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Effects of *Moringa oleifera* on Blood Pressure and Blood Glucose Level in Healthy Humans

Blessing Omolaso*[1], Olutunde A Adegbite[2], Samuel A Seriki[1], Idika I Ndukwe[1]
1.Department of Human Physiology, College of Medicine, Bingham University, Karu Nigeria
2.Centre for Infectious Diseases, Nigerian Army Reference Hospital, Yaba Lagos, Nigeria

ABSTRACT

Moringa oleifera is one of the many plants used today for treating various pathological conditions. The aim of the present study is to investigate the effects of *Moringa oleifera* leaf on blood glucose, blood pressure and temperature in normal conditions. The study is divided into two independent phases: acute phase and chronic phase. 34 participants took part in the acute phase. Subjects in this phase were divided into 5 groups of 6-8 participants. Group 1 was given water only, Group 2 received 75g oral glucose load and 2 hours later was given 75mg/kg dose of *M. oleifera*, Group 3 was given 75mg/kg dose of *M. oleifera* and received 75g oral glucose load 2 hours later. Group 4 was given 75g oral glucose load only, Group 5 received 75mg/kg *M. oleifera* only. Baseline readings for blood pressure, pulse rate and body temperature were taken for groups 1 to 4 in their fasting state, while group 5 baseline readings were taken as random blood glucose. 16 participants divided into two groups took part in the chronic phase of the study. Group 6 subjects received 37.5mg/kg doses while Group 7 received 75mg/kg doses of *M. oleifera*. *M. oleifera* decreased blood pressure significantly ($P<0.05$) after two hours of administration. There was a significant decrease ($P<0.05$) in pulse rate two hours after *M. oleifera* administration in the fed state and after an oral glucose load, while temperature also decreased significantly after two hours of *M. oleifera* administration. Blood glucose decreased significantly after 4 hours of administration of *M. oleifera* only. For the group taking glucose before *M. oleifera*, there was a peak decrease of 18.7% just after 30 minutes. There was no significant change in blood glucose level for the group that received *M. oleifera* in the fasting state. Intake of *M. oleifera* daily for 14 days reduced blood glucose level independent of the dose received. It has been observed that *M. oleifera* leaf is effective in reducing blood glucose particularly when levels are high but have no significant effect on normal fasting blood glucose levels. Blood pressure decreases 2 hours after *M. oleifera* intake across the groups. Pulse rate and body temperature have also been found to decrease as a result of *Moringa oleifera* leaf intake.

Keywords: Moringa oleifera, Blood Pressure, Blood Glucose Level

*Corresponding Author Email: seriki.adinoyi@gmail.com
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INTRODUCTION

Plants as medicinal agents were mentioned in historic documents dating back many thousands of years [1] . Currently, medicinal herbs as a whole were reported to be used against a wide range of health problems such as cough, cold, stomach, cataract, constipation and many other ailments [2] . One of such medicinal herbs is *Moringa oleifera* which is attracting a growing interest in various parts of the world for its therapeutic properties.

Moringa oleifera (MO) is referred to as the 'drum stick tree' or the 'horse radish tree' in some parts of the world. [3] . Locally, it is known as 'zogollagandi' in Hausa, 'okwe oyibo' in Igbo and 'ewe igbale' in Yoruba [4] . It belongs to *Moringacea* family which has fourteen species [5] . The tree ranges in height from 5 to 10m [6]. It is found wild and cultivated throughout the plains especially in hedges and in house yards, thrives best under the tropical insular climate, and is plentiful near the sandy beds of rivers and streams [7] . It can grow well in the humid tropics or hot dry lands, can survive destitute soils, and is little affected by drought [6] . It tolerates a wide range of rainfall with minimum annual rainfall requirements estimated at 250 mm and maximum at over 3000 mm and a pH of 5.0 - 9.0 [8] .

Various properties of *M.oleifera* have been documented including its anti-cancer [9] , anti-inflammatory [10] , anti-microbial [11] , thyroid status regulator [12] and anti-asthmatic [13] effects.

Diabetes Mellitus (DM) is a chronic metabolic disorder with impaired glucose tolerance and high risk of cardiovascular disease [14] . Cardiovascular risk factors, including hypertension tend to co-segregate more commonly than would be expected by chance. Hypertension and type-2 Diabetes Mellitus tend to coexist [15] . Hypertension is approximately twice as common in persons with diabetes as in persons without diabetes, and the association is even stronger in people of African descent [16] . The leading cause of death in patients with type 2diabetes is coronary heart disease, and diabetes increases the risk for acute myocardial infarction as much as a previous myocardial infarction in a non-diabetic person [16].

Since 35% to 75% of the cardiovascular complications of diabetes are attributable to hypertension, diabetic patients need aggressive antihypertensive treatment, as well as glucose control. Many oral synthetic anti-diabetic agents have been developed [17] . Hyperglycemia can be managed initially with oral agents and insulin therapy which sometimes require achieving targeted glycemic levels. These synthetic agents however, produce some serious side effects and are relatively expensive for developing countries like Nigeria [18] . Therefore, searching for effective, low cost hypoglycaemic agents with fewer side effects is important and the closest alternative is local herbs like *Moringa oleifera*.

With a rise in the use of *Moringa oleifera* as a medicinal agent and its anti-diabetic and hypotensive effects being confirmed by a growing number of researchers, there was a need to investigate its potential on non-diabetic and normotensive subjects

MATERIALS AND METHOD

The materials used include: Glucometer (Accu-chek®), glucometer strips (Accu-chek®), Lancets (Accu-chek®), Lancet click (Softclix®), *Moringa oleifera* leaf, D-glucose (Allenburyo®), timer, water heater, electric blender, cotton wool, methylated spirit, recording sheet, electronic weighing balance, bathroom scale, glass cups, sphygmomanometer, thermometer, digital blood pressure monitor, stethoscope, measuring tape.

Preparation of Administered Extract

Moringa oleifera leaf was harvested from a garden in Karu, Nasarawa State. Leaves were air dried at room temperature between 28-31°C for 6 days. The leaves were ground with an electric blender into powder. With the aid of an electric weighing balance, respective doses of the ground leaf were measured.

400g packs of pure glucose were bought from Tova Pharmacy in Karu, Nasarawa State. 75g of glucose was measured using an electronic weighing balance.

Participants

The study was divided into two phases with a total of 50 subjects taking part in the study. 34 subjects were randomly selected from the adopted community of Bingham University with age ranging from 18 to 27 years for the first phase while the remaining 16 subjects with age ranging from 29 to 48 constituted the second phase. Participants comprised of male and female subjects.

The subjects in phase-1 were divided into 5 groups with 6 - 8 subjects in each group:

Group 1: Water only

Group 2: Glucose + *Moringa oleifera*

Group 3: *Moringa oleifera* + Glucose

Group 4: Glucose only

Group 5: *Moringa oleifera* only

The subjects in phase-2 were divided into 2 groups

Group 6: Low dose

Group 7: High dose

Data Collection

Weight and height of each subject was measured using a weighing scale and measuring tape respectively hence body mass index (B.M.I.) was calculated.

Group 1

Fasting blood glucose level was determined for all the subjects in the group using a glucometer (Accu-chek®) 10-12 hours after their last meal the preceding day. Blood glucose tests were again carried out at 120 minutes and 240 minutes after the determination of fasting blood glucose.

Blood pressure as well as pulse rate was measured using a blood pressure monitor immediately before every blood glucose measurement. Body temperature was determined at respective times for all the subjects using a digital thermometer.

Group 2

Subjects were given 75g of glucose D dissolved in 250ml of water serving as oral glucose tolerance test (OGTT) [19] after their fasting blood glucose levels were tested. 75mg/kg body weight of ground *Moringa oleifera* leaf in 250ml of water was then given to the subjects 120 minutes after glucose intake.

Fasting blood glucose test was done using a glucometer (Accu-chek®) 10 -12 hours after their last meal the preceding day. Subsequent blood glucose levels, blood pressure, pulse rate and temperature measurements were determined as was done in Group 2.

Group 3

Subjects were given 75mg/kg body weight of ground *Moringa oleifera* leaf in 250ml of water after their fasting blood glucose levels were tested. Oral glucose tolerance test (OGTT) was done with glucose solution made from 75g of glucose D dissolved in 250ml of water [19] . This was given to the subjects 120 minutes after *Moringa oleifera* leaf intake.

Fasting blood glucose level was determined using a glucometer (Accu-chek®) 10-12 hours after their last meal the preceding day. Blood glucose tests were further carried out at 30 minutes, 60 minutes, 120 minutes, 150 minutes, 180 minutes and 240 minutes after the determination of fasting blood glucose.

Blood pressure and pulse rate measurements were done before the fasting blood glucose level was determined using a blood pressure monitor. Body temperature was also determined at this time. Blood pressure, pulse rate and temperature measurements were repeated at 120 minutes and 240 minutes after *Moringa oleifera* had been taken by the subjects.

Group 4

After 10-12 hours of overnight food privation, fasting blood glucose was determined using a glucometer (Accu-chek®) and oral glucose tolerance test (OGTT) was performed using 75g of glucose D solution dissolved in 250ml of water[19] . Subsequent blood glucose tests were done using the same glucometer 30, 60, 120, 150, 180 and 240 minutes after the OGTT was performed.

Blood pressure, pulse rate and body temperature measurements were done before the OGTT, at 120 minutes and 240 minutes after the OGTT.

Group 5

Post-prandial blood glucose test was carried out using a glucometer (Accu-chek®). Blood pressure, pulse rate as well as body temperature readings were taken before 75mg/kg body weight of *Moringa oleifera* leaf in 250ml water was given to the subjects. Subsequent blood glucose tests were done using the same glucometer at 30, 60, 120, 150, 180 and 240 minutes after the first blood glucose test was carried out.

Blood pressure, pulse rate and body temperature measurements were repeated at 120 minutes and 240 minutes after the initial measurements.

Group 6

Fasting blood glucose levels were determined for each subject on the first day. Subjects were given 37.5mg/kg body weight of *Moringa oleifera* leaf each day for 14 days. Fasting blood glucose was again measured after the 14 days of *M. oleifera* intake.

Group 7

Fasting blood glucose levels were determined for each subject on the first day. Subjects were given 75mg/kg body weight of *Moringa* oleifera leaf each day for 14 days. Fasting blood glucose was again measured after the 14 days of *M.* oleifera intake.

Statistical Analysis

Results were expressed as the mean ± standard error of mean (SEM). Statistical analysis of data was carried out using one-way student's t-test. Statistical computation was done using SPSS software version 17 and Microsoft Excel.

RESULTS AND DISCUSSION

Blood Pressure

Table 1: Systolic Blood Pressure Result

Group	T_0	T_{120}	T_{240}
Control	116.7 ± 1.9	118.2 ± 5.4	112.7 ± 3.0
Glucose + MO	128.5 ± 5.1	129.5 ± 5.7	121.8 ± 3.5[a]
MO + Glucose	129.7 ± 5.2	123.7 ± 5.1[b]	130.4 ± 5.9
Glucose only	122.4 ± 2.5	120.6 ± 5.0	117.9 ± 4.7
MO only	122.9 ± 3.4	115.4 ± 3.3[c]	116.3 ± 4.3

Mean ± SEM (mmHg)

MO = *Moringa oleifera*, [a] = P≤0.05 compared with Glucose only, [b] = P≤0.05 compared with Control, [c] = P≤0.05 compared initial T_0.

The difference in the systolic blood pressure between T_{120} and T_{240} in the Glucose + Mo group was significantly decreased at P<0.05 when compared with the values obtained for the

Glucose only group. The difference in the systolic blood pressure between T_0 and T_{120} in the *M.oleifera* + Glucose group was significantly decreased at $P<0.05$ when compared with the values obtained for the Control group. For the MO only group, there is a decrease in systolic blood pressure between T_0 and T_{120} statistically significant at $P<0.05$.

Table 2: Diastolic Blood Pressure Result

Group	T_0	T_{120}	T_{240}
Control	65.7 ± 2.9	66.7 ± 2.5	63.0 ± 2.2
Glucose + MO	75.8 ± 3.2	75.8 ± 3.0	74.5 ± 2.9[a]
MO + Glucose	76.4 ± 1.7	74.7 ± 2.0[b]	72.3 ± 2.6
Glucose only	70.3 ± 3.1	64.3 ± 3.3	64.7 ± 3.5
MO only	65.4 ± 1.9	65.0 ± 2.5	64.4 ± 1.9[c]

Mean ± SEM (mmHg)

MO = *Moringa oleifera*, [a] = P≤0.05 compared with Glucose only, [b] = P≤0.05 compared with Control, [c] = P≤0.05 compared initial T_0.

From the result it can be observed that decrease in diastolic blood pressure from T_{120} to T_{240} in the Glucose + Mo group when compared with the values obtained for Glucose only at the same time interval was statistically significant at T_{240} ($P<0.05$). The group given *M.oleifera* + Glucose showed a statistically significant decrease in diastolic blood pressure between T_0 and T_{120} at P≤0.05 compared with the values obtained for the Control group at T_{120}. For the group given *M.oleifera* only, there is a significant decrease in diastolic blood pressure after administration at T_{120} (P≤0.05).

Pulse Rate

Table 3: Pulse Rate Result

Group	T_0	T_{120}	T_{240}
Control	68.2 ± 4.4	69.8 ± 4.1	69.8 ± 2.9
Glucose + MO	74.5 ± 5.7	78.2 ± 4.7	73.3 ± 4.4[a]
MO + Glucose	65.1 ± 4.2	74.1 ± 4.9	71.4 ± 5.1
Glucose only	74.4 ± 6.6	72.4 ± 4.2	69.1 ± 4.0
MO only	74.1 ± 5.4	66.9 ± 4.7[b]	62.6 ± 4.1[b]

Mean ± SEM (pulse/minute)

MO = *Moringaoleifera*,[a] = P≤0.05 compared with Glucose only, [b] = P≤0.05 compared with initial T_0.

The result shows a significant decrease at in pulse rate P≤0.05 in the group given Glucose before *M.oleifera* compared with the group given Glucose only. The group given *M.oleifera* only also shows a significant decrease in pulse rate at P≤0.05 at T_{120} and T_{240} respectively compared with the initial T_0.

Body Temperature

Table 4: Body Temperature Result

Group	T_0	T_{120}	T_{240}
Control	36.3 ± 0.2	36.4 ± 0.2	36.5 ± 0.2
Glucose + MO	36.4 ± 0.1	36.4 ± 0.1	36.0 ± 0.2[a]
MO + Glucose	36.3 ± 0.2	36.1 ± 0.2[b]	36.3 ± 0.2
Glucose only	36.4 ± 0.2	36.3 ± 0.2	36.4 ± 0.2
MO only	36.4 ± 0.2	36.2 ± 0.2[c]	36.4 ± 0.1

Mean ± SEM (°C)

MO = *Moringa oleifera*, [a] = P≤0.05 compared with Glucose only, [b] = P≤0.05 compared with Control, [c] = P≤0.05 compared initial T_0.

From the result, the difference in body temperature between T_{120} and T_{240} in the Glucose + MO group was significantly decreased at P<0.05 when compared with the values obtained for the Glucose only group. The difference in body temperature between T_0 and T_{120} in the *M.oleifera* + Glucose group was significantly decreased at P<0.05 when compared with the values obtained for the Control group. For the MO only group, there is a decrease in body temperature between T_0 and T_{120} statistically significant at P<0.05 but there is no change when $T_0$is compared with T_{240}.

Blood Glucose

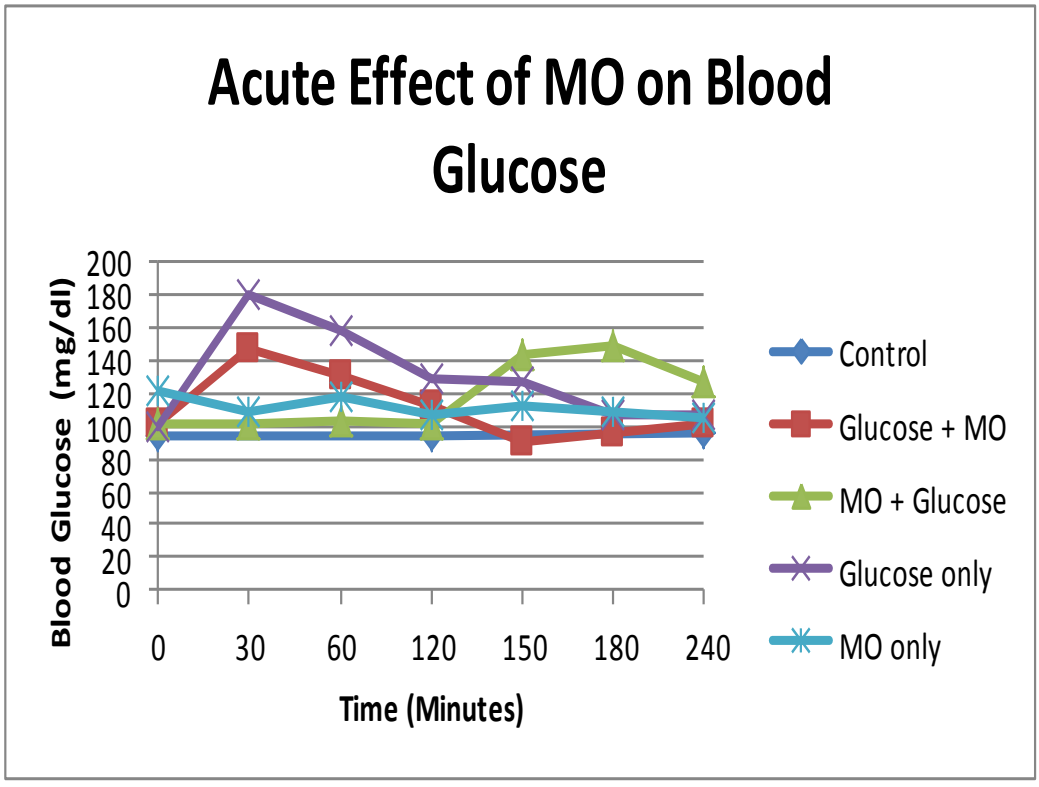

Figure 1: Graph Showing Blood Glucose Pattern across Groups

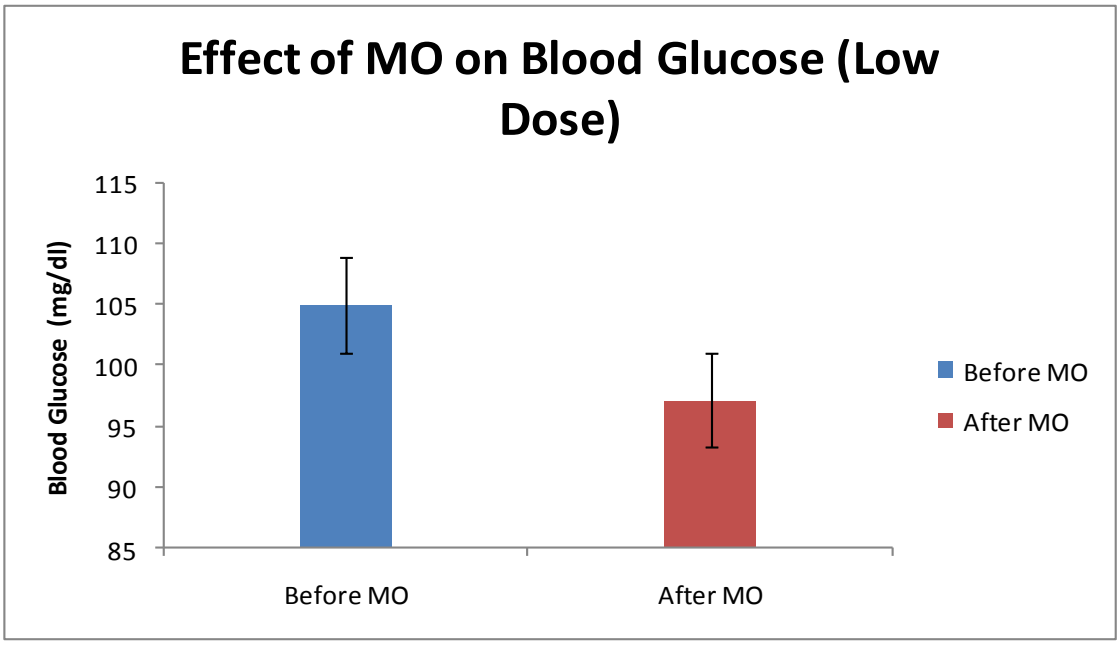

Figure 2: Effect of *M.oleifera* (37.5mg/kg-bw) on Blood Glucose

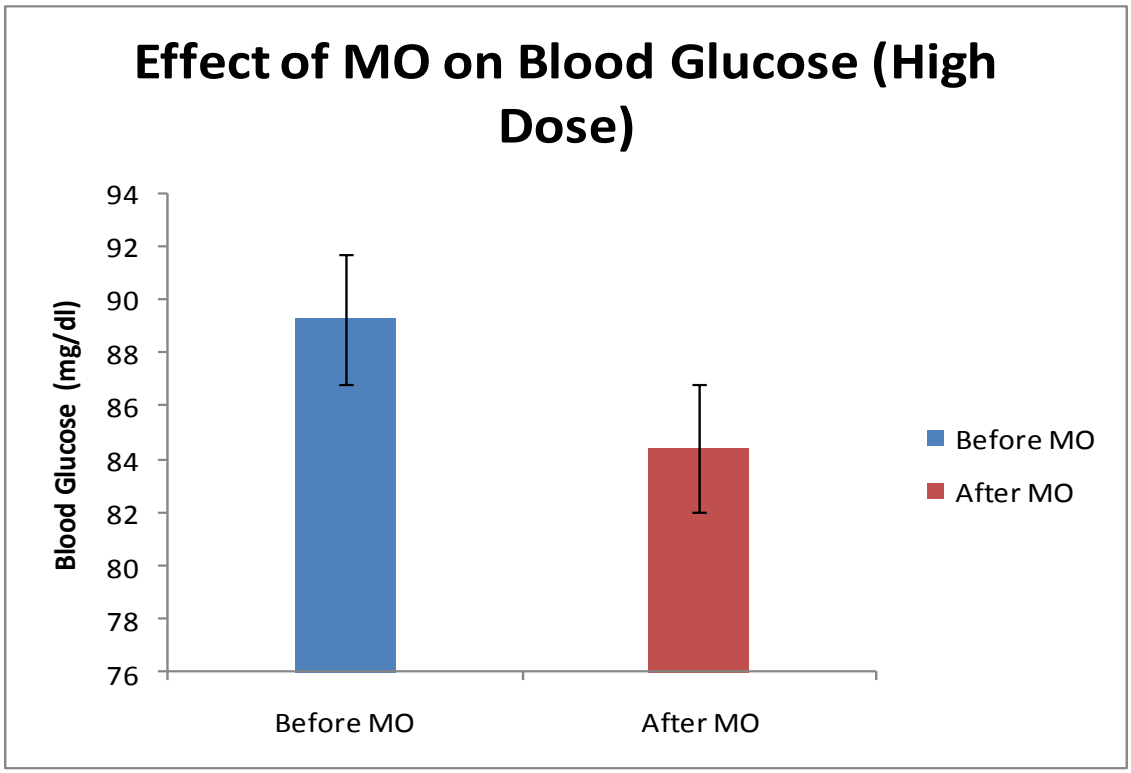

Figure 3: Effect of *M.oleifera* (75mg/kg-bw) on Blood Glucose

Figure 2 shows a significant decrease in blood glucose level of group 6 subjects from 105.00±4.42 to 97.14±3.45 at P≤0.05. Figure 3 shows a similar pattern for group 7 with a decrease from 89.29±4.84 to 84.43±3.29 statistically significant at P≤0.05.

DISCUSSION

This chapter discusses the major findings on the effect of *M. oleifera*on blood pressure, pulse rate, body temperature and blood glucose of normal human subjects.

Effect of *Moringa oleifera* on Blood Pressure

The blood pressure is found to decrease significantly two hours after *M.oleifera* intake for all the groups taking *M.oleifera*. This hypotensive effect has been attributed to the thiocarbamate and isothiocyanate glycosides of the glucosinolate family present in *M.oleifera*[20]. Specifically, compounds niazinin A, niazinin B, niazimicin and niaziminin A + B isolated by ethanolic extraction have been demonstrated to have potent hypotensive effect on rats which may also explain this observation in human subjects. This is possibly by their calcium antagonist effect [21] .

From the data emerging from this study, systolic blood pressure is found to decrease significantly ($P<0.05$) in all the groups taking *M.oleifera* before or after glucose two hours after *M.oleifera* intake. Further decrease in blood pressure four hours after *M.oleifera* intake is not observed in this study. This indicates that *M.oleifera* possibly has a short duration of action on blood pressure. Although there was decrease in both systolic and diastolic blood pressure, levels remained within the range of normal. This observation is similar to findings made in a research on *M. stenopetala* specie of the *Moringa*ceae family [22] .

Effect of *Moringa oleifera* on Pulse Rate

Results indicate that there is a significant decrease in pulse rate ($P<0.05$) when *M.oleifera* was administered in both the fed state (74.1±5.4 to 66.9±4.7) and after an oral glucose load (78.2±4.7 to 73.3±4.4). Pulse rate is directly related to heart rate [23]. The negative inotropic action of *M.oleifera* has been traced to its alkaloid content [24] which acts by inhibiting K^+ induced contractions in the heart [21].

Effect of *Moringa oleifera* on Body Temperature

From the result of the body temperature measurement in the different groups, it is observed that temperature reduced significantly ($P<0.05$) in the group taking *M.oleifera* before glucose as compared to the control group which showed an increase. A similar result is recorded in the group taking glucose before *M.oleifera* when compared to the group taking glucose only. *M.oleifera* is also seen to play a significant role in lowering body temperature in the group taking *M.oleifera* only. Body temperatures reduced within the first two hours of *M.oleifera* intake and remained decreased four hours after *M.oleifera* intake relative to the control and glucose only groups. In his experiment, high body temperatures were induced in adult rabbits using E. coli suspensions. Body temperatures were measured rectally every hour for five hours and he found that there was a decrease in the first four hours. A similar experiment with rats by [25] , also demonstrated a drop in body temperature within the first four hours on administration of *M.oleifera* seed. Phytochemicals such as moringinine, glycosides and alkaloids present in the leaf have been said to be responsible for this antipyretic property [26].

Mode of action of these phytochemicals is through the inhibition of synthesis of certain endogenous substances such as prostaglandins (released during tissue damage, inflammation, graft rejection or other disease states) which are responsible for increased temperature "set-point" by the hypothalamus during fever [2728]. However, mechanisms governing the decrease in body temperature in normothermic state have been suggested to be a result of vasodilatation of peripheral blood vessels.

Effect of *Moringa oleifera* on Blood Glucose

The results obtained from the first phase (acute ingestion) of the blood glucose experiment shows that for the MO only group, there is a significant decrease in the blood glucose level 30 minutes after *M.oleifera* (75mg/kg body weight) intake compared with the Control group. It is further observed that blood glucose remained less than the baseline (non-fasting state) blood glucose level at 1 hour and 2 hours after *M. oleifera* ingestion. After 4 hours of *M.oleifera* administration, blood glucose level had decreased from a baseline mean of 120.75mg/dl to 104mg/dl. This decrease agrees with findings made in another study involving hyperglycemic rats where blood glucose decreased within an hour of *M.oleifera* administration and continued to decrease 6 hours later [29] .

The group that was administered Glucose before *M. oleifera* shows a lower area under the curve (AUC) than the group which was given Glucose only. The lowest concentration of blood glucose achieved was an 18.7% (111.3mg/dl to 90.5mg/dl) decrease observed 30 minutes after *M.oleifera* administration; indicating an early onset for the effect of *M.oleifera*. Two hours after *M. oleifera* (i.e. four hours after the oral glucose load) is given, mean blood glucose concentration value in this group is observed to be uniform with its baseline reading unlike in the group given Glucose only whose mean value after 4 hours was higher than the baseline value.

For the group given *M. oleifera* before Glucose, there was no significant effect on their fasting blood glucose level 30 minutes, 1 hour and 2 hours after *M. oleifera* intake. This effect of *M.oleifera* on fasting blood glucose of normoglycemic subjects is comparable to the previous findings in a study of normoglycemic rats in which there was no significant change in blood glucose 3 hours post *M. oleifera* administration at a dose of 250mg/kg and 500mg/kg body weight [29] . Another study involving 30 human subjects in their fasting state showed no significant change in their blood glucose 2 hours after *M. oleifera* tea was taken. On the contrary, a study reported significant decrease in blood glucose 3 hours after administration of 100mg/kg, 200mg/kg and 300mg/kg body weight of *M.oleifera* to normoglycemic rats [5] . Thus the effect of M. oleifera on fasting blood glucose level is largely inconsistent from

existing studies. In this study however, it is established that acute ingestion of *M. oleifera* does not significantly affect the fasting glucose level in nornoglycaemic individuals.

Results from the *M. oleifera* before glucose group indicates that peak blood glucose level after glucose challenge is significantly decreased ($P<0.05$) when compared with the Glucose only group at corresponding time points. This suggests that the effect of *M.oleifera* remained present after four hours of administration.

Results from the second phase (chronic ingestion) showed a significant decrease in the fasting blood glucose of subjects after 14 days of *M.oleifera* intake. Decrease in blood glucose was 7.49% (from 105mg/dl to 97.14mg/dl) and 5.45% (from 89.29mg/dl to 84.42mg/dl) for the 37.5mg/kg-bw and 75mg/kg-bw doses respectively. Such a phenomenon of less hypoglycemic response athigher doses is common with various plants and has already been observed in *Psidium guajava* [30] , *Trichosanthesdioica* [31] , *Cynodon dactylon* [32] and *Cinnamomum tamala* [33] . Thus a higher concentration of M. oleifera does not necessarily lead to additional benefit on glucose control.

In the fasting state, hypoglycemic activity of the leaves of *M.oleifera* after chronic ingestion may probably be due to terpenoid present, which appears to be involved in the stimulation of the ß-cells and the subsequent secretion of preformed insulin. One or more of the other chemical constituents of the plant especially flavonoid is also likely to have played a crucial role in the hypoglycemic action of the leaf [29] . It has also been postulated that decrease in blood glucose level can also be attributed to increase in tissue utilization of glucose mediated by M. oleifera

CONCLUSION

Acute intake *Moringa oleifera* leaf is effective in lowering blood pressure and body temperature in healthy individuals. *M.oleifera* can also be used for lowering blood glucose in hyperglycemic conditions over a period of four hours but in fasting conditions will require a chronic intake to reduce blood glucose. This hypoglycemic effect is independent of the dose of the leaf taken.

REFERENCES

1. Rasonavivo, P., Petitjean, A., Ratsimamanga, P., Urverg, S. and Pakoto, R. A. Medicinal plants used to treat malaria in Madagascar. *J Ethnopharacol*, 1992; 37:117 – 127.
2. Jimenez- Arellanes, A., Meckes, M., Ramireez, R., Torres, J. and Luna-Herrera, J. Activity against multidrug-resistant mycobacterium tuberculosis in Mexican plants used to treat respiratory diseases. *J Phytother Res*. 2003, 17: 903 – 908.

3. Farooq, F., Rai, M., Tiwari, A., Khan, A.A. and Farooq, S. Medicinal properties of *Moringa oleifera*: An overview of promising healer. *Journal of Medicinal Plants Research,2012;* 6 (27): 4368-374.
4. Mann, A., Gbate M and Ndaumar A. Medicinal and Economic Plants of Nupeland. Bida: Jube-Evans Books and Publications, 2003; P276.
5. Edoga C.O., Njoku O.O., Amadi E.N., Okeke J.J. Blood Sugar Lowering Effect of *Moringa oleiferaLam* in Albino Rats. *International Journal of Science and Technology,2013;* 3 (1): 88-90.
6. Morton, J.F. The horseradish tree, Moringa pterigosperma (Moringaceae).A boon to arid lands.*Econ Bot, 1991;*45: 318–333.
7. Anwar, F., Latif, S., Ashraf, M. and Guillani, A.H. *Moringa oleifera:* a food plant with multiple medicinal uses. *PhytotherapyRes*. 2007, 21: 17-25
8. Palada, M.C. and Changl, L.C.Suggested cultural practices for Moringa.*International Cooperators' Guide AVRDC*, 2003; 03: 545.
9. Guevara, A.P., Vargas, C., Sakurai, H., Fujiwara, Y., Hashimoto, K., Maoka, T., Kozuka, M., Ito, Y., Tokuda, Y. and Nishino., H. An antitumor promoter from Moringa oleifera Lam. *Mutational Res*,1999; 440: 181-188.
10. Kurma, S.R. and Mishra, S.H. Anti-inflammatory and hepatoprotective activities offruits of *Moringa.Ind. J. Nat. Prod.1998;*14: 3-10.
11. Saadabi, A.M., Abu, Z.A.I. An in vitro antimicrobial activity of *Moringa oleifera* L. seed extracts against different groups of microorganisms. *Asian J. Basic Appl. Sci.2011,* 5: 129-134.
12. Talhiliani, P. and Kar, A. Role of Moringa oleifera leaf extract in the regulation of thyroid hormone status in adult male and female rats. *Pharmacol. Res.2000,*41: 319-323.
13. Agrawal, B. and Mehta, A. Antiasthmatic activity of *Moringa oleifera* Lam: A clinical study. *Indian J. Pharmacol.2008* 40: 28-31.
14. Schnell, O. and Standle, E. Impaired glucose tolerance, diabetes, and cardiovascular disease.*Endocr.Pract 2006.,* 16-19.
15. Reaven, G.M., Lithell, H. and Landsberg, L. Hypertension and associated metabolic abnormalities—the role of insulin resistance and the sympathoadrenal system. *N Engl J Med 1996.,* 334: 374-81.
16. Haffner, S.M., Lehto, S., Rönnemaa, T., Pyörälä, K. and Laakso, M. Mortality from coronary heart disease in subjects with type 2 diabetes and in nondiabetic subjects with and without prior myocardial infarction.*N Engl J Med.1998*, 339: 229-34

17. DeFronzo, R.A. Pharmacologic therapy for type-2 diabetes mellitus.*Ann InternMed*. 1999, 131:281–303.
18. Rubin, R.J., Altman, W.M., Mendelson, D.N. Health care expenditures for people with diabetes mellitus, 1992. *J. Clin. Endocrinol.Metab 1994.*,78: 809A-809F.
19. Philips, P.J. (2012). Oral Glucose Tolerance Testing.*Australian Family Physician,* 2012; 41 (6): 391-393.
20. Faizi, S., Siddiqui, B.S., Saleem, R., Siddiqui, S., Aftab, K. and Gilani, A.H. Fully acetylated carbamate and hypotensive thiocarbamate glycosides from Moringa oleifera.*Phytochemistry*,1995; 38: 957–963.
21. Gilani, H.A., Khalid, A., Suria, A., Siddiqui, S., Rubeena, S., Siddiqui, B.S. and Faizi, S. Pharmacological studies on hypotensive and spasmolytic activities of pure compounds from Moringa oleifera. *Phytotherapy Research, 1994;* 8 (2): 87-91.
22. Mengistu, M., Abebe, Y., Mekonnen, Y. and Tolessa, T. In vivo and in vitro hypotensive effect of aqueous extract of Moringa stenopetala.*Afr Health Sci. 2012,* 12(4): 545–551.
23. Hart A. Association between heart rate variability and manual pulse rate.*J Can Chiropr Assoc,2013;* 57 (3): 243-250.
24. Dangi, S.Y., Jolly, C.I. and Narayanan, S. Antihypertensive Activity of the Total Alkaloids from the Leaves of *Moringa oleifera*.*Pharmaceutical Biology, 2002;* 40 (2): 144-148.
25. Sutar, N.G., Patil, V.V., Deshmukh, T.A,, Jawle, N.M., Patil, V.R. and Bhangale, S.C. (2009). Evaluation of anti-pyretic potential of seeds of *Moringa oleifera* Lam. *Int J Green Pharm,* 3: 148-50.
26. The Wealth of India. Council of Scientific and Industrial Research. *New Delhi,* 1999; 6: 426-9.
27. Hukkeri, V.I., Nagathan, C.V., Karadi, R.V. and Patil, B.S. Antipyretic and wound healing activities of *Moringa oleifera* Lam. in rats.*Ind. J. Pharm. Sci. 2006,* 68: 124-126.
28. Lakshman, K.H., Shivaprasad, B. and Jaiprakash, S. Anti-inflammatory and antipyretic activities of Hemidesmus indicus root extract. *Afr. J. Trad. Chem. 2006*, 3: 90-94.
29. Tende, J.A., Ezekiel, I., Dikko, A.A.U. and Goji, A.D.T. Effect of Ethanolic Leaves Extract of Moringa oleifera on Blood Glucose Levels of Streptozocin-Induced Diabetics and Normoglycemic Wistar Rats. *British Journal of Pharmacology and Toxicology*, 2011; 2 (1): 1-4.

30. Rai, P.K., Rai, N.K., Rai, A.K., Watal, G. Role of LIBS in elemental analysis of *Psidium.guajava* responsible for glycemic potential. *Instrumentation Science and Technology, 2007;* 35: 507–522.
31. Rai, P.K., Jaiswal, D., Diwakar, S., Watal, G. Antihyperglycemic profile of *Trichosanthes dioica* seeds in experimental models. *Pharmaceutical Biology*, 2008; 46:360–365.
32. Singh, S.K., Rai, P.K., Jaiswal, D., Watal, G. Evidence based critical evaluation of glycemic potential of Cynodon dactylon. *Evidence Based Complementary and Alternative Medicine, 2008;* 10: 1093.
33. Sharma, S.R., Dwivedi, S.K. and Swarup, D. Hypoglycemic and hypolipidemic effects of *Cinnamomum tamala* Nees leaves. *Indian Journal of Experimental Biology*, 1996; 34: 372–374.