



HISTOLOGICAL AND BIOCHEMICAL EFFECT OF MORINGA OLEIFERA LEAF EXTRACT ON THE LIVER OF WISTAR RATS

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ABSTRACT

Moringa oleifera is a highly valued plant of great socio-economic importance because of its several nutritional, pharmacological and industrial applications. The aqueous extract from the leaves of *Moringa oleifera* was evaluated for its organ toxicity by oral route of administration and to determine if the effect of the extract is dose and time dependent. Forty-eight albino rats were used for the study. They were administered orally with the leaf extract once daily for 3 weeks. Doses of 1000mg/kg, 2000mg/kg, and 3000mg/kg were given to

groups A, B and C respectively. At the end of the 8th, 15th and 22nd day respectively, sixteen rats; four from each group were weighed and blood samples collected. Tissues collected were immediately prepared histologically for haematoxylin and eosin stain. The stained sections were observed under the microscope using x40 and x10 objective lens. More so, oral treatments in rats caused varied significant changes in the weights of the animals. Clinico-pathologically, there were no significant changes in all the organs examined in the course of the study, while the mean values for the biochemical parameters tested among group A animals, were as follows: Total bilirubin(TB) (0.51±0.1mg/dl), Conjugated bilirubin (CB)(0.28±0.03mg/dl), Aspartate amino-transferase (AST)(9.25±1.0iu/L), Alanine aminotransferase ALT (8.25±0.05mg/kg), Alkaline phosphatase(ALP)(44.5±4.8iu/l). While control groups were; TB(0.55±0.06mg/dl),CB(0.31±0.02mg/dl), AST (9.50±0.8iu/L), ALT (9.0±1.2iu/L), and ALP (48.75±5.5iu/L). For group B animals, the mean value results were; TB (0.5±0.006mg/dl), CB (0.27±0.07mg/dl), AST (8.75±0.8iu/L), ALT (8.0±0.8iu/L), and

ALP (45.0 ± 5.6 iu/L), whereas control groups were; TB(0.55 ± 0.08 mg/dl), CB (0.29 ± 0.03 mg/dl), AST(9.75 ± 0.8 iu/L), ALT(9.25 ± 1.2 iu/L), and ALP (44.75 ± 4.8 iu/L). Also, the group C animals had the following results: . TB (0.57 ± 0.04 mg/dl), CB (0.30 ± 0.03 mg/dl), AST (10.25 ± 0.4 iu/L), ALT (8.5 ± 0.5 iu/L), and ALP (50.2 ± 54.7 iu/L). While control groups had ., TB (0.58 ± 0.04 iu/L), CB (0.30 ± 0.02 mg/dl), AST (10.75 ± 1.2 iu/L), ALT (9.50 ± 1.5 iu/L), and ALP (45.75 ± 3.1). All the biochemical parameters tested above were within the reference range as their values were not significant using the standard T-test hypothesis, having all “parameters of liver, as $p > 0.05$, all through the course of the study”. The study concluded that *Moringa oleifera* leaf extract has no organ toxicity, it is time and dose dependent when within a dose of 4000mg/kg and it is relatively safe for consumption.

KEYWORD: Moringa oleifera, leaf extract, liver, wistar rat.

INTRODUCTION

Moringa Oleifera a highly valued plant of socio economic importance owing to its several nutritional, pharmacological (Caceres *et al.*, 1991; Fuglie, 2000). Its industrial applications has become of great significance in the society (Makkar and Becker, 1997; Foldl, 2001),. *Moringa oleifera* is widely used in traditional and herbal medicine, and has gained popularity so much that people have started *probing* the pharmacological importance in modern drug and manufacture and therapy. Almost all parts of the plant is useful in traditional medicine practice(Rathi *et al.*,2006).

Moringa Oleifera belongs to the family: Moringaceae. It is called drumstick tree or horseradish and is a highly valued plant, distributed in many countries of tropics and subtropics. It has been an ingredient of Indian diet since centuries. It is cultivated almost all over the world and its leaves and fruits are used as vegetables. For centuries, the people of Africa and Northern India have known of the many benefits to cultivate moringa plant, some call it “Tree of life, the clarifier tree, wonder plant etc”. Looking at the unassuming plant, one wonders why. In East Africa, the plant is known as “mother’s best friend”, the leaves of the moringa plant prevent 300 diseases. The juice of the leaves mixed with honey is used for the treatment of eye diseases (Sangeeta *et al.*, 2003). In fact, no plant can claim all the benefits moringa offers.

The phytochemical screening of the leaf revealed the presence of fatty acid, vitamin E, carotenoid, selected mineral elements like Fe, Cu, Zn, Co and amino acid, two nitrile

glycosides, Niazirin I and Niazirin II, three mustard oil glycosides, Niazinin, Niazimicin and Niaziminin, Flavonoids, Tannin, Saponin, alkaloids, anthraquinone, triterpenoids and reducing sugar. (Rathi *et al.*, 2006). It has been already documented that the chemical composition of plant extract is different in different locations (Gotep *et al.*, 2010).

Animal and human studies have showcased that *Moringa oleifera* possesses wide spectrum of pharmacological effects of antifertility, antitumor, antipyretic, antiepileptic, antispasmodic, anti-inflammatory, diuretic, antiulcer, hypotensive, hypolipidemic, hypoglycemic, hepatoprotective, antifungal and antibacterial activities (Sudha *et al.*, 2010), antinephrotoxic (Paliwal *et al.*, 2011). In addition to its compelling water purifying powers and high nutritional value. The various parts of this plant such as the leaves, roots, seed, bark, fruit, flowers and immature pods act as cardiac and circulatory stimulants (Anwar *et al.*, 2007). The liver is the principal organ of the body deeply involved in the drug biotransformation, excretion of products of body metabolism, drugs and chemicals.(Okolie, 2011). There could be damage to the liver following administration of leaf extract of *moringa oleifera* especially when there is no scientific data to evaluate the standard and suitability of the practice done by the traditional medical practitioners.

