The Effects of *Moringa oleifera* Leaves on Complete Blood Count, Renal and Liver Functions as Potential Therapy for Malnutrition

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**Background:** *Moringa oleifera* which is available in many areas all over the world including Sudan is low-cost and traditionally used in the treatment of many disorders, including malnutrition. This study aimed to determine the effect of aqueous extract of *M. oleifera* leaves in renal, liver functions and complete blood count (CBC) parameters, and its potential as therapy for malnutrition.

**Materials and methods:** This was an experimental case control study using twenty-five Wistar albino rats. Rats were divided into three groups: normal protein diet group, low protein diet with or without *M. oleifera* extract groups. We determined rats' weight, CBC parameters, blood mineral concentrations, as well as liver and renal functions at day 0, 7, and 14.

**Results:** Our findings showed that rats' weight were significantly different between the three groups at day 0, 7, and 14. Rats' weight, blood sodium, potassium, calcium, and urea concentration, as well as Hb concentration, TWBCs count, total platelets count, and %lymphocyte showed significant differences between three groups at day 0, 7, and 14.

**Conclusion:** *M. oleifera* leaves can be used as potential therapy for malnutrition because they have some effects on weight, blood mineral concentrations, renal and liver function, as well as CBC parameters.

**Keywords:** ALP, AST, ALT, creatinine, *Moringa oleifera*

**Introduction**

Malnutrition can lead to mental or physical disability, illness, and possible death.¹ The malnutrition prevalence rate in Sudan increased from 18% in 1995 to 23% in 1999, both in the North and the government-controlled areas in the South.²

Ready To-Use Therapeutic Foods (RUTFs) supplied by UNICEF for helping severe malnourishment are commonly used all over the world. However, it is expensive and it takes a long time to reach affected areas.³,⁴ In folklore medicine, many herbs are used to prevent and treat malnutrition and many other conditions e.g., snakebite and tumor. Among
these herbs, *Moringa oleifera* leaves are commonly used to treat malnutrition.5

These problems motivated us to search for an available, cheap, affordable, and effective malnutrition treatment. *M. oleifera* which is available in many areas all over the world including Sudan is low-cost and traditionally used in the treatment of many disorders, including malnutrition. This study aimed to determine the effect of aqueous extract of *M. oleifera* leaves in the treatment of malnutrition-induced Wister albino rats.

**Materials and methods**

**Study Design and Animal Treatment**

This was an experimental case control study using twenty-five Wistar albino rats. The samples were taken under anesthesia, animals were kept in well-ventilated area and fed properly.

Rats were divided into three groups. Group I (control) consisted of 5 rats that were fed a well-balanced diet containing 50% flour, 20% meat, 20% milk, 5% salt, and 5% oil.6,7 Group II consisted of 10 rats that were fed with low protein diet only. Group III consisted of 10 rats that were fed low protein diet added with aqueous extract of *M. oleifera*. All treatments were given for 7 days. The research was approved by the research committee of the Faculty of Health Sciences-Ahfad University for Women and Ministry of Health Ethical Research Committee (No. MH-RES/07-021-09, year 2021).

**Plant Materials**

*M. oleifera* fresh leaves were collected from Faculty of Agriculture, University of Khartoum. It was identified and authenticated by Department of Taxonomy, University of Khartoum. Twenty g of *M. oleifera* leaves were dried in oven at 40°C overnight for 8 h.

**Hematological and Biochemical Analysis**

All rats were weighed and the blood samples were collected at day 0, 7 and 14 from all rats for the determination of CBC parameters, magnesium, calcium, and phosphorus concentrations, as well as liver and renal functions to ensure the induction of malnutrition. Blood samples were collected from the retro-orbital plexus of all rats, using non heparinized and heparinized capillary tubes according to previous reports.6,8

The levels of total protein, albumin, urea, creatinine, sodium, potassium, calcium, phosphorus as well as aspartate transaminase (AST), alanine transaminase (ALT) and alkaline phosphatase (ALP) enzymes were determined using Plasmatec kits.9

Biochemical and hematological blood analysis was conducted at the Khartoum Hospital Laboratory Research Unit. CBC was estimated using Sysmex machine (Model KX-21N).10,11

**Statistical Analysis**

Mean values of whole blood and plasma parameters were compared using the student’s t-test to detect the differences (p≤0.05).12,13

**Results**

**Weights of Rats**

Table 1 showed the mean values of rats' weight after administration of three different diets. Results showed significant differences between 3 groups at day 0, 7, and 14. In all groups, rats' weight were increased in a time dependent manner.

