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EVALUATION OF PLASMA GLUCOSE AND SERUM LIPID PROFILE LEVELS AMONG STUDENTS IN NNEWI CONSUMING *GLYCINE MAX* (SOYA BEAN)

I. C. Maduka[1], R. A. Analike [2], S. N. Chiwetalu [3], E. C. Ogbodo [* 3], C. E. Onah [3], C. M. Njoku [2], J. C. Nnamdi [2], A. K. Amah [4] and U. N. Agada [5]

Department of Human Biochemistry [1], Faculty of Basic Medical Sciences, Department of Chemical Pathology [2], Nnamdi Azikiwe University, Awka, Nigeria.
Department of Medical Laboratory Science [3], Faculty of Health Sciences and Technology, Nnamdi Azikiwe University, Awka, Nigeria.
Department of Human Physiology [4], College of Medicine, Imo State University, Owerri, Nigeria.
Department of Medical Laboratory Services [5], Alex Ekwueme Federal University Teaching Hospital, Abakaliki, Nigeria.

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Correspondence to Author:
E. C. Ogbodo

Department of Medical Laboratory Science, Faculty of Health Sciences and Technology, Nnamdi Azikiwe University, Awka, Nigeria.

E-mail: augustinee442@gmail.com

ABSTRACT: Medicinal plants are becoming globally recognized because of their acclaimed therapeutic potentials. This study evaluated the plasma glucose and serum lipid profile levels among university students consuming *Glycine max* (Soya bean) in Nnewi, Nigeria. A total of thirty (30) apparently healthy male subjects aged between 18 and 30 years were randomly recruited from medical students to serve as both test and control groups. Each subject was advised to abstain from soya bean and similar food consumption for a period of three weeks prior to the commencement of the study. Subsequently, in addition to their normal diet, each of the subjects was given 25 g of soya bean powder before breakfast daily for 30 consecutive days. 6 mls each of baseline and test samples (after an overnight fast) were collected at day 0 and 31 respectively from each subject for the determination of plasma glucose and lipid profile parameters (TC, TG, LDL-C, HDL-C, and VLDL-C) using standard laboratory methods. Results showed no significant alterations in the mean body mass index (BMI), serum concentrations of TC, HDL-C, LDL-C, and plasma glucose, but there were significant decreases in the mean SBP and DBP and increases in the mean serum concentrations of triglyceride and VLDL-C ($P<0.05$) level of the participants after soya bean consumption compared with the results obtained before soya bean intake respectively ($P>0.05$). Significant positive correlations were observed in parameters studied after soya bean consumption between SBP *vs* DBP ($r=0.298$; $p=0.033$) and SBP *vs* HDL-C ($r=0.437$; $p=0.008$) respectively. Therefore, it is recommended that further studies involving a larger sample size and a longer period of study be carried out in order to better ascertain the claims laid down in the present study as well as help in further unraveling the mechanisms behind the present findings.

INTRODUCTION: Diabetes mellitus (DM) is a chronic metabolic disease that results from.

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Diminished or absent secretion of insulin or even by reduced tissue sensitivity to insulin [1, 2]. Diabetes is a global endemic with rapidly increasing prevalence in developing countries such as Nigeria and Type 2 diabetes mellitus is one of the leading causes of preventable death in the world, with stroke, myocardial infarction, and other cardiovascular diseases being the most common causes of death for adults with diabetes [3], with its main pathophysiological features been impaired insulin secretion and increased insulin resistance [4, 5]. A number of factors, including less glycemic control, smoking, high blood pressure, elevated cholesterol levels, obesity, and lack of regular exercise, are considered to be risk factors that accelerate the deleterious effects of diabetes [6].

On the other hand, cardiovascular diseases (CVDs) are a group of disorders of the heart and blood vessels. CVDs are the number 1 cause of death globally: more people die annually from CVDs than from any other cause. In 2016, an estimated 17.9 million people died from CVDs, representing 31% of all global deaths. Of these deaths, 85% are due to heart attack and stroke [7]. Also, In Nigeria, CVDs accounted for 11% of all deaths in 2018 [8]. Importantly, both CVDs and diabetes are caused by modifiable factors such as behavioural risk factors such as tobacco use, unhealthy diet and obesity, physical inactivity, and harmful use of alcohol [8].

