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# Nutritional Analysis of Cooked and Dried Leaves of *Moringa oleifera*

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**Abstract:** *Moringa oleifera* is one of the green leafy vegetables that are under-exploited and under-utilized. Available researches have shown that *Moringa oleifera* is rich in nutrients and can be used as a food-based strategy in combating nutrient deficiencies. The study was carried out to comparatively evaluate some nutrient contents of *Moringa oleifera* processed under different methods. The research analyzes and compares nutritional composition of dried and cooked *Moringa oleifera* leaves. The moisture content was determined by exposing the sample to heat under controlled conditions, the water from the material evaporated leaving the dry matter. The ash content was determined by burning off the organic matter leaving behind inorganic ash. Base on the principle that non-polar components of samples are easily extracted into organic solvent, crude lipid was determined using n-Hexane. The protein content was obtained by Kjeldahl method. Mineral analysis was also carried out to determine the amount of potassium, magnesium, sodium, calcium and phosphorus. The results show that, the dried leaves of *Moringa oleifera* and cooked leaves contain: Moisture 3.0% and 5.0%, Ash 13.5% and 10.0%, fibre 8.5% and 10.0%, Crude lipid 5.0% and 7.5%, Crude protein 5.43% and 9.98%, Carbohydrate 62.57% and 59.52% respectively. The mineral content of the leaves (mg/100g): were Sodium (Na) 0.14 and 0.08, potassium (K) 5.10 and 2.60, Calcium (Ca) 0.28 and 0.22, magnesium (Mg) 0.29 and 0.25, phosphorus (P) 5.58 and 4.91 respectively. The results showed that, the cooked leaves of *Moringa oleifera* contain more nutrients than the dried leaves. However, carbohydrate and mineral composition are lower in the cooked leaf. Nutrient loss is a consequence of nearly every cooking process. Exposure to heat, light or oxygen alters the nutrients found in food, and methods that involve water often reduce the amounts of nutrients as these get 'washed out' and left behind.

**Keywords:** *Moringa oleifera*, Leaves, Cooking, Drying, Nutrients

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## 1. Introduction

*Moringa oleifera* (*Moringa pterygosperma*) is the most widely cultivated species of the genus *Moringa* [1]. Also known as "Miracle Tree" [2], it is the best known of the thirteen species of the genus Moringaceae. *Moringa oleifera* has a host of other country specific vernacular names [2] such as *Babati* in Ewe, Ghana; *Zogalla* in Hausa, Nigeria, *Shingo* in Swahili, Kenya; *Alim* in Arabic, Sudan and Chad and many more. Other English common names are benzolive tree and West Indian ben. It is also known as drumstick tree, from the appearance of long, slender, triangular seed pods [3]. The tree is slender and with drooping branches that grow to approximately 10 m in height. In cultivation, it is often cut-back annually to 1-2 m and is allowed to re-grow, so the pods and leaves remain within arm's reach [1].

Given the increasing interest of populations in this food material, it is necessary to understand the effects of main post-harvest processes on their nutritional properties, such as the effect of cooking and drying techniques on the nutritional contents of *Moringa* [4].

In developing countries where most of the people are engulfed in poverty and cannot afford the expensive food products and suffer from various deficiency diseases, there is a need to identify cheap and easily available method of processing and preserving vegetables such as *Moringa*.

Drying is one of the methods of food preservation employed to reduce losses in quantity and quality [5]. It is the oldest method of food preservations particularly successful in the hot, dry climates [6].

The drying of green leafy vegetables such as *Moringa oleifera* is very important so as to preserve its numerous

nutrients, easy storage and transportation. Processing plant vegetable makes it safe for consumption because the effects of pathogens are greatly minimized. The processing of vegetable food matter like moringa leaves are affected by a number of factors such as sensitivity of the nutrient to light, heat and oxygen [7]. Certain qualities might be lost during drying, it is therefore imperative to determine the most appropriate method that will minimize loss in nutrients to the barest minimum.

Cooking or cookery is the art, technology and craft of preparing food for consumption with or without the use of heat. Cooking techniques and ingredients vary widely across the world from grilling food over an open fire to using electric stoves, to baking in various types of ovens, reflecting unique environmental, economic and cultural traditions and trends [8].

