



Phytochemical Profile and Antioxidant Activities of Aqueous Extract of *Moringa oleifera* (Lam) Collected from DR Congo and Kenya

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ABSTRACT

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Moringa oleifera Lam. is one of the most used plants in traditional medicine because of its high antioxidant properties. The antioxidant value, nonetheless, depends on locality where the plant is grown as well as specific parts on the plant. In this study, a phytochemical and antioxidant activity comparison of *M. oleifera* leaves, seeds and barks were carried out. Fresh leaves, seeds and barks were collected from 2 to 3 years old *M. oleifera* trees of Bukavu city of South Kivu province in DRC and Masii village of Machakos County in Kenya. A total of 300g of each dried sample powder was mixed with 700 mL of distilled water. Qualitative and quantitative assessment of alkaloids, saponins, phenols, flavonoids, glycosides, terpenoids and tannins were performed following standard methods while the antioxidant activity was assessed using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) assay. Results indicate that only alkaloids were absent in leaves from Kenya and DRC while phenols, flavonoids and tannins were absent in barks. Glycoside in seeds from DRC had the highest concentration (6.17%) followed by alkaloids in seeds from Kenya (5.56%). There was low concentration of terpenoids and flavonoids in all samples compared to other compounds. The highest extract yield was found in leaves from DR Congo (22.5%) and seeds from Kenya (20%). At the highest concentration (10 µg/mL), leaves from Kenya (88.29±1.12 µg/mL) and DRC (80.17±3.59 µg/mL) had the highest percentage inhibition of reactive oxygen-free radicals but lower than the reference standard (92.63±2.76 µg/mL). Leaves from Kenya (23.59 µg/mL) and DRC (28.67 µg/mL) had the highest IC₅₀ compared to mean values of seeds and barks from the two countries. *M. oleifera* leaves, especially from Kenya, are recommended as a satisfactory antioxidant but can be substituted with seeds and/or barks in order to alleviate the use of leaves which are overused these days.

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Introduction

Oxidative stress is defined as a physiological disturbance when the production of potentially destructive reactive oxygen species (ROS) exceeds the body's own natural antioxidant defense (Tremellen, 2008; Nimse and Pal, 2015; Mohammed et al., 2020). It has been associated with several chronic diseases such as diabetes, hypertension, inflammation, cancer, reproductive impairment in both humans and livestock (Nimse and Pal, 2015; Sevindik et al., 2018; Mutwedu et al., 2021) through DNA damage, lipid peroxidation, tissue injury and protein degradation (Unuigbo et al., 2014; Pehlivan et al., 2018). Research findings have shown that humans affected with

such ailments often revert to use of synthetic antioxidants, which have been proven to quench or trap ROS (Nimse and Pal, 2015; Sevindik, 2019). However, due to healthy lifestyles and poverty especially in rural areas, the use of these synthetic antioxidants has increasingly declined in favor of dietary sources of antioxidants (Ibrahim et al., 2013; Bal et al., 2020).

In recent years, extensive research on medicines derived from plants have been focused on treatment of a wide variety of clinical diseases. On the one hand, plants are widely preferred due to their availability and low toxicity, while on the other hand, they are considered as pure and ecologically

friendly for treatment of various ailments (Molla et al., 2012; Vijayakumar et al., 2012; Ikpeeme et al., 2012). Several studies reported the beneficial effects of medicinal plants on many diseases including gastrointestinal and respiratory disorders (Ojewole and Amabeoku, 2006), hepatotoxicity (Ekor et al., 2006), fertility impairment and improvement (Ngoumtso et al., 2017).