According to World Health Organization, medicinal plants would be the best source to obtain a variety of drugs. Therefore, such plants should be investigated for a better understanding of their properties, safety, and efficacy [9]. Interestingly, a number of plant source have been shown to have modulating effects on CVDs and diabetes and soya beans is one such plants to reckon with in this context. In recent decades, there has been increasing interest in functional foods that optimize physiological functions, contributing to the well-being and good health and/or reduction in the risk of diseases. A portion of food can be considered as functional if it can be demonstrated satisfactorily that it positively affects one or more functions of the organism, promoting the benefits cited above [10].

Furthermore, Soya bean is one of such functional food of enormous therapeutic potentials. Soya bean (*Glycine max*) is a leguminous crop, differing from other grain legumes because of the presence of high amounts of beneficial components like proteins, fibers, iron, calcium, zinc, and B vitamins phytosterols and isoflavones (ISOs) [11].

The main functional components of soybeans are the biologically active compounds termed ISOs which are important members belonging to the class of phytoestrogens.

There are 12 different types of ISOs reported in soybeans, mainly categorized into four groups, namely, acetylglucoside, glucoside and malonyl-glucoside, aglycon, and each of these groups contains three ISOs [12]. The most important ISOs in soybeans are genistein and daidzein, which are similar to mammalian estradiol, with respect to structure [12]. Soya bean is unique foods because of their rich nutrient content; their complex carbohydrate and dietary fiber content contribute to their low glycemic indexes, which benefit diabetic individuals and reduce the risk of developing diabetes [13, 14]. Soybean protein administration has been reported to reduce cholesterol; triglyceride, and Low-density lipoprotein levels in healthy persons as well as in diabetic patients and in experimental animals [15, 16]. The main scientific relevance associated with the action of soybean on health is its beneficial action on cardiovascular disease, with an emphasis on the reduction of cholesterol and inhibition of the formation of atherosclerotic plaque [17].

Also, Soybean proteins have been shown to reduce the risk of cardiovascular diseases by lowering blood pressure, blood cholesterol, and triglycerides [18, 19]. Diabetes is a global endemic with rapidly increasing prevalence in developing countries such as Nigeria. Type 2 diabetes mellitus is one of the leading causes of preventable death in the world, with stroke, myocardial infarction, and other cardiovascular diseases the most common causes of death for adults with diabetes [3].

CVDs are the number 1 cause of death globally: more people die annually from CVDs than from any other cause. In 2016, an estimated 17.9 million people died from CVDs, representing 31% of all global deaths. of these deaths, 85% are due to heart attack and stroke [7]. Also, In Nigeria, CVDs accounted for 11% of all deaths in 2018 [8].

Importantly, both CVDs and diabetes are caused by modifiable factors such as behavioural risk factors such as tobacco use, unhealthy diet and obesity, physical inactivity, and harmful use of alcohol [8].

However, Soya bean is functional food of enormous therapeutic potentials in ameliorating the ravaging effects of both diabetes mellitus and cardiovascular diseases [20].

Amer, (2012) has shown the reducing effect of soya bean consumption on blood glucose level while reporting a significant reduction in the mean total cholesterol (TC), triglyceride (TG), and low density lipoprotein (LDL) levels [21]. Similar, studies have also shown significant reductions in serum lipid profile parameters such as TC, TG, and LDL and an increase in high-density lipoprotein (HDL) levels [22-24]. However, some other similar previous studies had recorded no significant effects of soya bean on lipid profile [25, 26,] and blood glucose level [25]. Although a number of authorities have evaluated the effect of soya bean consumption on plasma glucose and serum lipid profile levels in other countries, researches in this regard seem to be scanty in Nigeria.

More so, despite the numerous benefits attributable to soya bean effects, a number of authorities have reported conflicting results regarding the effect of soya bean on both lipid profile parameters and blood glucose levels in humans as well as in animals alike. Therefore, the present study seeks to evaluate the plasma glucose and serum lipid profile levels among students in Nnewi consuming *Glycine max* (Soya bean).

MATERIALS AND METHODS:

Study Site: This research was carried out in the College of Health Sciences, Nnamdi Azikiwe University, Okofia, Nnewi Campus, Anambra State.

Study Design: A total of thirty (30) apparently healthy male students of College of Health Sciences and Technology, Nnamdi Azikiwe University, Nnewi campus who were aged between 18 and 30 years were randomly recruited to serve as both test and control groups. The study participants were properly informed about the study and only those who give their consent were recruited for the study.

Each subject was advised to abstain from soya bean and similar food consumption for a period of three weeks before the Commencement of the study. 6mls of baseline samples (after an overnight fast) were collected from each of the participants on day 0 as control samples. 2 ml and 4 ml were dispensed into fluoride oxalate and plain sample containers, respectively.

