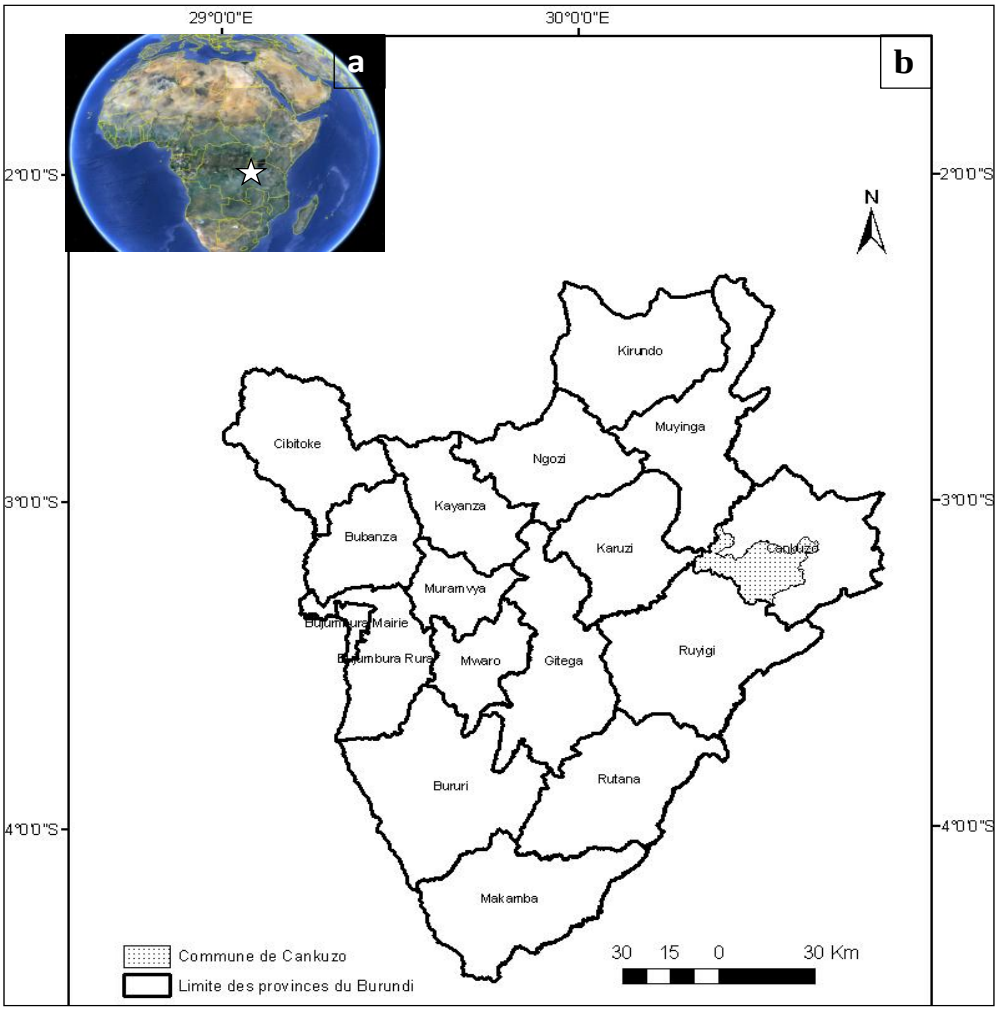

Figure 1: Geographic area of Amashindwi collection in eastern Burundi, Cankuzo district, Buyogoma ecological region (a). Burundi is located in central-estern Africa (b).

Total nitrogen was determined by the Kjeldahl method. About 1 g of the sample powder was mineralized using Tecator 1015 mineralizator. Filtered with Whatmann filter, the solution was distilled with K-350 Buchi apparatus as ammonia quantified by titration. Protein was calculated using the general factor (6.25) [5]. Data were expressed as percent of dry matter.

Carbohydrate content was estimated by the equation [5] : difference of mean values

Carbohydrate (%) = 100 - (moisture (%) + ash (%) + protein (%) + lipids (%)).

Oil was extracted from kernel powder (Figure 2.e) using soxhlet method for 6 h. The solvent (n-hexane) was removed using rotary evaporator at 70 °C and the residue weighed as oil extracted (Figure 2.g). The result was expressed as the lipid percentage of the kernel powder dry matter.