M. oleifera, a tree growing up to 5 to 12 m high with an open umbrella-shaped crown, is the most widely cultivated species of the *Moringaceae* family (Mahmood et al., 2010). It is widely distributed all over the world including India, Himalayan tracts, Pakistan, and Africa and can be found even in the hardest and driest soils (Luqman et al., 2012). Due to its several traditional medicinal properties, industrial and nutritional uses, this plant is considered as one of the most beneficial trees in the world (Anwar et al., 2007; Wadhwa, 2013). In fact, all parts of *M. oleifera* including leaves, gum, root, bark, flowers, fruit (pods), seed and seed oil are highly nutritious and contain important minerals, proteins, vitamins, antioxidants, β -carotene, amino acids and various phenolic compounds (Anwar et al., 2007).

The leaves of *M. oleifera* are edible by both humans and animals (Makkar et al., 2007) and exhibit anti-tumor, anti-inflammatory, anti-ulcer, anti-atherosclerotic and anticonvulsant activities (Chumark et al., 2008). Seeds possess several interesting biological activities including antioxidant, antimicrobial, anticancer, anti-inflammatory, antiasthmatic activities as well as hepatoprotective and hypotensive effects (Hamza, 2010). Roots are used as stimulant and diuretic while the bark act as analgesic, anti-inflammatory and antiviral (Siddhuraju and Becker, 2003). All these activities are due to *M. oleifera* bioactive compounds which has been reported to possess 46 antioxidant compounds including flavonoids, phenolic compounds, carotenoids, and ascorbic acid (Anwar et al., 2007; Adedapo et al., 2009; El-Alfy et al., 2011).

It is worthwhile stating, however, that intrinsic factors such as age and cultivar of the plant and extrinsic factors including extraction solvent, postharvest treatment, harvesting season, sunlight, soils, region of cultivation affect the phytochemical composition and antioxidant activity of plant materials (Tlili et al., 2014). Gelain et al. (2012) indicated that bioactive concentrations in plants are strongly dependent on the prevalence of growing conditions and its impact on the accumulation of related natural products. Plants belonging to the same species but occurring in different geographical zones may significantly differ in qualitative and quantitative content of their particular bioactive compounds (Szakiel et al., 2011). Therefore, different preparations from plants harvested from distinct locations in the world may produce different results (Tlili et al., 2014). Whether these concentrations increase or decrease in response to differences in growth environmental conditions, is still not clear.

M. oleifera phytochemical screening and antioxidant activity have been previously reported but scientific evidences on the comparison in their phytochemical composition as well as antioxidant activity at different geographical locations remains obscure. It was hypothesized that the phytochemical composition and antioxidant activity of *M. oleifera* does not vary with

geographical zones. On this basis, the present study was designed to study the effect of different harvest sites with regard to the phytochemical composition and antioxidant activity of *M. oleifera* leaves, seeds and barks aqueous extracts from Bukavu city in DRC and Machakos County in Kenya.

Material and Methods

Geographical Locations

Fresh Moringa leaves, barks and dry seeds were collected from Bukavu city, East of DR Congo and Masii village of Machakos County in Kenya in July 2019. All laboratory works were done in the laboratory of phytochemistry, Centre for Traditional Medicine and Drug Research of the Kenya Medical Research Institute (KEMRI) in Kenya.

The city of Bukavu, capital of the Province of South Kivu, is located in the East of the DR Congo between 2°30'55" South latitude and 28°50'42" East longitude precisely in the basin called Eastern Valley Grabben (region of the great lakes). With an altitude of between 1.500 m and 2.194 m above sea level Bukavu has a climate similar to that of sub-equatorial or humid tropics (of short duration). Two seasons are available: the rainy season (lasting more or less 8 months from September to mid-May) and the dry season (commences from July to mid-September). The average temperature is around 20°C throughout the temperate coast and due to the presence of Lake Kivu the rainfall varies between 1.000 mm and 2.500 mm with an annual average of 1.320 mm. The soil of Bukavu is much more compact, less impermeable and less porous since at the slightest drought, water runoff is experienced.