Plasma obtained from fluoride Oxalate containers were used for the determination of glucose levels, while serum from plain sample containers was use for lipid profile (TC, TG, LDL-C, HDL-C, and VLDL-C) determination using standard laboratory methods.

Subsequently, in addition to their normal diet, each of the subjects was given 25 g of soya bean powder before breakfast daily for 30 days. After an overnight fast, 6 mls of post-research (test) samples were collected on the 31st day, and the levels of glucose and lipid profile were also evaluated according. Also, a structured questionnaire was used to obtain relevant information such as age, height, sex, demographic factors, and dietary patterns while subjects' weight and blood pressure readings were obtained using a weighing scale and sphygmo-manometer, respectively, before and after soya bean consumption.

Inclusion and Exclusion Criteria: Apparent healthy male subjects aged between 18 and 30 years were recruited for this study, whereas individuals that are sick, on drugs (lipid-lowering or antidiabetic drugs) or those outside the age bracket of 18-30 years were excluded from the study.

Ethical Consideration: The ethical approval for this study was sought and obtained from the Ethics Committee of Faculty of Health Sciences and Technology, Nnamdi Azikiwe University, Nnewi, Anambra State, Nigeria (ERC/FHST/NAU/ 2019/2153).

Estimation of Total Cholesterol (TC): Total Cholesterol level was estimated using an enzymatic method as described by Roeschlau *et al.* [27].

Estimation of Triglycerides: Triglyceride level was estimated with the enzymatic method as described by Tietz [28].

Estimation of High-Density Lipoprotein Cholesterol (HDL-C): HDL-C level was estimated using the method described by Burstein *et al.* [29].

Estimation of Low-Density Lipoprotein Cholesterol (LDL-C): LDL-C level was estimated using the enzymatic method described byAssman *et al*. [30].

Estimation of Plasma Glucose (FBS): Plasma glucose level was determined using the glucose oxidase method as described by Barham and Trinder [31].

Statistical Analysis: The data obtained were presented as Mean ± SD, and the mean values of the baseline and test samples were compared by Students t-test and Pearson r correlation using Statistical package for social sciences (SPSS) (Version 23) software. Statistical significance was tested at P<0.05.

RESULTS: The mean age and height of the subjects studied were 25.03 ± 3.18 years and 1.70 ± 0.10 m, respectively. The mean weight and body mass index of the participants before soya bean intake did not differ significantly when compared with values observed after soya bean consumption (p=0.190; 0.252), respectively.

However, there were significant decreases in the mean systolic, and diastolic blood pressures in the participants after soya bean intake compared with baseline values (p=0.000; 0.003), respectively see **Table 1**.

There was no significant difference observed in the mean serum concentration of total cholesterol (TC) in the participants when baseline values were compared with the values obtained after soya bean intake (p=0.957). However, there was a significant increase in the mean serum triglyceride level in the participants after soya bean consumption compared with before consumption (1.13 ± 0.41 *vs*. 0.88 ± 0.35; p=0.008). Surprisingly, the mean levels of both high-density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C) did not differ significantly in the subjects studied after soya bean consumption compared with baseline (p=0.359; 0.612) respectively, whereas the mean serum concentration of very low-density lipoprotein cholesterol was significantly increased in the subjects after soya bean consumption compared with before soya bean intake (0.52 ± 0.19 *vs* 0.40 ± 0.16; p=0.007) see **Table 2**.

Interestingly, the mean plasma glucose concentration remained similar before and after soya bean consumption in the participants studied (p=0.864**)** see **Table 2**.

There were significant positive correlations observed in parameters studied before soya bean consumption between SBP *vs* DBP (r=0.390; p=0.033), SBP Vs HDL-C (r=0.477; p=0.008) and BMI Vs Glucose (r=0.421; p=0.020) respectively, while other remaining parameters did not show significant correlations (p>0.05) see **Table 3.**

Also, there were significant positive correlations observed in parameters studied after soya bean consumption between SBP Vs. DBP (r=0.298; p=0.033) and SBP Vs. HDL-C (r=0.437; p=0.008) respectively, while other remaining parameters did not show significant correlations (p>0.05) see **Table 4.**

TABLE 1: LEVELS OF SOME DEMOGRAPHIC PARAMETERS BEFORE AND AFTER SOYA BEAN INTAKE (MEAN ± SD)

Parameters	Before Soya Bean Intake (Baseline)	After Soya Bean Intake	t-Test	p-Value
Age (year)	25.03 ± 3.18	-	-	-
Height (m)	1.70 ± 0.10	-	-	-
Weight (kg)	68.43 ± 9.92	70.00 ± 9.44	0.823	0.190
BMI (Kg/m^2)	23.70 ± 3.84	24.23 ± 3.53	0.393	0.252
SBP (mmHg)	120.97 ± 14.18	110.07 ± 11.14	14.777	0.000
DBP (mmHg)	72.67 ± 10.33	68.40 ± 5.26	6.912	0.003

Statistically significant at p<0.05.

