

Research Article

Effects of *Moringa Oleifera* Leaves on Hematological Indices in Humans

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Abstract

Background: In recent times, attention has been drawn to the several beneficial effects of *Moringa Oleifera*. Its leaves have been known for its medicinal attributes. This is because of its richness in phytochemicals, antioxidants, vitamins, and proteins. It has been said to possess antitumor, anticancer, anti-inflammatory, antibacterial, hepatorenal and hematopoietic activities. Several researches have adopted animal models to elicit these benefits. The current study is on the effect of powdered *Moringa Oleifera* leaves on hematological indices in human. The study investigates the widespread belief of the usefulness of *Moringa Oleifera* to human like it is to animals.

Method: Twenty (20) human subjects used for the research were grouped into two of ten (n=10) and given low and high doses of *Moringa Oleifera* (0.038 g/kg and 0.077 g/kg respectively) for 14 days (two weeks). Their blood samples were collected and analyzed before and after the two weeks.

Results: Results show significant improvement in platelet count in the group given low dose of the extract (p<0.05), but insignificant improvement in the group given high dose. Though there was increase in red cell count, it was not significant in both groups. White blood cell count insignificantly dropped in both groups.

Conclusion: *Moringa Oleifera* has hematopoietic activity in humans; it is especially beneficial to platelet count (when taken in low dose), and it is also beneficial to red blood cell formation (though not to a significant level). However, its immune enhancing benefit is less certain.

Keywords: *Moringa Oleifera*; Red Blood Cell; Platelet; White Blood Cell; Hemopoietin; Hematinic

Introduction

Anemia is one of the major challenges in the developing countries. Its causes include malaria infection, bacterial and viral infections, worm infestation, pregnancy and other diseased conditions. Focus is therefore progressively on how to meet this blood demand posed by these conditions. Unlike in the past, attention is gradually shifting from blood transfusion, not only because of non-availability and non-affordability, but also because of the many risks associated with it. Several options that have been explored include the use of parenteral iron, hematinic like iron and folic acid supplements. Attention has recently been paid to the use of natural herbs, which are more available and affordable.

Products from many plants are known to have some hematopoietic activities. Examples of these are garlic [1], *Clerodendrum violaceum* leaves [2], *Mangifera indica* [3], *Telfairia occidentalis* (Ugwu leaves). These have all been used to boost blood production by the body. Literatures are replete with evidences of their effectiveness.

Recently, attention has been drawn to several benefits of *Moringa Oleifera*, including its ability to enhance blood formation and boost the immune system. Other medicinal properties have also been ascribed to various parts of *Moringa Oleifera*. Almost every part of the plant: root, bark, gum, leaf, fruit (pods), flowers, seed and seed oil has been

used for various ailments in medicine [4], including the treatment of inflammation and infectious diseases along with cardiovascular, gastrointestinal, hematological and hepato-renal disorders [5-8]. Acute intake of *Moringa Oleifera* leaves (Figure A) has been shown to lower blood pressure, body temperature and blood glucose level in human [9]. Most parts of the plant possess antimicrobial activity [10,11]. They are well known as good alternative for the treatment of diabetes mellitus [12-14], hepatotoxicity [15], rheumatism, venomous bites as well as for cardiac stimulation [16]. It is used for arthritis and



Figure A: Leaves of *Moringa Oleifera* plant.

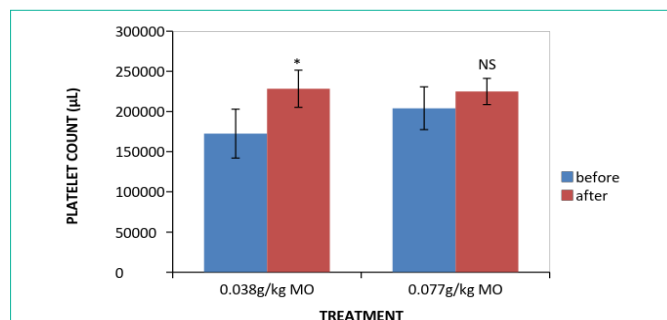


Figure 1: Effect of *Moringa Oleifera* leaves on platelet count. *statistically significant, NS-not significant at $P < 0.05$

