Original

Metabolic and Pancreatic Effects of Short-Term Bitter Leaf Enriched Herbal Tea Blend Consumption in A Healthy Student Population

[1]Nkiru Theresa Meludu, [2]Samuel Chukwuemeka Meludu, [3]Rosemary Adamma Analike, [4]Christian Ejike Onah, [4]Chinenye Stellamaris Chiedu,[3]Chidiadi Maryann Njoku, [4]Faith Uchechukwu Ndili, [4]Elijah Omeiza Aliyu, [4]Chinecherem Miracle Ebomuche, [5]Emmanuel Chukwuemeka Ogbodo

[1]Department of Agricultural Economics and Extension, Faculty of Agriculture, Nnamdi Azikiwe University, Awka;
[2]Department of Human Biochemistry, Faculty of Basic Medical Sciences, Nnamdi Azikiwe University, Awka;
[3]Department of Chemical Pathology, Faculty of Basic Clinical Sciences, Nnamdi Azikiwe University, Awka;
[4]Department of Chemical Pathology, Faculty of Medical Laboratory Science, Nnamdi Azikiwe University, Awka;
[5]Department of Medical Laboratory Science, Faculty of Health Sciences and Technology, David Umahi Federal University of Health Sciences, Uburu Ebonyi State.

Corresponding author: *Emmanuel C Ogbodo*, Department of Medical Laboratory Science, Faculty of Health Science and Technology, David Umahi Federal University of Health Sciences, Uburu Ebonyi State.augustinee442@gmail.com: +2348134488042.

Article history: Received 06 March 2026, Reviewed 11 April 2026, Accepted for publication 20 June 2026

ABSTRACT

Background: *Vernonia amygdalina* (Bitter Leaf) Enriched Herbal Tea Blend (BLEHTB) is commonly consumed for its assumed medicinal effects although there is limited scientific evidence in this respect. This pre-post study evaluated the effects of BLEHTB consumption on body weight (WT), fasting plasma glucose (FPG), insulin (INS), amylase, and lipid profile (total cholesterol (TC), Triglycerides (TG), high density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C)) among healthy students in Nnewi.

Method: Ten (10) participants aged 18-30 years were randomly selected and received 200 ml of BLEHT daily for 21 days. WT, Body mass index (BMI), blood pressure (BP), and pulse (P) were measured, and fasting blood samples were collected at baseline (Day 0), mid-intervention (Day 11), and post-intervention (Day 22) to determine biochemical parameters using standard methods.

Results: The mean body weight (67.8±14.1 Vs 68.4±14.0 kg/m^2; p = 0.012) was significantly increased after the consumption of BLEHT compared to baseline value. However, the mean serum TC, TG and LDL-C levels at day 11and day 22 were significantly decreased following BLEHT consumption compared to baseline values respectively ($p<0.05$). HDL-C was significantly increased at day 22 post BLEHT consumption than at baseline (1.50±0.51 Vs 1.00±0.17 mmol/l; p = 0.004). However, BMI, pulse, FPG, INS and Amylase activity remained the same after intervention ($p>0.05$).

Conclusion: This study has demonstrated that BLEHT intake has cardio-protective effects on a short-term basis. Long-term studies are desirable.

Keywords: Bitter leaf, Body weight, lipid and glucose metabolism, Cardio-protective effect, pancreatic function, Herbal Tea.

How to cite this article

Meludu NT, Meludu SC, Analike RA, Onah CE, Chiedu CS, Njoku CM, Ndili FU, Aliyu EO, Ebomuche CM, Ogbodo EC. Metabolic and Pancreatic Effects of Short-Term Bitter Leaf Enriched Herbal Tea Blend Consumption in A Healthy Student Population. The Nigerian Health Journal 2026; 26(2):685 – 692. https://doi.org/10.71637/tnhj.v26i2.1369