Consequently, there is an urgent need to determine the effect of the leaf extract of *moringa oleifera* on the liver in our local setting since the chemical composition of the leaf extract has been known to vary according to geographical location. This can be assessed by using histological and biochemical tools such as Bilirubin, Aspartate aminotransferase (AST), Alanine amino-transferase (ALT) and Alkaline phosphate (ALP). Hence, this is done with the view of educating and guiding the traditional herbal patronizers on the safety of the plant and better scientific approach in using them.

Plant materials: The fresh leaves of *Moringa Oleifera* (5kg) were collected from the botanical garden of Imo State University Owerri. It was identified and authenticated by Professor S. E. Okeke, a plant taxonomist of the Department of Plant and Science Biotechnology, Imo State University Owerri in the month of May 2013.

Plant Extraction Preparation

The leaves were collected, washed thoroughly with distilled water, they were subsequently dried and comminuted using a grinding machine. Maximum extraction was achieved within 48 hours at temperature of 60⁰c. The resulting extract was filtered using whatman No. 1 filter

paper and concentrated in rota vapor of 500mmHg atmospheric pressure at 45°C to give a semisolid residue. The extract concentrate was dried in an oven for further exploration.

Experimental Animals

48 healthy male and female albino rats (200-250g) were obtained from the Animal House of College of Medicine and Health Sciences, Imo State University Owerri which were used for the study. They were housed in plastic cages with steel netting in well ventilated house, of temperature 27°C, for 12 hours under natural light, and 12 hours darkness. They were allowed free access to sterilized tap water and dry rat pellet (purchased at Animal Friend Shop, No. 120 Royce Road, Owerri, Imo State, Nigeria.) They were allowed to acclimatize in two (2) week before the experiment.

Experimental Design

Forty-eight healthy albino wister rat (male and female) acclimatized were weighed and randomly distributed into four different groups, of twelve (12) in each. The groups were A-D. Group A was treated with a dose of 1000mg/kg, Group B a dose of 2000mg/kg, and Group C treated with a dose of 3000mg/kg while Group D was the control group not treated with any extract but received only laboratory rat pellet and water. To identify the animal groups, a dye was applied (Group A – blue dye, Group B – red dye, Group C – green dye and Control group – black dye). The extracts dissolved in water were administered once daily, orally and slowly to the healthy albino wister rat for three (3) weeks using cannula attached to a graduated syringe and needle.

Sample Collection

Twenty four hours after the last doses were administered, the animals were anaesthetized with chloroform vapour, quickly brought out of the jar and sacrificed. Whole blood was collected by cardiac puncture from each animal into plain specimen bottles for biochemical analysis. The animals were subsequently sacrificed, and the livers were dissected from each group and control, fixed in neutral buffered formalin and processed by popular automatic tissue processing method and all sections stained by haematoxylin and eosin staining technique. While the liver enzymes were determined from the blood sample using the following techniques: Total and Conjugated bilirubin by Powell method(1944), AST by Reitman and Frankel Method(1957), ALT by Reitman and Frankel method(1957), and ALP by modified King Armstrong method(1954).

Statistical Analysis

Results were expressed on mean \pm standard deviation. Analysis was carried out using student T-test. The level of significance was considered at $P < 0.05$.

RESULTS

Histological effects *Moringa oligifera* on wistar rats administered with different concentration of extract and Control.

Histological sections of liver from control group showed normal histological features which served as a basis for comparing with experiment groups.

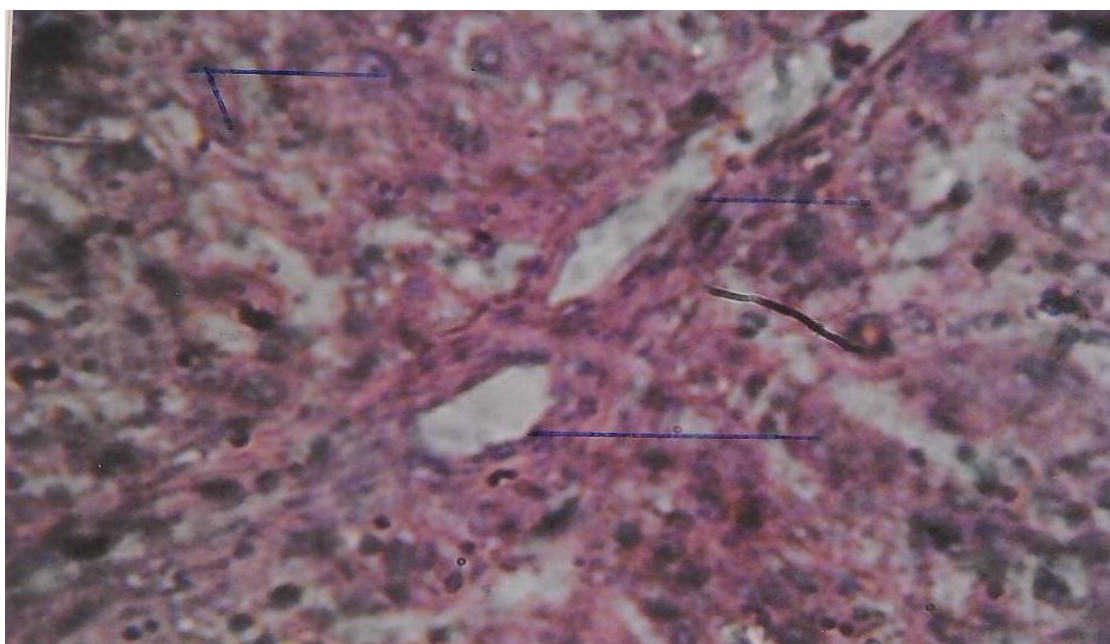


Plate 1: A photomicrograph of albino rat liver section from control group, showing the hepatic vein, bile duct and hepatocytes. magnification x 400 H & E stain.