other joint pains, asthma, cancer, constipation, diarrhea, epilepsy, stomach pain, stomach and intestinal spasms, headache, high blood pressure, kidney stones, fluid retention, thyroid disorders and bacterial, fungal, viral and parasitic infections. It is also used to reduce swelling, increase sex drive (as an aphrodisiac), prevent pregnancy, boost immune system and increase breast milk production. *Moringa* leaves act as a good source of natural antioxidant due to the presence of various antioxidant compounds such as ascorbic acid, flavonoids, phenolics and carotenoids [17,18]. It contains vitamins that are ten times the vitamin A of carrot, 7 times the vitamin C of orange, 17 times the calcium of milk, 15 times potassium of bananas, 25 times the iron of spinach and 9 times the protein of yogurt [19].

Despite the myriads of these properties, studies of these benefits in humans are rare. Hence, this study is designed to investigate the effects of *Moringa Oleifera* on blood indices.

Materials and Methodology

Subjects

20 Subjects: 400L Anatomy and Physiology students of both sexes from Bingham University, Karu, Nasarawa State, Nigeria.

Materials

EDTA anticoagulant bottles, Methylated spirit, 2 ml syringes, Tourniquet, Cotton wool, Hand gloves, Cysmex Hematological auto analyzer, Distilled water, Glass cups, Spoons, Rubber cups, Pap (akamu), Electric weighing scale, *Moringa Oleifera* powdered leaves (purchased from No 11B, Sam Aleno Wyse FRSC Estate, Masaka Nasarawa State, Nigeria).

Methodology

Sampling method: Twenty subjects (20) were recruited for this study using convenient sampling method. A verbal consent was

Table 1: Effect of *Moringa Oleifera* leaves on platelet and its indices.

	Groups	Dose	Hematological parameter			
			Platelet $\times 10^3$ (μ L)	MPV (fL)	P-LCR (%)	PDW (fL)
	1	0.038 g/kg MO				
Before			172.5 \pm 30.56	11.81 \pm 0.36	39.60 \pm 6.80	14.61 \pm 0.92
After			228.5 \pm 23.08*	10.81 \pm 0.31*	24.54 \pm 1.14 ^{NS}	11.81 \pm 0.36*
	2	0.077g/kg MO				
Before			204.1 \pm 26.67	11.91 \pm 0.50	29.42 \pm 1.82	13.250 \pm 0.63
After			225 \pm 16.42 ^{NS}	10.55 \pm 0.25*	24.45 \pm 1.62*	11.910 \pm 0.50*

All values are expressed as mean \pm SEM, *statistically significant, NS-not significant, $P < 0.05$ as compared with before.

gotten from each of them prior to the research. The method was explained to them clearly before the study began.

Collection of blood samples: 2.0ml of blood was collected from each subject via venipuncture at the dorsum of the wrist region, prior to this; the dorsum of each subject was cleaned with cotton wool that was dipped into methylated spirit. The blood samples were immediately emptied into the already prepared ethylenediaminetetraacetic acid (EDTA) bottles. This was done on the first day and fifteenth day of the research.

Experimental design: The subjects were randomly allotted into two groups of ten (10) as follows:

Group 1 (low dose group): subjects received powdered 0.038 g/kg *Moringa Oleifera* leaves

Group 2 (high dose group): subjects received powdered 0.077 g/kg of *Moringa Oleifera* leaves

Experimental procedures are:

1. Powdered leaves of *Moringa Oleifera* were purchased from No 11B, Sam Aleno Wyse FRSC Estate, Masaka Nasarawa State, Nigeria. They were measured using the electric kitchen scale into two groups, i.e., 2.5 g and 5 g.

2. Subjects converged to 400 level physiology class by 9 am; the experimental procedure was explained to them. 2.0 ml of blood was taken from the first subject using the 2.0 ml syringes via venipuncture. Prior to this, the dorsum of the wrist region was sterilized using cotton wool that was dipped in methylated spirit. The blood sample was immediately transferred to the already made EDTA bottles and labeled carefully. This was done on all the subjects, with the blood samples labeled accordingly, they were then taken to Defense Headquarters Medical center, Abacha barracks, Abuja, Nigeria for analysis, results were gotten after two days.

3. Group I subjects received 0.038 g/kg *Moringa Oleifera*. Seven (7) subjects took it with pap (*akamu*) to improve their tolerance to it, while three (3) subjects took it with water. Two subjects dropped after the third day.

