Original Research Article

**THE IMPACT OF REGULAR CONSUMPTION OF** **POLYHERBAL MEDICINE ON THE CARDIOVASCULAR PARAMETERS OF CONSUMERS IN NNEWI METROPOLIS**

**ABSTRACT**

**Background**: The consumption of polyherbal medicine (agbo) in developing countries like Nigeria is widespread due to lack of affordable and accessible healthcare. The attendant health challenges arising from the consumption of these products are yet to be fully elucidated. This study evaluated the levels of some cardiovascular parameters on consumers of polyherbal medicine (agbo) in Nnewi metropolis.

**Methods**: This is a cross-sectional study involving a total of sixty four (64) poly herbal drug consumers (test) and sixty four (64) non-consumers (control) aged between 18 and 65 years and domiciled within Nnewi metropolis. Five millilitres (5 ml) of blood sample were collected from each of the participants for the evaluation of some biochemical parameters (Apo A1, Apo B and some lipid profile) using standard laboratory methods.

**Results**: Results showed no significant difference in the mean systolic blood pressure (SBP), diastolic blood pressure (DBP), pulse rate, and body mass index (BMI) in polyherbal consumers (test group) when compared with non-consumers of polyherbal medicine (control groups) (p>0.05). Similarly, the mean serum levels of total cholesterol, triglycerides, high density lipoprotein, low density lipoproteins and Apo B did not differ significantly in test group when compared with the control group (p>0.05). However, Apo A1 was significantly higher in the test group when compared with the control group (p<0.05). There were no significant correlations between duration of intake and frequency of intake with the various biochemical parameters in test and control group (p>0.05).

**Conclusion**: Thus, poly herbal medicine intake may prove to be beneficial to cardiovascular system due to its improvement in Apo A1 level without alterations in other cardiovascular markers.

**Keywords**: lipid profile, polyherbal medicine, apolipoproteins, cardiovascular system.

**INTRODUCTION:**

Plants and various other plant components have previously been proven to offer significant therapeutic potential because of to their ability to modify distinct biochemical parameters. (Ezeodili *et al*., 2017; Ogbodo *et al*., 2017; Ogbodo *et al*., 2024a), resulting in overall improvement in human health.

The term "poly herbal medicine" refers to preparations and finished goods used to treat illness and disease that have plant parts and other plant components as their active ingredients (Chrysant and Chrysant, 2017). “It involves using more than one herb in medicinal preparation in a specific ratio to formulate potent mixtures for the treatment of illnesses” (Lawal *et al*., 2024). “Polyherbal products are important sources of new pharmaceuticals because they contain a significant amount of secondary metabolites, such as alkaloids, flavonoids, isoflavonoids, lignans, quinones, catechols, coumarins, polyphenols, lectins, monoterpenes, and triterpenes which are accountable for the positive effects of the herbal products” (Riaz *et al*., 2023; Roy *et al*., 2022; Singh *et al*., 2022; Nachimuthu *et al*., 2021; Aslam *et al*., 2016). “Polyherbal medicines are now widely preferred and used around the world because of their high effectiveness, ready availability, low toxicity, and environmentally friendly nature, and it reduces the time of treatment or the individual cost of anti-inflammatory and antimicrobial drugs, resulting in lower prescription costs” (Dev *et al*., 2019; Abbas *et al*., 2021). “The concept of polyherbal combination has been well established and has achieved remarkable success in allopathic medicine, providing patients with new hope” (Mussarat *et al*., 2021).

Several illnesses, including asthma, eczema, premenstrual syndrome, rheumatoid arthritis, migraine, and menopause, irritable bowel syndrome symptoms, chronic fatigue, and symptoms are cured using these products (Falodun andImieje, 2013). Polyherbal medicine provides advantages than single herbal formulation because of its synergistic effects and greater therapeutic efficacy at lower dosages (Lawal *et al*., 2024). The effects are further increased when viable herbal plants are combined in polyherbal medicine (Dwivedi and Daspaul, 2013).

