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## Determination of Chemical Composition and Nutritional Values of *Moringa oleifera* Leaves

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**Abstract:** The study on chemical composition and nutritional values of *Moringa oleifera* leaves has been carried out by analysing samples of this plant leaves collected from three different sectors of Ouagadougou. The analysis of nutrients contents including elemental has been done using recommended method of analysis. The result of analysis shows that the percentages (%) of proteins, moisture, fat, carbohydrate of the leaves are respectively 11.9; 73.9; 1.1 and 10.6% for the cool matter. For the dry matter, the contents in proteins, moisture, fat and carbohydrate are respectively 27.2; 5.9; 17.1 and 38.6%. The result of the mineral composition expressed in mg for 100 g of matters are 847.1; 151.3; 549.6; 17.5; 1.3 and 111.5 in the cool matter respectively for the Calcium, Magnesium, Potassium, Iron, Zinc and Phosphor. The contents of same minerals analyzed for the dry matter are respectively 2098.1; 406.0; 1922.0; 28.3; 5.4 and 351.1. The result showed a satisfactory composition and a significant variability between the nutrients contents of different sectors. This plant can be valorized for a balanced nutrition of populations.

**Key words:** *Moringa oleifera*, leaves, nutritional values

### INTRODUCTION

The *Moringaceae* is a single-genus family with 12 to 14 known Species (Lalas and Tsaknis, 2002). Almost all species of *Moringa* come from India and where they have been introduced in several countries of the tropics (Lalas and Tsaknis, 2002; Anwar and Banger, 2003). Among these species, the *Moringa oleifera* (Lam) is the most known and used (Lalas and Tsaknis, 2002). It is also met in Africa, in Arabia, in the Southeast of Asia, the Pacific, the Caribbean islands and in South America (Morton, 1991; Somali *et al.*, 1984).

This plant possesses multiple virtues. Indeed, the *Moringa* is supposed to have multiple medicinal qualities. Thus, the peels, the roots, the leaves, the flowers of *M. oleifera* tree are used in the traditional medicine for the treatment of the diarrhoea and hypertension and the folk remedies in a lot of countries (Anwar *et al.*, 2007). The seeds of *Moringa* are the best normal coagulants, possess antimicrobial, anti-oxidantes properties and are used efficiently for the treatment and the purification of the greatly troubled water (Anwar *et al.*, 2007; Ndabigengeser and Narasiah, 1998). The seeds also contain the oil which has high nutritional quality and can be used in the kitchen (Lalas and Tsaknis, 2002; Anwar and Banger, 2003). The leaves of *M. oleifera* can be a food available all year round and to have high quality for the men. The young leaves are edible and are commonly consumed after

cooking like spinach, or prepared in soup or in salad. This plant has a great utility on the food plan for the peoples in Northeast of Nigeria region (Lockett *et al.*, 2000). In other countries as Senegal, the leaves of *M. oleifera* are consumed like a sauce named "Mbuun", accompanying with the couscous prepared with cereals composed by millet, corns or rice. The "Mbeulekhé" is a meal prepared with rice and sauce. Ouagadougou where the study has been done is the capital of Burkina Faso, a country of West Africa with a tropical climate. In Burkina Faso, we meets only the *Moringa oleifera* species and its leaves are used for "tô" (dough of cereals flour submitted to the heat) and rice sauce preparation. In some households, the leaves are cooked with the water and eat after addition of the peanut oil, salt and other additives, permitting the seasoning. In Burkina Faso, these leaves are fluently consumed in the traditional societies. A valorization of *M. oleifera* leaves by a quantitative and qualitative production would be very important to satisfy the food and nutritional needs of the population of Burkina Faso.

The objective of this study is to study the nutritional values and evaluate *Moringa oleifera* leaves nutrients contents variability.

### MATERIALS AND METHODS

**Sampling:** For the biochemical composition analysis, the samples of cool leaves have been appropriated on

*Moringa oleifera* plants in three different sectors (sector 4, sector 13 and sector 26) of Ouagadougou. These cool samples have been preserved at +4°C before analysis. A part of the cool leaves appropriated has been dried to the laboratory temperature during fourteen (14) days and then, reduced in powder with a grinder (mark NIMA, model NO: BL - 888A, Japan). The powder has been sifted by a sifter with the meshes 0.5 millimeter (mm) of diameter and then, kept in plastic sachets to the laboratory temperature (25°C). The composition analyzes have been done in triplicate with the cool and dry sample.

