



## Impact of Cooking on the Nutritional Composition of *Moringa Oleifera* Pods

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**Abstract:** *Moringa oleifera* is a highly versatile plant known for its nutritional and medicinal benefits. This study analyzed the nutrient composition of *Moringa oleifera* pod powder before and after processing, focusing on total protein, carbohydrates, minerals, total fat, total calories, ash content, and crude fiber. Various analytical techniques, including the Biuret method, atomic absorption spectroscopy, Weende's method, and the Anthrone method, were employed. It was found that, the changes in the nutrient content of *Moringa oleifera* pods before and after processing: Moisture content: Before - 7.7 mg; After - 3 mg, Ash content: Before - 14.67 mg; After - 3.67 mg, Carbohydrate content: Before - 4.92 mg; After - 4.06 mg, Protein content: Before - 3.13 mg; After - 2.34 mg, Fat content: Before - 7.86 mg; After - 4.05 mg, Crude fiber content: Before - 1.50 mg; After - 2.72 mg, Energy value: Before - 102.94 k cal; After - 62.05 k cal. also rich in minerals Potassium (K): Before 4.34 ppm, After 7.01 ppm, Sodium (Na): Before 0.64 ppm, After 0.73 ppm, Calcium (Ca): Before 1.40 ppm, After 1.17 ppm, Zinc (Zn): Before 37.79 ppm, After 19.77 ppm, Iron (Fe): Before 95.17 ppm, After 121.72 ppm, Copper (Cu): Before 6.02 ppm, After 0.00 ppm, Manganese (Mn): Before 88.75 ppm, After 0.00 ppm, Phosphorus (P): Before 1.243 ppm, After 1.009 ppm, Sulfur (S): Before 0.175 ppm, After 0.282 ppm. These findings highlight the impact of processing on *Moringa oleifera* pod powder, suggesting potential alterations in its nutritional profile that may influence its dietary applications.

**Keywords:** *Moringa oleifera*, nutrition, protein, carbohydrates and minerals.

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## 1. Introduction

*Moringa Oleifera* is a plant that comes from the *Moringaceae* family and is the most well-known member of its genus. It is the best known of the genus *Moringa oleifera*, which has 13 species. Almost every part of *Moringa oleifera* (leaf, pod, bark, gum, flower, seed, seed oil, and root) has been used to treat various diseases (Tobias, 2010). *Moringa* is useful for treating conditions such as high blood pressure, anxiety, diarrhea, and as a diuretic. It is also used for dysentery and colitis (Stohs and Hartman, 2015). It is a source of medicinal compounds and has components of high nutritive value such as protein, amino acids, carbohydrate minerals, vitamin and organic acids. *Moringa oleifera* contains higher amounts of vitamin A than carrots, higher extent of vitamin C than oranges, more calcium and potassium content than milk and bananas respectively. Additionally, moringa is richer in iron than spinach by 9 times, also more in fibre than oats by 4 times, and a protein quality similar to that of egg and milk protein, which is more easily digested and absorbed (Zhang *et al.*, 2020). Phytochemicals present in *Moringa* leaves include tannins, sterols, terpenoids, flavonoids, saponins, anthraquinones, alkaloids, and reducing sugars (Rockwood *et al.*, 2013). Additionally, they contain anticancer agents like glucosinolates, isothiocyanates, glycoside compounds, and glycerol-1-9-octadecanoate (Berkovich *et al.*, 2013).

The pods of *Moringa* are fibrous and are valuable for treating digestive problems and preventing colon cancer. Research shows that immature pods contain approximately 46.78% fiber and 20.66% protein content. The amino acid content is 30% in pods, 44% in leaves, and 31% in flowers. Moreover, the immature pods and flowers have similar amounts of palmitic, linolenic, linoleic, and oleic acids (Oyeyinka and Oyeyinka., 2018).

Pregnant women and lactating mothers can safely consume drumsticks. They contain folic acid, which prevents birth defects, and iron, which prevents anemia. Drumsticks can help with morning sickness and low energy during pregnancy. Lactating women can drink drumstick leaves juice with ghee to promote breast milk production (Sanchez *et al.*, 2010).