Print ISSN: 0189-9287 Online ISSN: 2992-345X

INTRODUCTION

Non-communicable diseases (NCDs), which are otherwise called chronic diseases, have continued to be an issue of public health importance all over the world, especially in low and middle-income countries such as Nigeria. Examples of the most prevalent non-communicable diseases include cardiovascular diseases, diabetes, cancers, and chronic respiratory diseases.[1,2] There are different risk factors that influence the sustained rise in the prevalence of NCDS, and they are classified as modifiable and non-modifiable risk factors; with modifiable risk factors further sub-classified into metabolic risk factors such as obesity, dyslipidaemia and hypertension, as well as behavioural risk factors such as unhealthy dietary pattern, tobacco use, sedentary lifestyle and substance abuse or alcoholism[3]. Collectively, these risk factors contribute to the ongoing increase in the prevalence of non-communicable diseases (NCDs), which can alter various biochemical indices, such as glucose and lipid metabolism and pancreatic function, thereby affecting human health. Notably, these biochemical changes often begin as subclinical conditions that remain undetected and, if not diagnosed, may progress to clinically apparent disease in later life.[4-6] Such alterations can influence long-term cardiometabolic health.[7,8] Consequently, there is growing interest in identifying dietary strategies that are accessible, affordable, and acceptable for mitigating cardiometabolic disorders, and that can be readily incorporated into daily dietary routines.

Herbal teas and plant-based beverages have long been consumed not only for refreshment but also for their perceived health-promoting effects.[9-12] In many African communities, these beverages form part of routine dietary practices aimed at maintaining wellbeing and metabolic balance. One plant of particular interest is *Vernonia amygdalina* Delile, commonly known as bitter leaf. In Nigeria, bitter leaf is widely used as a vegetable and in traditional preparations, with reported benefits for blood sugar control, blood pressure regulation, digestion, and general health.[13,14]

Phytochemical studies have shown that *V. amygdalina* is rich in flavonoids, phenolic compounds, alkaloids, tannins, saponins, sesquiterpene lactones, triterpenoids, steroids, cardiac glycosides, and other bioactive constituents known for their antioxidant, anti-inflammatory, hypoglycaemic, and hypolipidaemic properties.[15,16]

There is increasing scientific evidence that supports the beneficial impact of plant-based interventions. For instance, several studies have demonstrated that dietary and herbal interventions can influence fasting plasma glucose, insulin levels, insulin sensitivity, and other markers of metabolic control in adult populations.[12,17,18] Previous studies conducted in southeastern Nigeria have reported a high prevalence of cardiometabolic risk factors among adult populations in Nnewi.[6,19-21], revealing significant alterations in lipid profile, blood pressure, and glucose levels in apparently healthy individuals, which further supports the present need for the exploration of functional foods and beverages with potential for maintaining cardiometabolic health.

Body weight, body mass index (BMI), blood pressure, and pulse rate are examples of anthropometric and hemodynamic markers that are still straightforward but effective measures of metabolic and cardiovascular health.[22] Increased long-term risk of hypertension and cardiovascular disease has been linked to elevations in these indices.[7, 23] According to experimental research, *V. amygdalina* may have an impact on vascular function and body weight regulation through enhanced endothelium responses and antioxidant activity.[13, 14] However, there is still a dearth of data from human research, especially those involving healthy adults.

There is a clear knowledge vacuum regarding anthropometric indices, hemodynamic parameters, pancreatic enzyme activity, and glucose metabolism in connection to glucose-insulin dynamics, and lipid metabolism following consumption of herbal tea enriched with *V. amygdalina*. The present study was therefore designed to evaluate the effects of *Vernonia amygdalina* enriched herbal tea consumption on body weight, BMI, blood pressure, pulse rate, fasting plasma glucose, insulin, amylase, and lipid profile parameters in apparently healthy adults in Nnewi, Nigeria.

MATERIALS AND METHOD

Study site: The College of Health Sciences (CHS), Nnamdi Azikiwe University, Nnewi Campus, Anambra State, Nigeria, was the site of this investigation.

Study Design and Subject Recruitment: The pre-post experimental study randomly included a total of 10 apparently healthy students from CHS, Nnewi, with ages ranging from 18-30 years. Participants were advised to abstain from all forms of supplementation for a period of two weeks before the commencement of the study. Two gram (2g) of the commercially prepared bitter leaf enriched herbal tea blend (BLEHTB) was purchased from the vendor in Nnewi. 200ml of boiled water was

Print ISSN: 0189-9287 Online ISSN: 2992-345X

poured into a cup and the tea bag (2g in weight) was infused into the hot water for 3 minutes and stirred gently. Participants received the prepared 200ml of BLEHTB once daily before their daily breakfast for 21 consecutive days using the oral method of administration. Fasting blood samples were collected from participants before, 11 days, and 22 days after BLEHTB consumption from the antecubital vein to measure biochemical parameters. Also, the participants' body weight (WT), body mass index (BMI), systolic blood pressure (SBP), diastolic blood pressure (DBP) and Pulse rate were obtained in the same manner. Structured questionnaire was used to obtain relevant patient data such as age, sex, dietary pattern, life style, etc

Inclusion Criteria: Apparently healthy male and female students aged between 18-30 years willing to drink herbal tea for 21 days.