Group 2 subjects received 0.077 g/kg *Moringa Oleifera*. Eight (8) subjects took it with pap and two (2) with water. This was done 9 am every day for the period of 14 days.

2.0 ml of blood was taken from each subject again on day 15. The same procedure was repeated as before. The clearly labeled EDTA anticoagulant bottles containing blood samples were taken to Defense

Headquarters Medical center, Abacha barracks, Abuja, Nigeria for analysis. Results were gotten two days later and recorded.

Analysis of hematological indices: Blood samples collected before and after two weeks (14 days) administration of *Moringa Oleifera* were analyzed using cysmex hematological auto analyzer.

Statistical analysis: Data were mean of each hematological parameter in the experimental groups' \pm standard error of mean. Statistical analysis was carried out using students t-test adopted for comparison, analyzed using statistical package for social sciences (SPSS) for Window software. The data were expressed as mean \pm standard deviation. $P < 0.05$ was considered significant.

Results

The effects of *Moringa Oleifera* leaves (0.038 g/kg and 0.077 g/kg) on blood indices of treated human subjects are as given in the table seen below (summary). The tables showing a detailed account of the raw data for the two groups before and after taking *Moringa Oleifera* are in the appendix. The summary shows raw data for the two groups giving their mean and standard error of mean. The blood parameters are grouped into three; platelet and its indices, red blood cell and its indices and white blood cell and its indices.

Moringa Oleifera increases platelet count from $172.5 \times 10^3 \pm 30.56$ to $228.5 \times 10^3 \pm 23.08$ (group 1), $P < 0.05$ which was statistically significant, and from $204.1 \times 10^3 \pm 26.67$ to $225 \times 10^3 \pm 16.42$ (group 2), which was not significant statistically as shown (Figure 1) (Table 1).

The Figure 2 shows a drop in mean platelet volume of both

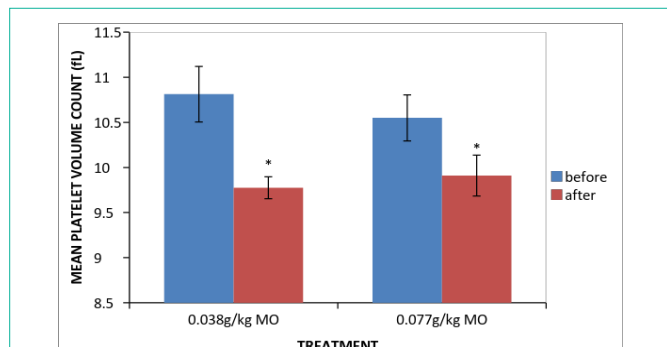


Figure 2: Showing effect of *Moringa Oleifera* leaves on mean platelet volume count. *statistically significant at $P < 0.05$

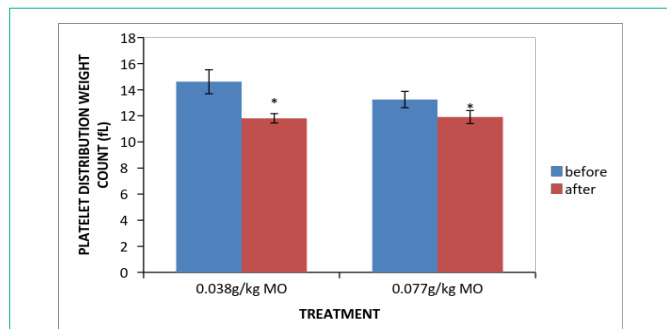


Figure 3: Showing effect of *Moringa Oleifera* leaves on platelet distribution weight count. *statistically significant at $P < 0.05$

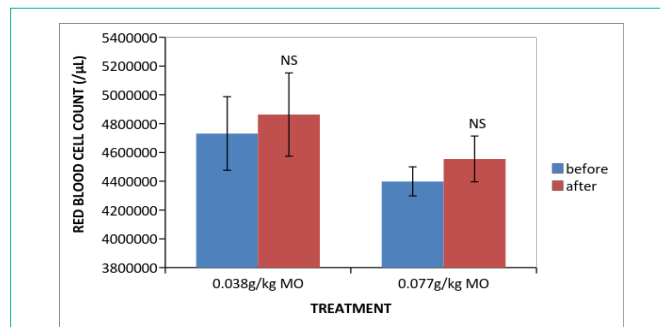


Figure 4: Showing effect of *Moringa Oleifera* leaves on red blood cell count. NS-not significant at $P < 0.05$