Nutrient loss is a consequence of nearly every cooking process. Exposure to heat, light or oxygen will alter the nutrients found in food, and methods that involve water often reduce the amounts of nutrients as these get 'washed out' and left behind. Certain nutrients, particularly sodium, potassium and calcium, may be lost when cooking in water. This process is called leaching; nutrients lost during leaching are usually discarded with the cooking waters. However, cooking foods also has its advantages, including a reduction of the number of possible malignant microbes, an increase in digestibility and the increased availability of certain phytonutrients. Cooking processes that involve heating also make certain nutrients more available for the body to use. For example, the amount of total carotenoids content in carrots and other vegetable-based dishes is higher in boiled versions. Cooking food improves digestion and increases absorption of many nutrients for example; protein in cooked egg is 180% more digestible than in raw eggs [9].

Leaves of *Moringa oleifera* which are rich in micronutrients but are mostly discarded or go waste was due to poor processing and preservation techniques. In This study the effect of drying (shade drying) and cooking on the nutritive value on Moringa Leaves was assessed. The aim of this research is to compare the nutritional content of dried and cooked Moringa leaves by determining the moisture contents, ash contents, crude fibre, crude lipid, protein, carbohydrate and mineral composition.

## 2. Materials and Methods

### 2.1. Sample Collection and Preparation

Fresh, mature and healthy leaves of *Moringa oleifera* were used for this study. The leaves samples were collected from Sokoto state in Northern Nigeria.

The collected samples were divided into two portions. Shade drying was employed to dry the sample. The second sample was cooked. The Sample for shade drying was spread on a tray under a net and dried for 14 days in a well ventilated room where natural current of air and an average room temperature of 25°C were prevalent which was shade dried and the other portion was subjected to cooking for 10

mins and then shade dried for 14 days. The two portions were grounded in a clean and dry mortar and pestle separately and respectively into fine powder, coarse and molded forms each sample was ground separately

### 2.2. Methods

The methods used in this work were described and recommended by the Association of official Analytical Chemists. Official Method of Analysis of the Association of Official's Analytical Chemist, 7th edition. Arlington, Virginia [10].

#### 2.2.1. Moisture Content

The samples (2g each) were weighed into each of the crucibles and weighed. The crucibles were then inserted into an oven at 105°C and allowed overnight. The crucibles were removed and inserted into a desiccator to cool for 5 mins. Each sample was carefully removed from the desiccator and weighed.

The %moisture content was calculated.

$$\%moisture = \frac{\text{loss in weight due to drying}}{\text{weight of sample taken}} \times 100$$

#### 2.2.2. Ash Content

2g of each sample were placed the empty crucibles and weighed. The crucible containing the sample was then heated in muffle furnace at 600°C for 5 hours to burn off all the organic matter. After the ashing period, the samples were placed into a desiccator gently to cool and weighed.

The ash content was calculated using the following

$$\%Ash = \frac{\text{weight of ash}}{\text{weight of sample}} \times 100$$

#### 2.2.3. Crude Lipid

The samples (2g each) were measured into glass bottle. 20cm<sup>3</sup> of n-Hexane was added. It was shaken thoroughly and the solvent solutions are allowed to settle for 24 hrs. Empty petri-dishes were weighed. The oil was then carefully extracted into petri-dish and the solvent was allowed to evaporate and then weighed.

The percentage of crude lipid was calculated using the formula:

$$\% \text{ Crude Lipid} = \frac{\text{weight of oil}}{\text{weight of sample}} \times 100$$

#### 2.2.4. Crude Fiber

The samples (2g each) were placed in a conical flask, 20cm<sup>3</sup> of distilled water and 20cm<sup>3</sup> of 10% H<sub>2</sub>SO<sub>4</sub> was added, it was fixed to boil for 30 minutes to maintain constant volume. The samples were filtered and rinsed with water. The samples were scrapped into a flask with the aid of spatula. 20cm<sup>3</sup> of 10% NaOH was added and then placed on a heater again to boil for 30mins. The samples were filtered using a filter paper and ethanol was used to rinse the samples once again, it was allowed to drain and the residue was scrapped into crucibles. The crucibles were then placed in an oven to dry at 105°C after which the weight was taken. The

crucibles were then placed in muffle furnace to ash for 2 hours at 550°C and allowed to cool in desiccators and

weighed again.

Percentage fibre was then calculated using the following

$$\%Crude\ fibre = \frac{weight\ after\ drying - weight\ after\ ashing}{weight\ of\ sample} \times 100$$

**2.2.5. Crude Protein**

The samples were (0.5g) weighed into 2 different distillation tubes and 10cm<sup>3</sup> of Conc. H<sub>2</sub>SO<sub>4</sub> was added into each tube followed by 40cm<sup>3</sup> of distilled water to dilute the acid then kjeldahl tablet was added in each tube to the mixture to digest the inorganic matter present. The tubes were sent into the digestion chamber for digestion.