4.2 Albino Rats (Administered with 1000mg/kg body weight of *Moringa oleifera* leaf extract at 8th day of Administration).

Histological sections of the liver of albino rats treated with 1000mg/kg of extract at 8th day of administration did not differ from the control group (Normal histo-architecture).

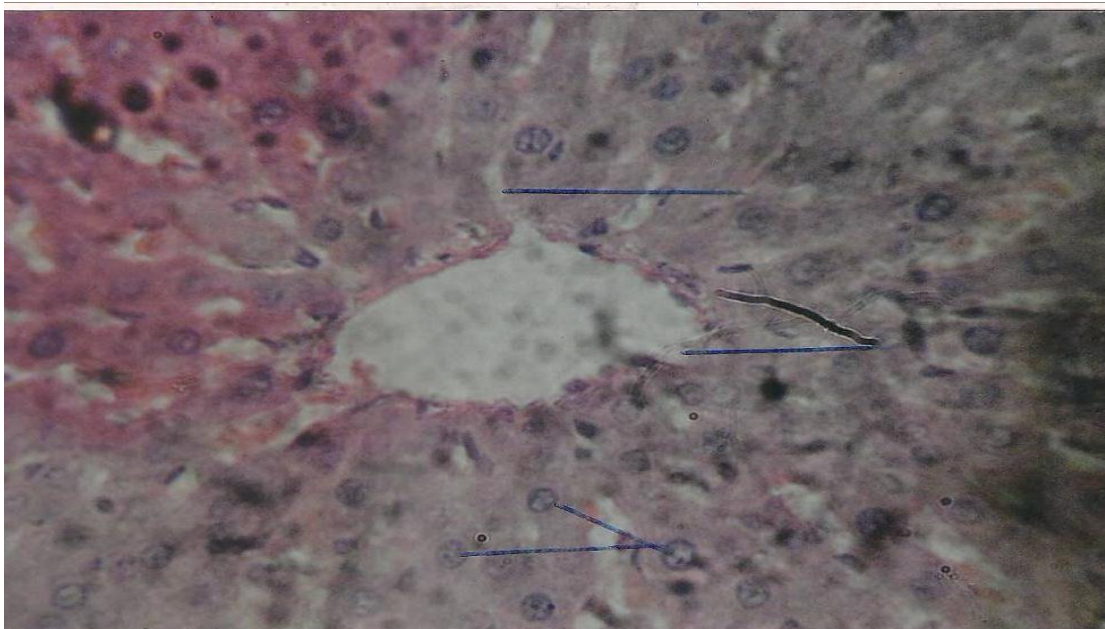


Plate. 3: A photomicrograph of albino rat liver treated with 1000mg/kg of extract showing normal histo-architecture at magnification x 400 H & E stain.

4.3.3 Albino rats treated with 2000mg/kg of *Moringa oleifera* leaf extract at 8th day of administration.

For albino rats treated with 2000mg/kg of leaf extract, both the liver and kidney sections showed no pathological lesions, at 8th day of administration.

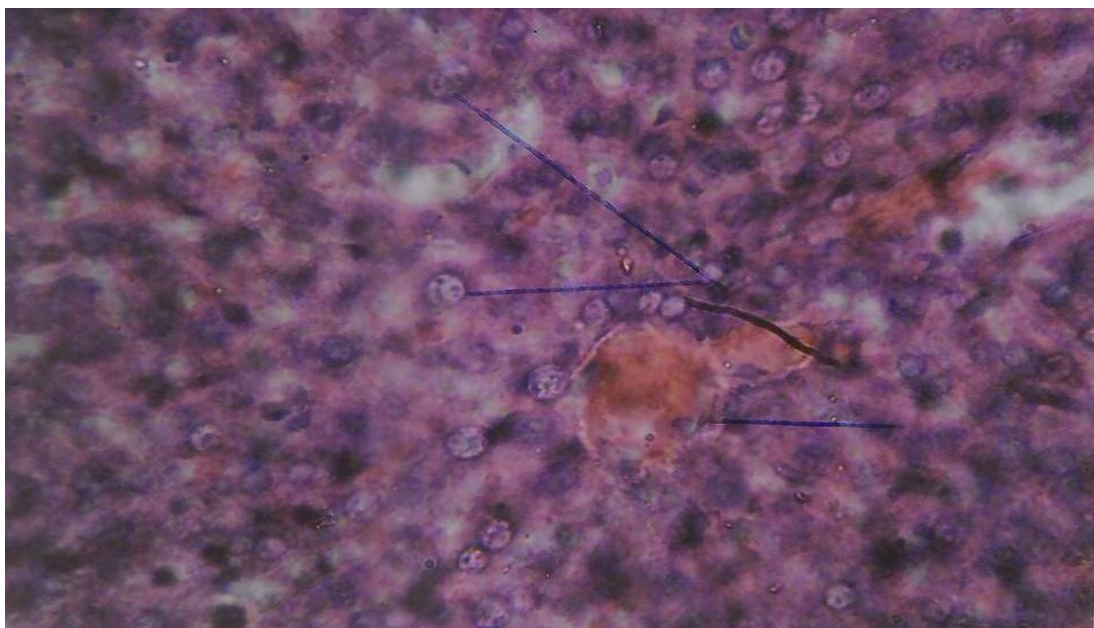


Plate 5: A photomicrograph of albino rat liver treated with 2000mg/kg of extract showing no pathological lesion, normal hepatocytes and portal tract seen. Magnification x 400 H & E stain.