Exclusion Criteria

- Individuals with known chronic diseases and metabolic diseases
- pregnant women or lactating mothers as well as alcoholics and smokers
- Participants on other forms of supplementation including actively exercising individuals.

Ethical Approval*: *Ethical Approval: The Faculty of Medical Laboratory Science Ethics Committee at Nnamdi Azikiwe University, Nnewi Campus, granted ethical approval (FMLS/REC/025/219). Written informed permission from the subjects was requested and obtained before the study commenced.

Collection of samples and analysis: Venipuncture was used to obtain six milliliters (6 ml) of venous fasting blood samples from each individual on days 0, 11, and 22, respectively, following ten to twelve hours of fasting. For the purpose of determining the fasting blood glucose level, 2 milliliters were added to fluoride oxalate and analyzed right away without being stored. A plain container was filled with the remaining 4 milliliters of the blood sample, which was then allowed to clot and retract. After centrifuging it for five minutes at 4000 rpm, it was separated to measure serum insulin, lipid profile (total cholesterol, triglycerides, high density lipoprotein cholesterol, low density lipoprotein cholesterol), and amylase activity. Samples of serum that were not examined immediately were kept frozen at -20°C.

Laboratory Method: The glucose oxidase peroxidase technique was used to measure fasting plasma glucose (FPG).[24] Serum human insulin was evaluated by enzyme linked immunosorbent assay (ELISA) technique as described by.[25] Total cholesterol (TC), triglyceride (TG), and high density lipoprotein cholesterol (HDL-C) were assessed by colorimetric method according to [26–28], whereas Low density lipoprotein cholesterol (LDL-C) was estimated by computation using the method described by [29] .The modified Caraway method described by was used to measure amylase activity.[30]

Anthropometric indices measurements: Body weight was determined using a calibrated digital scale, with participants barefoot. Height was measured using a stadiometer, with participants standing barefoot, heels together, and head positioned in the Frankfurt plane. BMI was calculated as weight in kilogram divided by the square of height in meter (kg/m^2).

Blood pressure (BP) and pulse measurements: Blood pressure and pulse rate was measured with an automated sphygmomanometer while the participant was seated and relaxed for a minimum of two minutes.

Statistical Analysis: The data was analysed using SPSS statistical software, version 26.0. Paired t-test was used to analyse the data obtained and statistical significance set at $p<0.05$.

RESULTS

Table 1 presents the mean ± standard deviation of selected anthropometric, blood pressure and pulse rate measured before bitter leaf–enriched herbal tea blend consumption (day 0), at the midpoint of consumption (day 11), and post consumption (day 22).

As shown in Table 1, body weight was changed significantly during the course of bitter leaf–enriched herbal tea blend consumption. There was a significant increase in the mean body weight following the consumption of bitter leaf–enriched herbal tea blend at day 22 compared to the observed values at day baseline and day 11 ($p = 0.012$; 0.022) respectively, although the observed values did not differ significantly at day 11 when compared to baseline values ($p = 0.363$).

Body mass index did not differ significantly across the three time points ($p > 0.05$), suggesting that the observed variations in body weight were not sufficient to translate into meaningful changes in BMI over the study period.

Systolic blood pressure did not differ significantly following 11 days consumption of bitter leaf enriched herbal tea blend when compared with the observed baseline value ($p = 0.175$), although there was a

Print ISSN: 0189-9287 Online ISSN: 2992-345X

statistically significant reduction observed at the midpoint of bitter leaf–enriched herbal tea blend consumption when compared with post consumption ($p = 0.032$). This reduction, however, was not maintained at day 22, as systolic blood pressure values at post-consumption were comparable to baseline measurements ($p = 0.257$).

No significant differences were observed in diastolic blood pressure as well as pulse rate across baseline, midpoint, and post-consumption measurements ($p > 0.05$), indicating that these parameters remained relatively stable throughout the period of bitter leaf–enriched herbal tea blend consumption.