“Around 80% of the global population relies on herbal-based products to treat different ailments and the global market for herbal formulations is currently estimated at $1.5 billion and it is expected to expand significantly as demand for natural remedies used for preventing and curing different diseases arising” (Nachimuthu *et al.*, 2021). “Similarly, the new health agenda in Africa and indeed Nigeria focuses on the institutionalization of traditional medicine in parallel with orthodox medicine into natural Health Care Scheme in order to move the health agenda forward since effective healthcare in Africa cannot be achieved through orthodox medicine alone unless complemented with complementary and alternative medicine” (Elujoba *et al*., 2005).

According to Aladejana (2023), “the various pharmacological studies conducted have shown that polyherbal medicines possess antimicrobial, anti-inflammatory, antioxidant and toxicological properties, hence, validating their traditional use. However, a major hindrance to the integration of herbal formulations in modern medical practice is the lack of scientific and clinical data proving their efficacy and safety” (Lawal *et al*., 2024). Poly herbal medicines, which are made up of a combination of several herbs, have been used for centuries to treat various ailments, including cardiovascular diseases. Herbal medicines are perceived as being natural and therefore safe; however, they are not free from adverse effects, which may be due to factors such as adulteration, contamination, misidentification, lack of standardization, incorrect preparation and dosage (Brantley *et al*., 2014; Oluyege and Oluyege, 2010). While there are many potential benefits to using poly herbal drugs, there are also some safety concerns and potential side effects, particularly when it comes to cardiac functions. Thus, it has become imperative to evaluate the impact of polyherbal consumption on some cardiovascular parameters of consumers especially in Nnewi which has high acceptance to this alternative medicine.

**MATERIALS AND METHODS**

**Study Design and Population**

This is a comparative cross-sectional descriptive study designed to evaluate the effect of polyherbal medicine consumption on the cardiovascular system of consumers in Nnewi metropolis. This study involved one hundred and twenty eight individuals comprising of sixty four consumers of polyherbal medicine, alcohol and cigarettes as the test group and sixty four consumers of alcohol, cigarettes and non-consumers of the polyherbal medicine as control group. They were randomly selected from various parks located in Nnewi. Both test and control group were matched for age, rate of alcohol and cigarette consumption. Questionnaires were used to select the subjects and obtain other necessary information.

This study was conducted in Nnewi which lies between latitude 6 ' 0" North of the equator and longitude 6° 55' 0" East of the Greewinch Meridian. Nnewi falls within the tropical rain forest region of Nigeria and is located east of the Niger River, and about 22 kilometers south east of Onitsha in Anambra State, Nigeria. Nnewi is the second largest city in Anambra State in southeastern Nigeria.

The inclusion criteria include subjects between the ages of 18-65 years without the history of any chronic diseases such as hypertension, diabetes, tuberculosis or any cardiovascular disorder. Individuals who fall below or above the age range or pregnant women or subjects who have a history of chronic diseases were excluded from this study.

**Sample Size and Sampling Technique**

A total of 128 subjects were recruited for this study using simple random sampling technique

Sample Size Calculation:

The sample size was calculated using G\*Power software version 3.1.9.4 (Universitat Dusseldorf Germany) power analysis for difference between two independent means (two groups), was conducted in G\*Power to determine the sufficient sample size using an alpha of 0.05, a power of 0.80 and an effect size of 0.50. Based on this, the calculated sample size is 64, has a power of 80% to detect difference of 0.50 at a significant level of 0.05.

**Sample Collection and Biochemical Analysis**

Five milliliters (5ml) of fasting venous blood were collected from each of the subjects and dispensed into plain tubes and allowed to clot and retracted. The serum was separated from the whole blood after centrifugation at 4000 rpm for 5 minutes into another sterile plain container and stored at -20°C until analysis of biochemical parameters.

Apo A1, and Apo B were determined by Turbidometric method using commercial kits from Biobase company (China). Total cholesterol, Triglycerides, high density lipoprotein and low density lipoproteins were determined by spectrophotometric method using commercial kits from Biobase company (China).

The subjects’ height and weight were measured using height and weight scale respectively. The subject body mass index was calculated by using the formula (weight in kg divided by height in meter square). Systemic blood pressure was obtained using an OMRON automatic digital blood pressure monitor (www.omron-healthcare.ng/) on the left arm after 10-minute rest using a cuff of appropriate size with the subject in the sitting position. Blood pressure was expressed as Systolic and Diastolic rate.