4.3.4 Albino rats treated with 3000mg/kg of *Moringa oleifera* leaf extract at 8th day of administration.

Albino rats treated with 3000mg/kg of *Moringa oleifera* leaf extract, both the liver sections showed no visible lesions at 8th day of administration.

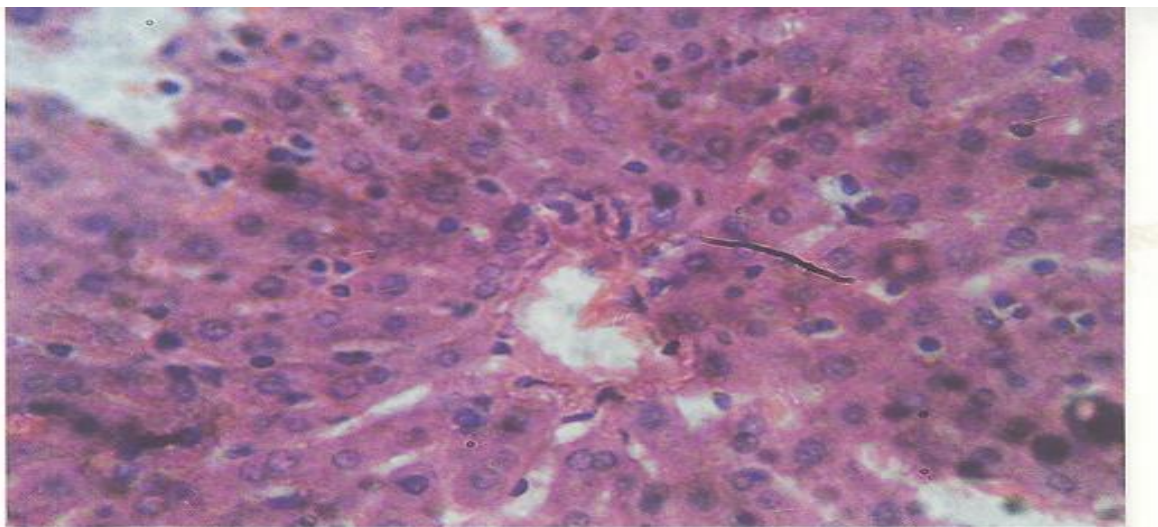


Plate 7: A photomicrograph of albino rat liver treated with 3000mg/kg of extract showing no visible lesion. Magnification x 400 H & E stain.

Other experimental groups at 15th and 22nd day of administration.

All other albino rats treated with 1000mg/kg, 2000mg/kg and 3000mg/kg *Moringa oleifera* leaf extract respectively at 15th and 22nd day respectively, did not also differ from control groups (normal – histoarchitecture).

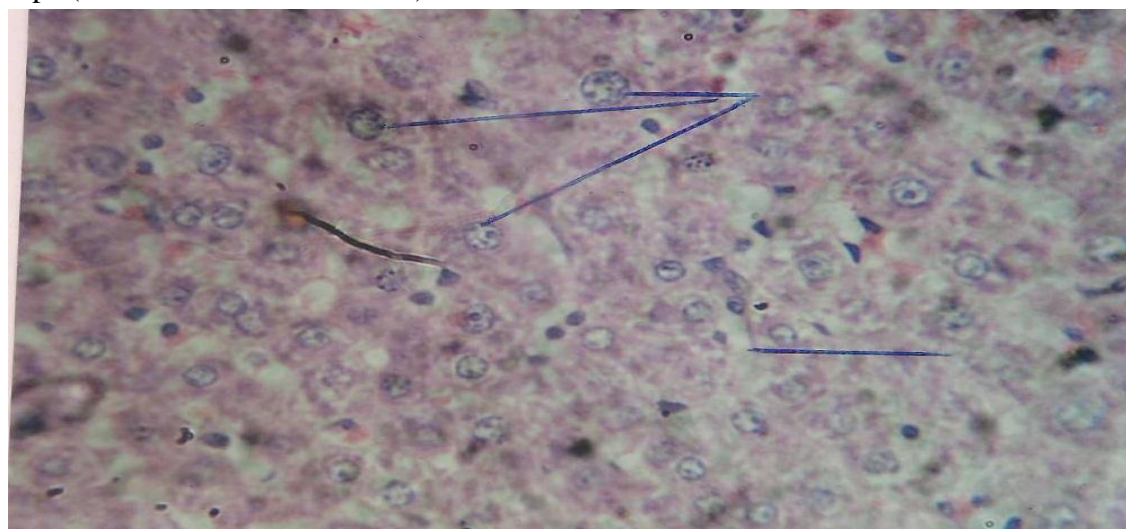


Plate 9: A photomicrograph of albino rat liver treated with 1000mg/kg of extract at 15th day of administration showing normal histoarchitecture, and residual macrophages. Magnification x 400 H & E stain.