2.2.2. Quality indices of the kernel oil

Acidity value defines the percentage of free fatty acid present in the oil and was evaluated with respect to the major fatty acid (palmitic acid) using the modified official method of the European Commission described for olive oils [14]. A 500 mg oil was dissolved in a mixture of ethanol and petroleum ether (3:2, v/v) and neutralized by KOH, 0.01N.

Peroxide value was also evaluated. It assesses hydroperoxide present in oil. This Peroxide value was determined by the acetic acid and chloroform method corresponding to the standard AOCS Cd 8-53 [15]. About 1 g oil was dissolved in 30 ml of acetic acid and chloroform (3:2, v/v) mixture. 500 µl of saturated KI were added to the

solution and left to react for one minute before adding 30 ml of distilled water. The titration of the iodine excess was performed using $Na_2S_2O_3$ 0.01N. Peroxide value was expressed as meq peroxide per kg of oil.
The extinction coefficients K_{232} and K_{270} of amashindwi kernel oil were calculated respectively from the absorption at 232 and 270 nm according to the official method of the European Commission described for olive oils [14]. A 1 g of kernel oil was dissolved in cyclohexane up to 1%. The UV absorbance was measured in an UV spectrophotometer (RAYLEIGH, UV-1800). The variation of the specific extinction (ΔK) was calculated from the absorbance at 266, 270 and 274 nm.

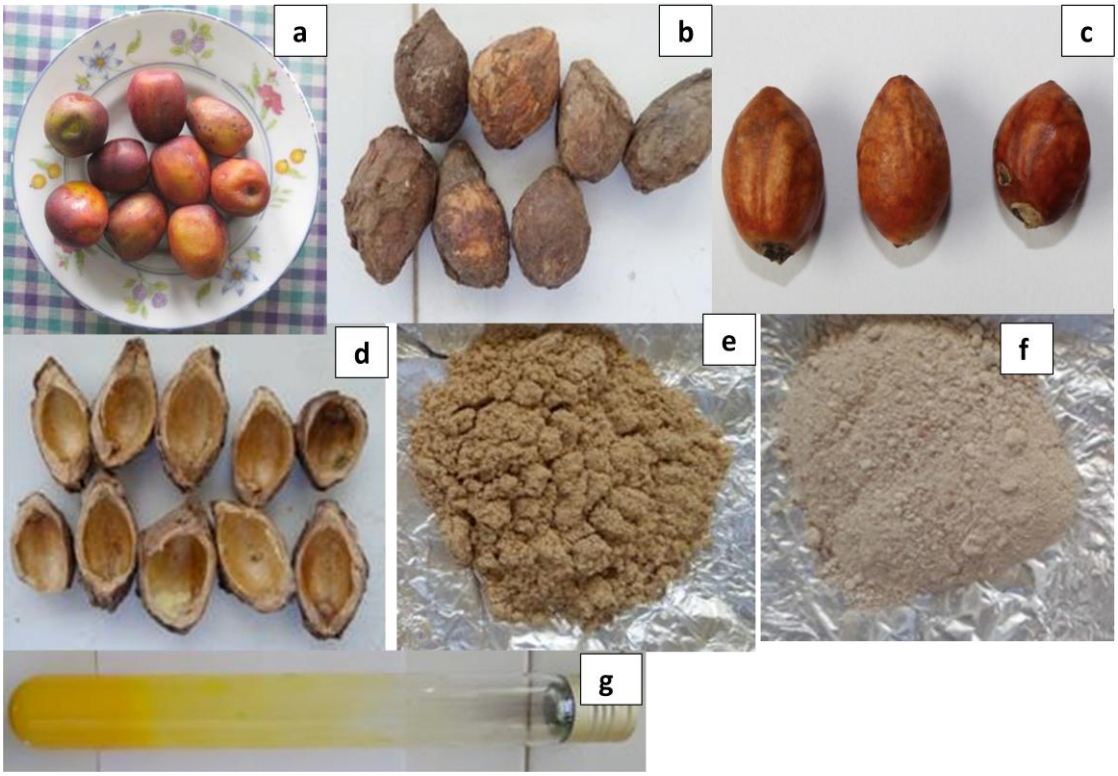

Figure 2: Fresh (a) and dry (b) *amashindwi* containing kernels (c) and endocarp heavily lignified (d). Kernel powder (e) and remaining kernels'cake (f) after extraction of oil (g)

