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Original Article

Comparative Studies on the Phytochemical Content and Proximate Composition of Different Parts of Moringa Oleifera Plant Grown in Ado-Ekiti, Nigeria

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Abstract

Moringa oleifera Lam. is a well-known versatile multipurpose tree used for medicine and as vegetable to bridge the protein gap and energy demand of many communities in Africa. This study examined and compared the phytochemical contents and proximate composition of different parts of this plant, using standard analytical methods. Results obtained from this study on the phytochemical contents of *M. oleifera* revealed that there was presence of alkaloids, cardiac glycoside, flavonoids, phenols, saponins and tannins in different proportions inall the plant parts investigated. The levels of alkaloids, flavonoids and tannins were highest in the leaf (0.33%, 26.29mgQE/g and 2.83 mgTAE/g, respectively), followed by the stem bark (0.22%, 20.41mgQE/g and 0.84 mgTAE/g, respectively) which also had the highest total phenol content (10.20 mgTAE/g). Surprisingly, the seed had almost the lowest level of these secondary metabolites, while the root and flower have them in moderate proportions. The protein contents of the seed (34.48%), flower (30.08%), leaf (28.32%), stem bark (23.11%) and root (17.50%) were above 12%, they are therefore, good sources of protein. *M. oleifera* leaf seemed to have the highest medicinal attributes as reflected in the appreciable level of phytochemicals found in it. Hence, the wide spread use of the leaf for medicinal purpose. However, the seed and flower contained higher amount of the nutrients investigated, thus they can be included in diets to supplement foods lacking protein, carbohydrates and lipids to meet the human's daily nutritional needs. Moreover, all the *M. oleifera* plant parts could be good supplements for animal feeds.

INTRODUCTION

For thousands of years, plants have been an important source of food and medicine for mankind. The World Health Organization (WHO) estimates that up to 80% of people still depend primarily on traditional remedies for their healthcare (Ekor, 2014). The medicinal value of these plants is due to the

presence of a variety of secondary metabolites known as phytochemicals present in them and their elemental composition. Generally, plants that produce constituents mostly as secondary metabolites having medicinal values are called medicinal plants. Interestingly, the composition of these substances differs from plant to plant and as such, the plant kingdom provides a large store of various chemical substances with potential therapeutic properties which have been utilized in treatment and cure of many human and other animal diseases (Oyenuga and Fetuga, 2003). These chemical substances are usually found in the various parts (leaves, roots, stem barks, flowers and seeds) of medicinal plants. *Moringa oleifera* Lam. in the family Moringaceae, is one of such plant species with promising medicinal value. It is widely distributed throughout Africa, Western Asia, Southeast Asia, the Caribbean Islands, and South America (Valdez-Solana *et al*., 2015).

M. oleifera plant is 5–15 m in height with soft and brittle stems (Ijarotimi *et al*., 2013), having a diameter of about 30 cm when fully mature. The leaves are compound, pinnate double, and of small roundor oval shape. The fruit, called "drumstick," is long and angular, with its sides forming a triangle; the drumsticks are about 15–45 cm-long, with around 20 seeds each (Sengupta andGupta 1970). The plant is considered as one of the world's most useful trees, as almost every part of theMoringa tree can be used for food, medication, and industrial purposes (Khalafalla *et al*., 2010). Traditionally, the leaves, fruits, flowers, and immature pods of this tree are edible; they are used as a highly nutritive vegetable in many countries, particularly in India, Pakistan, the Philippines, Hawaii, and some African nations (Anwar *et al*., 2005; Oluduro, 2012). In different parts of Nigeria, *M. oleifera* is a common and popular vegetable. According to Keay (1989), the plant is known with the following local names across the three major ethnic groups in the country; "Zogallagandi" (Hausa), "Ewe-igbale" (Yoruba) and "OkweOyibo" (Igbo).