Recent studies show that different extracts of *Moringa Oleifera* have various effects. These include antimicrobial (Mishra *et al.*, 2011), antifungal (Upadhyay *et al.*, 2015), anti-inflammatory, antioxidant, anticancer, fertility-enhancing, wound-healing (Venkatesh *et al.*, 2019), and other medicinal properties (Mishra *et al.*, 2011).

*Moringa oleifera* ethanolic root extract contains N-benzylethylthioformate, a compound that fights many types of microbes and fungi (Upadhyay *et al.*, 2015).

The methanolic leaf extract can help prevent urinary tract infections caused by bacteria like *Klebsiellapneumoniae*, *Staphylococcus aureus*, and minerals, making them a nutrient-dense super food that has been used as medicine for a long time. *Escherichia coli*, and *Staphylococcus saprophyticus*. Drumsticks (*Moringa oleifera*) are low in calories but packed with important vitamins (Maurya and Singh, 2014). This adaptable plant offers many health benefits, showing its versatility and making it a great addition to any diet. In this post, we will look at the nutritional value of drumstick per 100 grams.

## 2. Material and Methods

### 2.1. Sample Preparation

Fresh *Moringaoleifera* pods were sourced from a local farm market. Plant material authenticated at botany Department, Kwcsangli. Pods of uniform size and maturity were selected to ensure consistency in the analysis. Pods were dried before cooking. Pods were cooked, then ground into fine powders both before and after cooking. The powders were stored in airtight containers.

### 2.2. Moisture Content Determination

The method outlined by Rajput et al. (2017) was used to determine the moisture content of the dried *Moringa* pod powder. Two petri dishes were each filled with 3 g of powder: one with powder before cooking and the other with powder after cooking. Both petri dishes were then weighed to record the initial weights. The samples were dried in an oven at 100°C for 4 hours. After drying, the petri dishes were weighed again to obtain the final weights. The moisture content of each sample was calculated using the following equation:

$$\text{Moisture Content (\%)} = \frac{\text{initial weight of sample} - \text{final weight of sample}}{\text{Final weight of sample}}$$

### 2.3. Protein Content (Biuret Method)

Collected two moringa powder samples: before cooking and after cooking. Weighed exactly 10 grams of each sample using an analytical balance. Dissolved each 10 g sample in distilled water, stirring thoroughly until completely mixed. Centrifuged each sample solution to remove larger particles. Filtered the supernatant through muslin cloth to obtain clear solutions. Pipetted 0.5

ml, 1.5 ml, 2 ml, and 2.5 ml of standard moringa solution into separate, clean, and dry test tubes. Adjusted the final volume of each solution to 2.5 ml by adding distilled water. Added 5 ml of Biuret reagent to each test tube containing the moringa solution. Mixed thoroughly to ensure even reaction. Allowed the solutions to stand at room temperature for 30 minutes to ensure complete reaction. Measured the absorbance of each sample, including both the uncooked and cooked moringa samples, using the colorimeter at 620 nm (David, 1987)

#### **2.4. Fat Content**

Homogenized 1 gram each of pre-cooked and post-cooked powder with chloroform and methanol in a 2:1 concentration (using a total volume of 20 ml of the solvent mixture). Agitated both mixtures in an orbital shaker at room temperature for 15–20 minutes. Filtered both homogenates using a filtration assembly. Washed the solvent with 4 ml of 0.9% NaCl solution into each 20 ml homogenate and mixed well. Centrifuged each homogenate at 2000 rpm for 10 minutes. Collected the organic phase containing lipids from each sample and added 2.3 ml of this phase to a pre-weighed evaporating dish. Evaporated the solvent at 50°C and reweighed the dish to determine the lipid content (AOAC).