Biochemical parameters measured in **Table 2** showed that fasting plasma glucose and insulin levels were not significantly altered during the course of the intervention ($p > 0.05$). In contrast, lipid profile parameters were significantly modulated. Total cholesterol decreased significantly from baseline to midpoint ($p = 0.012$) and from midpoint to post-consumption ($p = 0.027$), with baseline-to-post differences also significant ($p = 0.002$). Low-density lipoprotein cholesterol (LDL-C) decreased significantly across all time points (baseline vs midpoint, $p = 0.010$; midpoint vs post-consumption, $p = 0.004$; baseline vs post-consumption, $p = 0.001$). High-density lipoprotein cholesterol (HDL-C) increased significantly from midpoint to post-consumption ($p = 0.001$) and from baseline to post-consumption ($p = 0.004$). Triglyceride levels exhibited statistically significant reductions across all time points comparisons ($p < 0.05$), been significantly decreased at midpoint consumption (1.00 ± 0.15; $p = 0.026$) and post consumption (1.00 ± 0.15; $p = 0.015$) when compared with baseline values respectively.

Pancreatic amylase activity did not differ significantly at mid-point and post-consumption compared to baseline values ($p = 0.472$; 0.051) respectively but decreased significantly at midpoint compared with post consumption ($p = 0.031$).

Table 1: Selected vital parameters of the respondents before and after bitter leaf enriched herbal tea blend consumption (Mean± SD; n = 10).

Parameter	Baseline (A)	Midpoint (B)	Post (C)	P value (AvsB)	P value (BvsC)	P value (AvsC)
WT (Kg)	67.8±14.1	67.7±14.2	68.4±14.0	0.363	**0.022***	**0.012***
BMI (Kg/m²)	23.5±7.7	23.4±7.7	23.9±7.6	0.245	0.058	0.056
SBP (mmHg)	115.4±9.7	112.4±11.5	117.0±5.9	0.175	**0.032***	0.257
DBP (mmHg)	66.2±10.3	65.0±5.5	65.8±7.6	0.366	0.411	0.456
Pulse (bpm)	76.3±14.0	73.5±10.2	76.8±11.7	0.162	0.204	0.439

*Statistically significant at $p<0.05$.

Table 2: Levels of fasting plasma glucose, insulin, lipid profile and amylase activity before and after consumption of bitter leaf enriched herbal tea (Mean± SD; n = 10)

Parameter	Baseline (A)	Midpoint (B)	Post (C)	P value (AvsB)	P value (BvsC)	P value (AvsC)
Glucose (mg/dl)	86.20±7.21	83.00±9.04	83.40±10.36	0.279	0.217	0.348
Insulin (mIU/L)	14.90±3.96	16.40±3.43	15.60±3.16	0.072	0.087	0.096
TC (mmol/L)	5.60±1.07	4.60±0.86	4.30±0.90	**0.012***	**0.027***	**0.002***
TG (mmol/L)	1.00±0.20	1.00±0.15	1.00±0.15	**0.026***	**0.037***	**0.015***
HDL-C (mmol/L)	1.00±0.17	1.20±0.17	1.50±0.51	0.073	**0.001***	**0.004***
LDL-C (mmol/L)	4.10±0.96	2.90±0.70	2.30±0.77	**0.010***	**0.004***	**0.001***
Amylase (IU/L)	174.10±27.96	145.50±35.08	172.40±27.52	0.472	**0.031***	0.051

Statistically significant at $p<0.05$

DISCUSSION

Herbal tea consumption has been documented to have clinical relevance as a complementary dietary strategy for cardiometabolic health, with evidence indicating beneficial effects on lipid profiles, blood pressure, and oxidative stress markers.[31-34]

In this study, one of the most notable outcomes of this study was the significant improvement in lipid profile**,** characterized by reductions in total cholesterol and

Print ISSN: 0189-9287 Online ISSN: 2992-345X

LDL-cholesterol, as well as an increase in HDL-cholesterol. These findings are consistent with the reports of previous studies.[35- 38] The lipid-lowering effects observed in this study may be attributed to the phytochemical composition of bitter leaf, which includes flavonoids, phenolic acids, sesquiterpene lactones, and saponins.[39] These compounds have been shown to exert antioxidant effects, reduce lipid peroxidation, and modulate lipid-regulating enzymes.[40] These findings imply a reduction in the atherogenic lipids and as such a potential reduction in the risk of cardiovascular diseases. Reduced LDL oxidation is a critical mechanism in the prevention of atherogenesis and may partly explain the observed reductions in LDL-cholesterol in the present study. The concomitant increase in HDL-C levels further shows an improvement in the anti-atherogenic potential of bitter leaf enriched herbal tea blend. This increase in HDL-C reflects an enhanced protective capacity against cardiovascular disease risk, given the established role of HDL-C in reverse cholesterol transport and lipid clearance.