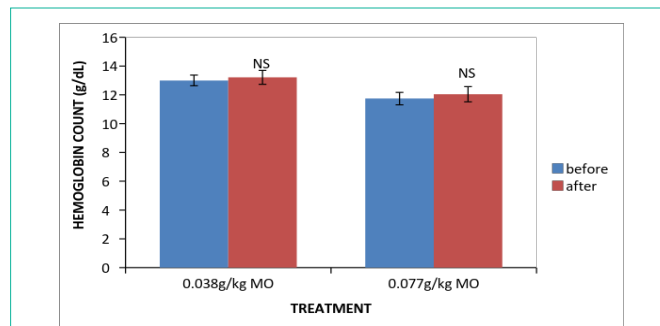


Figure 5: Showing effect of *Moringa Oleifera* leaves on hemoglobin count. NS-not significant at $P < 0.05$

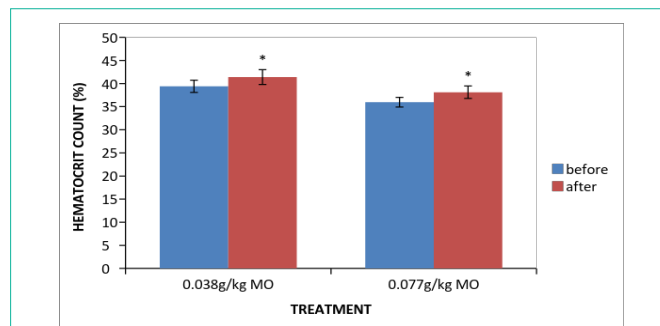


Figure 6: Showing effect of *Moringa Oleifera* leaves on hematocrit count. *statistically significant at $P < 0.05$

groups. Group 1 decreased from 11.81 ± 0.36 to 10.81 ± 0.31 and group 2 decreased from 11.91 ± 0.50 to 10.55 ± 0.25 . This was however proven to be statistically significant for both groups at $P < 0.05$.

The Figure 3 shows a decrease in platelet distribution weight count which is significant in both groups at $P < 0.05$. The decrease with administration of 0.038g/kg MO (group 1) was more than 0.077g/kg MO (group 2), which decreased from 14.61 ± 0.92 to 11.81 ± 0.36 and from 13.25 ± 0.63 to 11.91 ± 0.50 in group 2.

Moringa Oleifera increased red blood cell count in both groups. Group 1 increased from 4.73 ± 0.25 to 4.86 ± 0.29 and group 2 increased from 4.40 ± 0.10 to 4.56 ± 0.16 (Figure 4) (Table 2).

Group 1 increased from 13.00 ± 0.38 to 13.21 ± 0.48 . Group 2 increased from 11.74 ± 0.43 to 12.05 ± 0.53 . Statistically however, there were not significant (Figure 5).

Hematocrit count as seen below increased in both groups. Group

Table 2: Summary table showing effect of *Moringa Oleifera* leaves on red blood cell and its indices.

	Groups	Dose	Hematological parameters				
			RBC×10 ⁶ (/ μ L)	HGB (g/dL)	HCT (%)	MCV (fL)	MCH (pg)
	1	0.038 g/kg MO					
Before			4.73±0.25	13.00±0.38	39.40±1.34	83.96±2.01	27.80±0.89
after			4.86±0.29 ^{NS}	13.21±0.48 ^{NS}	41.39±1.59 [*]	85.93±2.37 [*]	27.45±0.81 ^{NS}
	2	0.077 g/kg MO					
Before			4.40±0.10	11.74±0.43	35.97±1.06	82.00±2.32	26.75±0.93
after			4.56±0.16 ^{NS}	12.05±0.53 ^{NS}	38.12±1.34 [*]	84.03±2.38 [*]	26.55±0.98 ^{NS}

MCHC (g/dL)	RDW-SD (fL)	RDW-CV (%)
33.08±0.38	45.26±0.73	14.40±0.41
31.95±0.33 [*]	47.48±0.78 [*]	14.53±0.44 [*]
32.59±0.43	42.39±1.00	14.02±0.42
31.56±0.44 [*]	45.55±0.42 [*]	14.40±0.46 [*]

1 increased from 39.40±1.34 to 41.39±1.59 and group 2 increased from 35.97±1.06 to 38.12. Both were statistically significant (Figure 6).