**Statistical analysis**

Statistical package for Social Science (SPSS) version (26.0) was used for the analysis of the results. Data was presented as mean ± Standard deviation (SD). Student’s t-test was used to determine the mean difference between two independent groups. Association between duration of consumption and other biochemical variables was determined using Pearson's Correlation coefficient. The level of significance was set at P<0.05.

**Results**

The mean levels of SBP, DBP, pulse rate, BMI and age did not differ significantly in test group when compared with the control group (p>0.05) (table 1). Similarly, the mean levels of total cholesterol, triglycerides, HDL-C, LDL-C and Apo B did not differ significantly in test group when compared with the control group (p>0.05) (table 2). However, there was a significant increase in the mean value of Apo A1 in test group when compared with the control group (p<0.05) (table 2). There was no significant correlation between duration of intake and frequency of intake with the various biochemical parameters in test and control group (p>0.05) (tables 3 and 4).

**Table 1: Comparison of some demographic and anthropometric indices in test and control group (mean**±SD)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Test group | Control  | t-test | p-value |
| **Age (years)** | 45.28±10.44 | 42.88±10.92 | 1.271 | 0.206 |
| Systolic Blood pressure (mmHg) | 126.28±24.46 | 123.00±17.89 | 0.866 | 0.388 |
| Diastolic Blood pressure (mmHg) | 75.91±14.12 | 76.67±13.13 | -0.315 | 0.753 |
| Pulse (beat per minute) | 82.96±14.32 | 76.85±17.15 | 1.863 | 0.066 |
| Body mass index (Kg/m2) | 24.14±4.69 | 25.02±3.05 | -1.258 | 0.211 |

\*Statistically significant at p<0.05.

**Table 2: Comparison of Apo-lipoproteins and some lipid profiles in test and control group (mean**±SD).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameters | Test group | Control  | t-test | p-value |
| APO-A1 (mg/dl) | 268.16±53.41 | 238.54±81.81 | 2.144 | 0.035 |
| APO-B (mg/dl) | 248.82±94.26 | 267.22±72.90 | -1.092 | 0.278 |
| Total Cholesterol (mmol/L) | 5.62±1.25 | 5.58±0.96 | 0.187 | 0.852 |
| Triglyceride (mmol/L) | 0.94±0.47 | 0.86±0.29 | 1.004 | 0.318 |
| High density lipoprotein (mmol/L) | 1.06±0.37 | 0.95±0.26 | 1.628 | 0.107 |
| Low density Lipoprotein (mmol/L) | 4.24±0.94 | 4.13±0.88 | 0.608 | 0.544 |

\*Statistically significant at p<0.05.

**Table 3: Correlation between BMI, Systolic, and diastolic blood pressure with lipid profile, Apo-A1 and Apo-B levels in test group.**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Pearson correlation | BMI | SBP | DBP | Duration of intake | Frequency of intake |
| Total Cholesterol (mmol/L) | r | 0.102 | -0.184 | -0.038 | 0.235 | 0.137 |
| p-value | 0.440 | 0.160 | 0.773 | 0.100 | 0.342 |
| Triglyceride (mmol/L) | r | 0.168 | -0.022 | 0.055 | -0.187 | -0.087 |
| p-value | 0.200 | 0.866 | 0.678 | 0.194 | 0.567 |
| High density lipoprotein (mmol/L) | r | 0.135 | -0.013 | 0.166 | -0.113 | 0.242 |
| p-value | 0.302 | 0.920 | 0.206 | 0.436 | 0.091 |
| Low Density Lipoprotein (mmol/L) | r | 0.022 | -0.211 | -0.118 | 0.035 | 0.022 |
| p-value | 0.867 | 0.106 | 0.371 | 0.810 | 0.882 |
| APOA1 (mg/dl) | r | -0.007 | 0.064 | 0.104 | 0.048 | 0.035 |
| p-value | 0.960 | 0.627 | 0.427 | 0.738 | 0.810 |
| APOB (mg/dl) | r | 0.143 | -0.089 | -0.049 | -0.183 | -0.118 |
| p-value | 0.277 | 0.501 | 0.711 | 0.203 | 0.470 |

\*Statistically significant at p<0.05.