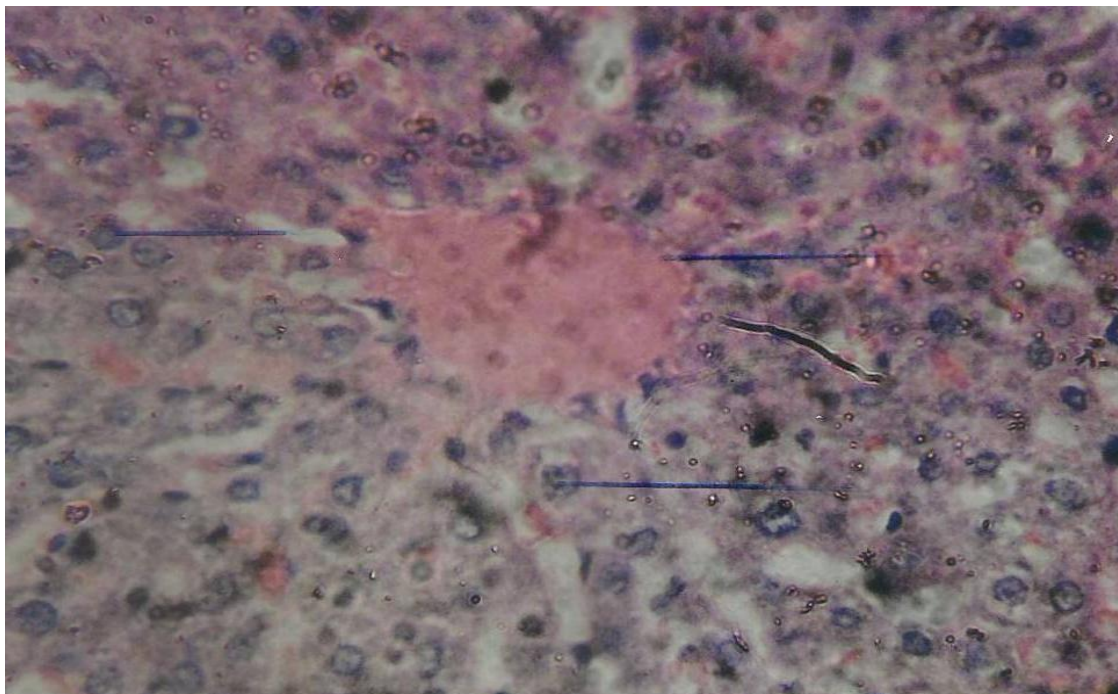


Plate 10: A photomicrograph of albino rat liver treated with 1000mg/kg of extract at 22nd day of administration showing normal histoarchitecture of liver. Magnification x 400 H & E stain.

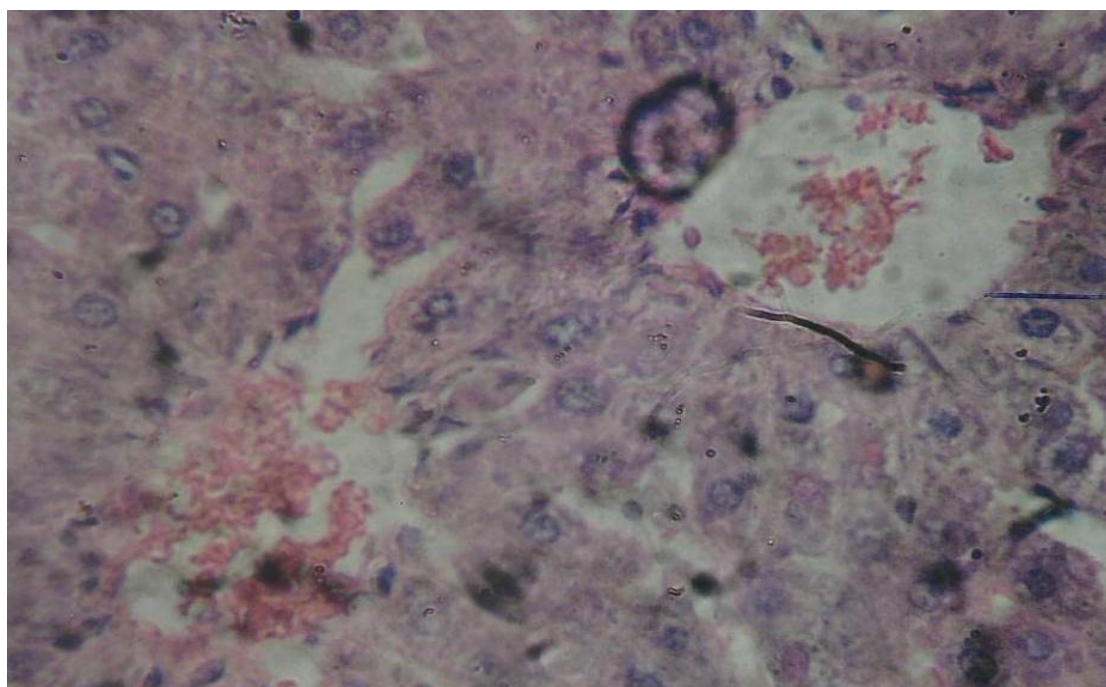


Plate 13: A photomicrograph of albino rat liver treated with 2000mg/kg of extract at 15th day of administration showing liver architecture. Magnification x 400 H & E stain.