**Mineral Concentrations of Rats' Blood**

Table 2 showed the mean values of sodium, potassium, magnesium concentrations measured after feeding the...
rats. The mean values of blood sodium concentration showed significant differences between three groups at day 0, 7, and 14. In Group II and III, sodium concentrations were decreased in a time dependent manner. The mean values of blood potassium concentration also showed significant differences between three groups at day 0, 7, and 14. Meanwhile, the mean values of blood magnesium concentration were not significantly different at day 0, but significantly different at 7 and 14.

Table 3 showed the mean values of calcium and phosphorus concentration. The mean values of blood calcium concentration showed significant differences between three groups at day 0, 7, and 14. While the mean values of blood phosphorus concentration were not significantly different at day 0 and 7, but significantly different at day 14.

**Blood Urea and Creatinine**

Table 4 shows that the mean values of blood urea and creatinine concentration measured after feeding the rats. The mean values of blood urea concentration showed significant differences between three groups at day 0, 7, and 14. Meanwhile, the mean values of creatinine concentration were significantly different at day 0, but not significantly different at day 7 and 14.

**Liver Function Test**

Table 5 shows the mean values of blood total protein concentration, albumin concentration, as well as ALT, AST and ALP concentrations that were measured after feeding the rats. The mean values of total protein concentration were significantly different at day 0 and 14, but not significantly different at day 7. The mean values of serum albumin concentration were significantly different at day 0, but not significantly different at day 7 and 14. The mean values of blood ALT concentration were significantly different at day 0, but not significantly different at day 7 and 14. The mean values of blood AST concentration showed no significant differences between three groups at day 0, 7, and 14. Lastly, the mean values of blood ALP concentration were significantly different at day 0 and 7, but not significantly different at day 14.
Table 3. Mineral concentrations of rats' blood on day 0, 7, and 14.

| Group                        | Day 0          | Day 7          | Day 14         |
|------------------------------|----------------|----------------|----------------|
| Calcium (mg/dL)              |                |                |                |
| Normal protein diet          | 4.68±1.56      | 4.63±1.54      | 3.34±1.36      |
| Low protein diet without M. oleifera | 8.57±0.96 | 11.35±1.40     | 9.26±2.10      |
| Low protein diet with M. oleifera | 9.93±0.14 | 9.71±1.26      | 7.53±1.26      |
| Phosphorus (mEq/L)           |                |                |                |
| Normal protein diet          | 1.77±0.62      | 1.60±0.60      | 1.37±0.57      |
| Low protein diet without M. oleifera | 3.07±0.41 | 1.45±0.23      | 1.03±0.26      |
| Low protein diet with M. oleifera | 3.19±0.25 | 1.62±0.21      | 3.04±0.53      |
| *p*-value                    | 0.004          | 0.006          | 0.040          |

**CBC Parameters**

Table 6 showed the mean values of hemoglobin (Hb) concentration, total white blood cells (TWBCs) count, red blood cells (RBCs) count, total platelets count, %neutrophil, %lymphocyte, %monocyte, %basophil, and %eosinophil that were measured after feeding the rats.

Hb concentration, TWBCs count, total platelets count, and %lymphocyte showed significant differences between three groups at day 0, 7, and 14. The mean values of RBCs count were significantly different at day 0 and 7, but not significantly different at day 14.

The mean values of %neutrophil were significantly different at day 0, but not significantly different at day 7 and 14. The mean values of %monocyte, %eosinophil and %basophil were not significantly different at day 0, 7, and 14.