2.2.3. Fatty acid composition analysis

Fatty acid composition analysis was performed according to the method described by Ben Moumen et al.[16]. Conversion of fatty acids to fatty acid methyl esters before analysis was performed by mixing a solution of 10 mg of oil in 0.2 ml of hexane with 0.5 ml of solution A (55 ml of methanol + 20 ml of pentane + 25 ml of BF3 at 14% weight in methanol). Tubes glasses containing the mixture were placed in a water bath at 75 °C for 90 minutes before adding 0.6 ml of saturated NaCl and 0.2 ml of H_2SO_4 10% (v/v). Fatty acids analysis were performed from fatty acid methyl esters using a HP 6890 series GC System chromatograph, equipped with a capillary column (Supelcowax: 30.0 m x 250 mm x 0.25 µm) and a FID detector. The carrier gas was nitrogen, at a flow of 1.7 ml/min. The temperatures of the injector and detector were fixed at 150 and 250 °C, respectively and the oven temperature was adjusted at 210 °C. The injection volume was 1 µl. The results were expressed as a percentage obtained by identification of fatty acids considering their retention time compared to those of standard range containing 37 fatty acids ester obtained from Sigma Aldrich (Germany).

2.2.4. Tocopherols analysis

To evaluate the content of amashindwi kernel oil tocopherols (α-Tocopherol, β-tocopherol, γ-tocopherol and δ-tocopherol), a known amount of oil was weighed and dissolved with hexane in a 1.0 ml vial according to the AOCS Method Ce 8-89 [17]. The solution was injected into HPLC system (Agilent Technologies series 1200 system), equipped with an automatic injector, on Uptisphere 120Å NH_2 column (150 mm × 3 mm x 3 µm), maintained at 30°C. The injection volume was 10 µl. The elution was performed at the flow rate of 1 ml/min

using a mobile phase made up by mixing hexane and 2-propanol (99:1, v/v). A fluorescence detector with excitation and emission wavelengths set at 298 and 325 nm was used by external standardization with mixed tocopherols obtained from Sigma Aldrich (Germany).

3. Results and discussion

3. 1. Chemical composition of amashindwi *kernels*

The chemical composition of amashindwi kernels is presented in Table 1. It can be seen that kernels are composed of ash : 2.52 %, oil : 24.04%, carbohydrate : 48.48%, proteins : 12.02% and moisture : 12.92%. The mineral composition shows that amashindwi kernel can be considered as a source of potassium (3872.33 mg/kg) and phosphorus (2670.03 mg/kg). The kernel is certainly a source of carbohydrates and lipids. Furthermore the content of 12.02% protein is not negligible. The potential of oil production by nearly quarter of the kernel weight (24.04%) makes this species potentially lucrative oil source on the economic level as well as conventional sources. Indeed, its potential of oil production is comparable or even higher than some conventional sources, such as some varieties of cottonseed [2] or safflower [16]. In the current context of increased demand for oils, all sources including those without commercial interest should be studied diligently for at least their importance at the community level [2]. Amashindwi kernel oil is a response to the seeking of new oil sources [2, 5] and justify the need of further investigations on its quality indices and composition.

Table 1: Chemical composition of amashindwi kernels

Composantes	**Valeur**
Moisture content (%)	12.92 ± 0.46
Ash (%)	2.52 ±0.02
Oil (%)	24.04 ± 0.25
Protein (%)	12.02 ±0.10
Carbohydrate (%)	48.48±0.42
Phosphorus mg/kg	2670.03 ±4.50
Potassium total (mg/kg)	3872.33 ±10.28
Calcium (mg/kg)	438.02 ±26.42
Magnesium (mg/kg)	860.13 ±6.34
Iron (mg/kg)	23.08 ±1.11

Values are expressed in dry matter. Carbohydrate value was obtained by difference.