The Figure 7, it was seen that *Moringa Oleifera* elevated the mean corpuscular volume count in both groups. Group I increased from 83.96±2.01 to 85.93±2.37, group 2 increased from 82.00±2.32 to 84.03±2.38. They both were statistically significant.

The Figure 8 shows a reduction in mean cell hemoglobin count in both groups which were not significant statistically. Group 1

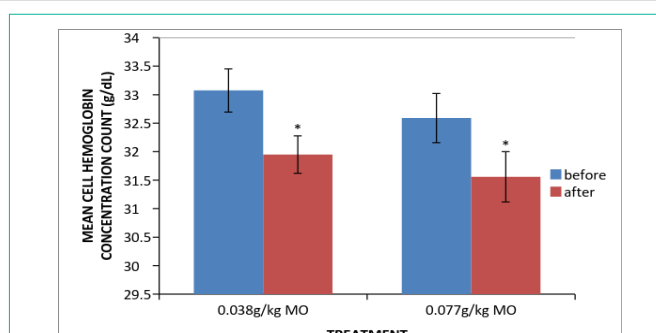


Figure 9: Showing effect of *Moringa Oleifera* leaves on mean cell hemoglobin concentration count. ^{*}statistically significant at P<0.05

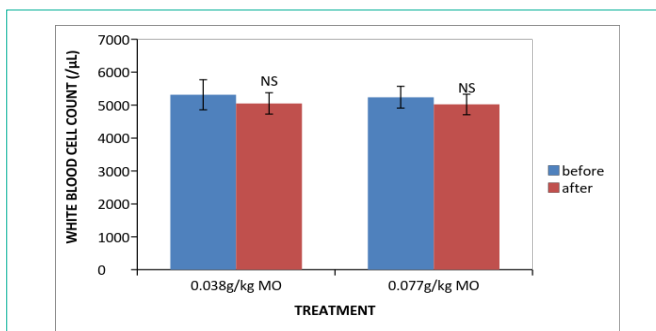


Figure 10: Showing effect of *Moringa Oleifera* leaves on white blood cell count. NS-not significant at P<0.05

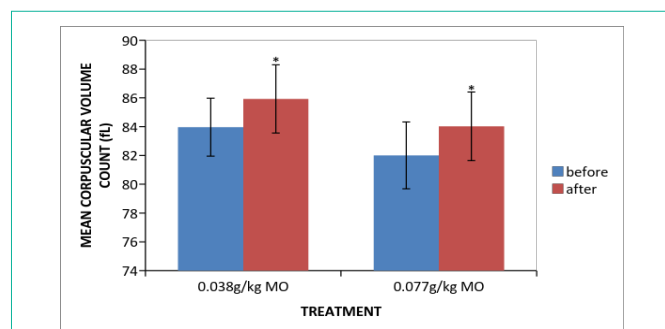


Figure 7: Showing effect of *Moringa Oleifera* leaves mean corpuscular volume count. ^{*}statistically significant at P<0.05

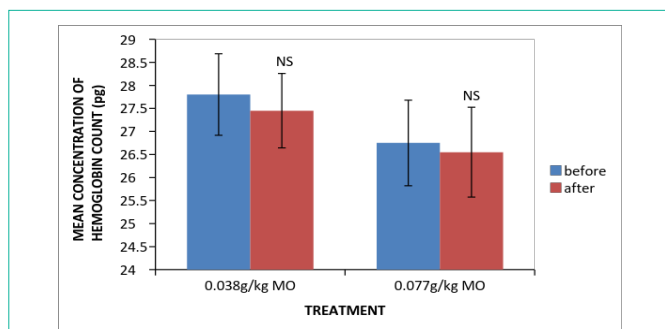


Figure 8: Showing effect of *Moringa Oleifera* leaves on mean cell hemoglobin count. NS-not significant at P<0.05

decreased from 27.80±0.89 to 27.55±0.81, while group 2 decreased from 26.75±0.93 to 26.55±0.98.

Moringa Oleifera significantly decreased mean cell hemoglobin concentration in both groups. Group 1 fell from 33±0.10 to 31.95±0.025 and from 32.65±0.067 to 31.8±0.27 in group 2 (Figure 9).