**Table 4; Correlation between BMI, Systolic, and diastolic blood pressure with lipid profile, Apo-A1 and Apo-B levels in control group.**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Pearson correlation | BMI | SBP | DBP | Duration of intake | Frequency of intake |
| Total Cholesterol (mmol/L) | r | 0.177 | 0.142 | 0.226 | -0.183 | 0.034 |
| p-value | 0.275 | 0.326 | 0.161 | 0.203 | 0.813 |
| Triglyceride (mmol/L) | r | 0.246 | 0.053 | 0.237 | -0.005 | 0.073 |
| p-value | 0.126 | 0.747 | 0.140 | 0.972 | 0.655 |
| High density lipoprotein (mmol/L) | r | 0.150 | -0.129 | 0.136 | -0.038 | 0.076 |
| p-value | 0.229 | 0.428 | 0.404 | 0.795 | 0.642 |
| Low Density Lipoprotein (mmol/L) | r | 0.150 | 0.105 | -0.134 | -0.128 | -0.061 |
| p-value | 0.229 | 0.518 | 0.354 | 0.376 | 0.708 |
| APOA1 (mg/dl) | r | 0.076 | 0.038 | 0.164 | -0.128 | 0.089 |
| p-value | 0.642 | 0.817 | 0.313 | 0.376 | 0.586 |
| APOB (mg/dl) | r | 0.134 | 0.142 | 0.034 | -0.083 | -0.187 |
| p-value | 0.345 | 0.381 | 0.813 | 0.567 | 0.194 |

\*Statistically significant at p<0.05.

**Discussion**

“A survey carried out in Lagos metropolis, Nigeria, among herbal medicine users, showed that herbal medicine was popular among the respondents but they appeared to be ignorant of its potential toxicities” (Oreagba *et al.,* 2011). “Consumers generally consider herbal medicines as being natural and therefore safe and view them as alternatives to conventional medications” (Ezekwesili-Ofili, and Okaka, 2019). The prevalence of poly herbal formulations (agbo) use in Nigeria is high. For instance, a study carried out in Nigeria, found out that 81.6% of Nigerian women had used Agbo at least once in their lifetime (Li *et al.,* 2020). One of the reasons for the popularity of polyherbal medicine is that it is often seen as a more affordable and accessible alternative to conventional medicine (Welz *et al.,* 2018). “However, a major hindrance to the integration of herbal formulations in modern medical practice is the lack of scientific and clinical data proving their efficacy and safety” (Lawal *et al*., 2024) especially as it relates to cardiovascular system.

In this study, the anthropometric indices (SBP, DBP, Pulse rate and BMI) were not affected by this polyherbal consumption. This shows that polyherbal drugs do not impact negatively to blood pressure as well as body mass index. Instead of being harmful, polyherbal medicine has been shown to be beneficial to people with prehypertension/hypertension even though the mechanism of action remains unknown (Shen *et al*., 2019). Similarly, some studies have shown that polyherbal drugs may have a beneficial effect on pulse rate. For example, a study by Malik *et al.* found that a polyherbal formulation containing garlic, ginger, and turmeric was effective in reducing pulse rate in patients with hypertension than in patients with normal blood pressure (Malik *et al.,* 2017).

In this study, the mean values of lipid profile and Apo B did not vary in test group when compared with the control group. This may imply that poly herbal dugs do not affect the lipid profile and Apo-B levels in consumers. However, some studies have revealed the potential benefits of poly herbal drugs in improving lipid profile in consumers. For instance, a study by Sun *et al.,* found that a poly herbal formulation containing garlic, ginger, and turmeric was effective in reducing serum total cholesterol, triglyceride, and LDL-C levels in patients with hyperlipidemia (Sun *et al.,* 2018*)*. Another study by Jazani *et al.,* found that a poly herbal formulation containing ginkgo biloba, red clover, and saw palmetto was effective in reducing serum total cholesterol and LDL-C levels in patients with metabolic syndrome (Jazani *et al.,* 2019). Also, Zarvandi *et al*. (2017) in their study showed that polyherbal formulation (PHF) consisting of *Allium sativum*, *Aloe vera*, *Nigella sativa*, *Plantago psyllium*, *Silybum marianum* and *Trigonella foenum-graecum* was safe and efficacious in lowering the levels of blood glucose and serum lipids in patients with advanced-stage of type-2 diabetes. Other similar studies were also in keeping with the present findings (Borzoei *et al*., 2017; Hajimonfarednejad *et al*., 2018). These studies suggest that poly herbal drugs may be a safe and effective way to improve lipid profile in people with dyslipidemia or metabolic syndrome. However, more research is needed to confirm these findings and to determine the optimal dose.