3.2. Quality indices of amashindwi kernel oil

The quality indices of amashindwi kernel oil are presented in Table 2. At room temperature, this kernel oil is semi solid and yellow (Figure 2.g). For both characteristics, this oil is comparable with palm oil [4] and would contein a high level of carotenoid pigments and saturated fatty acids.

Table 2: Quality indices of amashindwi kernel oil

Parameters	
Oil's color	Yelow
Physical state at room temperature	Semi-solide
K-232	3.25 ± 0.08
K-270	1.11 ± 0.28
Δ K	0.05 ± 0.02
Peroxide value (meq O_2/kg)	2.29 ± 0.66
Acidity value (%)	5.96 ± 0.83

The UV absorbance (at 232 and 270 nm) has been performed. The absorption is due to the presence in the oil of conjugated diene and triene systems and allows to assess its quality, expressing the conservation conditions and

technological processes [14]. The UV absorbance values of the amashindwi kenrel oil were 3.25 and 1.11 respectively at 232 and 270nm. We believe that these values could be explained in one hand by the chemical method of extraction (around 80 °C) used in the present study and in the second hand, could refer to the nature of the oil. However, these values would serve as reference in later studies and should be taken into account in designing a standard of this "new" oil.

The peroxide value has been analysed. It assesses for an oil, the presence of peroxide, the oxidation products [4, 18]. This index estimated to be 2.29 meqO_2/kg for the amashindwi kernel oil is situated in the normal range recommended by Codex Alimentarius [19] to a maximum of 15 meqO_2/kg oil. This peroxide value is comparable to that of palm oil from various parts of the world [4, 18]. However, Akusu et al. [20] described higher values up to 6 meqO_2/kg. Kaijser et al. [21] suggested that the kernels protected by thick pericarp would form less peroxides. Furthermore, the same authors suggested that low polyunsaturated fatty acid composition could explain these low peroxide values. Mansouri et al. [22] found peroxide values more higher ranking from 8.26 to 10.51 in virgin olive oil. This is consistent for this oil whose kernels are protected by a fleshy pericarp and very lignified endocarp and less polyunsaturated fatty acid composition (13.09%) (Table 3). Fortunately, the low value of peroxides is a quality that positively informs on oil edibility [2].

The kernel oil quality is further evaluated by the acid value to assess the level of free fatty acids in oil. This is suggested to be the most important quality parameter to be evaluated in palm oil. It indicates the level of hydrolysis of triglycerides to release free fatty acids in particular under the action of lipases [18]. Isolated, these free fatty acids are easily oxidised to harmful products on the health [18]. The acid value of amashindwi kernel oil is 5.961% of free fatty acid based on the major fatty acid, palmitic acid. Compared to other oils, acid value is similar to that of palm oil [4, 18]. Poram (2013) in Almeida et al.[18] recommends that a good oil should not exceed 5% based on palmitic acid. However, higher values up to 19% have been found in palm oil consumed in America or Africa [18, 20]. According to Almeida et al. [18] and Mba et al. [4], the high acidity values are due to lack of care during harvest, transport and oil extraction and poor storage conditions of the oil. We believe, in our case that the relative content of free fatty acids could due to the chemical method of extraction at high temperature (around 80 °C). There is a need to develop a specific amashindwi kernel oil standard before its food use.