**Macronutrients composition characterization:** The samples of cool and dried leaves of *M. oleifera* have been analyzed for the following constituent: water, proteins, lipids, crude fibers, total sugars and ashes. The Analyses have been done in triplicate.

**Determination of water content:** The content in water has been determined by the method (AOCS, 1990). A mass, 5 grams (g) of samples has been weighed and placed in crucibles. The crucibles have been placed in drying oven to 105°C until getting a constant mass.

**Determination of ashes content:** The ashes content have been determined by the method (AOCS, 1990). In three crucibles, 2 g of samples has been placed. The samples have been submitted to mineralize in the oven to 550°C during 3 h. After this time, the crucibles have been withdrawn, cooled to the dessicator during 30 min before being weighed. It has been put back at the oven during one hour and has been weighed after cooling to the dessicator. The operation has been restarted until obtaining a constant weight.

**Determination of proteins content:** The content in proteins has been determined by the method of Kjeldahl (AOCS, 1990). The organic nitrogen of the sample (0.2 g) has been transformed in mineral nitrogen (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub> by the oxidizing action of the sulphuric acid concentrated in presence of a catalyst. The content in total proteins has been calculated by multiplication of nitrogen quantity with a conversion factor (6.25).

**Determination of crude fibers content:** The crude fibers content has been estimated by insoluble formic method (Deymie *et al.*, 1981). We put 5 g of samples in a vial containing 100 ml of formic acid 80% (V/V). The mixture has been placed in the boiling water during 75 min. After cooling, the product of the digestion has been filtered and the insoluble phase has been recovered in a crucible, dried to 103°C and weighed (w<sub>1</sub>). After incineration in an oven, the weight of the ashes has been determined (w<sub>2</sub>). The crude fibers content has been determined after calculation of the difference of these two weights.

**Determination of total sugars content:** Total sugars content has been estimated according Tollier and Robin method (1979). A quantity of sample (0.1 g) has been weighed and introduced in three test-tube with 10 ml of NaOH; 0.1 N. The mixture has been placed in the boiling water during 30 min, after cooling the mixture has been decanted in a tube. Then, 0.01 ml of the mixture has been appropriated in a tube and adds 0.99 ml of distilled water, 2 ml of orcinol and 7 ml of H<sub>2</sub>SO<sub>4</sub> 60%. The mixture has been homogenized and has been placed again in hot water (80°C) during 20 min. Then, the tubes have been put to the obscurity after cooling during 45 min. The reading of the optic density has been done to 510 nanometer. A curve of standardization has been achieved using glucose 0.5 mg/ml as reference. The range of concentration in glucose varying between 5 and 50 µg/ml. The curve permitted to determine the concentration in total sugars of samples.

**Determination of lipids content:** The lipids content has been determined according to the soxhlet method extraction using the hexane like solvent (AOCS, 1990). A quantity of samples (5 g) has been weighed and placed in three extraction cartridges. The cartridges have been plugged with cotton and have been placed in the soxhlet. Cleans and dry extraction balls have been weighed before pouring 250 ml of hexane. The extraction has been done during 5 h. After this time, the solvent has been separated by evaporation in the ROTAVAPOR. The weight of lipids has been gotten by difference between the final weight and the initial weight of balls.

**Determination of energizing values:** The energizing values of proteins, total sugars and lipids have been determined by Merrill and Watt (1955) coefficients adopted by the Food and Agriculture Organization in 1970. The energizing value of samples have been gotten by the following relation:  $P \times 4 \text{ Kcal} + G \times 4 \text{ Kcalorie (Kcal)} + L \times 9 \text{ Kcal} = X \text{ Kcal}/100 \text{ g}$ , with P = percentage of proteins, G = percentage of sugars, L = percentage of lipids, X = energizing values.