Despite the favorable lipid modulation as recorded in the current study, fasting plasma glucose and insulin levels did not change significantly post intervention. These findings are invariance with the reports of some other previous studies.[41-44] The disparity in findings may be influenced by the differences in the study populations employed; the duration of study as well as the small sample size used in the current study.

However, the present study showed no significant difference in the activity of pancreatic amylase after bitter leaf enriched herbal tea blend consumption. This finding is invariance with the previous studies by Adeoye *et al.*[42] and Uthman [45] which demonstrated that bitter leaf extracts inhibit α-amylase activity.

Furthermore, the diastolic blood pressure, body mass index and pulse rate remained the same before and after the intervention. Nevertheless, the modest, transient reduction in systolic blood pressure at day 11 may reflect the vascular effects of flavonoid-mediated antioxidant mechanisms, which enhance endothelial nitric oxide bioavailability and reduce oxidative vascular stress. While direct clinical evidence of bitter leaf's antihypertensive action in humans remains scarce, similar polyphenol-rich botanical interventions have demonstrated improvements in systolic pressure in animal models of hypertension.[46]

CONCLUSION

This study showed significant reductions in the serum levels of total cholesterol, triglycerides, and low-density lipoprotein cholesterol and an increase in the serum high density lipoprotein cholesterol level as well as body weight after bitter leaf enriched herbal tea consumption. These findings suggest that bitter leaf–enriched herbal tea blend consumption has positive effect on lipid metabolism and therefore, may be a useful adjunct in the therapeutic management of cardiometabolic disorders characterized by hyperlipidaemia. However, further research with larger sample size and longer intervention durations is necessary to elucidate the underlying mechanisms associated with the present findings.

Declarations

Authors' contribution: Ndili FU, Aliyu EO and Ebomuche CM were involved in all aspects of the work, Meludu NT, Meludu SC, Analike RA, Chiedu CS and Njoku CM designed and supervised the work, Meludu NT and Onah CE were involved in the acquisition, analysis and interpretation of data for the study, Ogbodo EC was involved in data analysis and interpretation, Literature review and manuscript preparation. All authors read through and approved the final manuscript

Disclosure in AI use: Nil

Conflict of interest: None

Funding: Self-funded.

REFERENCES

1. GBD 2019 Risk Factors Collaborators. Global burden of 87 risk factors in 204 countries and territories, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet (London, England)*. 2020; 396(10258):1223–1249. Doi:10.1016/S0140-6736(20)30752-2
2. WHO. Global report on hypertension: the race against a silent killer. Geneva: World Health Organization; 2023.
3. Budreviciute A, Damiati S, Sabir DK, Onder K, Schuller-Goetzburg P, Plakys G, et al. Management and Prevention Strategies for Non-Communicable Diseases (NCDs) and Their Risk Factors. Frontiers in Public Health. 2020; 8:574111. Doi: 10.3389/fpubh.2020.574111.
4. Ogbodo EC, Onah CE, Meludu SC, Ogbodo MC, Ezeugwunne IP, Ehiage FA, et al. Anthropometric Indices, Blood Pressure and Some Apolipoproteins in older Adults in Nnewi, Southeast Nigeria. *African Journal of Biomedical Research*. 2024a; 27(1):39- 47. Doi: 10.4314/ajbr.v27i1.5