Machakos County, on the other hand, is found in Kenya and located between latitude -1°31'0.01" S and longitude 37°16'0.01" E and has very unique physical and topographical landscapes. Machakos is found between 790 to 1594 m above sea level while small plateau reaching 1800-2100 m above sea level accompanied by Hills constitute the Central part of the County. Machakos soils are dark red clay, shallow and well drained particularly in the plains. The vegetation of the whole County of Machakos is depending on the particular altitude of each area/location. The average rainfall ranges between 500 mm and 1300 mm. October and December are usually the expected months of the short rains whereas the long rains are predictable in March to May. Through the year, the temperature is ranged between 18°C and 29°C with July as the coldest month while October and March are the warmest months of the year. The maps showing the location of Bukavu city (DR Congo) and Machakos County (Kenya) are represented in Figure 1.

Plant Collection and Preparation

The plant materials of *M. oleifera* (*Lam*) aged 2 to 3 years were collected and taxonomically identified at the Department of Biology, University of Nairobi, Kenya. The leaves, seeds and barks were air dried at 24 to 31°C for 14 days. An electric mill was used to ground the plant materials after spreading and the fine powder was collected and stored in airtight glassware until use.

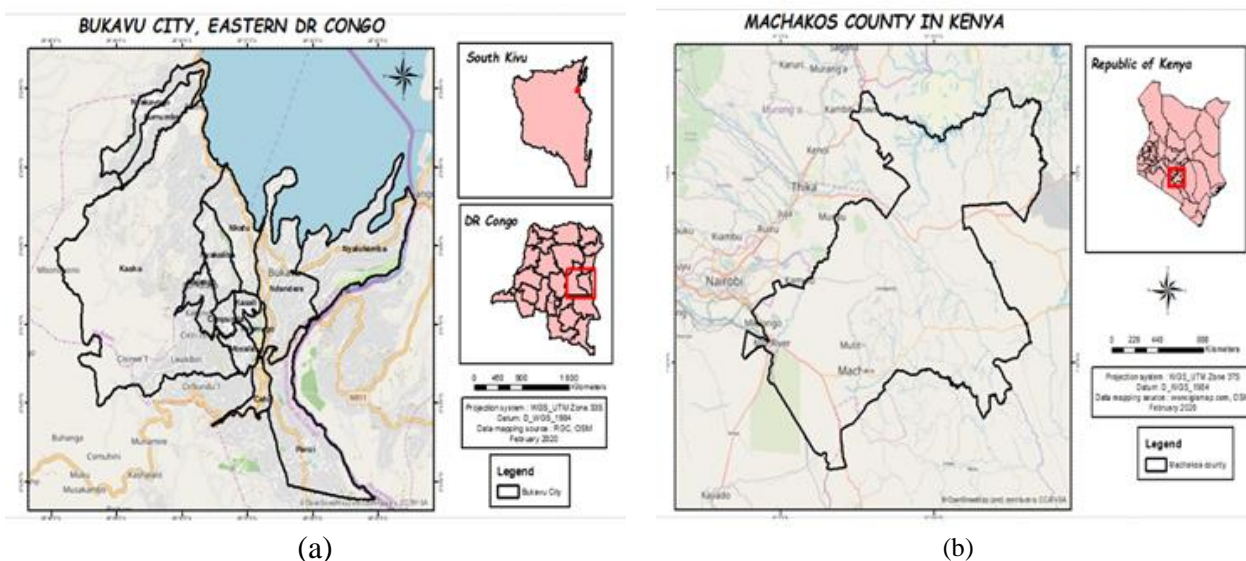


Figure 1. Map of Bukavu city in DR Congo (a) and Machakos county in Kenya (b)

Extraction of Crude Powdered Sample

The *M. oleifera* powder (300 g) was dried, then, using a bottle wrapped in aluminum foil, a total of 70ml of distilled water was added to it. With gentle stirring, the distilled water was gradually added to the powder until a slurry of uniform texture was formed. Thus, with a magnetic bar and a stirrer operating at 200 RPM for 48 hours, the phytochemicals present in the powder were extracted. The resulting slurry was centrifuged at 3000 RPM for 5 minutes and the supernatant was then collected in light-resistant bottles and freeze-dried.