Interestingly, the mean level of APO-A1 was significantly higher in the test group when compared with the control. This is suggestive that poly herbal drugs may increase levels of apolipoprotein-A1 (apo A1), a protein that is important for transporting cholesterol away from the arteries and to the liver for disposal Ogbodo *et al*., 2024b). Polyherbal drugs may be a potential treatment for people with low levels of apo A1, which is a risk factor for cardiovascular disease (Ogbodo *et al*., 2024b).

In this study, the correlation of duration of intake and frequency of intake with various biochemical parameters did not show any significant association. This shows that duration of intake as well as frequency of intake do not impact negatively on lipid parameters in consumers of polyherbal medicine.

**Conclusion**

In conclusion, polyherbal medicine intake may prove to be beneficial to the cardiovascular system due to its improvement in Apo A1 level without alterations in other cardiovascular markers. However, more research is needed to confirm these findings and to determine the optimal dose of polyherbal drug intake.

**Ethical approval and consent**

The ethical approval for this research was obtained from Faculty of Health Science and Technology ethical committee (FHST/REC/023/00217). Written informed consen**t** of subjects was sought and obtained prior to the commencement of the study.

Disclaimer (Artificial intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

**References**

Abbas, Z., Manoharan, A.L., Jagadeesan, G., Nataraj G., Muniyandi, K., Sathyanarayanan, S., & Thangaraj, P. (2021). Evaluation of an edible polyherbal formulation against urinary tract infection pathogens, its antioxidant and anti-inflammatory potential. *Biocatalysis and Agricultural Biotechnology*, 35, 102104.

Aladejana, E.B. (2023). Biological Properties of Polyherbal Formulations: A Review of their Antimicrobial, Anti-Inflammatory, Antioxidant, and Toxicological Activities. *Pharmacognosy Journal*, 15(5), 933-963.

Aslam, M.S., Ahmad, M.S., Mamat, A.S., Ahmad, M.Z., & Salam, F. (2016). An Update Review on Polyherbal Formulation: A Global Perspective. *Systematic Reviews in Pharmacy*, 7(1), 35-41.

Borzoei, A., Rafraf, M., Niromanesh, S., Farzadi, L., Narimani, F., & Doostan, F. (2017). Effects of cinnamon supplementation on antioxidant status and serum lipids in women with polycystic ovary syndrome. *Journal of Traditional and Complementary Medicine*, *8*(1), 128–133. <https://doi.org/10.1016/j.jtcme.2017.04.008>

Brantley, S.J., Argikar, A.A., Lin, Y.S., Nagar, S., & Paine, M.F. (2014). Herb-drug interactions: challenges and opportunities for improved predictions. *Drug metabolism and Disposition: the biological fate of chemicals*, *42*(3), 301–317. <https://doi.org/10.1124/dmd.113.055236>

Chrysant, S.G., & Chrysant, G.S. (2017). Herbs Used for the Treatment of Hypertension and their Mechanism of Action. *Current Hypertension Reports*, *19*(9), 77. <https://doi.org/10.1007/s11906-017-0775-5>

Dev, S.K., Choudhury, P.K., Srivastava, R., & Sharma, M. (2019). Antimicrobial, anti- inflammatory and wound healing activity of polyherbal formulation. *Biomedicine and Pharmacotherapy*, 111, 555-567.

Dwivedi, C., & Daspaul, S. (2013). Antidiabetic Herbal Drugs and Polyherbal Formulation Used for Diabetes: A Review. *The Journal of Phytopharmacology*, 2(3), 44-51.