As reported by Elangovan *et al*. (2014), *M. oleifera* is well known for its extraordinary nutritional and medicinal properties. It is a natural anthelmintic, antibiotic, detoxifier, outstanding immune builder and is used in many countries to treat malnutrition and malaria. Apart from the records of its traditional, medicinal and nutritional uses, there are several reports on the biological and physiological activities of the plant. These include, hypoglycemic and hypo-cholesterolemic effects (Ghosi *et al*., 2000; Dangi *et al*., 2002; Naznin *et al*., 2008), anti-inflammatory and anti-hepatotoxic activities (Rao, 1998), hypotensive properties, anti-helmic, analgesic, dyspepsia potentials and in the management of heart diseases and treatment of ulcers (Nikkon *et al*., 2003).

Unfortunately, most of the research work reported on *M.oleifera* were carried out on each of the parts (roots, stem barks, leaves, flowers and fruits) of the plant separately. More so, such separate reports are not the results from organs of the same plant growing in a particular environment that are of the same age. Thus, it is difficult to know the relative nutritional and or medicinal potentials of the various parts of this highly valued plant due to varied factors. It is therefore necessary, to do a comparative study on the phytochemical and proximate compositions of the different parts of *Moringa oleifera* plant grown in Ado-Ekiti, Nigeria.

MATERIALS AND METHODS

Collectionand preparation of plantmaterials

Mature dry pods, fresh leaves, stem bark, roots and flowers of *Moringa oleifera* werecollectedfrom18-month -old tree in the Botanical Garden of the Department of Plant Science and Biotechnology, Ekiti State University, Ado-Ekiti, Nigeria, in the Month of January, 2017.Theplant parts were authenticated in the herbarium of the Department. The pods were split open and the seeds removed, and then pooled together to form the bulk sample. The parts of the *M.oleifera* plant (except the seeds and the flowers) were rinsed properly with distilled water and properly drained. The, leaves and the flowers were air dried at room temperature for seven days and separately ground in to fine powder using manual grinder, while the seeds, roots and stems were cut in to pieces first, using knives and air-dried separately for two weeks, before grinding into fine powder with a grinding machine.

Qualitativephytochemicalanalysisofsamples

Test for the presence of alkaloids, anthraquinones, cardiac glycoside, flavonoids, total phenols, phlobatannins, Saponins and tannins were carried out on the different samples usingstandard phytochemical screening methods as described by Trease and Evans (2002), Sofowora (1993), Ordonez *et al.* (2006) and Jaradat *et al*. (2015) as follows;

Testforthepresenceofalkaloids

Five grams (5 g) of each of the ground samples was defatted with 5% ethyl ether for 15 min and extracted for 20 min with 5 mL aqueous HCL on a boiling water bath. The resultant mixture was centrifuged for 10 min at 3000 rpm. To 1 mL of the filtrate was added few drops of Mayer's reagent and another 1 mL with Dragendoff's reagent. Creamish/ Brown/ Red/ Orange precipitate indicated the presence of alkaloids.

Test for the presence of anthraquinones

Borntrager's test was used for detecting the presence of anthraquinones. Equal volume (3 mL) of benzene and aqueous extract of each of the samples were shaken together, filtered and 5 mL of 10% ammonia solution was added to the filtrate. This was shaken together and the presence of a pink, red or violet colour in the lower phase showed the presence of anthraquinones.

Test for Cardiac glycosides

Killer Killani Test was used to detect the presence of cardiac glycosides in the samples. Portion of each of the powdered samples (I g) was dissolved in $5cm^3$ of distilled water and $2cm^3$ of glacial acetic acid solution containing one drop of ferric chloride solution. This was under played with $1cm^3$ of concentrated H_2SO_4. Formation of a brown ring at the interface indicated the presence of deoxy sugar characteristics of cardenolides. Avioletring appeared below the brown ring while in the acetic acid layer a greenish ring was formed just above the brown ring and gradually spread throughout this layer.

Test for the presence of Flavonoids

To 0.5 mL of each of the samples' solution was added 0.5 mL of 2% $AlCl_3$-ethanol solution and left for 1 h at room temperature. A yellow colour indicated the presence of flavonoids.