**Micronutrients composition characterization Phosphor (P), Potassium (K), Sodium (Na), Magnesium (Mg) and Calcium (Ca) determination:** The content of these minerals in *M. oleifera* leaves has been determined after the sample mineralization by humid voice according to Houba *et al.* method (1989). In three tubes, 0.5 g of samples ground to 0.5 mm has been weighed and 5 ml of the extraction solution (sulphuric acid - selenium - salicylic acid: 7.2%) have been added in each tube. A Blanc solution has been prepared with 5 ml of the extraction solution. The samples have been let to rest during 2 h at least. After this time, they have been heated with temperatures varying between 100-340°C. The mixture gotten after heating has been cooled to the ambient temperature during 24 h and then, has been

diluted to 2/3 of tubes, agitated, cooling again and completed to 75 ml with the distilled water. After agitation and decanting, a quantity of the solution has been used for:

- The dosage of the total phosphor with the auto-sensor (model SKALAR 1000) to 880 nm using the ammonium molybdate as indicator.
- The dosage of Magnesium and Calcium after dilution in the Lanthane [(La (NO<sub>3</sub>)<sub>3</sub> 6H<sub>2</sub>O)] respectively to 285.2 nm and 422.7 nm with an atomic absorption spectrophotometer (model PERKIN ELMER A100).
- The dosage of Sodium and Potassium with a flame photometer (model CORNING 400)

Ranges of standards solutions have been prepared for the dosage of micronutrients. These ranges are given like follows:

- Phosphor (P): a solution (300 ppm) of potassium hydrogenophosphate (K<sub>2</sub>HPO<sub>4</sub>) permitted to achieve a range of concentration varying between 3 and 15 ppm.
- Potassium (K) and Sodium (Na): a standard solution of Sodium-potassium (100 ppm) permitted to prepare a range concentration between 0 and 10 ppm.
- Magnesium (Mg) and Calcium (Ca): standards solutions of Magnesium (1000 ppm) and Calcium (1000 ppm) permitted to prepare concentrations ranges varying between 5 and 30 ppm for the Calcium, 0.5 and 3 ppm for Magnesium.

**Zinc (Zn) and Iron (Fe) Determination:** In three tubes, 0.5 g of samples ground to 0.5 mm has been weighed and 5 ml of the extraction solution: Nitric acid (HNO<sub>3</sub>; 65%), sulphuric acid (H<sub>2</sub>SO<sub>4</sub>; 96%) and perchloric acid (HClO<sub>4</sub> 70%) have been added in each tube. A Blanc solution has been prepared with 5 ml of the extraction solution. The samples have been let to rest during 2 h at least. After this time, they have been heated with temperatures varying between 75-240°C. The mixture gotten after heating has been cooled to the ambient temperature during 24 h and then, has been diluted to 2/3 of tubes, agitated, cooling again and completed to 75 ml with the distilled water. After agitation and decanting, a quantity of the solution has been used for analyze the Iron (Fe) and Zinc (Zn) in atomic absorption, respectively to 219.9 nm and 248.3 nm. A concentration range of standard solution has been 6 to 36 ppm for the Iron (Fe) and 1 to 6 ppm for the Zinc (Zn).

**Statistical analysis:** The averages and Standards Deviations (SD) calculation have been done with the software EXCEL 2007. The test of Tukey with the software XLSTAT pro 7.1 has been used to do the comparison between the averages. The test has been found meaningful at the doorstep of 5%.

## RESULTS

The analysis of *M. oleifera* leaves chemical composition and nutritional values showed a high concentration in water of cool leaves appropriated in the three sectors (Table 1). These concentrations in water have been 74.5; 71.6 and 73.7% respectively for the samples of Sector 4, Sector 13 and sector 26. Non significant differences have been observed between the contents in water for the samples of Sectors 4 and 13 (p = 0.05). However, a significant difference has been observed between the content in water for the sample of sectors 13 and 26 (p = 0.01). An average content in water: 73.9% has been observed for the three samples (Table 3).

The concentrations in proteins have been respectively 13.6; 10.3 and 9.1% respectively for the cool samples of Sector 4; Sector 13 and Sector 26. Significant difference have been observed between the contents in proteins for the three samples (p = 0.004). The average concentration in proteins for the three cool samples has been 11.9% (Table 3).

The concentrations observed for total sugars have been 7.3; 11.3 and 11.3% respectively for the samples of Sector 4; Sector 13 and sector 26. Significant difference have been observed between the concentration in total sugars of sector 4 and 13 (p = 0.004), Sector 4 and 26 (p = 0.004). The average concentration in total sugars for the cool samples has been 10.6% (Table 3).