Elujoba, A., Odeleye, M., & Ogunyemi, M. (2005). Traditional Medicine development for Medical and Dental Primary Health Care Delivery System in Africa. *African Journal of Traditional, Complementary and Alternative Medicines*; 2(1), 46-61.

Ezekwesili-Ofili, J.O. & Okaka, A.N.C. (2019). Herbal Medicines in African Traditional Medicine. IntechOpen. <https://doi.org/10.5772/intechopen.80348>

Ezeodili, V.K., Ihim, A.C., Ogbodo, E.C., Ezeugwunne, I.P., Analike, R.A., Onah, C.E., Amah, U.K., Okwara, J.E., Ezego, A.I., Ugwu, M.C., Oguaka, V.N., Asebioyo, S.J., & Meludu, S.C. (2017). Effect of Cucumber Consumption on Serum Lipid Profile Andliver Aspartate Transaminase and Alanine Transaminase Inapparently Healthy Undergraduate Students. *International Journal of Basic, Applied and Innovative Research*, 6(2), 38 – 45.

Falodun, A., & Imieje, V. (2013). Herbal Medicine in Nigeria; holistic overview. *Nigerian Journal of Science and Environment*; 12(1), 1-13.

Hajimonfarednejad, M., Nimrouzi, M., Heydari, M., Zarshenas, M. M., Raee, M. J., & Jahromi, B. N. (2018). Insulin resistance improvement by cinnamon powder in polycystic ovary syndrome: A randomized double-blind placebo controlled clinical trial. *Phytotherapy Research : PTR*, *32*(2), 276–283. <https://doi.org/10.1002/ptr.5970>

Jazani, A.M., Azgomi, H.N.D., Azgomi, A.N.D., & Azgomi, R.N.D. (2019). A comprehensive review of clinical studies with herbal medicine on polycystic ovary syndrome (PCOS). *Daru: Journal of Faculty of Pharmacy, Tehran University of Medical Sciences*, *27*(2), 863–877. <https://doi.org/10.1007/s40199-019-00312-0>

Lawal, I.O., Olajuyigbe, S.O., Akinwumi, I.A., & Olugbami, D. (2024). Assessment of Plants Used in Polyherbal Formulations for Traditional Treatment of Skin Infections in Ibadan Metropolis. *Journal of Herbal Medicine*, 47, 100919.

Li, S., Odedina, S., Agwai, I., Ojengbede, O., Huo, D., & Olopade, O. I. (2020). Traditional medicine usage among adult women in Ibadan, Nigeria: a cross-sectional study. *BMC Complementary Medicine and Therapies*, *20*(1), 93. <https://doi.org/10.1186/s12906-020-02881-z>

Malik, A., Mehmood, M. H., Channa, H., Akhtar, M. S., & Gilani, A. H. (2017). Pharmacological basis for the medicinal use of polyherbal formulation and its ingredients in cardiovascular disorders using rodents. *BMC Complementary and Alternative Medicine*, *17*(1), 142. <https://doi.org/10.1186/s12906-017-1644-0>

Mussarat, S., Adnan, M., Begum, S., Ur Rehman, S., Hashem, A., & Abd\_Allah, E.F. (2021). Antimicrobial screening of polyherbal formulations traditionally used against gastrointestinal diseases. *Saudi Journal of Biological Sciences*, 28(12), 6829-6843.

Nachimuthu, S., Kandasamy, R., Ponnusamy, R., Dhanasekaran, M., & Thilagar, S. (2021). Neurotoxicity of Polyherbal Formulations: Challenges and Potential Solutions. *Medicinal Herbs and Fungi*, 187-201.

Ogbodo, E.C., Ogbodo, C.M., Onah, C.E., Okeke, C.S., Ifesinachi, M.O., Okezie, A.O., Iwuji, J.C., Achiaku, A., & Akpa, K.C. (2024a). Impact of Cucumber Supplementation on some Hepato-Renal Parameters in the Elderly Individuals in Nnewi. *The Nigerian Health Journal*, 24(4), 1738 – 1745. <https://doi.org/10.60787/tnhj.v24i4.911>

Ogbodo, E.C., Ezeugwunne, I.P., Analike, R.A., Ezeodili, V.K., Egbe, J.U., Obiorah, M.O., Aguta, U.E., Madukwe, D.U.P., Nwanko, J.C., Onah, C.E., Ugwu, M.C., & Meludu, S.C. (2017). Effect of Cucumber consumption on plasma creatinine, urea, uric acid and glucose levels on apparently healthy students of College of Health Sciences, Nnamdi Azikiwe University, Nnewi Campus, Anambra State, Nigeria. *International Journal of Basic, Applied and Innovative Research*, 6(1), 2-9.