Test for the presence of Tannins and Phenols

Two milliliters of 2% $FeCl_3$ solution was mixed with crude extracts of each sample. Black or blue-green color indicated the presence of tannins and phenols (Jaradat *et al*., 2015)

Test for the presence of Phlobatannins

Aqueous extract (2 mL) of each of the samples was added to 2 mL of 1% HCL and then boiled in a water bath. Deposition of a red precipitate indicated the presence of phlobatannins.

Test for the presence of Saponins

Each of the powdered samples (2 g) was boiled in 20 mL of distilled water in a water bath and filtered. To 10 mL of the filtrate was added 5 mL of distilled water and shaken vigorously for a stable persistent froth. The frothing was mixed with 3 drops of olive oil, shaken vigorously, and then observed for the formation of emulation.

Quantitative phytochemical analysis of samples

***Determination of Alkaloid Contents*:** Total alkaloid contents of the samples were determined quantitatively using a modified method of Harborne (2006). A volume of 200 µL of 10% acetic acid was prepared in ethanol and added to 5 g of each of the samples, covered and allowed to stand for 4 h. The filtrates obtained after filtration were reduced to one-fourth of their original volume over a water bath. Concentrated ammonium hydroxide was added in drops to the extracts until precipitation was completed. The whole solution was allowed to settle and re-filtered

after washing with dilute ammonium hydroxide. The residue obtained for each sample was dried, weighed and the percentage composition was determined using the formula:

$$\% \text{ alkaloid} = \frac{\text{Final weight of the sample}}{\text{Initial weight of the extract}} \times \frac{100}{1}$$

***Determination of Flavonoid Contents*:** The amount of flavonoids in the extract of each of the *M.oleifera* samples was determined by using the aluminum colorimetric assay method (Arowosegbe *et al*., 2012). To 0.5 mL of the sample solution was added 0.5 mL of 2% $AlCl_3$ ethanol solution. After 1 h at room temperature, the absorbance was measured at 420 nm using UV spectrophotometer. Extract samples were evaluated at a final concentration of 0.1 mg/mL. Total flavonoids were calculated as mg/g of quercetin standard curve using the following calibration:
Y = 0.0255x; R2 = 0.9812, where x was the absorbance and Y was the quercetin equivalent.

***Determination of Total Phenols Contents*:** The amount of phenols in each of the samples extract was determined spectro photometrically using the modified method of Oyedemi *et al*. (2012). An aliquot of the extract (1 mg/mL) was mixed with 5 mL Folin-Ciocalteu reagent that was previously diluted with water (1:10 *v*/*v*) and 4 mL (75 g/L) of sodium carbonate. The tubes containing all these were vortexed for 15 s and allowed to stand for 30 min at 40 °C to allow for colour development. The absorbance was then measured at 765 nm using the UV spectrophotometer. Results obtained were expressed as mg/g of tannic acid equivalent using the calibration curve from the equation:

Y=0.1216x; R2=0.936512, where x was the absorbance and Y the tannic acid equivalent.

***Determination of Saponin Contents*:** Saponin contents were determined using the method of Obadoni and Ochuko (2001). The plant sample (20 g) was added to 100 mL of 20% aqueous ethanol and kept in a shaker for 30 min. The samples were heated over a water bath for 4 h at 55 °C and then filtered. The residues were re-extracted with 200 mL of 20% aqueous ethanol. The extracts obtained were concentrated over a water bath at 90 °C to approximately 40 mL. The concentrate was transferred into a 250 mL separatory funnel and extracted twice with 20 mL diethyl ether. The ether layer was discarded and the aqueous layer retained and to which 60 mL *n*-butanol was added. The *n*-butanol extracts were washed twice with 10 mL of 5% aqueous sodium chloride. The samples were dried in the oven at 40 °C to a constant weight after evaporation. The saponins content was then calculated using the formula:

$$\% \text{ Saponin} = \frac{\text{Final weight of sample}}{\text{Initial weight of extract}} \times \frac{100}{1}$$