For the lipids, their contents have been found in very weak concentrations comparatively for the proteins and total sugars. Thus, the concentrations have been 1.2; 1.7 and 1% respectively for the cool samples of Sector 4, Sector 13 and Sector 26. A significant difference has been observed between the contents in lipids of the three samples (p = 0.002). The average concentration in lipids for the three samples has been 1.1%.

The contents in crude fibers and in ashes observed for the three cool samples have been determined. Thus, the average contents have been respectively 2.3 and 3.4% for the contents in ashes and crude fibers. An acceptable average energizing value (86.6 Kcal/100 g) has been observed for the three cool samples.

For the dried leaves, the average contents in proteins, lipids, total sugars, ashes and crude fibers have been respectively 27.2; 17.1; 38.6; 11.1 and 19.4% (Table 3). A high average energizing value (339.7 Kcal/100 g) has been observed for the dried leaves.

Table 1: Contents in g/100 g of cool leaves (average ± Standard Deviation)

Components	Sector 4	Sector 13	Sector 26
Water	74.5±0.1	71.6±0.7	73.7±0.7
Proteins	13.6±0.1	10.3±0.2	9.1±0.1
Lipids	1.2±0.0	1.7±0.0	1.0±0.0
Crude fibers	3.3±0.0	4.5±0.0	4.0±0.2
Ashes	3.0±0.0	2.2±0.1	1.8±0.0
Total sugars	7.3±0.0	11.3±0.1	11.3±0.0
Energy (Kcal)	82.1	95.4	86.1

Table 2: Contents in g/100 g of dried leaves (average ± Standard Deviation)

Components	Sector 4	Sector 13	Sector 26
Water	4.8±0.0	4.9±0.7	8.1±0.1
Proteins	26.2±0.2	27.6±0.9	27.6±0.3
Lipids	16.9±0.9	21.6±0.3	12.5±0.8
Crude fibers	15.7±0.7	22.3±0.3	20.0±0.9
Ashes	16.0±0.2	9.1±0.1	8.2±0.1
Total sugars	35.7±0.0	36.6±0.0	43.3±0.1
Energy (Kcal)	337.8	362.4	317.0

Table 3: Contents in g/100 g of samples (average ± Standard Deviation)

Components	Cool leaves	Dried leaves
Water	73.9±1.8	5.9±1.8
Proteins	11.9±2.1	27.2±0.8
Lipids	1.1±0.5	17.1±4.5
Crude fibers	3.4±1.2	19.4±3.3
Ashes	2.3±0.5	11.1±4.3
Total sugars	10.6±2.3	38.6±4.1
Energy (Kcal)	86.6±6.1	339.1±22.7

The analysis of micronutrients composition in *M. oleifera* leaves showed remarkable concentrations in minerals and trace elements (Table 4, 5 and 6). The results showed high concentrations in Ca, K, Mg and P in the cool leaves of the three Sectors. The content in Na has been found in weak concentration among the minerals determined. The concentrations in trace elements (Fe and Zn) have been found acceptable. The Ca has been found in very high concentration, followed by K, Mg and P for the three cool samples (Table 4). The content in Ca has been 1460.3; 790 and 463mg in 100g of cool matter respectively for the samples of Sector 4, Sector 13 and sector 26 (Table 4). The content in K has been 308.6; 690 and 600mg in 100g of cool matter respectively for the samples of Sector 4, Sector 13 and sector 26 (Table 4). The contents in P, Mg also found in remarkable concentrations have been indicated in the Table 4. The concentration in Fe of cool samples has been 31.1; 17.9; 10mg in 100g respectively for the samples of sector 4, sector 13 and sector 26. The average concentration in Zn has been 2.8; 1.5; 0.2mg in 100g of cool matter respectively for the samples of sector 4, sector 13 and sector 26. The average contents found for the three cool samples have been 847; 549.6; 151.3; 111.5; 17.5 and 1.3mg for 100g of cool matter respectively for the Ca, K, Mg, P, Fe and Zn (Table 6). The average contents in Ca, K, Mg, P, Fe and Zn found in the dry matter have been respectively 2098.1; 1922; 406; 28.3 and 5.4mg for 100g of dry matter (Table 6). A comparative analysis showed a significant variation between the contents in micronutrients of the three sectors ( $p < 0.05$ ).