Qualitative Analysis of the Phytochemicals of *Moringa oleifera* Aqueous Extracts Samples

To identify the presence of bioactive compounds such as phenols, saponins, alkaloids, flavonoids, tannins, terpenoids and glycosides, simple chemical tests were performed according to standard methods developed by Harborne (1988) and Evans and Trease (2009). Alkaloids were performed according to Dragendorff test while the presence of saponin was identified using foam test and ferric chloride test was used for detection of phenolic compounds. The presence of flavonoids was observed using alkaline reagent test and the Keller-Killiani test was used to identify glycosides while the test of Salkowski was used to assess the presence of terpenoids and the ferric chloride test for tannins. The resultant color development was reported as presence (+) or nil (-) following the color intensity developed from the reactions.

Quantitative Analysis of the Phytochemical's Constituents of *Moringa oleifera* Aqueous Extracts Samples

The determination of the quantity of alkaloids present in the samples was performed following the method of Harborne (1973) while the method proposed by Ejikeme et al. (2014) was used to determine the percentage of saponins and flavonoids. The percentage of total phenols in the

samples was evaluated using Edeoga et al. (2005) method while Amadi et al. (2004) procedure was used to evaluate the glucoside content. The method described previously by Ferguson (1956) was used to determine the terpenoid content and tannin content was determined following the procedure described by Van-Burden and Robinson (1981).

Antioxidant Activity

The 2,2-diphenyl-1-picrylhydrazyl (DPPH) assay was used to assess the antioxidant activity in *M. oleifera* samples (Siddhuraju and Becker, 2003; Williams et al., 2004). The DPPH free radical scavenging activities of the crude extracts from the different parts of *M. oleifera* were evaluated as previously described by Zhu et al. (2011) and Bal et al. (2019). The quantity of the extract that react with 50% of DPPH radicals represented the 50% inhibitory concentration (IC₅₀).

Statistical Analysis

The obtained results were submitted to one-way ANOVA and significant difference between means were observed when P- value < 0.05. results were expressed as mean ± SD of three replicates. The XL STAT for Windows 10 software was used for statistical analyses.

Results

Preliminary Phytochemical Screening of *Moringa oleifera* Leaves, Seed and Bark Extracts

The phytochemical characteristics of leaves, seeds and barks of *M. oleifera* from Bukavu city and Machakos County are summarized in Table 1. The results revealed the presence of glycosides in all the plant parts with absence of terpenoids in seeds from DRC and phenols and flavonoids in barks from Kenya and DR Congo. Alkaloids were absent in leaf samples while saponins absent in seeds collected from Kenya and DR Congo while tannins were absent in barks and seeds of samples collected from Kenya.

Aqueous Extract Yield (Percentage Weight by Weight) from Leaves, Seeds and Barks of *Moringa oleifera*

Water was used as solvent for its efficiency in extracting antioxidant compounds from 100 grams of *M. oleifera* leaves, seeds and barks. The use of aqueous solvent produced more extract when using leaves of *M. oleifera* from DR Congo while seeds and barks had the same yield. Samples collected in Kenya had the highest yield in seeds followed by leaves and barks (Figure 2).

Quantitative Phytochemical Analysis of Leaves, Seeds and Barks of *Moringa oleifera* from DRC and Kenya

Results of Table 2 indicate that glycoside in seeds from DRC had the highest concentration (6.17%) followed by alkaloids in seeds from Kenya (5.56%) and saponin in barks from Kenya (5.33%). Where available, terpenoids and flavonoids had low concentration in all samples compared to other compounds.