Ogbodo, E.C., Onah, C.E., Meludu, S.C., Ogbodo, M.C., Ezeugwunne, I.P., Ehiage, F.A., Analike, R.A., & Mbam, R.E. (2024b). Anthropometric Indices, Blood Pressure and Some Apolipoproteins in older Adults in Nnewi, Southeast Nigeria. *African Journal of Biomedical Research*, 27(1), 39-47. <https://doi.org/10.4314/ajbr.v27i1.5>

Oluyege, J., & Oluyege, O. (2010). Microbial contamination of some hawked herbal products in Ado – Ekiti, Nigeria. *Continental Journal of Microbiology*; 4, 8-14. <https://doi.org/10.5281/zenodo.823805>

Oreagba, I.A., Oshikoya, K.A., & Amachree, M. (2011). Herbal medicine use among urban residents in Lagos, Nigeria. *BMC Complementary and Alternative Medicine*, *11*, 117. <https://doi.org/10.1186/1472-6882-11-117>

Riaz, M., Khalid, R., Afzal, M., Anjum, F., Fatima, H., Zia, S., Rasool, G., Egbuna, C., Mtewa, A. G., Uche, C. Z., & Aslam, M. A. (2023). Phytobioactive compounds as therapeutic agents for human diseases: A review. *Food science & nutrition*, *11*(6), 2500–2529. <https://doi.org/10.1002/fsn3.3308>

Roy, A., Khan, A., Ahmad, I., Alghamdi, S., Rajab, B. S., Babalghith, A. O., Alshahrani, M. Y., Islam, S., & Islam, M. R. (2022). Flavonoids a Bioactive Compound from Medicinal Plants and Its Therapeutic Applications. *BioMed Research International*, *2022*, 5445291. <https://doi.org/10.1155/2022/5445291>

Shen, T., Xing, G., Zhu, J., Cai, Y., Zhang, S., Xu, G., Feng, Y., Li, D., Rao, J., & Shi, R. (2019). Effects of 12-Week Supplementation of a Polyherbal Formulation in Old Adults with Prehypertension/Hypertension: A Randomized, Double-Blind, Placebo-Controlled Trial. *Evidence-based Complementary and Alternative Medicine: eCAM*, *2019*, 7056872. <https://doi.org/10.1155/2019/7056872>

Singh, S., Bansal, A., Singh, V., Chopra, T., & Poddar, J. (2022). Flavonoids, alkaloids and terpenoids: a new hope for the treatment of diabetes mellitus. *Journal of Diabetes and Metabolic Disorders*, *21*(1), 941–950. <https://doi.org/10.1007/s40200-021-00943-8>

Sun, Y. E., Wang, W., & Qin, J. (2018). Anti-hyperlipidemia of garlic by reducing the level of total cholesterol and low-density lipoprotein: A meta-analysis. *Medicine*, *97*(18), e0255. <https://doi.org/10.1097/MD.0000000000010255>

Welz, A. N., Emberger-Klein, A., & Menrad, K. (2018). Why people use herbal medicine: insights from a focus-group study in Germany. *BMC Complementary and Alternative Medicine*, 18(1), 92. <https://doi.org/10.1186/s12906-018-2160-6>

Zarvandi, M., Rakhshandeh, H., Abazari, M., Shafiee-Nick, R., & Ghorbani, A. (2017). Safety and efficacy of a polyherbal formulation for the management of dyslipidemia and hyperglycemia in patients with advanced-stage of type-2 diabetes. *Biomedicine & pharmacotherapy = Biomedecine & Pharmacotherapie*, 89, 69–75. <https://doi.org/10.1016/j.biopha.2017.02.016>