## DISCUSSION

The analysis of nutritional values showed satisfactory contents in nutrients for *M. oleifera* leaves. The contents

Table 4: Contents in mg/100 g of cool leaves (average ± Standard Deviation)

Components	Sector 4	Sector 13	Sector 26
Calcium (Ca)	1460.3±56.1	790.0±9.5	463.0±9.1
Magnesium (Mg)	267.0±9.16	155.0±3.0	40.3±4.6
Potassium (K)	308.6±6.5	690.0±2.6	600.0±6.2
Sodium (Na)	20.3±0.5	2.7±0.0	1.2±0.0
Iron (Fe)	31.1±4.2	17.9±0.0	10.0±0.0
Zinc (Zn)	2.8±0.2	1.5±0.0	0.2±0.0
Phosphor (P)	56.0±0.0	152.0±4.5	108.0±4.3

Table 5: Contents in mg/100 g of dried leaves (average ± Standard Deviation)

Components	Sector 4	Sector 13	Sector 26
Calcium (Ca)	3512.6±335.7	2100.0±2.0	682.3±2.0
Magnesium (Mg)	717.0±12.1	313.0±0.0	188.0±3.4
Potassium (K)	1296.0±50	2250.0±2.6	2220.0±6.2
Sodium (Na)	78.3±4.0	5.2±0.0	3.0±0.0
Iron (Fe)	52.1±2.8	19.8±0.0	12.9±0.0
Zinc (Zn)	10.9±0.2	2.2±0.0	0.8±0.0
Phosphor (P)	252.0±0.00	368.3±3.0	433.0±8.0

Table 6: Contents in mg/100 g of samples (average ± Standard Deviation)

Components	Cool leaves	Dried leaves
Calcium (Ca)	847.1±430.6	2098.1±1414.8
Magnesium (Mg)	151.3±92.7	406.0±225.7
Potassium (K)	549.6±199.3	1922.0±542.3
Sodium (Na)	ND	ND
Iron (Fe)	17.5±9.7	28.3±20.8
Zinc (Zn)	1.3±1.1	5.4±4.6
Phosphor (P)	111.5±41.1	351.1±91.7

ND: Non Determined

in cool leaves have been found lower than the contents in dried leaves. This result can explain by a reduction of water contents in the samples.

An analysis of *M. oleifera* dried leaves chemical composition showed proteins (27.2%) and lipids (17.1%) contents lower than the contents observed in other part as the seeds. Thus, the seeds of *M. oleifera* contents found by Anwar and Muhammad (2005) in Faisalabad have been 34% and 33.23% respectively for the proteins and lipids. However, the crude fibers (19.4%) and ashes (11.1%) contents in *M. oleifera* dried leaves of our study has been found superior compared to the contents found by Anwar and Muhammad (2005) for the crude fibers (7.5%) and the ashes (7%) in the *M. oleifera* seeds.

A content in Iron (17.2 mg/100 g) of *M. oleifera* leaves of this study has been found higher than the contents in other cool vegetables given by the Food and Agriculture Organization in 2002: *Amaranthus sp.* (8.9 mg/100g), *Manihot esculenta* (7.6 mg/100g), *Ipomoea batatas* (8.2 mg/100 g). The contents in Ca observed in our study for the dried leaves of *M. oleifera* have been found lower than the Ca contents observed in some dried leaves frequently consumed in Africa and have been found by Ibsatou *et al.* (2001). It is the sorrel of Guinea leaves

(3630 mg/100 g), amaranth leaves (3590 mg/100 g), gumbo leaves (2850 mg/100 g), onion leaves (2540 mg/100 g) and baobab leaves (2240 mg/100 g).

The three sectors where the samples have been appropriate are localized in the same city of Ouagadougou, under the same climatic factors. Therefore, the variability of different contents in macronutrients and micronutrients between the samples observed can be explained by a difference of the soil composition that can influence the soil nutrients absorption by the plants. Indeed, the soil factors acts on the mineral composition and can modify the soil composition and the nutritional properties, or they acts on the plants absorption (Heller *et al.*, 1998).

The result of this study showed that the *M. oleifera* is an important plant with the leaves which have high concentration in energies, nutrients (proteins, Ca, K, Mg, P, Fe and Zn). The leaves have nutritional potentialities showing their importance in the rural and urban population's nutrition. A variability of nutrients composition for the *M. oleifera* leaves appropriated on three different sectors of the same city and under the same climate has been highlighted.

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