The Figure 10 shows that *Moringa Oleifera* decreased white blood cell count in both groups, the decrease were not significant at P<0.05. Group 1 decreased from 5.31×10³±0.46 to 5.05×10³±0.32, while group 2 decreased from 5.24×10³±0.33 to 5.02×10³±0.01 (Table 3).

Lymphocyte count dropped as seen on the figure above in both groups. Group 1 decreased from 47.70±3.35 to 44.45±2.40, while group 2 decreased from 48.82±3.13 to 45.43±2.01. They were not significant statistically (Figure 11).

Neutrophil count as shown above increased in both groups. They were not statistically significant. Group 1 increased from 40.90±3.98

Table 3: Summary table showing effect of *Moringa Oleifera* leaves on white blood cell and its indices.

	Groups	Dose	Hematological parameters			
			WBC×10 ³ (/ μ L)	LYM (%)	NEUT (%)	LYM#×10 ³ (/ μ L)
	1	0.038g/kg MO				
Before			5.31±0.46	47.70±3.35	40.90±3.98	2.59±0.35
After			5.05±0.32 ^{NS}	44.45±2.40 ^{NS}	47.25±3.39 ^{NS}	2.10±0.24 ^{NS}
	2	0.077g/kg MO				
Before			5.24±0.33	48.82±3.13	41.77±3.15	2.53±0.22
After			5.02±0.01 ^{NS}	45.43±2.01 ^{NS}	43.11±2.18 ^{NS}	2.30±0.21 ^{NS}

	Groups	Dose	Hematological parameter
			NEUT#×10 ³ (/ μ L)
	1	0.038 g/kg MO	
Before			2.08±0.13
After			2.25±0.12 ^{NS}
	2	0.077 g/kg MO	
Before			2.21±0.24
After			2.14±0.13 ^{NS}

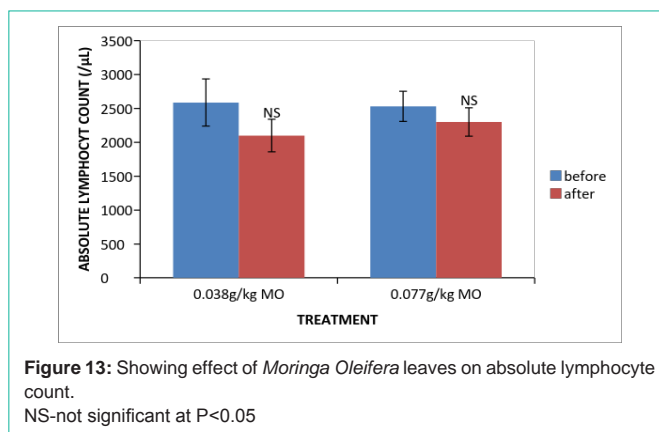


Figure 13: Showing effect of *Moringa Oleifera* leaves on absolute lymphocyte count. NS-not significant at P<0.05

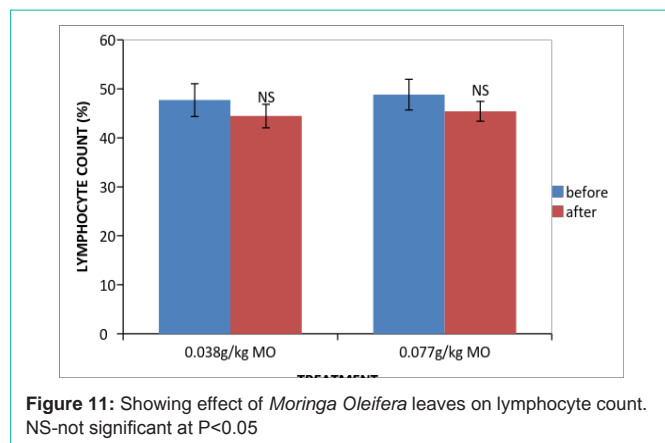


Figure 11: Showing effect of *Moringa Oleifera* leaves on lymphocyte count. NS-not significant at P<0.05