TABLE 2: LEVELS OF LIPID PROFILE BEFORE AND AFTER INTAKE OF SOYA BEAN (MEAN ± SD)

Parameters	Before soya Bean intake (Baseline)	After Soya Bean intake	t-tTest	p-Value
Total cholesterol (mmol/l)	4.45 ± 0.68	4.44 ± 0.66	0.055	0.957
Triglyceride (mmol/l)	0.88 ± 0.35	1.13 ± 0.41	-2.869	0.008
HDL-cholesterol (mmol/l)	0.99 ± 0.22	0.95 ± 0.20	0.931	0.359
LDL-cholesterol (mmol/l)	3.06 ± 0.67	2.98 ± 0.63	0.512	0.612
VLDL-cholesterol (mmol/l)	0.40 ± 0.16	0.52 ± 0.19	-2.875	0.007
Glucose (mmol/l)	4.63 ± 0.51	4.65 ± 0.54	-0.173	0.864

Statistically significant at p<0.05.

TABLE 3: LEVELS OF ASSOCIATION BETWEEN PARAMETERS BEFORE SOYA BEAN CONSUMPTION IN PARTICIPANTS STUDIED

Parameters	r-Value	p-Value
SBP Vs DBP	0.390	0.033*
SBP Vs HDL-C	0.477	0.008*
SBP Vs LDL-C	-0.118	0.535
SBP Vs VLDL-C	0.203	0.283
SBP Vs Glucose	-0.017	0.929
DBP Vs BMI	-0.175	0.356
DBP Vs TC	-0.232	0.218
DBP Vs TG	-0.218	0.248
DBP Vs HDL-C	0.127	0.503
DBP Vs LDL-C	-0.227	0.227
DBP Vs VLDL-C	0.215	0.253
DBP Vs Glucose	0.181	0.340
BMI Vs SBP	-0.240	0.200
BMI Vs DBP	-0.175	0.356
BMI Vs TC	0.147	0.440
BMI Vs TG	0.021	0.914
BMI Vs HDL-C	0.048	0.800
BMI Vs LDL-C	0.161	0.395
BMIVs VLDL-C	0.017	0.931
BMI Vs Glucose	0.421	0.020*

Statistically significant at $p<0.05$.

TABLE 4: LEVELS OF ASSOCIATION BETWEEN PARAMETERS AFTER SOYA BEAN CONSUMPTION IN PARTICIPANTS STUDIED

Parameters	r-Value	p-Value
SBP Vs DBP	0.298	0.033*
SBP Vs BMI	0.037	0.200
SBP Vs TC	0.319	0.665
SBP Vs TG	-0.395	0.280
SBP Vs HDL-C	0.437	0.008*
SBP Vs LDL-C	0.313	0.535
SBP Vs VLDL-C	0.397	0.283
SBP Vs Glucose	0.207	0.929

Statistically significant at $p<0.05$.

DISCUSSION: According to World Health Organization (WHO), medicinal plants would be the best source to obtain a variety of drugs in the near future, and therefore, such plants should be investigated for a better understanding of their properties, safety, and efficacy [9]. In this study, the effect of soya bean consumption on plasma glucose and lipid profile levels in male students was evaluated. The present finding indicates that there was no significant effect of soya bean consumption on the mean weight and body mass index (BMI) of the participants when compared with before soya bean consumption. Soya bean peptides may play a role in body weight regulation, possibly by increasing energy utilization [32]. However, based on WHO classification of BMI levels [33] underweight ≤ 18.5 kg/m^2, normal weight = 18.5-24.9 kg/m^2, obesity class I =30.0-34.9 kg/m^2, obesity class II= 35.0-39.9 kg/m^2 and obesity class III=>40.0 kg/m^2; our present study revealed that soya bean consumers had normal body mass index. A potential explanation for this result could be related to the quantity of soya been consumed by the participants or perhaps the duration of this study. The present finding corroborates with the report of several previous similar studies earlier documented [34].