From the digestion tubes, 10cm<sup>3</sup> of the samples were measured respectively and added into the digestion flask followed by 20cm<sup>3</sup> distilled water and then 20cm<sup>3</sup> NaOH (40%) to make up the solution. The mixture was sent into the distillation chamber for the nitrogen content; to extract out ammonia present in the sample which will be evaporated into the boric acid indicator, before protein analysis. It was allowed for about 3 minutes, where 20cm<sup>3</sup> of the boric acid indicator was placed into a flask and inserted beneath the distillation chamber used as the receiver of the nitrogen

extracted. Where the ammonia was liberated into the boric acid and changes the indicator's colour from pink to green.

The green mixture with ammonia was titrated against 0.01M H<sub>2</sub>SO<sub>4</sub> to end point, which give the actual amount of protein content in sample. The colour change was from green to pink and the end point and the titre values were recorded respectively.

The crude protein was calculated using the following equations

$$\% \text{ Nitrogen} = \frac{Tv \times N \times 0.014 \times \text{Dilution factor} \times 100}{\text{weight of sample (w)} \times \text{vol of aliquot}}$$

$$\% \text{ crude protein} = \% \text{ Nitrogen} \times \text{conversion factor (6.25)}$$

**2.2.6. Carbohydrate**

The carbohydrate content of a food is not determined directly but obtained by the method of differences as shown below;

$$\% \text{ Total carbohydrate} = 100 - (\% \text{ ash} + \% \text{ moisture} + \% \text{ crude protein} + \% \text{ crude lipid} + \% \text{ crude fibre})$$

**2.2.7. Mineral Analysis**

2g of each sample were weighed into the crucible, and then later taken into muffle furnace for ashing. The ash sample was digested with 5cm<sup>3</sup> of 20% HCl and distilled water was added to make it 50cm<sup>3</sup>.

Calcium: A pipette was used to measure 1cm<sup>3</sup> of the sample and was diluted with 19cm<sup>3</sup> distilled water. 1cm<sup>3</sup> of NaOH was added with murexide indicator to a diluted sample solution. The colour of the solution at the initial stage was pink. The solution was then titrated with 0.01M EDTA solution until the colour changed to purple. The calcium content was determined using the formula

$$\% \text{ Calcium} = \frac{TV \times M.EDTA}{\text{Aliquot of sample}} \times 1000$$

Magnesium: From the digested sample, 1cm<sup>3</sup> was pipette and diluted with 19cm<sup>3</sup> of distilled water, 5cm<sup>3</sup> of ammonium buffer solution and Erichrome black T indicator was added. The initial colour of the solution was pink. The solution was then titrated with 0.01M EDTA solution until it changes to blue color at the end point. The magnesium content was determined using the formula

$$\% \text{ Magnesium} = \frac{TV \times M.EDTA}{\text{Aliquot of sample}} \times 1000$$

**Sodium and Potassium**

These were determined using flame photometry. The flame photometer was switched on and allowed to stabilize. It was then calibrated to zero with blank using distilled water and then set to full range of 100% transmittance using 10 ppm of sodium standard solution. 2 ppm, 4 ppm, 6 ppm, 8 ppm and the samples were run and the readings obtained were used to

plot a straight line graph of transmittance against concentration. The concentration obtained was multiplied by dilution factor.

Phosphorus: Using a pipette, 2cm<sup>3</sup> of the aliquot samples were measured into 50cm<sup>3</sup> volumetric flask. Phosphorus extraction solution (2cm<sup>3</sup>) and Ammonium molybdate solution (2cm<sup>3</sup>) were added to ¾ of the flask. Diluted stannous chloride (1cm<sup>3</sup>) was added. The mixture was then shaken thoroughly and distilled water was added to the marked of volumetric flask (50cm<sup>3</sup>). The colour intensity of the samples was measured using a spectrophotometer. The absorbance readings were recorded, and the phosphorus content was determined using all the dilution factors. Phosphorus content can be determined using the formula below.

$$P = \frac{A \times C.F \times D.F_o \times D.F_i}{\text{Atomic weight of phosphorus}}$$

**3. Results and Discussion**

*Table 1. Table of Proximate composition of dried and cooked leaves of Moringa Oleifera.*

Parameters	Dried Cooked	
Moisture (%)	3.00	5.00
Ash (%)	13.50	10.00
Crude Lipid (%)	5.0	7.5
Crude Fibre (%)	8.50	10.00
Protein (%)	5.43	9.98
Carbohydrate (%)	62.57	59.52

*Moringa oleifera* leaves contain protein, lipid, carbohydrates and minerals making it a nutritionally important vegetable. Table 1 shows the proximate analysis

results of dried and cooked leaves of *Moringa oleifera*.