Table 4. Blood urea and creatinine levels on day 0, 7, and 14.

| Group                        | Day 0          | Day 7          | Day 14         |
|------------------------------|----------------|----------------|----------------|
| Urea (mg/dL)                 |                |                |                |
| Normal protein diet          | 17.90±6.18     | 19.00±6.56     | 16.20±6.73     |
| Low protein diet without M. oleifera | 37.00±4.41 | 61.40±7.54     | 61.90±11.02    |
| Low protein diet with M. oleifera | 35.90±3.30 | 68.30±8.91     | 52.30±9.74     |
| *p*-value                    | 0.0100         | 0.0002         | 0.0050         |
| Creatinine (mg/dL)           |                |                |                |
| Normal protein diet          | 0.52±0.18      | 0.52±0.18      | 0.46±0.19      |
| Low protein diet without M. oleifera | 0.94±0.12 | 0.93±0.39      | 0.92±0.60      |
| Low protein diet with M. oleifera | 1.12±0.13 | 0.98±0.41      | 0.92±0.60      |
| *p*-value                    | 0.0400         | 0.0700         | 0.2000         |
Table 5. Mineral concentrations of rats’ blood on day 0, 7, and 14.

| Group                                      | Total protein (mg/dL) | Serum albumin (U/L) | ALT (U/L) | AST (U/L) | ALP (U/L) |
|--------------------------------------------|-----------------------|---------------------|-----------|-----------|-----------|
|                                      | Day 0     | Day 7     | Day 14   | Day 0     | Day 7     | Day 14   |
| Normal protein diet                       | 3.77±1.23 | 3.60±1.20 | 2.29±1.20| 2.11±0.71 | 2.10±0.70 | 1.45±0.31|
| Low protein diet without *M. oleifera*     | 6.90±0.78 | 4.24±0.57 | 3.22±0.77| 3.88±0.45 | 1.88±0.29 | 1.51±0.38|
| Low protein diet with *M. oleifera*        | 7.55±0.18 | 4.16±0.60 | 5.73±0.97| 4.12±0.20 | 1.71±0.35 | 2.46±0.49|
| *p*-value                                 | 0.020     | 0.800     | 0.001    | 0.010     | 0.300     | 0.400    |