Print ISSN: 0189-9287 Online ISSN: 2992-345X

5. Ogbodo EC, Onah CE, Amah AK, Okeke CS, Obiorah, MO, Okezie AO, et al. Assessment of fasting plasma glucose, insulin, insulin resistance and glycated haemoglobin as markers of glycemic control in apparently healthy older adults in Nnewi. *Indian Journal of Forensic and Community Medicine*. 2024b; 11(2):49-55. Doi: 10.18231/j.ijfcm.2024.013
6. Ogbodo EC, Onah CE, Meludu SC, Ogbodo CM, Ezeugwunne IP, Ehiaghe FA. Assessment of Lipid Profile Levels among Older Adults in Nnewi. *Asian Journal of Cardiology Research*. 2023; 6(1):132–141.
7. Lloyd-Jones DM, Allen NB, Anderson CAM, Black T, Brewer LC, Foraker RE, et al. Life's Essential 8: Updating and Enhancing the American Heart Association's Construct of Cardiovascular Health: A Presidential Advisory From the American Heart Association. *Circulation*. 2022; 146(5):e18–e43. Doi: 10.1161/CIR.0000000000001078
8. Grundy SM, Stone NJ, Bailey AL, Beam C, Birtcher KK, Blumenthal RS, et al. Guideline on the Management of Blood Cholesterol: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *Circulation*. 2019;*139*(25): e1082–e1143. Doi: 10.1161/CIR.0000000000000625
9. Huda HS, Majid NBA, Chen Y, Adnan M, Ashraf SA, Roszko M, et al. Exploring the ancient roots and modern global brews of tea and herbal beverages: A comprehensive review of origins, types, health benefits, market dynamics, and future trends. *Food Science and Nutrition*. 2024; 12(10):6938–6955. https://doi.org/10.1002/fsn3.4346
10. Vlaicu PA, Untea AE, Varzaru I, Saracila M, Oancea AG. Designing Nutrition for Health—Incorporating Dietary By-Products into Poultry Feeds to Create Functional Foods with Insights into Health Benefits, Risks, Bioactive Compounds, Food Component Functionality and Safety Regulations. *Foods*. 2023;12(21):4001. Doi: 10.3390/foods12214001
11. Amah AK, Ogbodo EC, Mbanaso EL, Akunne-Wariso CC, Ejiofor DC, Njoku CM, et al. Determination of the heavy metal contents of *Vernonia amygdalina* collected from Eke Okigwe Market, Imo State, Nigeria. *International Journal of Medical Science and Health Research*. 2018; 2(5):135–141.
12. Ogbodo EC, Emeka NC, Ezeugwunne IP, Analike RA, Dike CC, Njoku CM, et al. Effect of ethanoic leaf extract of *Phyllantus amarus* on fasting blood glucose, bilirubin, albumin and total protein on diabetic induced albino wistar rats in College of Health Sciences, Nnamdi Azikiwe University, Nnewi campus, Anambra State, Nigeria. *Global Scientific Journal*. 2017; 5(7):78–88.
13. Ijeh II, Ejike CECC. Current perspectives on the medicinal potentials of *Vernonia amygdalina* Del. *Journal of Medicinal Plants Research*. 2011;5(7):1051–1061.
14. Farombi EO, Owoeye O. Antioxidative and chemopreventive properties of *Vernonia amygdalina* and *Garcinia biflavonoid*. *International Journal of Environmental Research and Public Health*. 2011; 8(6):533–2555. Doi: 10.3390/ijerph8062533
15. Degu S, Meresa A, Animaw Z, Jegnie M, Asfaw A, Tegegn G. *Vernonia amygdalina*: A comprehensive review of the nutritional makeup, traditional medicinal use, and pharmacology of isolated phytochemicals and compounds. *Frontiers in Natural Products*. 2024; 3:1347855. Doi: 10.3389/fntpr.2024.1347855
16. Sailah I, Tallei TE, Safitri L, Tamala Y, Halimatushadyah E, Ekatanti D, et al. A network pharmacology approach to elucidate the anti-inflammatory and antioxidant effects of bitter leaf (*Vernonia amygdalina* Del.). *Narra J*. 2024; 4(3):e1016. Doi: 10.52225/narra.v4i3.1016
17. Ogbodo EC, Ogbodo CM, Onah CE, Okeke CS, Ifesinachi MO, Okezie AO, et al. Impact of Cucumber Supplementation on some Hepato-Renal Parameters in the Elderly Individuals in Nnewi. *The Nigerian Health Journal*. 2024c; 24(4):1738 – 1745. Doi: 10.60787/tnhj.v24i4.911
18. Ogbodo EC, Ogbodo CM, Onah CE, Onuora IJ, Olisah MC, Amah AK, et al. Effect of Cucumber Supplementation on Blood Pressure (BP) and Anthropometric Indices in the Older Adults in Nnewi, Anambra State, Nigeria. *Journal of Applied Science and Environmental Management*. 2025; 29 (10):3306-3311. Doi: 10.4314/jasem.v29i10.37
19. Ezeugwunne IP, Ezeora JC, Ogbodo EC, Analike RA, Okwara JE, Oguaka VN, et al. Assessment of Cardiovascular Disease Risk Factors of Adult Male and Female Diabetic Patients Attending Nnamdi Azikiwe University Teaching Hospital, Nnewi, Anambra State, Nigeria. *International Journal of Novel Research in Healthcare and Nursing*. 2017; 4(2):68-72.
20. Analike RC, Okwara JE, Meludu SC, Analike RA, Ogbodo EC, Onah CE. Evaluation of dyslipidemia prevalence among undergraduate university students. *Journal of Clinical Research and Reports*, 12(1). Doi:10.31579/2690-1919/274