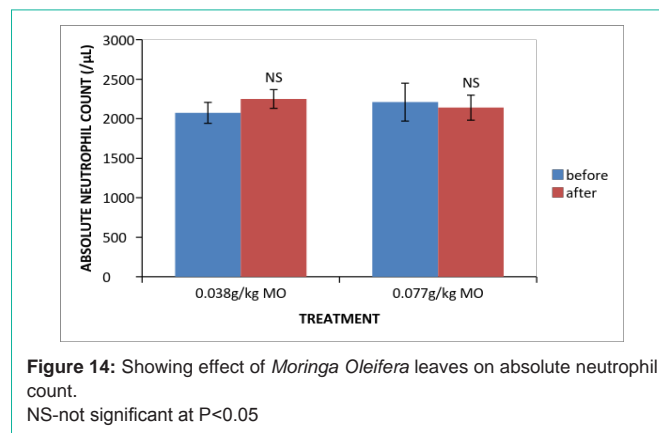


Figure 14: Showing effect of *Moringa Oleifera* leaves on absolute neutrophil count. NS-not significant at P<0.05

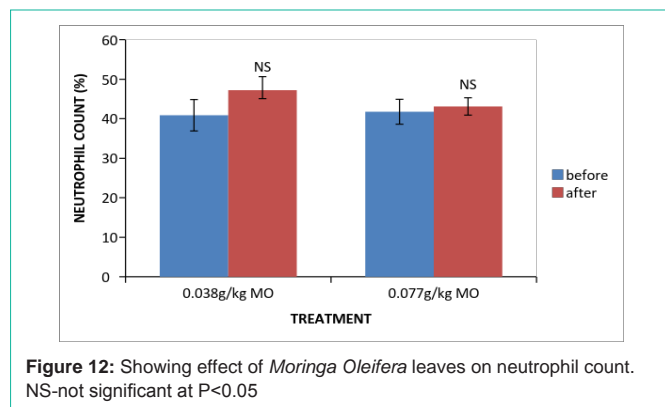


Figure 12: Showing effect of *Moringa Oleifera* leaves on neutrophil count. NS-not significant at P<0.05

to 47.25±3.39, while group 2 increased from 41.77±3.15 to 43.11±2.18 (Figure 12).

Absolute lymphocyte count decreased from 2.59±0.35 to 2.10±0.24 and 2.53±0.22 to 2.30±0.21 in groups 1 and 2 respectively. These values were not statistically significant (Figure 13).

The Figure 14 demonstrated that *Moringa Oleifera* rose the

absolute neutrophil count in group 1 from 2.075±0.0025×10³ to 2.245±0.057×10³. In contrast to group 2, this dropped from 2.05±0.201×10³ to 2.02±0.13×10³. Both values were not significant at P<0.05.

Discussion and Conclusion

Discussion

Treatment with different doses of the extract was not initially tolerated by some of the subjects at the beginning of the research. In the first three days, three subjects experienced diarrhea, but this became resolved from day 4 onward.

Effect of *Moringa Oleifera* on platelet and its indices

Table 1 shows the changes in platelet, mean platelet volume (MPV), platelet larger cell ratio (P-LCR) and platelet distribution weight (PDW) for groups 1 (0.038 g/kg MO) and group 2 (0.077 g/kg MO).

Moringa Oleifera caused a rise in platelet count of both groups, from $172.5 \times 10^3 \pm 30.56$ to $228.5 \times 10^3 \pm 23.08$ and $204.1 \times 10^3 \pm 26.67$ to $225 \times 10^3 \pm 16.42$ for I and II respectively. In this observation, while the rise for group I (0.038 g/kg MO) is statistically significant, that of group 2 (0.077 g/kg MO) is not at $P < 0.05$. These findings are in agreement with findings of Lowell [19], that dietary component of *Moringa Oleifera* increased platelet count, although their research was carried out in rats. However, mean values of these parameters were within the normal ranges, which are consistent with findings from other studies [20]. Decreasing response to increasing dose has also been noted in the present study. This implies that the beneficial effect on platelet count is more pronounced at lower concentration of *Moringa Oleifera*, and increasing the dose may not necessarily raise the count. This observation of decreasing benefit with higher doses seems dissimilar to the study of Adedapo et al [21] in which platelet count elevated proportionately to higher *Moringa Oleifera* doses.