3. 3. Fatty acid composition

The fatty acid composition of amashindwi kernel oil is presented in Figure 3 and Table 3. The majority of the edible oils have an even number of carbons [2] and is the case in our oil except for the negligible amount of heptadecanoic acid (0.37%). The most important were palmitic (C16: 0), oleic (C18:1n9), palmitoleic (C16:1), linoleic (C18:2) and vaccenic (C18:1n11) acids, which together composed 97.73% of total fatty acids. Amashindwi kernel oil can be considered as a palmitic oil by the predominance (41.47%) of palmitic acid like palm oil (*Elaeis guineensis*) which the palmitic acid content corresponds to average of 44% (ranging from 39.3 to 47.5%) of the total fatty acid composition [2, 4, 18, 19]. However it differs completely from the palm kernel oil dominated by near 45.0-55.0% of lauric acid ; palmitic acid is ranged from 6.5 to 10.0% [2, 19]. Among the conventional sources, based on its composition in palmitic acid, amashindwi kernel oil is similar to the palm oil [2, 4, 18]. However, these two oils differ markedly by the noteworthy presence of palmitoleic acid (18.40%) in amashindwi kernel oil ; palm oil conteins rarely beyond 0.6% of palmitoleic acid [2, 4, 19]. Of the conventional oils, palmitoleic acid is rarely found in significant amount ; some olive and coconut oils could contein this fatty acid up to a maximum of 3% and sunflower seed oil up to 6.1% [2, 22]. Apart from fish which can be a good source of palmitoleic acid, plant species with a relative large amount of palmitoleic acid (>15%) include *Entandrophragma angolense* seed oil (10.8–16.5%), *Gevuina avellana* oil (22.7%), *Salvania cuculata* oil (14.6%), *Mangifera indica* oil (16–30%), *Isochrysis galbana* oil (23%), *Alosa pseudoharengus* oil (16%) [23]. Nevertheless, Pulp and peel of *Hippophae rhamnoides* and macadamia nut cultivars both native of New Zealand would be among the best known species to contain a high level of palmitoleic acid up to 47.8% and 33.75% respectively [21, 23]. Thus, amashindwi kernels become a good source of palmitoleic acid. Note that microorganisms are another potentially rich source [2]. Due to its benefits and its limited sources, researchers are seeking from microorganism strains and species, to perform best conditions for its high production [25]. In fact, palmitoleic acid has shown many medical potential and health benefits : cytoprotection and prevention of

β-cell apoptosis induced by glucose [26]. Moreover, Lee et al.[27] found that this fatty acid may be used as an « objectvie lipid biomarker » to be used as indicator of lipogenesis instead of isotope.
Furthermore, the fatty acid composition showed the presence of another particular acid, vaccenic acid with 5.68%. Naturally, some of plant species contain less than 5% [23]. A relative higher level of vaccenic acid (above 5%) were identified in *Hippophae rhamnoides* L and *Erythrophleum fordii* holding up to 7.3%, 10% and 14.3% respectively [22, 27]. Whatever the vaccenic acid content touches barely 6%, amashindwi kernel oil ranks among the major plant sources of this fatty acid.

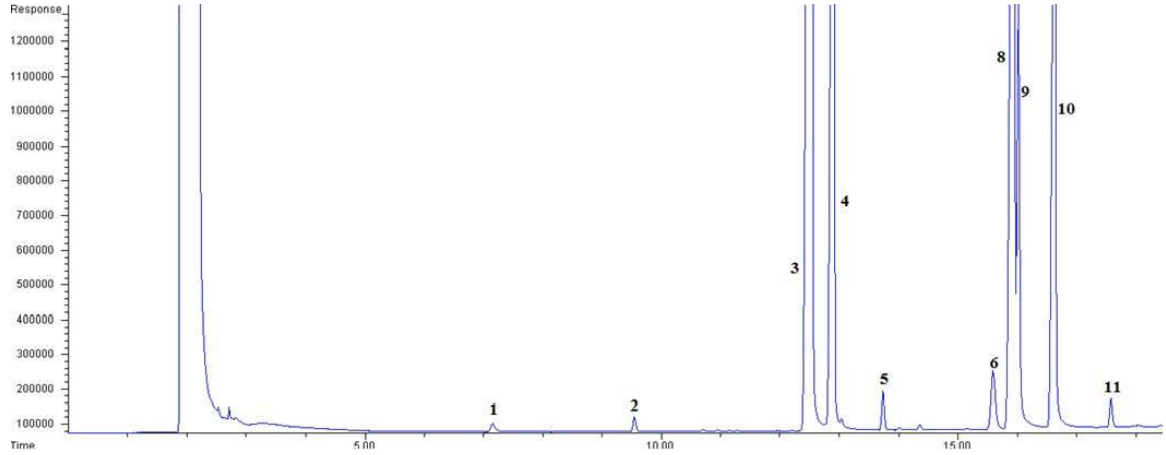

Figure 3: Chromatogram of fatty acid composition of amashindwi kernel oil. (**1**) lauric acid; (**2**) myristic acid; (**3**) palmitic acid; (**4**) palmitoleic acid; (**5**) heptadecanoic acid ; (**6**) stearic acid ; (**7**) Oleic acid; (**8**) Vaccenic acid; (**9**) linoleic acid; (**10**) α-linolenic acid.