***Determination of Tannin Contents*:** The method of AOAC (1990) was used, with little modification. To 0.20 g of the sample was added 20 mL of 50% methanol, shaken together and placed in a water bath at 77 to 80°C for 1 h. The extract was then filtered into a 100 mL volumetric flask and 20 mL distilled water was added followed by 2.5 mL Folin-Denis reagent and then 10 mL of 17% aq. Na_2CO_3. The mixture was made up to 100 mL with distilled water, and allowed to stand for 20 min. The absorbance of the tannic acid standard and the samples were measured at 760 nm. Results were expressed as mg/g of tannic acid equivalent using the calibrated curve from the equation:

Y= 0.0593 x -0.0485; R2= 0.9826, where x was the absorbance and Y tannic acid equivalent.

Proximate analysis

The standard methods of Udo and Oguwele (1986), James (1995) and the Association of Official Analytical Chemists(AOAC,1991) were used for the determination of moisture, ash, crude fibre, crude lipids and crude proteins of the seeds, leaves, flowers, roots and the stems bark of *M. oleifera*.

Estimation of energy values

The calorific values of seed, leaf, flower, root and stem bark of *Moringaoleifera* were estimated in kilocalories using the methods of Amadi *et al*. (2004), by multiplying the percentage crude proteins, lipids and carbohydrates by the recommended factors 4, 9, and 4 respectively.

Statistical Analysis

Data were analyzed using one-way Analysis of Variance (ANOVA) and the means were separated at $P < 0.05$ using Duncan's Multiple Range Test (DMRT). The statistical analyses were done using SAS software, 1999 version.

RESULTS

Phytochemical composition of different parts of *M. oleifera*

The phytochemical composition of the seed, leaf, flower, root and stem bark of *M. oleifera* plant are shown in Table 1. Results obtained from this study revealed that there was presence of alkaloids, cardiac glycoside, flavonoids, phenols, Saponins and tannins in all this plant parts. However, phlobatannins was found to be absent in all the plant parts, while anthraquinones was found to be present only in the leaf and flower.

Table 1: Qualitative phytochemical composition of the seed, leaf, flower, root and stem bark of *M. oleifera.*

Phytochemical	*M. Oleifera* plant part				
	Seed	Leaf	Flower	Root	Stem Bark
Alkaloids	+	++	+	+	+
Anthraquinons	-	+	+	-	-
Cardiac glycoside	+	+	+	+	+
Flavonoids	+	+++	++	+	+
Phenols	+	+	+	+	++
Phlobatannins	-	-	-	-	-
Saponins	++	+	+	+	+
Tannins	+	++	+	+	+

The results for the quantitative phytochemical analysis of the various parts of *M. oleifera* are shown in Table 2. The alkaloids were found to be statistically highest ($P \leq 0.05$) in the leaf (0.33%), followed by stem bark (0.22%), flower (0.12%), seed (0.08%) and the root (0.10%). A similar trend was recorded for flavonoid contents; with the leaf (26.29 mgQE/g) having the highest, followed by the stem bark (20.41mgQE/g), root (12.18mgQE/g), flower (10.19 mgQE/g) and the seed (8.16 mgQE/g). However, there were more phenols in the stem bark (10.20mgTAE/g), followed by root (8.25 mgTAE/g), flower (5.25mgTAE/g) and the leaf (2.87 mgTAE/g), with the seed having the least (1.25 mgTAE/g). The results also revealed that saponins are much more in the root (1.13%), stem bark (0.53%), leaf (0.45%), flower (0.20%) and the seed (0.11%) in that order.On the other hand, the tannin contents were also found to be statistically highest in the leaf (2.83mgTAE/g), followed by flower (2.40 mgTAE/g), root (2.11 mgTAE/g), seed (1.10 mgTAE/g) and stem bark (0.84 mgTAE/g).