Print ISSN: 0189-9287 Online ISSN: 2992-345X

21. Okwara JE, Ike NA, Ogbodo EC, Okwara NA, Igwebuobi CF, Odumodu IO, et al. Assessment of cardiovascular disease awareness and risk factors in a market population in Nnewi, Nigeria. *Advances in Bioresearch*. 2021; 12(4): 236-243.
22. Hall JE, do Carmo JM, da Silva AA, Wang Z, Hall ME. Obesity-induced hypertension: interaction of neurohumoral and renal mechanisms. *Circulation research*. 2015; 116(6):991–1006. Doi: 10.1161/CIRCRESAHA.116.305697
23. Alo SN, Onumaru TN, Nwodom FN, Uguru PO, Olatokun TP, Ewelugo CA, et al. Correlation of Anthropometric Measurements and Cardiovascular Risk Factors among Medical Students in Ebonyi State University, Nigeria. *Journal of Advances in Medicine and Medical Research*. 2025; 37(5):342-352.
24. Trinder P. Enzymatic determination of glucose in blood serum. *Annals of Clinical Biochemistry*. 1979; 6: 24.
25. MacDonald MJ, Gapinski JP. A rapid ELISA for measuring insulin in a large number of research samples. *Metabolism: Clinical and Experimental*. 1989; 38(5):450–452. Doi: 10.1016/0026-0495(89)90197-2
26. Allain CC, Poon LS, Chan CS, Richmond W, Fu PC. Enzymatic determination of total serum cholesterol. *Clinical Chemistry*. 1974; 20(4):470–475.
27. Fossati P, Prencipe L. Serum triglycerides determined colorimetrically with an enzyme that produces hydrogen peroxide. *Clinical Chemistry*. 1982; 28(10):2077–2080.
28. Assmann G. Determination of high-density lipoprotein cholesterol. *Internist*. 1979; 20:559– 565.
29. Friedewald WT, Levy RI, Fredrickson DS. Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. *Clinical Chemistry*. 1972; 18:499-502.
30. Cheesbrough M. Measurement of serum alpha amylase activity: in District Laboratory Practice in Tropical Countries Part 1, 4th edition, Cambridge University press, 2010, 360-362.
31. Xu Z, Tao Z, Guo Y. The role of tea in managing cardiovascular risk factors: Potential benefits, mechanisms, and interventional strategies. *Frontiers in Nutrition*. 2025; 12:1530012. Doi: 10.3389/fnut.2025.1530012
32. Zhang B, Tang W, Wu Y, Feng S, Yang B. Association of herbal tea consumption with cardiovascular diseases in the general population: evidence from the MESA cohort. *Nutrition Journal*. 2025; 24(1);154. Doi: 10.1186/s12937-025-01196-4
33. Xu R, Yang K, Li S, Dai M, Chen G. Effect of green tea consumption on blood lipids: a systematic review and meta-analysis of randomized controlled trials. *Nutrition Journal*; 19(1): 48. Doi: 10.1186/s12937-020-00557-5
34. Hartley L, Flowers N, Holmes J, Clarke A, Stranges S, Hooper L, et al. Green and black tea for the primary prevention of cardiovascular disease. *The Cochrane Database of Systematic Reviews*. 2013; 2013(6):CD009934. Doi: 10.1002/14651858.CD009934.pub2
35. Hasan IC, Subroto H, Puspasari G. Bitter Leaves Ethanol Extract (*Vernonia amygdalina*) Decreases Total Cholesterol Serum Level of Hypercholesterolemic Male Wistar Rats. *Journal of Medicine and Health*. 2018; 2(2). Doi: 10.28932/jmh.v2i2.1017
36. Olooto WE, Ogunkoya OO, Alabi AO, Oyinloye EO. Hypolipidaemic Potentials of *Vernonia amygdalina* in Male Albino Rats Fed High-Sucrose Diet. *Annals of Health Research*. 2017; 3(1): 10-17.
37. Adaramoye OA, Akintayo O, Achem J, Fafunso MA. Lipid-lowering effects of methanolic extract of *Vernonia amygdalina* leaves in rats fed on high cholesterol diet. *Vascular Health and Risk Management*. 2008; 4(1):235–241. Doi: 10.2147/vhrm.2008.04.01.235
38. Purwanti N, Putri RA. The Effectiveness of *Vernonia amygdalina* (African Bitter Leaf) Tea for Reducing Cholesterol Levels in Individuals with Hypercholesterolemia. *Journal of Health Science*. 2021; 14(1): 1-7. Doi: 10.33086/jhs.v13i02.1306
39. Elebiyo TC, Olori OO, Rotimi DE, Al-Megrin WAI, De Waard M, Alkhuriji AF, et al. Chemical fingerprinting, comparative in vitro antioxidant properties, and biochemical effects of ginger and bitter leaf infusion. *Biomedicine and Pharmacotherapy*. 2022; 155:113788. Doi: 10.1016/j.biopha.2022.113788
40. Adewuyi HA, Atapia M, Ochonung E, Waheed SA, Oluwatoyin AH, Obunadike CV, et al. Phytochemical and nutritional composition of *Vernonia amygdalina*: Antioxidant, antidiabetic efficacy, and hematological benefits. *Pharmacology and Clinical Pharmacy Research*. 2025; 10(2):127-137. Doi: 10.15416/pcpr.v10i2.59067
41. Adekemi FE, Folake JK, Omowumi FP. Antidiabetic effects of aqueous leaf extract of *Vernonia amygdalina* on serum liver markers in streptozotocin-induced diabetic albino Rats: a new data to support its Anti-diabetic effect. *Clinical Phytoscience*. 2024; 10:13. Doi: 10.1186/s40816-024-00376-9

Print ISSN: 0189-9287 Online ISSN: 2992-345X

42. Adeoye AT, Oyagbemi AA, Adedapo AD, Omobowale TO, Ayodele AE, Adedapo AA. Antidiabetic and antioxidant activities of the methanol leaf extract of *Vernonia amygdalina* in alloxan-induced diabetes in Wistar rats. *Journal of Medicinal Plants for Economic Development.* 2017; 1(1): a30. Doi: 10.4102/jomped.v1i1.30
43. Djeujo FM, Cusinato F, Ragazzi E, Froldi G. α-Glucosidase and advanced glycation end products inhibition with Vernonia amygdalina root and leaf extracts: new data supporting the antidiabetic properties. *The Journal of Pharmacy and Pharmacology*. 2021; 73(9):1240–1249. Doi: 10.1093/jpp/rgab057
44. Djeujo FM, Stablum V, Pangrazzi E, Ragazzi E, Froldi G. Luteolin and Vernodalol as Bioactive Compounds of Leaf and Root *Vernonia amygdalina* Extracts: Effects on α-Glucosidase, Glycation, ROS, Cell Viability, and In Silico ADMET Parameters. *Pharmaceutics.* 2023; 15(5):1541. Doi: 10.3390/pharmaceutics15051541
45. Uthman H. Kinetic Studies on the Inhibition Potential of Bitter Leaf (*Vernonia amygdalina*) in the Management of Diabetes. *GSC Advanced Research and Reviews*; 21(03):184–197. Doi: Doi: 10.30574/gscarr.2024.21.3.0483
46. Olędzki R. Polyphenolic Compounds in the Prevention and Treatment of Hypertension: A Review. *International Journal of Molecular Sciences*. 2025; 26(21):10665. Doi: 10.3390/ijms262110665

Print ISSN: 0189-9287 Online ISSN: 2992-345X