#### **2.5. Ash Content Determination**

Using a technique developed by Akubugwo *et al.* (2007), Collected samples of *Moringa Oleifera* pod powder before cooking and after cooking. Weighed exactly 3 grams of each sample and placed them into separate crucibles. Heated the samples at 530°C for 3 hours in a muffle furnace. Weighed the residue left after heating to determine the ash content of each sample.

$$\text{Ash content (\%)} = \frac{\text{Initial weight of sample} - \text{final weight of sample}}{\text{final weight of sample}} \times 100$$

#### **2.6. Crude Fiber Content**

Weighed 2 grams each of the pre-cooked and post-cooked samples and placed them into separate 250 ml flasks. Added 200 ml of 1.25% sulfuric acid (H<sub>2</sub>SO<sub>4</sub>) to each flask containing the samples. Boiled both mixtures for 30 minutes. Filtered each mixture using filter paper. Rinsed each residue with hot water until the rinse water was no longer acidic (checked with pH paper). Transferred each

residue to a 250 ml beaker. Added 200 ml of 1.25% sodium hydroxide (NaOH) to each beaker and boiled for another 30 minutes. Filtered each mixture again and rinsed with distilled water until the rinse water was neutral (checked with pH paper). Moved each residue to a separate crucible. Dried the crucibles with the residues in an oven at 230°C for 2 hours. Cooled the crucibles in a desiccator and weighed them. (AOAC)

*Crude Fiber Content (%)*

$$= \frac{\text{initial weight of sample} - \text{final weight of sample}}{\text{final weight of sample}} \times 100$$

### **2.7. Carbohydrates estimates (Anthrone method)**

Weighed 100 mg each of the pre-cooked and post-cooked moringa powder samples into separate boiling tubes. Hydrolyzed both samples by placing them in a boiling water bath for 3 hours with 5 ml of 2.5 N HCl, then allowed them to cool to room temperature. Neutralized each solution with solid sodium carbonate until effervescence ceased. Adjusted the volume of each solution to 10 ml and centrifuged the mixtures. Collected the supernatant from each and took 0.5 ml and 1 ml aliquots for analysis. Prepared standards for both samples by taking 0.2, 0.4, 0.6, and 0.8 ml of the working standard solution into separate tubes. Marked a blank tube to serve as a control. Make up the volume in each tube to 1 ml by adding distilled water. Added 4 ml of anthrone reagent to each tube. Heated the tubes for 8 minutes in a boiling water bath. Cooled the tubes rapidly and measured the color intensity, which ranged from green to dark green, at 630 nm. Draw a standard graph by plotting the concentration of the standard on the x-axis versus absorbance on the y-axis. Calculated the amount of carbohydrate present in the sample tube using the graph (David, 1987).

### **2.8. Caloric Value Estimation**

The total calories were estimated by multiplying the amounts of: Crude protein by its energy value of 4. Crude fat by its energy value of 9. Carbohydrates (excluding crude fiber) by its energy value of 4.

$$\text{Calories} = (\text{Protein (g)} \times 4) + (\text{Fat (g)} \times 9) + (\text{Carbohydrate (g)})$$

**Table 1: Mineral analysis procedure**

Sl. No.	Parameter	Formula	Producer
1	Preparation & Processing of Plant sample.	Washing – In Four plastic pots. 1. In Detergent Soln. 0.2 gm Vim in 100 ml tap water. 2. In acid soln. 4 ml HCl + 1 lit tap water. 3. In Single D/W. 4. In Double D/W.	After washing oven dry plant leaf & petiole sample separately at 60 to 70°C & grind & stored in polythene bags in open laboratory.
2	Digestion - Diacid	Stock Diacid - 300 ml Nitric acid + 100 ml Perchloric acid .	1 gm petiole sample + 20 ml diacid soln. till clear, colourless cool & make volume to 100 ml
3	Potassium % Apr. (2.00 to 3.02 ) Oct. (1.14 to 2.20 )	Reading in ppm $\times$ 0.05 ( Calculation with dilution factor )	Dil. diacid 1 to 50. Read abs. on flame photometer.
4	Sodium % Apr. (Less than 0.5 ) Oct. (Less than 0.5)	Reading in ppm $\times$ 0.5 ( Calculation with dilution factor )	Dil. diacid 1 to 50. Read abs. on flame photometer
5	Calcium % Apr. (0.98 to 1.36 ) Oct. (0.74 to 1.14 )	Reading in ppm $\times$ 0.25 ( Calculation with dilution factor )	Dil. diacid 1 to 50. Read abs. on flame photometer
6	Zinc ppm Apr. ( 33 to 88 ) Oct. ( 53 to 132 )	Reading in ppm $\times$ 100	Direct diacid ext. run on AAS.
7	Ferrous ppm Apr. (Gre. than 25 ) Oct. (Gre. than 25)	Reading in ppm $\times$ 100	Direct diacid ext. run on AAS
8	Copper ppm Apr. ( 5.0 to 10.0 ) Oct. ( 5.0 to 10.0 )	Reading in ppm $\times$ 100	Direct diacid ext. run on AAS
9	Manganese ppm	Reading in ppm $\times$ 100	Direct diacid ext. run on AAS
10	Phosphorous % Apr. (0.29 to 0.65 ) Oct. (0.38 to 0.75 )	Abs $\times$ 0.05 0.077 Slope – 0.077	5 ml Diacid ext. + 5 ml vanadomolybdate + dil. to 25 ml D/W + Yellow colour + After 30 min. read abs. at 420 nm.
11	Sulphur % Apr. (0.09 to 0.13 ) Oct. (0.14 to 0.27 )	Abs $\times$ 0.01 0.002 Slope – 0.002	5 ml diacid + 1 ml 6N HCl + 1 ml Gum acasia + Before reading add 0.5 gm Bari. Chloride & stir 1 min. white turbidity. formed. Imme. Read abs. at 420 nm.