Table 3: Fatty acid composition of amashindwi kernel oil

Fatty acids	Composition (%)
Lauric acid[1] (C12:0)	0.15 ± 0.02
Myristic acid[2] (C14:0)	0.17 ± 0.01
Palmitic acid[3] (C16:0)	41.74 ± 1.61
Heptadecanoic acid[5] (C17:0)	0.37 ± 0.02
Stearic acid[6] (C18:0)	1.24 ± 0.06
Palmitoleic acid[4] (C16:1n9)	18.40 ± 0.39
Oleic acid[7] (C18:1n9)	19.16 ± 0.67
Vaccenic acid[8] (C18:1n11)	5.68 ± 0.13
Linoleic acid[9] (C18:2n6)	12.75 ± 0.66
α-linolenic acid[10] (C18:3n3)	0.34 ± 0.01
TSFA	43.67 ± 2.54
TMUFA	43.23 ± 1.59
TPUFA	13.09 ± 0.95
TUSFA	56.32 ± 2.54
TMUFA/ TPUFA	3.30

The numbers from 1 to 10 superscript indicate the position of each fatty acid on the chromatogram, Figure 3. TSFA: total satureted fatty acids, TMUFA: total monosaturated fatty acid, TPUFA: total polyunsaturated fatty acid, TUSFA: total unsaturated fatty acid

Amashindwi kernel oil showed a saturation profile of 43.67% for saturated fatty acids, 43.23% of monounsaturated fatty acids and 13.09% of polyunsaturated fatty acids. This composition seems to be an ecological adaptation related to umushindwi's geographical distribution between the tropics. In fact, the plant lipidic biosynthesis favors the saturated fatty acids progressively with rising temperatures ; the oil unsaturation being an adaptive strategy against cold [29]. The low content of polyunsaturated fatty acids (13.09%) seems to find the same ecological explanation for their low oxidative resistance to high tropical temperatures.

The food quality analysis would make amashindwi kernel oil a recommended oil for consumption. The total saturated fatty acid of this oil (43.67%) and the low level of polyunsaturated fatty acids (13.09%) favor to the oxidtive stability to rancimat test [30], suggesting a strong resistance to oxidative rancidity and a potential long-term storage [21, 29, 30]. The ratio of monounsaturated versus polyunsaturated fatty acids estimated to 3.30 is an additional factor which shows the good quality of the oil against the oxidation making it good for food cooking use. Its high content in monounsaturated fatty acids (43.23%) is sought in the use of lipids for its qualities ranging from maintaining a better profile of blood lipids and modulation of its pressure, the improvement of the obesity risk and glucose regulation level [32]. In addition, the polyunsaturated fatty acid fraction is recognized to be crucial in human nutrition especially linoleic acid, known as preventing deficiency symptoms and cannot be synthesized by humans [33].

3.4. Tocopherol composition

Tocopherols together with tocotrienols form vitamin E, liposoluble compounds found in plants. Different forms of vitamin E are distinguished by their biological activities; α-tocopherol is the most common form of vitamin E and is recognized to have the highest biological activity [34]. Tocopherols play an important role in the antioxidant activity and the oil stability by an effective inhibition of lipid oxidation and presents a nutritional and health benefits [4, 5, 22]. Furthemore, they protect polyunsaturated fatty acids against peroxidation and increase the induction time. Kaijser et al. [21] showed that a cultivar of Macadamia nuts with the higher content of tocopherol had the greatest stability by Rancimat. The tocopherol composition of amashindwi kernel oil is presented in table 4 and Figure 4. The total tocopherol content was 2280.24 mg/kg, which is high compared to common oils such as palm, olive, sunflower, safflower and cotton oils [4, 19, 22, 30, 34]. However, it is comparable to that of corn oil, rapeseed oil, soybean oil and wheat germ oil which total tocopherol content can range up to 3000mg/kg [19, 22]. In addition, α-tocopherol, which the biological activity is the highest represents 93.46% of total tocopherols. It has been reported that α-tocopherol plays key role to block the oil oxidation especially the photo-oxidation [4]. The tocopherol content of amashindwi kernel oil promotes its quality and future uses. By its exceptional content in tocopherols, amashindwi kernel oil could be used in blends to improve the quality of certain low oxidative stability oils [36]. It could also be used as a food additive rich in vitamin E in food industry.