Table 2: Quantitative phytochemical composition of the seed, leaf, flower, root and stem bark of *M. oleifera.*

Plant part	Phytochemical				
	Alkaloids (%)	Flavonoids (mgQE/g)	Total phenols (mgTAE/g)	Saponins (%)	Tannins (mgTAE/g)
Seed	0.08 ±0.01^{d}	8.16 ±0.05^{e}	1.25 ±0.02^{e}	0.11±0.01^{e}	1.10 ± 0.01^{d}
Leaf	0.33 ±0.05^{a}	26.29 ±0.11^{a}	2.87 ±0.04^{d}	0.45 ±0.03^{c}	2.83 ±0.07^{a}
Flower	0.12 ±0.01^{c}	10.19±0.03^{d}	5.25 ±0.02^{c}	0.20 ±0.02^{d}	2.40 ±0.01^{b}
Root	0.10 ±0.02^{cd}	12.18 ±0.03^{c}	8.25 ±0.03^{b}	1.13±0.04^{a}	2.11 ±0.02^{c}
Stem bark	0.22 ±0.01^{b}	20.41 ±0.02^{b}	10.20 ±0.05^{a}	0.53 ±0.02^{b}	0.84 ±0.05^{e}

TAE, tannic acid equivalent, QE, quercet in equivalent. Values are means (±Standard deviation.) of triplicate samples; means with different superscripts in the same column show significant difference ($P < 0.05$) according to Duncan Multiple Range Test (DMRT)

Proximate composition and energy values of different parts of *M. oleifera*.

Proximate composition and calorific values of *M. oleifera*seed, leaf, flower, root and stem bark are presented in Table 3.The moisture contents of the stem bark (5.01%) was significantly lower when compared with root (6.21%), leaf (7.26%), seed (8.27%) and flower (8.97%) samples, respectively ($P < 0.05$). The highest % ash content was found in the leaf (4.48%) followed by root (3.49%), stem bark (3.12%), seed (2.37%) and flower (2.06%), in that order. The % crude fibre content was found to be significantly highest in the stem bark (5.14%), root (4.21%), leaf (3.22%), seed (2.59%) and flower (2.17%), respectively. Interestingly, the % crude lipids content is comparatively high in the seed (12.15%), flower (10.27%) and leaf (6.26%) in that order, but low in the stem bark (4.44%) and root (2.16%). The same trend is recorded for the protein contents; where the seed also had the highest (34.48%), followed by flower (30.08%), leaf (28.32%), stem bark (23.11%), and the root (17.50%). The root (66.43%) was found to have the statistically highest carbohydrate contents followed by stem bark (59.18%), leaf (51.46%), flower (46.45%) and the seed (40.14%), respectively.

The results for the energy values of different parts of *M. oleifera* plant revealed that the seed had the highest colorific value (407.83Kcal/100g), followed by the flower (398.55 Kcal/100g), the leaf (375.46 Kcal/100g), the stem bark (369.12 Kcal/100g) and the root (355.16 Kcal/100g). It is of interest that the energy content profile, % crude lipids and % protein contents of the different parts of the plant are in the order:

Seed > flower > leaf > stem bark >root.

Table 3: Proximate composition and energy values of the seed, leaf, flower, root and stem bark of *M. oleifera.*

Proximate	Plant part				
	Seed	Leaf	Flower	Root	Stem bark
Moisture (%)	8.27±0.02^{b}	7.26 ±0.01^{c}	8.97±0.09^{a}	6.21±0.02^{d}	5.01± 0.14^{e}
Ash (%)	2.37±0.03^{d}	4.48±0.02^{a}	2.06±0.05^{e}	3.49±0.01^{b}	3.12±0.07^{c}
Crude fiber (%)	2.59±0.04^{d}	3.22±0.03^{c}	2.17±0.03^{e}	4.21±0.11^{b}	5.14±0.07^{a}
Crude lipids (%)	12.15±0.04^{a}	6.26±0.06^{c}	10.27±0.03^{b}	2.16±0.01^{e}	4.44±0.06^{d}
Proteins (%)	34.48±0.09^{a}	28.32±0.03^{c}	30.08±0.05^{b}	17.50±0.25^{e}	23.11±0.09^{d}
Carbohydrates (%)	40.14±0.14^{e}	51.46±0.53^{c}	46.45±0.48^{d}	66.43±0.54^{a}	59.18±0.20^{b}
Energy value (Kcal/100g)	407.83 ±4.34^{a}	375.46±62.52^{c}	398.55±0.57^{b}	355.16±2.18^{e}	369.12±1.32^{d}