### 3. Result and Discussion

#### 3.1. Nutritional Analysis

*Moringa Oleifera* pods are highly nutritious, providing a rich source of vitamins and minerals both before and after cooking. The nutritional analysis of *Moringa Oleifera* pods highlights the importance of preparation methods. While raw pods are nutrient-dense and rich in vitamins and antioxidants (Khan and Ali., 2023), cooking them can improve their flavor, texture, and digestibility, making them more enjoyable and accessible (Table 2).

**Table 2: Proximate analysis of *Moringa Oleifera* pod**

Sl. no.	Proximate composition	Before cooking of <i>Moringaoleifera</i> pod (%)	After cooking of <i>Moringaoleifera</i> pod (%)
1	Moisture	7.7	3
2	Ash	14.67	3.67
3	Carbohydrates	4.92	4.06
4	protein	3.13	2.34
5	Fat	7.86	4.05
6	Crude fiber	1.50	2.72
7	Energy value	102.94	62.05

*Moringa Oleifera* pods are a rich source of essential minerals, contributing to their nutritional value and health benefits. These minerals play crucial roles in various bodily functions, including bone health, muscle function, immune support, and overall metabolic processes. The cooking process can affect the mineral content of moringa pods, with some minerals showing slight reductions, while others, like iron, may become more bioavailable (Table 3).

**Table 3: Minerals analysis of *Moringa Oleifera* pod**

Sl. no	Mineral	Before cooking of <i>Moringa Oleifera</i> pod (ppm )	After cooking of <i>Moringa Oleifera</i> pod (ppm)
1	Potassium (K)	004.34	007.01
2	Sodium (Na)	000.64	000.73
3	Calcium (Ca)	001.40	001.17
4	Zinc (Zn)	37.79	19.77
5	Iron (Fe)	95.17	121.72
6	Copper (Cu)	6.02	0
7	Manganese (Mn)	88.75	0.00
8	Phosphorus (p)	1.243	1.009
9	Sulphur (S)	0.175	0.282

The study on the impact of cooking on the nutritional composition of *Moringa oleifera* pods reveals significant changes in various nutrient levels before and after processing. Before cooking, the moisture content of the moringa pods was measured at 7.7%, while after cooking, it significantly decreased to 3%. Interestingly, thermally processed moringa pods showed a higher moisture content than their raw counterparts. This increase in moisture can be attributed to the absorption of water during the thermal processing stage, which could heighten the risk of microbial growth. Consequently, the elevated moisture levels in thermally processed pods suggest that appropriate storage measures are essential to mitigate spoilage risks (Shareef *et al.*, 2019). The ash content, which serves as an indicator of mineral composition and overall food quality, showed a slight reduction in thermally processed moringa pods, measuring 3.67% compared to 13.67% in the raw pods. This decrease suggests that thermal processing may result in some mineral loss. Moringa, known for its leaves, pods, seeds, and roots, is a rich source of essential nutrients, including proteins, vitamins (A, C, E, and B-complex), minerals (such as calcium, iron, and potassium), and dietary fiber. It is particularly renowned for its high protein content and a wide array of antioxidants (Khan and Ali., 2023).