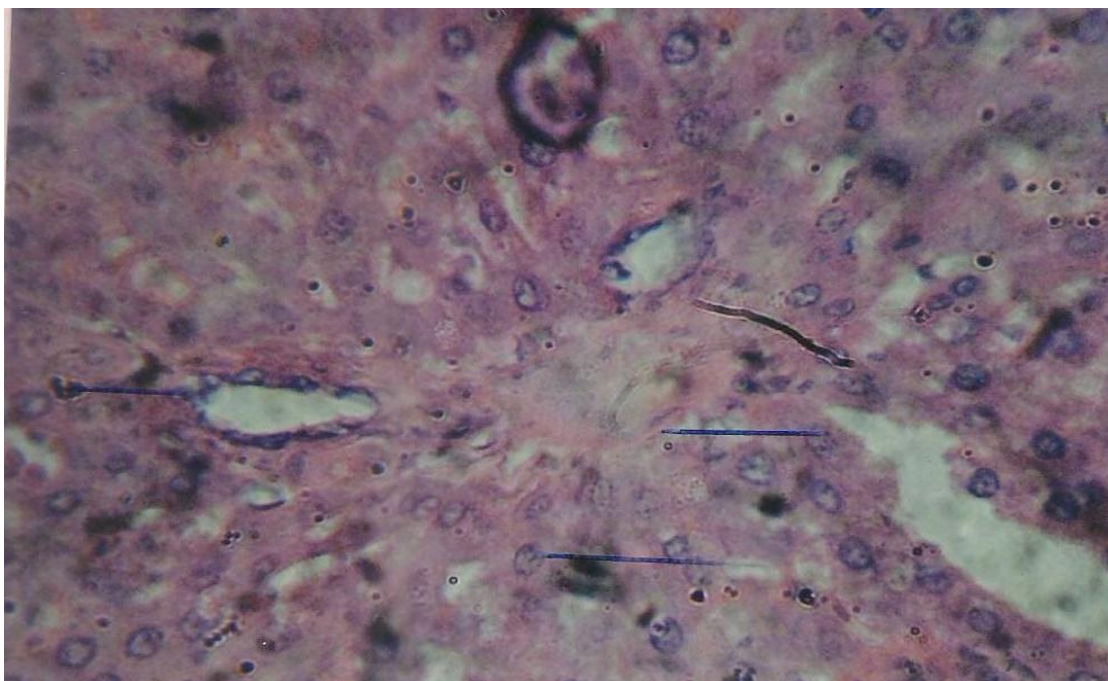


Plate 17: A photomicrograph of albino rat liver treated with 3000mg/kg of extract at 15th day of administration showing normal architecture. Magnification x 400 H & E stain.

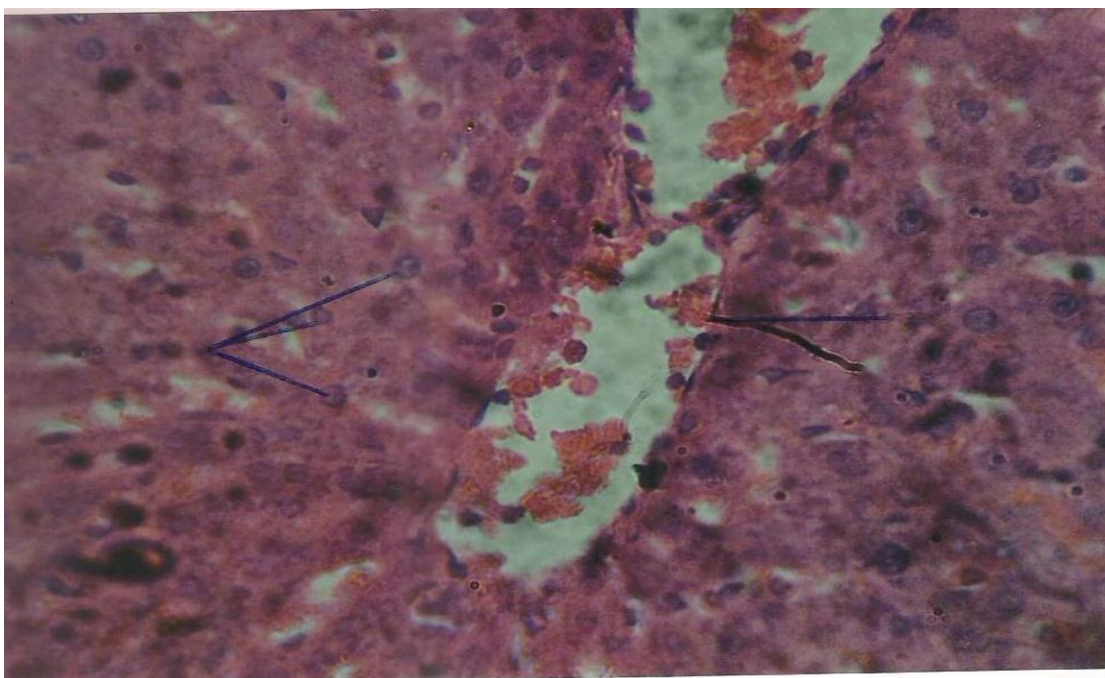


Plate 18: A photomicrograph of albino rat liver treated with 3000mg/kg of extract at 22nd day of administration showing no pathological changes. Magnification x 400 H & E stain.

Table 4.1: shows the mean values of total bilirubin (TB), conjugated bilirubin (CB), Aspartate aminotransferase (AST), Alanine aminotransferase (ALT), and Alanine phosphatase (ALP) of group A with the control group.

Parameters	Group A ₁ (1 Wk)	Group A ₂ (2 Wks)	Group A ₃ (3 Wks)	Control 1	P-Value
TB (mg/dl)	0.51 ± 0.1	0.52 ± 0.07	0.49 ± 0.03	0.55 ± 0.06	P>0.05
CB (mg/dl)	0.28 ± 0.03	0.30 ± 0.03	0.27 ± 0.04	0.31 ± 0.02	P>0.05
AST (iu/L)	9.25 ± 1.0	9.00 ± 0.8	8.75 ± 0.5	9.50 ± 0.8	P>0.05
ALT (iu/L)	8.25 ± 0.05	8.50 ± 1.2	7.50 ± 0.5	9.0 ± 1.2	P>0.05
ALP (iu/L)	44.5 ± 4.8	47.8 ± 7.1	44.0 ± 5.1	48.75 ± 5.5	P>0.05

No significant differences for all the biochemical parameters tested among groups A (1week, 2weeks and 3weeks) when compared with control 1 (P>0.05).

Table 4.2: Shows the comparison of the mean values of, total bilirubin (mg/dl) , conjugated bilirubin (mg/dl) (CB), AST (iu/L), ALT (iu/L), ALP (iu/L) of the group B (1week, 2weeks and 3weeks) with the control group.