Values are means (± Standard deviation.) of triplicate samples; means with different superscripts in the same row show significant difference ($P < 0.05$) according to Duncan Multiple Range Test (DMRT)

DISCUSSION

Results obtained from this study on the phytochemical contents of *M. oleifera* revealed that there was presence of alkaloids, cardiac glycoside, flavonoids, phenols, Saponins and tannins in different proportions in all the plant parts of (Tables 1 and 2.). The levels of alkaloids, flavonoids and tannins were highest in the leaf (0.33%, 26.29mgQE/g and 2.83 mgTAE/g, respectively), followed by the stem bark (0.22%, 20.41mgQE/g and 0.84 mgTAE/g, respectively) which also had the highest total phenol content. (10.20 mgTAE/g). Surprisingly, the seed had almost the lowest level of these secondary metabolites namely; alkaloids (0.08%), flavonoids (8.16mgQE/g), total phenols (1.25mgTAE/g) and saponins (1.13%), while the root and flower have them in moderate proportion. According to Sofowora (1993) and Okwu (2005), phytochemicals are responsible for the curative and preventive properties of many plants.

As reported by Ali (2012), alkaloids have antitumor, antiviral, antihypertensive, antidepressant, antimicrobial and anti-inflammatory activities. Hence, their presence in the leaves of the *M. Oleifera* plant studied can attest to their use in the management of diseases. Edeoga and Enata (2011) also reported that alkaloids are powerful pain relievers, have an antipyretic action, a stimulating effect and can act as tropical anesthetic in ophthalmology. Flavonoids widely distributed in leaf and stem bark of this plant have been reported to have antibacterial, anti-inflammatory, antiallergics, antimutagenic, antiviral, antithrombotic and vasodilatory activity (Sofowora, 1993). Phenols, another phytochemical found to be present mostly in the stem bark, root and flower of the studied*M. Oleifera* plant are reported to be strong antioxidants and play a role in the prevention and management of chronic diseases such as cancer and cardio vascular disease (Holland, 2001).The author also reported that, plant phenols may interfere with all stages of the cancer process resulting to reduction ofcancer risk.

Saponins found mostly in the root of this plant was reported to have antifungal, antiviral, antimicrobial, antibacterial, anti-inflammatory, anthelmintic, anti-dermatophytic, anticancer and anticytotoxic activities (Chen *et al*., 2010). They impact the immune system and possess cholesterol lowering potential that has been demonstrated in animal and human trials (Gūçlū and Mazza, 2007). Tannins discovered to be more in the leaf and root of this plant are known to have antiviral, antibacterial and anti-tumor properties. Tannins can also be effective in curing hemorrhages as well as restrict bare swellings. When applied internally, tannins affect the walls of the stomach and contract or squeeze the membranes thereby, restricting secretions from the cells. Long term and / or excessive use plants with high concentration of tannins arenot advisable (Reed, 1995)

It is a thing of interest that, the nutritional properties of *M. oleifera* plant compete favourably with the medicinal properties. The leaf of this plant is consumed in powdered form or as vegetable in many countries of the world. Fuglie (2001) reported that the dietary constituent of the leaf is as a result of the essential amino acid which is important in bridging the protein gap of resource- poor communities of developing nations.

Moringa oleifera seed (34.48%), flower (30.08%), leaf (28.32%), stem bark (23.11%) and root (17.50%) as shown in table 1, are all rich in proteins, since they have more than 12% of the calorific values from protein according to Pearson (1976). The protein values obtained for the various parts of *M.oleifera* grown in Ado-Ekiti, Nigeria are higher than that reported for this plant in Akwa, Nigeria by Igwilo *et al*. (2017), where the crude protein contents for the seed, flower, leaf, stem and root were, 28.02, 25.99, 27.60, 3.59 and 5.02%, respectively. These variations could be as a result of differences in the age of the Moringa plant before evaluation, as well as the differences in the climatic conditions and the soil type of the two environments where the plants were collected. The report of the studies conducted by Fowoyo and Oladoja (2015) on the seed and leaf extracts of *M. oleifera* also supports this assertion.