Besides, fall in mean platelet volume (MPV) and platelet distribution weight (PDW) are part of notable observation. MPV decreased from 11.81 ± 0.36 to 10.55 ± 0.25 in group 1 and from 11.91 ± 0.50 to 10.55 ± 0.25 in group 2. This was significant at $P < 0.05$ for the two groups. Platelets are important in the formation of platelet plugs during normal hemostasis, clot retraction, and coagulation factor activation. This observation appears promising as a possible dietary choice for treating thrombocytopenia. The effect of *Moringa Oleifera* on clotting factors, which is beyond the scope of the present study, also needs to be ascertained as this may provide alternative method for treating bleeding disorders.

Effect of *Moringa Oleifera* leaves on red blood cell and its indices

Similarly, the results of this study also demonstrated elevation in the red blood cell count and hemoglobin; although, these are not statistically significant. Whereas, hematocrit, mean corpuscular volume, mean cell hemoglobin concentration demonstrated significant rise at $P < 0.05$. The increase in the red blood cell count of group 1 (from $4.73 \times 10^6 \pm 0.25$ to $4.86 \times 10^6 \pm 0.29$) with lower dose is not too different from that seen in group 2 (from $4.40 \times 10^6 \pm 0.10$ to $4.56 \times 10^6 \pm 0.16$) who received higher *Moringa Oleifera* dose. Also, the hemoglobin level rose from 13.00 ± 0.38 to 13.21 ± 0.48 in group 1 and from 11.74 ± 0.43 to 12.05 ± 0.53 in group II. Concomitant rise in hematocrit to 41.39 ± 1.59 and 38.12 ± 1.34 from 39.40 ± 1.34 and 35.97 ± 1.06 for groups 1 and 2 respectively were also evident.

These interesting findings suggest that dietary supplement with *Moringa Oleifera* may have the potential of reversing anemia within a short period of administration. Therefore, more researches are needed to fully evaluate this benefit in the anemic. *Moringa Oleifera* has been found to contain alkaloids, flavonoids, phytosterols and saponin which are known to possess hematopoietic property [20]. Beside these bioactive substances in the leaf of *Moringa Oleifera*, it has also been said to be an outstanding source of vitamin A, B, C, minerals like iron as well as protein [20], which may all contribute to its observed effects on red blood cells.

On the contrary, group 1 mean cell hemoglobin decreased from 27.80 ± 0.89 to 27.45 ± 0.81 , as well as group 2, from 26.75 ± 0.93 to 26.55 ± 0.98 . Mean cell hemoglobin concentration also dropped in both groups.

Effect of *Moringa Oleifera* leaves on white blood cell count and its indices

On the other hand, white blood cell, lymphocyte, absolute lymphocyte and mixed basophils, monocytes and eosinophil decreased in both groups. Neutrophil and absolute neutrophil however increased. These changes are not statistically significant at $P < 0.05$. Total White blood cell became lowered from $5.31 \times 10^3 \pm 0.46$ to $5.05 \times 10^3 \pm 0.32$ in group I and from $5.24 \times 10^3 \pm 0.33$ to $5.02 \times 10^3 \pm 0.01$ in group 2. While lymphocyte dropped from 47.70 ± 3.35 to 44.45 ± 2.40 and from 48.82 ± 3.13 to 45.43 ± 2.01 in the two groups respectively. Fall in absolute lymphocyte is also seen. Conversely, neutrophil was raised from 40.90 ± 3.98 to 47.25 ± 3.39 , 41.77 ± 3.15 to 43.11 ± 2.18 in groups 1 and 2 in that order.

White blood cells are involved in protecting the body from infections [22], and are usually raised in acute infection but may be low in overwhelming infection [23]. Amongst other functions, they kill virus-infected cells, enhance the production of antibodies and engulf foreign materials (antigens) that enter the body. A higher presence would therefore connote a threat to normal health. The reason for the fall in the overall white cell count and some indices as observed in this study is not clear and this needs to be elucidated with further research.

Conclusion

The study revealed that *Moringa Oleifera* significantly increased platelet count in human subjects that took low dose only. The study also demonstrated a non-significant increase in red blood cell in the two groups. Contrariwise, white blood cell showed a non-significant decrease in both groups. It is therefore concluded that *Moringa Oleifera* has hematopoietic activity; it is especially beneficial to platelet count (when taken in low dose), and it is also beneficial to red blood cell formation in humans (though not to a significant level). However, its immune enhancing benefit is less certain.

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