*Discussion*

The mean weight of rats that were fed a low protein diet added with aqueous extract of *M. oleifera* leaves (Group III) was increased in a time dependent manner, indicating the nutritive role of *M. oleifera* leaves. This result was aligned with previous studies.\(^{14-17}\) In addition, young post-
|                          | Group                                      | Day 0          | Day 7          | Day 14         |
|--------------------------|--------------------------------------------|----------------|----------------|----------------|
| **Hb concentration (mEq/L)** | Normal protein diet                        | 28.00±9.72     | 34.50±7.94     | 27.00±7.80     |
|                          | Low protein diet without *M. oleifera*     | 65.10±8.39     | 63.90±7.82     | 40.30±8.50     |
|                          | Low protein diet with *M. oleifera*        | 70.54±4.67     | 50.00±11.70    | 59.70±7.56     |
| *p*-value                |                                            | 0.0030         | 0.0500         | 0.0050         |
| **TWBCs (mEq/L)**        | Normal protein diet                        | 2,715.00±950.67 | 3,500.00±121.11 | 2,190.00±918.51 |
|                          | Low protein diet without *M. oleifera*     | 4,300.00±594.47 | 5,560.00±447.45 | 5,000.00±178.70 |
|                          | Low protein diet with *M. oleifera*        | 5,675.00±518.18 | 7,045.00±765.90 | 4,050.00±704.00 |
| *p*-value                |                                            | 0.0004         | 0.0020         | 0.0400         |
| **RBCs (mg/dL)**         | Normal protein diet                        | 2,237,000±4,948 | 2,570,000±5,226 | 2,307,000±3,142 |
|                          | Low protein diet without *M. oleifera*     | 4,792,800±6,229 | 5,945,700±6,260 | 3,616,500±7,070 |
|                          | Low protein diet with *M. oleifera*        | 4,902,000±4,109 | 6,613,800±6,268 | 4,343,000±6,351 |
| *p*-value                |                                            | 0.0100         | 0.0040         | 0.2000         |
| **Total platelets (mg/dL)** | Normal protein diet                        | 121,000±45,276 | 104,000±44,076 | 99,000±49,068  |
|                          | Low protein diet without *M. oleifera*     | 287,000±42,165 | 356,000±54,123 | 299,000±67,831 |
|                          | Low protein diet with *M. oleifera*        | 330,000±36,788 | 432,000±61,583 | 525,000±63,495 |
| *p*-value                |                                            | 0.0030         | 0.0040         | 0.3000         |
| **Neutrophil (%)**       | Normal protein diet                        | 28.40±9.53     | 27.90±5.70     | 22.60±7.70     |
|                          | Low protein diet without *M. oleifera*     | 49.70±6.05     | 45.40±13.09    | 32.20±12.87    |
|                          | Low protein diet with *M. oleifera*        | 53.50±2.67     | 42.90±11.87    | 45.40±17.78    |
| *p*-value                |                                            | 0.0200         | 0.1000         | 0.0100         |
| **Lymphocyte (%)**       | Normal protein diet                        | 19.30±6.46     | 19.40±7.94     | 15.10±3.00     |
|                          | Low protein diet without *M. oleifera*     | 36.80±4.66     | 30.10±6.80     | 31.90±17.99    |
|                          | Low protein diet with *M. oleifera*        | 42.70±2.73     | 41.40±6.09     | 32.07±16.65    |
| *p*-value                |                                            | 0.0050         | 0.0200         | 0.0100         |
| **Monocyte (%)**         | Normal protein diet                        | 0.70±0.67      | 1.10±0.90      | 1.10±0.78      |
|                          | Low protein diet without *M. oleifera*     | 1.41±1.00      | 1.70±0.97      | 2.20±0.98      |
|                          | Low protein diet with *M. oleifera*        | 1.42±1.05      | 2.12±1.02      | 1.70±0.88      |
| *p*-value                |                                            | 0.4000         | 0.0600         | 0.2000         |
| **Eosinophil (%)**       | Normal protein diet                        | 1.30±0.12      | 1.1±0.20       | 1.0±0.90       |
|                          | Low protein diet without *M. oleifera*     | 1.40±0.33      | 1.6±0.50       | 2.3±1.89       |
|                          | Low protein diet with *M. oleifera*        | 1.30±0.88      | 1.9±0.89       | 1.1±0.67       |
| *p*-value                |                                            | 0.9000         | 0.3000         | 0.1000         |
| **Basophil (%)**         | Normal protein diet                        | 0.20±0.15      | 0.50±0.03      | 0.20±0.15      |
|                          | Low protein diet without *M. oleifera*     | 0.80±0.71      | 0.90±0.61      | 0.90±0.61      |
|                          | Low protein diet with *M. oleifera*        | 0.70±0.54      | 0.90±0.61      | 0.50±0.03      |
| *p*-value                |                                            | 0.0700         | 0.4000         | 0.1000         |
The Effects of Moringa oleifera Leaves as Potential Therapy for Malnutrition

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Ready-to-use therapeutic food (RUTF) leaves have some supplement leaves on blood tree should be used. Additional studies in medicinal purposes. They have a distinctive strong, mustard-parameters. regarding the effects of fall within the normal range. There are no available studies decreased in a time dependent manner. All blood parameters revealed by Idohou and his colleagues.

M. oleifera leaves are mostly used for food as well as medicinal purposes. They have a distinctive strong, mustard-like taste and are rich in antioxidants and other nutrients, such as calcium and iron, which are commonly deficient in people living in developing countries. M. oleifera leaves have been used for the treatment of various diseases from malaria and typhoid fever to hypertension and diabetes.

There are some limitations in this study, including small sample size and short duration of experimental analysis. This study could not be applied as a nutritional therapy in human subjects, too. Further studies should be conducted using larger sample sizes and different parts of the M. oleifera tree should be used. Additional studies in humans, including clinical trials are needed to confirm the effects of M. oleifera leaves on malnutrition.

Conclusion

We suggest that M. oleifera leaves can be used as potential therapy for malnutrition. M. oleifera leaves have some effects on weight, blood mineral concentrations, renal and liver function, as well as CBC parameters.

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