The protein values of the parts of Moringa plant in this study were also higher than the ones reported for some traditionally consumed vegetables in Nigeria like *Cucurbita pepo* (15.81%), *Corchorus olitorious*

(13.70%), *Brassica oleracea* (11.67%), *Launneataraxacifolia* (17.64%), *Cnidoscolusaconitifolina* (2.96%), *Solanum nigrum* (3.10%), *Crassocephalumcrepidiodes* (1.76%) and *Colocassia esculenta* (2.67%) (Adeleke and Abiodun, 2010; Emebu and Anyika, 2011, Arowosegbe *et al*., 2015). This implies that, all the plant parts of *M. oleifera* grown in Ado-Ekiti, Nigeria are good sources of proteins.

The carbohydrate values obtained in this study for all the plant parts is above 40% and higher that the amount reported by Oyeyemi *et al*. (2014) in leaves of *M.arboreus* (7.20%) and *S.sporgonophora* (12.58%).The *M. oleifera* seed (12.15%) and flower (10.27%) recorded higher amount of crude lipids compared to the stem bark (4.44%) and root (2.16%). This finding is not in line with that of Igwilo *et al*. (2017), who reported higher lipids content in the leaf than the flower of this plant. Crude lipids, though serves as principal sources of energy, should be consumed with caution so as to avoid obesity and other related diseases (Okoh, 2012).However, the level of lipids in this plant is perhaps, save for consumption. The crude fibre in the parts of the studied plant is moderate, ranging from 5.14% in stem bark to 2.14% in the flower. Dietary fibre had been reported to help prevent constipation, gastrointestinal disorder, pile, diabetes and breast cancer (Ishida *et al*., 2000). However, the ash content in the parts of the plant studied were low compared to that of 20.05% reported for *Talinumtriangulare* leaf (Ladan *et al*., 1996) and 13. 80%in *Amaranthus hybridus* (Akubugwo *et al*., 2007).The moisture contents in the respective parts of *M. oleifera* in this study ranged between 5.01% in the stem bark to 8.97% in the flower, compared favourably with the findings of Igwilo *et al*. (2017).The moisture content of food is used as a measure of its stability and susceptibility to microbial contamination. Hence, the flower with the highest moisture content is likely to be more unstable and susceptible to contamination over a long storage.

The calorific values of *Moringa oleifera* plant parts ranged between 407.83Kcal/100gin the seed, to 355.16 Kcal/100g in the root. These are higher than the values reported for some Nigerian vegetables with values between 248.8 and 307.10 Kcal/100g. (Anita *et al*., 2006; Akubugwo *et al*., 2007). Nevertheless, the calorific values obtained in this study agree withthe report of Lintas (1992) that vegetables generally have low energy values. Therefore, Moringa (leaf and seed) is to be eaten with other foods rich in calories to get the required energy needed for daily activities.

CONCLUSION AND RECOMMENDATION

The results of the phytochemical analysis and proximate estimation of different parts of *M.oleifera* revealed that the seed, leaf, flower, root and stem bark contain appreciable amounts of alkaloids, cardiac glycoside, flavonoids, phenols, Saponins, tannins and different nutrients in different proportions, which are medicinally and nutritionally important. Moringa leaf comparatively has the highest medicinal attributes as reflected in the appreciable level of phytochemicals found in it. This justifies the wide spread use of the leaf for medicinal purpose. However, the seed and flower seemed to contain higher amount of the nutrients investigated, thus they can be included in diets to supplement foods lacking protein, carbohydrate and lipids to meet the human's daily nutritional needs. Moreover, all the *M. oleifera* plant parts will be good supplements for animal feeds.

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