From the table the moisture contents of the cooked one is 5.0% which is slightly higher than that of the dried leaves (3.0%).

Ash content signifies the level of minerals present in samples. From table 1, the ash content of the two samples analyzed revealed the ash content of the dried leaves to be 13.5% and that of the cooked leaves to be 10.0%. This shows that the dried sample contain more minerals than the cooked sample.

From Table 1, it can also be seen that the crude protein values of the two samples are 5.43% and 9.98% for the dried and cooked samples respectively. The higher amount of protein in the cooked sample is in agreement with Diaz, that cooking increase and makes protein more digestible [9]. Dietary proteins are needed for the synthesis of new cells, repair of worn out tissues, enzymes, antibodies and other substances required for healthy body functioning and development of the body and its protection and for treatment of protein energy malnutrition [11].

The crude lipid reported from the analysis showed that the cooked leaves contain more crude lipids (7.5%) than the dried sample (5.0%) which is similar to that (5.46±0.19) reported by Mouminah [12].

Deficiency of fibre in foods is linked to appendicitis, diverticular disease and haemorrhoids [13].

From table 1, the crude fibre of the dried leaves was found to be 8.5% and that of the cooked leaves was higher having (10.0%). This shows that the cooked leaf is a good source of dietary fibre. The carbohydrate content in the two samples of *Moringa Oleifera* leaves as shown in table 1 were 62.57% and 59.52% for the dried leaves and cooked leaves. This indicates that cooking decreases the carbohydrate content

**Table 2.** Table of Mineral Composition of dried and cooked leaves of *Moringa oleifera*.

Minerals Dried (mg/g)	Cooked (mg/g)
Na	0.14 0.08
K	5.10 2.60
Ca	0.28 0.22
Mg	0.29 0.25
P	5.58 4.91
N	0.87 1.61

Table 2 represents the mineral composition of the dried and cooked leaves of *Moringa Oleifera*. Five minerals were analyzed based on their importance in metabolism and general body regulations

Magnesium is very important in calcium metabolism in bones and also involved in prevention of circulatory diseases, it helps in regulating blood pressure and insulin release [14]. Magnesium deficiency reduces cell formation it also reduces the osteoblasts formation of bones [15]. From table 2 the concentration of Mg in the two samples is as follows; 0.29 mg/g and 0.25 mg/g for the dried and cooked leaves respectively.

Calcium is an important element/mineral required for bone formation and neurological function of the body. The world

health organization (WHO) daily intake permissibility is 0.8 mg/g per day for both adults and children. From table 2 the calcium content for the dried leaves was 0.14 mg/g and that of the cooked leaves was 0.08 mg/g

Phosphorus value obtained in the analysis carried out on samples showed moderate value of concentrations.

From table 2, the results showed that the dried leaves retained more sodium content than cooked leaves. The lower sodium content in cooked vegetables is attributed to effects of cooking. Sodium is micronutrient that, maintain the osmotic pressure, acid-base balance, relaxation of the muscles. It also helps in absorption of glucose and transmission of nerve impulses [16].

The result of potassium showed that, the dried leaves have higher value than the cooked leaves. The higher potassium in dried leafy vegetables may be advantage since it can be used for therapy. Dietary potassium decrease blood pressure, it involves in nerve functions of muscles control. Increase potassium in diet may protect against hypertension in people who are sensitive to higher level of sodium [16].

## 4. Conclusion

The studies showed that the cooked leaves of *Moringa oleifera* contain higher proximate composition with exception of Carbohydrate which is higher in the dried leaves. Also the minerals contents are higher in dried leaves than the cooked leaves. It can be concluded that drying reduces the nutrients such as fibre, lipid and protein of *Moringa*, while these contents are retained in the cooked leaves. However mineral composition is lower in the cooked leaves. The nutrient loss is a consequence of nearly every cooking process. Exposure to heat, light or oxygen alters the nutrients found in food, and methods that involve water often reduce the amounts of nutrients as these get 'washed out' and left behind. Certain nutrients, particularly sodium, potassium and calcium are lost when cooking in water and are usually discarded with the cooking waters. It is therefore recommended that *Moringa Oleifera* leaves should be cooked moderately, excessive washing should be avoided. It should also be dried at ambient conditions in order to retain its nutrients.

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