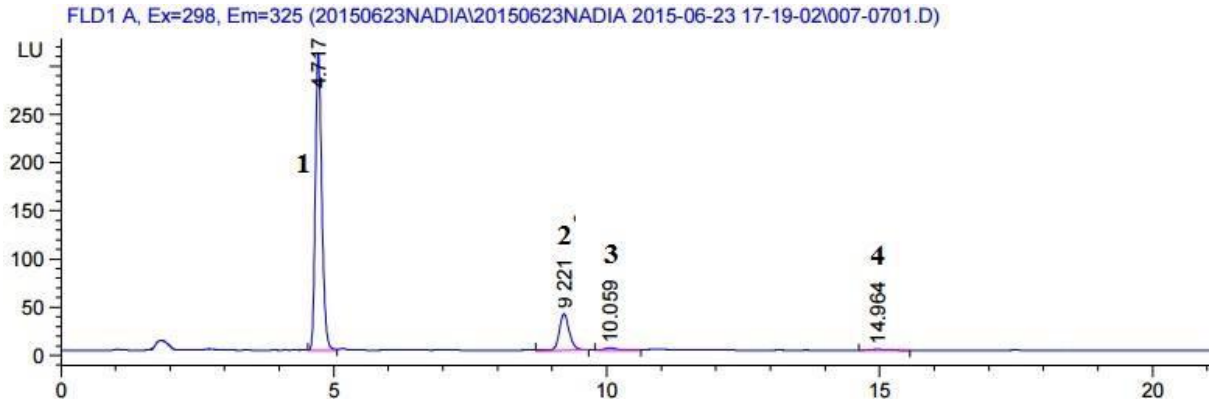

Figure 4: Chromatogram of tocopherol composition of amashindwi kernel oil. (**1**) α-tocopherol; (**2**) β-tocopherol; (**3**) γ-tocopherol; (**4**) δ-tocopherol.

Table 4: Tocopherol composition of amashindwi kernel oil (mg/Kg oil)

Tocopherols	Value (mg/kg oil)	Percent
α-Tocopherol[1]	2131.22 ± 16.81	93.46 ± 0.10
β-Tocopherol[2]	139.00 ± 2.19	6.09 ± 0.11
γ-Tocopherol[3]	6.38 ± 0.29	0.28 ± 0.01
δ-Tocopherol[4]	3.64 ± 0.30	0.16 ± 0.01
Total tocopherol	2280.25 ± 16.44	100

The numbers from 1 to 4 superscript indicate the position of each tocopherol on the chromatogram.

Conclusion

Characterization of unconventional vegetable oils has a double issue commercial and food supply purposes. Although it is true that the tropical flora has not been yet fully explored, this is more true for the African side. Furthermore, the reduction of forest areas affects many undescribed species or just known on taxonomic level. Efforts should be concentrated also in terms of their potential to feed the humanity or other functions related to their contribution to the socio-economic development of communities.

This study has shown that amashindwi kernel is a rich-oil source. Its production was estimated to over 24%. The fatty acid profile showed a codominant importance of saturated and monounsaturated fatty acids. Moreover, it is a tocopherol rich-oil, particularly in α-tocopherol. It could be usefull in the quality improvement of certain oils with low oxidative stability or as a food additive rich in vitamin E in food industry. Its composition makes it less oxidable with a better long-terme conservation and interesting in cooking.

Furthermore, it constitutes a good source of rare fatty acids found in vegetable oils (palmitoleic acid and vaccenic acid) with a significant proportion of essential polyunsaturated fatty acids. Its fatty acid and tocopherol composition as well as its quality indices confer to amashindwi kernel oil qualities for food use.

The socio-economic importance of amashindwi has been documented in eastern and southern Africa. This study, has shown the potential and the quality of this "new oil", and has demonstrated the interest of the conservation of this species from preservation status to domestication plan.

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