Antioxidant Activity by DPPH Free Radical Scavenging Assay

Antioxidant activity result with free radical inhibition method DPPH (2,2-diphenyl-1-picrylhydrazyl) from *M. oleifera* aqueous extract in leaves, seeds and barks

collected from DRC and Kenya is indicated in table 3. The result of DPPH free radical scavenging activity showed that *M. oleifera* leaf and seed extracts have appreciable and concentration-dependent increase in scavenging effect with the fraction of the leaves being the most active compared to the seeds and barks. At the highest concentration (10 µg/mL), the mean percentage antioxidant inhibition for aqueous extract of leaves, seeds and barks from Kenya and DRC were 88.29±1.12, 80.17±3.59, 30.08±0.80, 33.21±2.62, 37.34±10.26 and 41.86±2.01, respectively whereas the reference standard (ascorbic acid) had a mean percentage inhibition of 92.63±2.76 at 10 µg/mL (Table 3).

IC₅₀ Value in Selected Aqueous Extracts

The IC₅₀ value refers the concentration that will scavenge 50% of the initial DPPH radicals. Evaluation of the IC₅₀ as shown in Table 4 indicated that the leaves from Kenya and DRC exhibit the highest antioxidant activities (23.59 µg/mL and 28.67 µg/mL respectively) compared to IC₅₀ values of seeds and barks from the two geographical zones and much lower compared to that of the ascorbic acid (3.16 µg/mL), which was considered as the reference standard.

Table 1. Phytochemical composition of aqueous extracts of *Moringa oleifera* leaf, seed and bark collected from Bukavu city and Machakos County.

Chemical groups	Leaves		Seeds		Barks	
	Kenya	DRC	Kenya	DRC	Kenya	DRC
Alkaloids	-	-	+	+	-	+
Saponins	+	+	-	-	+	+
Phenols	+	+	+	+	-	-
Flavonoids	+	+	+	+	-	-
Glycosides	+	+	+	+	+	+
Terpenoids	+	+	+	-	+	+
Tannins	+	+	-	+	-	-

Table 2. Percentage of crude phytochemicals in aqueous extract of *Moringa oleifera* leaf, seed and bark collected from Bukavu city and Machakos County.

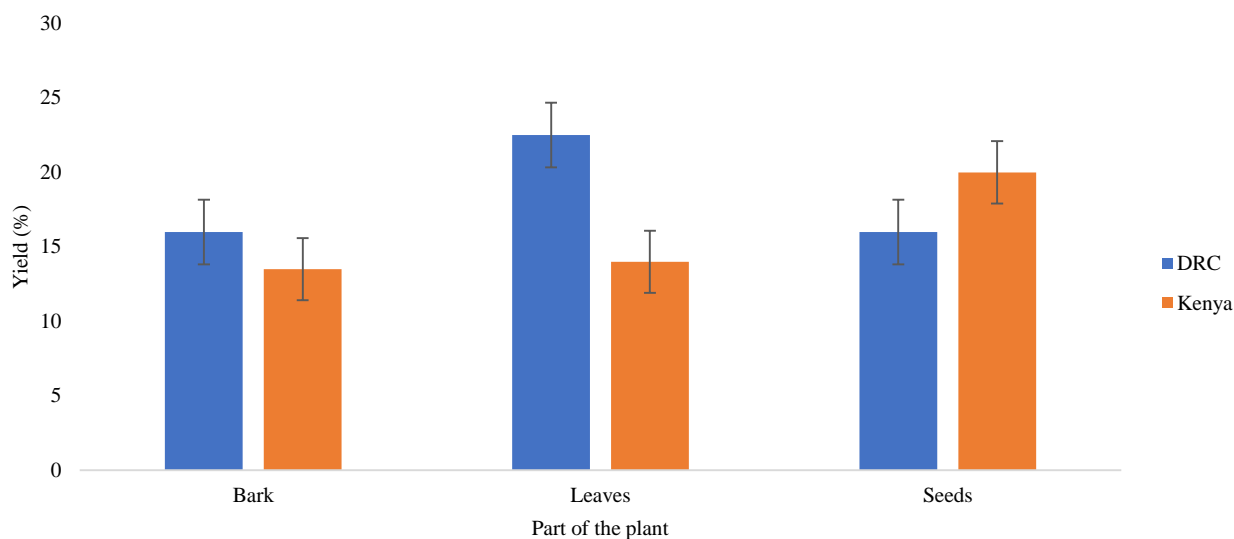
Chemical groups (%)	Leaves		Seeds		Barks	
	Kenya	DRC	Kenya	DRC	Kenya	DRC
Alkaloids	-	-	5.56	3.12	-	2.46
Saponins	1.78	3.78	-	-	5.33	4.92
Phenols	3.47	2.84	3.88	0.97	1.98	-
Flavonoids	0.84	0.71	0.53	0.51	-	-
Glycosides	4.34	3.89	4.18	6.17	4.86	4.61
Terpenoids	0.53	-	0.25	0.57	-	0.46
Tannins	3.73	4.12	-	-	1.65	-