Cooking resulted in a decline in several important nutrient components, including protein (from 3.13 mg to 2.34 mg), total fat (from 7.86 mg to 4.05 mg) and total calories (from 102.94 kcal to 62.05 kcal). This suggests that cooking may lead to the loss of some beneficial macronutrients. Increase in Crude Fiber: Interestingly, the crude fiber content increased from 1.50 mg to 2.72 mg post-processing, indicating that some processing methods may enhance the fiber content, potentially benefiting digestive health. Mineral Variability: The mineral content exhibited mixed results; while levels of potassium (K), sodium (Na), and iron (Fe) increased after cooking, there were notable decreases in zinc (Zn) and copper (Cu) levels. Specifically, iron content rise from 95.17 ppm to 121.72 ppm, which could be advantageous for dietary iron intake. Decreased Ash Content: The ash content, which reflects the mineral content, showed a significant reduction from 14.67 mg to 3.67 mg, indicating that the overall mineral content may have been diminished by the cooking process, despite some individual minerals showing increases. Iron content in drumsticks has increased from 95.17 ppm to 121.72 ppm, making them a valuable addition to the diet of pregnant women and lactating mothers. These nutritious vegetables provide essential folic acid, which helps in preventing birth defects, and their higher iron content plays a crucial role in combating anemia. Drumsticks can also alleviate morning sickness and boost energy levels during pregnancy. For

lactating women, consuming juice made from drumstick leaves combined with ghee may enhance breast milk production (Sanchez *et al.*, 2010). Further studies indicate that the *Moringa* seed kernel extract can effectively inhibit *Bacillus cereus*, *Staphylococcus aureus*, *Mucor* species, and *Aspergillus* species, though its efficacy is diminished against *Pseudomonas aeruginosa* and *Escherichia coli*. This reveals the potential for using *Moringa* seed extract in treating infections caused by susceptible species (Anzano *et al.*, 2022). Moreover, low-dose aqueous extracts from *Moringa Oleifera* leaves have been shown to possess anti-diabetic properties by slowing glucose absorption through the intestinal membrane. Research from 2018 indicated that *Moringa* leaf powder could reduce glucose absorption in diabetic mice, suggesting its potential as an antidiabetic treatment, although further research is essential before it can be fully endorsed as a viable therapeutic option. Emerging evidence also suggests that *Moringa oleifera* may play a role in cancer prevention (Khan and Ali., 2023). A study in 2013 demonstrated that crude aqueous extracts from *Moringa* leaves could inhibit the growth of A549 lung cancer cells by increasing oxidative stress, leading to DNA fragmentation and inducing apoptosis. These findings underscore the need for further *in vivo* studies to explore *Moringa*'s anti-tumor effects and identify the active anti-cancer compounds. Lastly, *Moringa Oleifera* extracts have been associated with lowering blood pressure and cholesterol levels (Tiloke *et al.*, 2013). Compounds like thiocarbamates and isothiocyanate glycosides in *Moringa* pods and seeds exhibit anti-hypertensive effects. An *in vivo* study demonstrated that mustard oil glycosides present in *Moringa* leaves could reduce blood pressure through tissue relaxation, albeit through mechanisms different from traditional vasodilators like atropine. However, the safety of these compounds warrants further investigation (Lin *et al.*, 2010). Overall, the nutritional profile of *Moringa*, rich in proteins and minerals, further underscores its potential as a functional food with diverse health benefits.

#### 4. Conclusion

Overall, the findings indicate that while cooking can enhance some aspects of the nutritional composition of *Moringa Oleifera* pods, such as crude fiber and certain minerals, it can also lead to the loss of key macronutrients like proteins and fats. This suggests that the preparation method can significantly influence the dietary applications of *Moringa Oleifera* pods, and those looking to maximize its health benefits should consider these changes in nutrient composition when planning its use in diets. Further research may be warranted to explore optimal

cooking methods that preserve nutritional quality while enhancing safety and digestibility.

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