Parameters	Group B(1) (1 Wk)	Group B(2) (2 Wks)	Group B(3) (3 Wks)	Control 2	P-Value
TB (mg/dl)	0.50 ± 0.06	0.55 ± 0.05	0.58 ± 0.1	0.55 ± 0.08	P>0.05
CB (mg/dl)	0.27 ± 0.07	0.29 ± 0.03	0.30 ± 0.7	0.29 ± 0.03	P>0.05
AST (iu/L)	8.75 ± 0.8	9.75 ± 0.8	10.25 ± 1.2	9.75 ± 0.8	P>0.05
ALT (iu/L)	8.0 ± 0.8	8.75 ± 0.5	9.0 ± 1.2	9.25 ± 1.2	P>0.05
ALP (iu/L)	45.0 ± 5.6	46.0 ± 3.1	48.75 ± 8.3	44.75 ± 4.8	P>0.05

No significant changes occurred in all the parameters tested in group B in relation to control 2 (P>0.05).

Table 4.3: Shows the comparison of the mean values of total bilirubin (TB) (mg/dl), conjugated bilirubin (CB) (mg/dl), AST (iu/L) < ALT (iu/L), ALP (iu/L) of the group C (1week, 2weeks and 3weeks) with the control group.

Parameters	Group C(1) (1 Wk)	Group C(2) (2 Wks)	Group C(3) (3 Wks)	Control 3	P-Value
TB (mg/dl)	0.57 ± 0.04	0.59 ± 0.03	0.56 ± 0.07	0.58 ± 0.04	P>0.05
CB (mg/dl)	0.30 ± 0.03	0.31 ± 0.02	0.32 ± 0.02	0.30 ± 0.02	P>0.05
AST (Iu/L)	10.25 ± 0.4	9.75 ± 1.2	10.25 ± 1.0	10.75 ± 1.2	P>0.05
ALT (Iu/L)	8.50 ± 0.5	9.25 ± 1.2	9.00 ± 1.0	9.50 ± 1.5	P>0.05
ALP (Iu/L)	50.25 ± 4.7	48.2 ± 6.7	47.5 ± 5.8	45.75 ± 3.1	P>0.05

There was no significant differences observed in all the biochemical parameters tested among group C when compared with control group 3 (P>0.05).

Table 4.4: Shows the comparison of the three different durations (Week 1, Week 2 and Week 3) of the extract administered amongst group A , group B and group C to check if it is time dependent.

Group A

Parameters	Group A1) (1 Wk)	Group A2) (2 Wks)	Group A3) (3 Wks)	P-Value
TB (mg/dl)	0.51 ± 0.1	0.52 ± 0.07	0.49 ± 0.03	P>0.05
CB (mg/dl)	0.28 ± 0.03	0.30 ± 0.03	0.27 ± 0.04	P>0.05
AST (iu/L)	9.25 ± 1.0	9.00 ± 0.8	8.75 ± 0.5	P>0.05
ALT (iu/L)	8.25 ± 0.05	8.50 ± 1.2	7.50 ± 0.5	P>0.05
ALP (iu/L)	44.5 ± 4.8	47.8 ± 7.1	48.75 ± 5.5	P>0.05

There was no significant effect of time duration among the three different groups of the group A (1week, 2weeks and 3weeks) treated with the leaf extract of *moringa oleifera* (P>0.05).

Group B

Parameters	Group B(1) (1 Wk)	Group B(2) (2 Wks)	Group B(3) (3 Wks)	P-Value
TB (mg/dl)	0.50 ± 0.06	0.55 ± 0.05	0.58 ± 0.1	P>0.05
CB (mg/dl)	0.27 ± 0.07	0.27 ± 0.03	0.30 ± 0.7	P>0.05
AST (lu/L)	8.75 ± 0.8	9.75 ± 0.8	10.25 ± 1.2	P>0.05
ALT (Iu/L)	8.0 ± 0.8	8.75 ± 0.5	9.0 ± 1.2	P>0.05
ALP (Iu/L)	45.0 ± 5.6	46.0 ± 3.1	48.75 ± 4.3	P>0.05

No significant effect of duration was observed among the three different groups in group B administered with 2000mg/kg of the leaf extract of *Moringa oleifera* within the period of 1 week, 2 weeks and 3 weeks respectively.(P>0.05).

Group C

Parameters	Group C(1) (1 Wk)	Group C(2) (2 Wks)	Group C(3) (3 Wks)	P-Value
TB (mg/dl)	0.57 ± 0.04	0.59 ± 0.03	0.56 ± 0.07	P>0.05
CB (mg/dl)	0.30 ± 0.03	0.31 ± 0.02	0.32 ± 0.02	P>0.05
AST (iu/L)	10.25 ± 0.5	9.75 ± 1.2	10.25 ± 1.0	P>0.05
ALT (iu/L)	8.50 ± 0.5	9.25 ± 1.2	9.00 ± 1.0	P>0.05
ALP (iu/L)	50.25 ± 4.7	48.2 ± 6.7	47.5 ± 5.8	P>0.05

There was no significant effect of duration among the three different in group 3, treated with 3000mg/kg of the extract within the period of 1 week, 2 weeks and 3 weeks respectively.

DISCUSSION

In the present era, plant and herb resources are abundant, but these resources are dwindling fast due to the onward march of civilization (Prakash *et al.*, 1987). Although a significant number of studies have been used to obtain purified plant chemical, very few screening programmes have been initiated on crude plant materials. Plant has played a significant role in maintaining human health and improving the quality of human life for many years. They have also been a source of dyes, cosmetics, medicine, beverages and seasonings. Herbal medicine is based on the fact that plants contain natural substances that can promote health and alleviate sickness. The extract of *Moringa oleifera* and the isolated compounds have demonstrated spectrum of biological activities.

From table 4.1, it can be deduced that after the first week of administration of the leaf extract of M.O, Groups A – C which were the experimental group had slight changes in their weight, whereby there was an increase of weights in Groups A and C and control group respectively, while Group B which was given a dose of 2000mg/kg of *Moringa oleifera* leaf extract had a reduction in weight. However, in weights of animals at the 15th and 22nd day of administration, there was no variation in weight, but as compared to the weight of animals at 8th day of administration; there was a remarkable decrease in weight of the animals ranging from Groups A to C. The control group (Group D) however had their weight increased significantly.