Dietary modification has important therapeutic roles in blood pressure control. Strong evidence supports the recommendation of a diet containing high potassium, moderate alcohol, and high fiber intake [35]. Soya bean contains a high-quality protein alongside some other important constituents such as isoflavone, dietary fibers, calcium, magnesium, and potassium, which have been shown to be beneficial in the management of hypertension.

In the present study, there were significant decreases in the mean systolic (110.07 ± 11.14 *vs.* 120.97 ± 14.18; p=0.000) and diastolic blood pressures (68.40 ± 5.26 *vs.* 72.67 ± 10.33; p=0.003) in the participants after soya bean intake compared with before consumption respectively. This is in line with the findings of previous studies [34, 36]. Furthermore, several studies have shown the potential of soya bean consumption in the lowering of blood pressure in humans and subsequently, helping to reverse the condition [37]. Also, soya bean intakes ≥25 g d^{-1} has been previously reported to significantly decrease SBP and DBP, and this may be due to the isoflavones and phytoesterogen components [37]. Isoflavones are thought to work by increasing the production of enzymes that create nitric oxide (NO), a substance that helps to dilate or widen blood vessels, thereby reducing the pressure created by blood against the vessel walls. This is an important finding as this may serve as an adjunct in the prevention and management of hypertension.

Surprisingly, no significant difference was observed in the mean serum concentration of total cholesterol (TC) in the participants after soya bean intake when compared with before soya bean intake, although TC level showed a trend towards reduction post-consumption of soya bean. This reduction in the mean TC concentration shows that soya bean intake may have the potential to cause a significant reduction in TC concentration perhaps following its intake at a longer-term basis or duration. This is in consonance with the results documented by some previous similar studies [25]. In contrast to the present finding, Amer had earlier shown that soya bean consumption caused a significant reduction in the mean total cholesterol (TC) level [21]. Also, other similar studies have also shown significant reductions in serum TC level following the consumption or intake of soya bean [22-24]. Importantly, the exact mechanism of the cholesterol-lowing effect of soybeans is not clear. However, this reduction may have been mediated by the phytoestrogens and saponins in soybean. Plasma cholesterol-lowering activity of saponins is also connected with their capabilities to precipitate cholesterol from micelles and interference with enterohepatic circulation of bile acids, making it unavailable for intestinal absorption and hence reduce plasma cholesterol levels [38].

However, there was a significant increase in the mean serum triglyceride level in the participants studied after soya bean consumption compared with the baseline value (1.13 ± 0.41 *vs* 0.88 ± 0.35; p=0.008). This might imply that at the short term, administration of soya bean may elicit a temporary increase in the mobilization of free fatty acids from the peripheral fat depots. Similar, studies documented earlier showed significant reductions in serum triglyceride concentration following the administration of soya bean [17, 23-24,] which are contrary to the present finding. This disparity in results may be due to differences in the dosage, duration of administration or perhaps the subjects used.

In the present study, the mean levels of both high-density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C) did not differ significantly in the subjects studied following soya bean consumption when compared with before consumption (p=0.359; 0.612) respectively, although they showed a trend towards reduction. This is in consonance with the previous finding of Jaekel and Rodrigues that investigated the effect of a soybean and rice beverage on the lipid and glycemic metabolisms in hamsters and documented no significant alterations in the serum levels of both HDL-C and LDL-C [25]. However, this is in contrast with the results of some previous similar studies [39, 23, 24, 36]. The reduction in LDL levels is important in hypercholesterolemic individuals since elevated plasma LDL-C concentrations are highly associated with the occurrence of coronary arterial diseases such as atherosclerosis. Furthermore, the mean serum concentration of very-low-density lipoprotein cholesterol was significantly increased in the subjects after soya bean consumption than before soya bean intake (0.52 ± 0.19 *vs* 0.40 ± 0.16; p=0.007). This is in contrast with the report of Kusuma and Shanthi that found a significant decrease in the VLDL-C following the intake of soya bean, although in middle-aged women [36].

Interestingly, the mean plasma glucose concentration remained similar before and after soya bean consumption in the participants studied (p=0.864**)**. The implication is that plasma glucose level may not be affected following the administration or consumption of soya bean at a short-term basis or duration. The present results confirm the work of Jaekel and Rodrigues that showed no significant effect of soya bean intake on plasma glucose level in hamsters[25]. