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METHANOLIC EXTRACT OF *Ficus platyphylla* LEAF MODULATES WEIGHT, BLOOD GLUCOSE LEVEL AND SERUM LIPID PROFILES IN WISTAR ALBINO RATS

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ABSTRACT

Excessive weight gain following the prolonged elevation of blood glucose and lipids is the major driver of obesity, diabetes, and related conditions. This study, therefore, aims to evaluate the effect of *Ficus platyphylla* leaves extract on body weight, blood glucose levels, and serum lipids of albino rats. Methanolic extract from a sample of the plant's leaves was first prepared and subjected to phytochemical screening. Doses of 100 mg/kg, 200 mg/kg, and 400 mg/kg were administered to three groups of rats daily while a fourth (control group) received distilled water for 21 days. Phytochemical screening revealed the presence of alkaloids, flavonoids, saponins, tannins, and steroids. A significant ($p<0.05$) reduction in body weight was observed in the rats administered 100 and 200 mg/kg extract but the reduction is not statistically significant in the 400 mg/kg group. All treatments led to a significant reduction in blood glucose, total cholesterol, triglycerides, and low-density lipoprotein levels with a concomitant rise in high-density lipoprotein cholesterol levels. Our findings demonstrate that the methanolic extract of *Ficus platyphylla* leaves has an ameliorative effect on body weight, blood glucose, and lipids, and hence the plant could be beneficial to obese and diabetic patients.

Keywords: body weight, diabetes, *Ficus platyphylla*, glucose, lipids, obesity

INTRODUCTION

The increasing global prevalence of overweight and obesity is the major trigger of the escalating burden of diabetes mellitus and related sequelae every year. Plants have been rich sources of bioactive metabolites capable of lowering blood glucose and lipids for a long time (Ogbiko, 2021; Yusuf e*t al*., 2022). However, many plant species with such benefits are still at large in different parts of the world. It has been reported that 60% of the world's population relies on herbal medicine and about 80% of the population in developing countries depends almost totally on it for their primary healthcare needs (Ahmad Khan & Ahmad, 2019). It is also believed that most Nigerian citizens today, use medicinal plants and consult traditional medicine practitioners for their healthcare needs (Balogun, 2021).

Ficus platyphylla, one of the species of the Ficus genus native to Africa, is a deciduous tree with spreading roots and branches commonly called broad leaf fig tree. In Nigeria and other parts of the world, the plant along with many others in the genus, *Ficus* is used in the treatment of diarrhea, dysentery, sexually transmitted diseases, chest ailments, tuberculosis, leprosy, convulsions, pain, anemia, and wound (Olayemi *et al*., 2004; Amos *et al*., 2001; Sandabe & Kwari, 2000). Evidence suggests that the role of this plant in traditional medicine is a result of the presence of secondary metabolites such as phenols, saponins, tannins, alkaloids, terpenoids, and flavonoids which are known as phytochemicals (Amos *et al*., 2001). The leaf extracts of this plant have been reported to possess inhibitory activities, against some pathogenic microorganisms (Sandabe & Kwari, 2000). The leaves of *Ficus platyphyplla* are used in conjunction with *Ficus sycomorus* to investigate antibacterial activities (Adeshina *et al*., 2010). Extracts of *Ficus platyphylla* are commonly employed in folk medicine to treat diseases such as mental illness (Olayemi *et al*., 2004). Previous studies on this plant by Amos *et al.* (2002) and Audu, (1989) revealed that it possesses anti-inflammatory and promotes fertility and some central nervous system effects.

Uncontrolled elevation of blood glucose and lipids is the major driver of weight gain, obesity, diabetes, and cardiovascular diseases among others (Dal Canto *et al.*, 2019). Hence, the identification of plants with glucose and lipid-lowering abilities could provide safe and cheaper therapeutic options for obese and diabetic patients. Interestingly, the protective role of some members of the genus Ficus (Moraceae), and their active compounds against diabetes mellitus and related chronic disorders have been reported in the existing literature (Deepa *et al*., 2018). However, there is a dearth of information on the hypoglycemic and hypolipidemic activities of *Ficus platyphylla* leaves. Hence, this research aims to examine the effect of the methanolic extract of *Ficus platyphylla* leaves on body weight, blood glucose, and lipids in Wistar Albino rats.

MATERIALS AND METHODS

Materials

Equipment and apparatus used in this research include UV-spectrophotometer, Centrifuge, Test tubes, Syringe, EDTA bottles (ethylene diamine tetra-acetic Acid) Cotton wool, Mortar and Pestles, Measuring cylinder, Conical flask, cages, Feeding bottles, Beaker, Fridge, Fine test glucometer, Glucometer strip, Micropipette, Spatula, Surgical blade, Weighing balance**,** Hand gloves Water bath, Crucible, Stirrer, Masking tape, etc. All reagents were of analytical grade.

Plant sample collection and identification

Fresh leaves of *Ficus platyphylla* were collected within Dutsin-Ma town, Katsina State, Nigeria. Samples were identified at the Biological Science Department of Federal University Dutsin-Ma, Katsina State.

Animal housing and maintenance
Twenty (20) albino rats of average weight 112 ± 10 g of both sexes were obtained from the Animal Holding Unit of the Department of Biochemistry, Bayero University, Kano, and were kept in plastic cages under laboratory conditions to acclimatize to the laboratory environment for two weeks before the commencement of the experiment. The animals were fed standard animal feed and tap water was provided during acclimatization and experimental periods.

Animal ethics
All animals received humane care according to the Guideline of (OECD, 2001). The ethical regulations of the national and institutional guidelines for the protection of animals' welfare were strictly followed during experiments.

Preparation of Plant Extract
The leaves were sorted to remove the decayed ones, and rinsed with cleaned water to remove debris and dust particles. They were air-dried at room temperature for fourteen days. The dried leaves were milled by mortar and pestle to get a fine-powdered sample required for the extraction. The method described by Ganiyu *et al*. (2023) was adopted for the extraction briefly, *Ficus platyphylla* powdered (100 g) sample was extracted exhaustively in 1 liter of methanol (1:10) for 72hours, after which it was filtered using a muslin cloth and the filtrate was then refiltered using filtered paper (Whatmann size no.1). The extract was concentrated to dryness using water bath at 65ºC. The concentrated extracts were then stored in a refrigerator until it was required for use.

Phytochemicals Screening
A preliminary phytochemicals screening of the leaves extract of *ficus platyphylla* was conducted to detect the presence of alkaloids, flavonoids, terpenoids, tannins, saponins, steroids, cardiac glycosides, and anthocyanins using the methods described by (Brain & Turner, 1975).

Experimental Design
The animals were randomly divided into four groups of five rats each and were subjected to oral administration of methanol extract of *Ficus platyphylla* leaves at different doses of (100 mg/kg, 200 mg/kg, and 400 mg/kg) body weight daily while the control group was given distilled water for 21 days.

Determination of body weight
The animals were weighed using an electronic weighing balance every 7 days to verify and quantitate the change in weight throughout the treatment period.

Biochemical Analysis
Blood glucose determination
The animals fasted for 12hrs with free access to water before the administration of the extract. After 12 hrs, blood was drawn from the tail of each rat and blood glucose levels were determined using Glucometer (fine test Glucometer) following the manufacturer's protocol.

Serum lipid profile assay
Blood sample collection
At the end of 21 days, the rats were anesthetized with diethyl ether after fasting for twelve hours and the organs were excised. Blood was collected through cardiac puncture using a syringe. The blood was collected into heparinized bottles and centrifuged at 4000 rpm for 15 min under room temperature. The clear supernatant (serum) was separated from the pellet and transferred into plane plastic test tubes for the assay.

Serum triglycerides
Three test tubes were labeled sample, standard, and reagent blank. Appropriately diluted serum (10 µL) was added to the sample labeled test tubes. Standard (10 µL) was added to test tubes labeled Reagent RI (1 mL) was added to each of the three test tubes. The reaction mixtures were incubated for 5 minutes at 37 C. Absorbance of the sample (A_{sample}) and standard ($A_{standard}$) against the reagent blank was read within 60 minutes (Richmond, 1973).

$$\text{Trigycerides concentration (mg/dl)} = \frac{A_{sample}}{A_{standard}} \text{ x concentration of standard}$$

Concentration of standard = 191 mg/dl

Total cholesterol
Three test tubes were labeled sample, standard, and reagent blank. Appropriately diluted serum (10 µL) was added to the test tubes. Standard (10 µL) was added to the test tubes labeled standard. Distilled water (10 µL) was added to the reagent blank labeled test tube. Reagent RI (1 mL) was added to each of the three test tubes. The mixtures were incubated for 10 minutes at 25^0C. The absorbance of the sample/standard against the reagent blank (ΔA) was noted within 60 minutes at 500 nm (Richmond, 1973).
The concentration of the total cholesterol was calculated by the following expression:

$$\text{Concentration (mg/dl)} = \frac{\Delta A \text{ Sample}}{\Delta A \text{ Standard}} \text{ x concentration of standard (206 mg/dl)}$$

Change in absorbance of the sample denote ΔASample, while Change in the absorbance of the standard and Absorbance of the reagent blank represent ΔAStandard and A

High-density lipoprotein concentration (HDL)
This was determined using the method described by Gordon and Gordon (1977). Three test tubes were labeled sample, standard, and reagent blank. The supernatant (100 µL) was added to the sample labeled test tubes. (10 µL) of the standard cholesterol was added to the test tubes labeled standard. Reagent 1(1000 µL) of the HDL was also added to the labeled blank. Reagent 2 (1000 µL) of CHOLES –was added to all three labeled test tubes. The mixture was incubated for 5 minutes. Absorbance of the sample (A_{Sample}) and standard ($A_{standard}$) against the reagent blank were read within 60 minutes (Gordon *et al*., 1977).

$$\text{HDL concentration (mg/dl)} = \frac{\text{Abs sample x concentration of the standard (60 mg/dl)}}{\Delta \text{ Abs standard}}$$

Concentration of standard = 60 mg/dl

Low-Density Lipoprotein (LDL)
The method described by Friedewald *et al*. (1972) was adopted.

LDL (mg/dl) = Total cholesterol – HDL

Very low-density lipoprotein (VLDL)
The method described by Friedewald *et al*. (1972) was adopted.

$$\text{VLDL} - \text{cholesterol} = \frac{\text{Triglycerides (mmol/L)}}{2.2}$$

Statistical Analysis

All results are expressed as mean ± SEM. One-way analysis of variance (ANOVA) was used to test the mean differences in the groups and the multiple-range test of significance was used to determine the difference between the control group and the treated groups. Statistical analysis of findings was done with SPSS software version 22 at P<0.05

RESULTS

Phytochemical screening

The result of phytochemical screening of the plant's extract indicated the presence of tannins, saponins, alkaloids, steroids and flavonoids (Table 1).

Table 1: Phytochemical constituents in the leaf of *F. platyphylla* extract

Phytochemicals	Status
Alkaloids	+
Tannins	+
Saponins	+
Steroids	+
Flavonoids	+
Cardiac Glycosides	-
Anthraquinones	-

Key: + =Detected, - = Not detected

Effect of oral administration of methanolic extract of *Ficus platyphylla* leaves on body weight of albino rats.

Oral administration of the methanolic extracts of *F. platyphylla* led to significantly (P < 0.05) decreased body weight in all the treatment groups by the end of the first week (treatment day 7) compared to the control (Table 2). However, in weeks 2 and 3, only the 100 and 200 mg/kg groups sustained a significantly (P < 0.05) decreased body weight but no significant changes (P > 0.05) were observed in the 400 mg group compared to the control (Table 2). Interestingly, the 200 mg/kg dose appeared to be the most efficient in reducing the body weight of the rats.

Table 2: Effect of oral administration of methanol extracts *F. platyphylla* leaves on the weight of normal rats

Groups	Day 0 (g)	Day 7 (g)	Day 14 (g)	Day 21 (g)
Control	110 ±12.6^{a}	116.7± 10.61^{a}	124 ± 6.67^{a}	128 ±5.79^{a}
100 mg/Kg	91.0 ± 0.1^{a}	83 ± 8.55^{bc}	82.3 ± 8.75^{b}	91.7 ±7.51^{a}
200 mg/Kg	95.7± 0.67^{a}	84.0 ±1.53^{bc}	74.7±7.89^{b}	85.3±1.53^{a}
400 mg/Kg	115.0±0.58^{a}	103.7±2.03^{ac}	123±6.75^{a}	113.7±10.1^{a}

Values are expressed as means ± SEM of three determinations

Effect of oral administration of methanolic extract of *Ficus platyphylla* leaves on the blood glucose level on albino rats.

Our results suggest that oral administration of the methanolic extracts of *Ficus platyphylla* leaves caused a significant reduction (P<0.05) in the blood glucose levels of the rats in the 200 and 400 mg/kg groups but no significant change (P>0.05) in blood glucose was observed in the 100 mg/kg group compared to control at treatment day 7 (Table 3). However, a statistically significant decrease (P<0.05) in blood glucose was observed in all the treated groups on treatment day 14 but no significant changes (P>0.05) in blood glucose were observed in all the groups at treatment day 21 compared to control (Table 3). Interestingly, unlike in body weight, the 400 mg treatment seems to provide the best results in blood glucose reduction within the first two weeks of the experiment (Table 3).

Table 3: Effect of oral administration of methanol extract of *F. platyphylla* leaves on the blood glucose levels

Groups	Day 0 (g)	Day 7 (g)	Day 14 (g)	Day 21 (g)
Control	89.60 ± 16. 62^{a}	96.3 ± 22.50^{a}	103 ± 5.25^{a}	110 ±18.1^{a}
100 mg/Kg	99.3 ± 8.09^{a}	77.0 ± 4.92^{a}	69.0 ± 4.42^{b}	81.0 ± 18.9^{a}
200 mg/Kg	94.3 ± 21.1^{a}	65.7 ± 3.33^{a}	59.3 ± 5.21^{b}	86.7 ± 17.6^{a}
400 mg/Kg	80.7 ± 14.9^{a}	63.7 ± 9.30^{a}	58.3 ± 8.34^{a}	88.0 ± 5.82^{a}

Values are expressed as means ± SEM of three determinations

Effect of oral administration of methanolic extract of *Ficus platyphylla* leaves on serum lipid profile on albino rats.

The lipid profile of the rats treated with methanolic extract of *Ficus platyphylla* leaf was observed on experimental day 21 only. In comparison with the control, a slight decrease in total cholesterol and triglycerides was observed in all the groups but the decrease was only statistically significant (P<0.05) in the 200 and 400 mg/kg treatments for cholesterol and 200 mg/kg for triglycerides (Table 4). There was a slight but statistically insignificant (P>0.05) increase in the HDL-c in all the treated groups compared with the control (Table 4). Interestingly, all the treatment groups have shown a statistically significant (P<0.05) decrease in LDL and VLDL (Table 4).

Table 4: Effect of oral administration of methanol extract *F. platyphylla* leaves on lipid profile on normal rats.

Groups	Total-c (mmol/L)	TG (mmol/L)	HDL-c (mmol/L)	LDL-c (mmol/L)	VLDL (mmol/L)
Control (mg/Kg)	1.18 ± 0.10[a]	1.33 ± 0.34[a]	0.52 ± 0.11[a]	0.66 ± 0.05[a]	0.59 ± 0.04[a]
100 (mg/Kg)	1.02 ± 0.10[a]	1.31 ± 0.10[a]	0.75 ± 0.16[a]	0.27 ± 0.10[b]	0.39 ± 0.04[b]
200 (mg/Kg)	0.86 ± 0.15[a]	0.81 ± 0.08[a]	0.63 ± 0.15[a]	0.23 ± 0.05[b]	0.35±0.03[b]
400 (mg/Kg)	0.77± 0.21[a]	0.73 ± 0.33[a]	0.58 ± 0.18[a]	0.18 ± 0.02[b]	0.32±0.05[b]

Values are expressed as means ± SEM of three replicates for each group.
HDL- High-Density Lipoprotein, **LDL -** Low-Density Lipoprotein, **TG**-Triglyceride, **VLDL**-Very Low-Density Lipoprotein.

DISCUSSION

Excessive weight gain caused by prolonged elevation of blood glucose and lipids mainly due to overeating, consumption of a high-calorie diet, and sedentary lifestyle among several factors is the major risk factor for obesity which is a prerequisite to cardiometabolic diseases such as diabetes mellitus, cardiovascular diseases, and related sequelae (Bhupathiraju & Hu, 2016; Scherer & Hill, 2016; Deshpande *et al*., 2008). Hence, plants housing bioactive compounds with the ability to reduce body weight and lower blood glucose and lipids are considered promising alternatives in the management of cardiometabolic diseases. In this research, we found that the methanolic extract of *Ficus platyphylla* leaf is efficacious in reducing the body weight of Wistar rats, especially at doses of 100 and 200 mg/kg. This implies that *F. platyphylla* leaves can be used to control overweight and obesity. Many indigenous medicinal plants have been reported by various authors to have anti-hyperglycemic effects. Our research data also revealed a significant reduction in blood glucose levels of the administered methanolic extract of *Ficus platyphylla* leaf especially at doses above 100mg/kg. This finding is consistent with the hypoglycemic effects of various preparations of *Ficus* species reported in diabetic models which have been attributed to their phytochemical constituents (Deepa *et al*., 2018). For example, a study reported that some isolated flavonoids from the stem bark of *Ficus racemosa* have a hypoglycemic effect and body weight control in streptozoticin-induced diabetic rats. Interestingly, the phytochemical screening of *Ficus platyphylla* leaf conducted in this study also indicated the presence of flavonoids (Table 1). We may, therefore, suggest that the blood glucose-lowering effect of *Ficus platyphylla* reported in this research could result from its flavonoids and other phytoconstituents.

For lipid profile assay, methanol extract of *Ficus platyphylla* leaves has a significant serum lipid-lowering effect as observed in the level of total cholesterol, triacylglyceride, and low-density lipoprotein. The observed reduction in LDL-cholesterol may be attributed to the presence of saponins. Saponins are known as antinutritional factors that reduce the uptake of certain nutrients, especially cholesterol in the gut through intraluminal physiochemical interactions (Price *et al*., 1987). The significant reduction in the level of cholesterol might have contributed to the observed increase in the serum HDL-cholesterol of the animals. About 30% of blood cholesterol is usually carried in the form of HDL-cholesterol. HDL-cholesterol is capable of removing cholesterol from atheroma within arteries and transporting it back to the liver for its excretion or re-utilization (Calabresi *et al*., 2015). Thus, a high level of HDL-cholesterol protects against cardiovascular disease. The observed increase in HDL-cholesterol concentration upon the administration of the extract indicates that the leaves extract at different doses has HDL-cholesterol boosting effect. LDL-cholesterol transports cholesterol to the arteries where it can be retained in arterial proteoglycans and facilitate the formation of plaques. An increase in LDL-c (bad cholesterol) poses a risk of cardiovascular disease when it invades endothelium and becomes oxidized since the oxidized form is more easily deposited within the arteries (Cromwell & Otvos, 2004). LDL-cholesterol is associated with myocardial infarction, atherosclerosis, heart attack, stroke, and even high blood pressure and peripheral vascular disease. The lipid-lowering effect of *Ficus platyphylla* reported in this research implies that the extract may aid in the prevention or reduction of cardiovascular diseases since the elevation of blood lipids correlates positively with a higher risk of cardiovascular diseases (Pašková, 2019).

CONCLUSION

The present study has provided some biochemical information on the usefulness of *Ficus platyphylla* leaves for medicinal purposes as indicated by their anti-hyperlipidemic and anti-hyperglycemic potential. This study justifies the use of plant leaves as a potential medicinal ingredient at least for the treatment of those diseases caused by high blood glucose and lipid levels.

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CONFLICT OF INTEREST

The authors have no conflict of interest to declare.

REFERENCES

Adeshina, G. O., Okeke, C. L., Onwuegbuchulam, N., & Ehinmidu, J. (2010). Preliminary studies on antimicrobial activities of ethanolic extracts of Ficus sycomorus Linn. and Ficus platyphylla Del. (Moraceae). *International Journal of Biological and Chemical Sciences*, *3*.

Ahmad Khan, M. S., & Ahmad, I. (2019). *Chapter 1 - Herbal Medicine: Current Trends and Future Prospects* (M. S. Ahmad Khan, I. Ahmad, & D. B. T.-N. L. to P. Chattopadhyay (eds.); pp. 3–13). Academic Press. https://doi.org/https://doi.org/10.1016/B978-0-12-814619-4.00001-X

Amos, S., Binda, L., Chindo, B., Akah, P., Abdurahman, M., Danmallam, H. U., Wambebe, C., & Gamaniel, K. (2001). Evaluation of methanolic extract of Ficus platyphylla on gastrointestinal activity. *Indian Journal of Experimental Biology*, *39*(1), 63–67.

Amos, S., Chindo, B., Edmond, I., Akah, P., Wambebe, C., & Gamaniel, K. (2002). Antinociceptive and anti-inflammatory properties of F. platyphylla stem bark. *J Herbs Spices Med Plants*, *9*, 47–53.

Audu, J. (1989). Medicinal herbs and their uses in Bauchi State. *The Nigerian Field*, *54*, 157–168.

Balogun, J. A. (2021). *Emerging Developments in Traditional Medicine Practice in Nigeria BT - The Nigerian Healthcare System: Pathway to Universal and High-Quality Health Care* (J. A. Balogun (ed.); pp. 235–275). Springer International Publishing. https://doi.org/10.1007/978-3-030-88863-3_8

Bhupathiraju, S. N., & Hu, F. B. (2016). Epidemiology of obesity and diabetes and their cardiovascular complications. *Circulation Research*, *118*(11), 1723–1735.

Brain, K. R., & Turner, T. D. (1975). *The practical evaluation of phytopharmaceuticals*.

Calabresi, L., Gomaraschi, M., Simonelli, S., Bernini, F., & Franceschini, G. (2015). HDL and atherosclerosis: Insights from inherited HDL disorders. *Biochimica et Biophysica Acta*, *1851*(1), 13–18. https://doi.org/10.1016/j.bbalip.2014.07.015

Cromwell, W. C., & Otvos, J. D. (2004). Low-density lipoprotein particle number and risk for cardiovascular disease. *Current Atherosclerosis Reports*, *6*(5), 381–387. https://doi.org/10.1007/s11883-004-0050-5

Dal Canto, E., Ceriello, A., Rydén, L., Ferrini, M., Hansen, T. B., Schnell, O., Standl, E., & Beulens, J. W. (2019). Diabetes as a cardiovascular risk factor: An overview of global trends of macro and micro vascular complications. *European Journal of Preventive Cardiology*, *26*(2_suppl), 25–32. https://doi.org/10.1177/2047487319878371

Deepa, P., Sowndhararajan, K., Kim, S., & Park, S. J. (2018). A role of Ficus species in the management of diabetes mellitus: A review. *Journal of Ethnopharmacology*, *215*, 210–232. https://doi.org/10.1016/j.jep.2017.12.045

Deshpande, A. D., Harris-Hayes, M., & Schootman, M. (2008). Epidemiology of diabetes and diabetes-related complications. *Physical Therapy*, *88*(11), 1254–1264. https://doi.org/10.2522/ptj.20080020

Friedewald, W. T., Levy, R. I., & Fredrickson, D. S. (1972). Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. *Clinical Chemistry*, *18*(6), 499–502.

Ganiyu, A. I. , Oloyede, H. O. B., Salawu, M. O., Amuzat, A. O. & Akolade, J. O. (2023). Acetaminophen-induced Liver Injury: Protective Effect of *Laportea aestuans* Aqueous Leaf Extract in Experimental Mice Model. *Nigerian Journal of Biotechnology, 40(1),11-20.*

Gordon, T., Castelli, W. P., Hjortland, M. C., Kannel, W. B., & Dawber, T. R. (1977). High density lipoprotein as a protective factor against coronary heart disease. The Framingham Study. *The American Journal of Medicine*, *62*(5), 707–714. https://doi.org/10.1016/0002-9343(77)90874-9

Ogbiko, C. (2021). Gc-Ms Screening, Acute Toxicity and In Vivo Antidiabetic Activity of The Methanol Whole Plant Extract of Plantago rugelii (Plantaginaceae). *Fudma Journal of Sciences*, *5*(3), 324–328. https://doi.org/10.33003/fjs-2021-0503-688

Olayemi, W., Aziba, P., R.B, A., Solomon, U., & E.O, A. (2004). NEUROPHARMACOLOGICAL ACTIVITIES OF FICUS PLATYPHYLLA STEM BARK IN MICE. *African Journal of Biomedical Research (ISSN: 1119-5096) Vol 7 Num 2*.

Pašková, U. (2019). Lipid profile and risks of cardiovascular diseases in conditions of rheumatoid arthritis. *Ceska a Slovenska Farmacie : Casopis Ceske Farmaceuticke Spolecnosti a Slovenske Farmaceuticke Spolecnosti*, *68*(6), 219–228.

Price, K. R., Johnson, I. T., & Fenwick, G. R. (1987). The chemistry and biological significance of saponins in foods and feedingstuffs. *Critical Reviews in Food Science and Nutrition*, *26*(1), 27–135. https://doi.org/10.1080/10408398709527461

Richmond, W. (1973). Preparation and properties of a cholesterol oxidase from Nocardia sp. and its application to the enzymatic assay of total cholesterol in serum. *Clinical Chemistry*, *19 12*, 1350–1356.

Sandabe, U. K., & Kwari, H. D. (2000). Some aspects of ethno-veterinary medicine among Kanuri and Bura of Borno state. *QJ Borno Museum Soc*, 44–45.

Scherer, P. E., & Hill, J. A. (2016). Obesity, Diabetes, and Cardiovascular Diseases. *Circulation Research*, *118*(11), 1703–1705. https://doi.org/10.1161/CIRCRESAHA.116.308999

Yusuf, A. P., Zhang, J., Li, J., Muhammad, A., & Abubakar, M. B. (2022). Herbal medications and natural products for patients with covid-19 and diabetes mellitus: potentials and challenges. *Phytomedicine Plus*, *2*(3), 100280. https://doi.org/10.1016/j.phyplu.2022.100280