Table 3 DPPH-scavenging activity of aqueous extract of *Moringa oleifera* leaf, seed and bark collected from Bukavu city and Machakos County

Concentration (µg/mL)	Percentage Inhibition						
	Ascorbic acid	Leaves		Seeds		Barks	
		Kenya	DRC	Kenya	DRC	Kenya	DRC
0.5	41.12±1.16	28.02±3.47	22.19±2.53	15.44±6.51	14.63±2.42	17.01±1.13	14.29±1.41
1	64.35±2.28	42.11±4.23	25.81±1.88	15.74±0.42	14.21±3.67	21.38±4.37	25.09±3.53
2	77.49±5.21	44.17±0.65	37.85±3.32	17.40±1.71	22.34±3.29	24.58±4.62	27.38±0.70
5	84.36±1.28	62.83±0.14	51.22±13.03	21.93±2.34	27.14±4.95	30.17±2.66	34.82±0.70
10	92.63±2.76	88.29±1.12	80.17±3.59	30.08±0.80	33.21±2.62	37.34±10.26	41.86±2.01

Table 4. IC₅₀ of aqueous extract of *Moringa oleifera* leaf, seed and bark collected from Bukavu city and Machakos county.

Sample	Origin	IC ₅₀
	Ascorbic acid (reference standard)	3.16 µg/mL
Leaves	Kenya	23.59 µg/mL
	DRC	28.67 µg/mL
Seeds	Kenya	64.21 µg/mL
	DRC	72.94 µg/mL
Barks	Kenya	84.11 µg/mL
	DRC	75.48 µg/mL

Figure 2. Yield of aqueous extracts of *Moringa oleifera* leaf, seed and bark collected from Bukavu city and Machakos county.

Discussion

Results on phytochemical screening of the aqueous extract of leaves, seeds and barks of *M. oleifera* collected from DRC and Kenya indicated that compounds such as alkaloids, saponins, phenols, flavonoids, glycosides, terpenoids and tannins are found in leaves, seeds or barks of the same plant. These results agree with findings of Barreira et al. (2008) on leaves, seeds and stem bark of *M. oleifera* and Ayirezang et al. (2020) on leaves and seeds of *M. oleifera*. It was previously reported that, in these parts of *M. oleifera*, the presence of these phytochemicals is a great indicator of the medicinal potential of the plant (Ifesan et al., 2013). In fact, several findings have reported that secondary metabolites present in many plant extracts possess a lot of pharmacological properties such as hypoglycemic (Tlili et al., 2014) and anti-hypertensive effects (Da Costa et al., 2018).