Furthermore, this study which showed that all animals in Groups A, C and Control Group (Table 4.1) after 8 days of administration of the extract gained weight but animals in Group B showed a significant decrease in weight, collaborates with the research work by Awodele *et al.* (2011) which states that there was significant difference in weight gain of the control groups. It is also interesting to note that the weight of the animals at the 15th and 22nd day of animals did not change but there was further decrease in weight of all the experimental animals as the days of administering the leaf extract progressed, except for the control group that had weight gain, which is not in agreement with Adedapo *et al.* (2009) which states that all animals used in his study with *Moringa oleifera* leaf extract gained weight. Weight loss for the experimental animals did not show any direct relationship with the graded doses of the leaf extract, since at a low dose of 1000mg/kg, there was a significant increase in weight, then at the medial dose of 2000mg/kg, there was a significant decrease in weight, while at the high dose of 3000mg/kg, there was also a significant increase in weight, hence it can be

deduced that at a moderate dose or recommended dose of 2000mg/kg, the weight of an animal can be drastically reduced, and at a low dose of 1000mg/kg and high dose of 3000mg/kg respectively, the weight of animal can be increased. This may imply that at the initial stage of administration of the extract, there might likely be an alteration of the body system metabolism with respect to the different doses of the extract. However, as the time of administration of extract progressed, there was weight loss in all the experimental animals at the 15th and 22nd day of administration (Table 4.1). Therefore, it can be deduced that *Moringa oleifera* leaf extract was time dependent at week 1 but was no longer time dependent as the week progressed probable due to adjustment of the rat at the early stage. Hence, it can be said that the extract is not time and dose extract dependent, since at whatever dose, i.e. either the low dose, moderate dose, or high dose of the extract, all showed a loss in weight of the animals at the 15th and 22nd day of animals respectively (Table 4.1). Could it be that this findings has the ability of burning down fat in the rat i.e. has a hypo-cholesterolemic effect or could there be other factors causing the reduction of weight in the rat.

Histological sections of rats kidneys treated with *Moringa oleifera* leaf extract Plates- 4, 6, 8, 11, 12, 15, 16, 19 and 20 were collected from rats treated with 1000mg/kg, 2000mg/kg, 3000mg/kg of extract at different time duration (8, 15 and 22 days respectively). Plates 4, 6 and 8 were collected early in the study, that is after 8 days of administration of extract and it revealed no visible lesion or damage. Plates 11, 15 and 19 were collected midway in the experiment, that is after 15 days of administration of extract and it revealed no visible lesion or damage, while Plates 12, 16 and 20 were collected lastly, that is after 22 days of administration of extract, which also showed no visible lesion but showed hyperplasia in the glomerulus of the kidney, hence there was rapid regeneration of cells in the renal corpuscle. These findings mean that the leaf extract of *Moringa oleifera* is not time and dose dependent at within 4000mg/kg, with relation to organ toxicity of the extract since no visible pathological lesion was associated with the administration of the extract. This findings tallies with Adedapo *et al.*(2009), but disagrees with recent studies (Josephine *et al.*, 2012).

Concerning the liver, Plates 3, 5 and 7 represent liver sections collected from rats treated with 1000mg/kg, 2000mg/kg and 3000mg/kg plant extract respectively at 8 days of administration of *Moringa oleifera* leaf extract. The sections all revealed no pathological lesion.

Furthermore, Plates 9, 13 and 17 represent liver sections collected from rats treated with 1000mg/kg, 2000mg/kg and 3000mg/kg at 15 days of administration of leaf extract. These sections all revealed no visible lesion.

Lastly, Plates 10, 14 and 18 represent liver sections collected from rats treated with 1000mg/kg, 2000mg/kg and 3000mg/kg at 22nd days of administration of leaf extract. These sections also showed no visible lesion. All possessed normal histo-architecture of the liver. These findings therefore implies that there is no organ toxicity associated with the oral ingestion of *Moringa oleifera* leaf extract which tallies with (Joseph *et al.*, 2011; Adedapo *et al.*, 2009) but disagrees with previous study (Josephine *et al.*, 2012).

The liver function tests of the rats at 8th, 15th and 22nd days of administration showed insignificant changes in the levels of the ALP, ALT and AST, total bilirubin, conjugated bilirubin. The values obtained for liver function parameters showed that the conjugated ability of the liver was not compromised from the total and conjugated bilirubin levels (Tables 4.3, 4.4, 4.5 respectively). There was also no hepatocellular damage as revealed by ALT, ALP and AST values, (Tables 4.3, 4.4, 4.5 respectively). Aminotransferases (ALT and AST) are produced in the liver and are good markers of damage to liver cells but not necessarily the severity of the damage (Rej, 1989). They are normally present at low levels in the blood so if the liver cells are damaged, it would be expected that some of the enzymes leak into the blood and increases in levels. But since there was no significant increase or decrease in the liver enzymes of the rat, it therefore impiles no hepatocellular damage. This finding is in confirmation with Taofeeq *et al.* (2010) but contradicts previous studies (Paliwal *et al.*, 2011; Josephine *et al.*, 2012).

CONCLUSION

In conclusion, *Moringa oleifera* leaf extract does not produce effect visible on time or dose dependent in albino rats, and the leaf extract is relatively safe for consumption because there is no organ toxicity as all liver including liver function test of rats show no evidence of adverse effect.

Therefore, *Moringa oleifera* leaf extract should be recommended for consumption within 4000mg/kg dosage, since within this dose administered to rats in the study, there was no adverse effect, rather regeneration of cells of renal corpuscle was seen, therefore this herbal

remedy could be given to patients who have undergone kidney transplant, since it is capable of regenerating renal cells.

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