Due to their good antioxidant activities, these compounds are associated to several biological effects such as antitumor and anti-inflammatory activities (Sharma et al., 2011). In fact, alkaloids have diverse pathophysiological effects including antimutagenic, analgesic, antibacterial, hypnotic, anti-inflammatory, local anesthetic, hypnotic, antitumor and psychotropic activity (Chisholm, 2015). Saponins are used as foaming agents in carbonated beverages and cosmetics, as emulsifiers in preparations containing lipophilic colors or flavors, as preservatives, and for removal of dietary cholesterol (Güçlü-Ustündağ and Mazza, 2007). Phenolic compounds

can be used as antibiotics and antidiarrheal, antiulcer, and anti-inflammatory agents, as well as for the treatment of diseases such as hypertension, vascular fragility, allergies, hypercholesterolemia (Saito et al., 1998; Pehlivan et al., 2021). Flavonoids are well known to protect enzyme systems, cardiovascular diseases, cancers, steroid hormone-dependent cancers, and other age-related diseases (Yao et al., 2006). Glycosides have been shown to suppress or inhibit growth of one type of cells (microbial, fungal, tumor, genetically altered, etc.) and do not or to a lesser extent affect the growth of host cells (Chisholm et al., 2015). Many terpenes have biological activities and are used for medical purposes; they have antioxidant, anticonvulsant, antiulcer, anti-inflammatory, antiseptic, antitumor, antiviral, analgesic, antihypertensive, antibacterial, and therapeutic antidiabetic properties (Vuerich et al., 2019). Tannins have shown many health promoting properties like antiviral, anti-inflammatory, immune modulator and antioxidant effects (Manzoor et al., 2020).

Results of the present study showed that leaves from Kenya and DRC seem to have many bioactive compounds compared to seeds and barks but with no alkaloids. These results agree with the findings of Unuigbo et al. (2014) which reported absence of alkaloids in leaves but present in seeds of *M. oleifera*. According to Nantongo et al. (2018), the concentration of alkaloids can only be discovered in 20% of the plant species particularly in

young, actively growing tissues. Therefore, the production and abundance of alkaloids are mainly related to factors that affect growth of fresh plant tissues such as light, soil nutrients and moisture, temperature and other physicochemical factors (Kirk et al., 2010; Desgagné-Penix, 2017).

It is well known that flavonoids endow a wide range of pharmacological and biochemical properties, such as antimicrobial and anti-inflammatory activities as well as inhibition of platelet aggregation (Kang et al., 2010). In the present study the flavonoids were not detected in bark but abundant in leaves compared to seeds from Kenya and DRC. Although not the focus of our study, the results of the present study are in agreement with the findings of Tlili et al. (2014) in *Searsia tripartita* (Ucria) Moffett which reported variation in flavonoid content from different localities and stage of maturity and with a decrease observed in advanced maturity of the plant (Menichini et al., 2008).

Total phenol and glycoside concentration were higher in leaves, seeds and barks of *M. oleifera* from Kenya compare to those from DRC. The observed variation in these metabolites have been reported among and within plant species primarily due several factors such as genetic factors (Adesina, 2006; Sun et al., 2013), environmental effects and their interaction (War et al., 2012). In fact, when growth conditions are not the same, especially nitrogen availability, the abundancy of phenolic compounds in plant tissues can vary from plant to plant within the same species. For instance, nitrogen deficiency or limitation leads to phenolic accumulation in different plant parts (Larbat et al., 2014).

The concentration of terpenoids seems to be very low in each plant part when compared to other compounds in plant samples collected from DRC and Kenya. Generally, in most plants the common order of secondary metabolites with respect to abundance is phenolics > alkaloids > cyanogenic glycosides > tannins > flavonoids and saponins > terpenoids (Nantongo et al., 2018). In addition, concentrations of terpenoids in plant tissues are regulated by the availability of substrate and the activity and type of biosynthetic enzymes. Therefore, emission rates of volatile terpenoids from plant leaves are controlled by their synthesis rates and compound-specific physicochemical characteristics, mainly their solubility, volatility and diffusivity (Ferguson, 1956). These are affected by physicochemical constraints caused by temperature, stomatal conductance and leaf structure. Rapid changes in the physiological status e.g., stomatal function and allocation of resources (i.e., substrate availability) at high temperatures could have dramatic changes in production of terpenes by plants. This can explain the low terpenoids concentration recorded in this study as *Moringa* samples were collected during dry season when sunlight was stinging (Nantongo et al., 2018).

Leaves of *M. oleifera* collected from DRC showed a higher extraction yield (22.5%) compared to other plant parts. This result is comparable to findings of Ayirezang et al. (2020) in *M. oleifera* aqueous leaf extracts (24.9%) when compared to seeds (11.45%) but much higher compared to those reported by Okumu et al. (2016) where *M. oleifera* aqueous extraction yield was approximately 14.23%. The observed variance is attributed to a large

variability of bioactive compounds and their high concentration found in this study and reported by several authors (Okumu et al., 2016; Kumbhare et al., 2012).

The 2,2-diphenyl-1-picrylhydrazyl assay is one of the most widely used methods and has become routine in establishing the antioxidant activity of herbal extracts and phytochemicals. DPPH is known to obstruct labile hydrogen and the ability to scavenge the DPPH radical is related to the inhibition of lipid per oxidation (Zheng and Wang, 2001). The result of DPPH radical scavenging activity showed that aqueous extract of *M. oleifera* leaves from DRC and Kenya have the highest inhibition percentage depending on the concentration used. These results are comparable to those of Unuigbe et al. (2014) in leaves and seeds of *M. oleifera*. At the highest concentration (10 µg/mL), the percentage inhibition was 88.29±1.12, 80.17±3.59 for leaves from Kenya and DRC respectively, 30.08±0.80, 33.21±2.62 for seeds from Kenya and DRC respectively and 37.34±10.26, 41.86±2.01 for barks from Kenya and DRC respectively, whereas the reference standard (ascorbic acid) had a percentage inhibition of 92.63 ± 2.76. This result is in accordance with findings of Unuigbe et al. (2014), Tlili et al. (2014) and Sharma et al. (2011) who reported that, in most cases, sample concentrations do not exceed the ascorbic acid concentration (considered as the standard). The evaluation of the IC₅₀ in this study indicate that aqueous extract of *M. oleifera* leaves from DRC and Kenya exhibit the highest antioxidant activity with IC₅₀ value of 23.59 µg/mL and 28.67 µg/mL respectively. This is the result of the large variability and concentration of bioactive compounds in leaves compared to seeds and barks as reported in this study. These values were very low and different from that of the reference standard (3.16 µg/mL). These results concur with those of Unuigbe et al. (2014) where IC₅₀ of *M. oleifera* leaf and seed samples were lower than that of ascorbic acid (standard). However, the IC₅₀ values of *M. leaves* were very high compared to Kenyan seeds (64.21 µg/mL) and barks (84.11 µg/mL) and DRC seeds (72.94 µg/mL) and barks (75.48 µg/mL).

Conclusion

In this study, a phytochemical characterization and antioxidant activity comparisons of *M. oleifera* leaves, seeds and barks collected from DR Congo and Kenya were carried out. Results clearly indicated that the composition and concentration in bioactive compounds as well as antioxidant capacity of *M. oleifera* vary significantly across geographical regions and the different plant parts used. In this work, we also reported the richness of leaf extracts from DRC and Kenya compared to seeds and barks. Based on this observation, leaves, especially those from Kenya, are recommended as a satisfactory antioxidant. However, despite their low composition in bioactive compounds and antioxidant capacity compared to leaves, seeds and barks also have pharmacological proprieties. Our study has for the first time provided insights into the use of *M. oleifera* seeds and barks as important natural source of antioxidant and this can offer reprieve on the over use of leaves hence conservation of ecosystem.

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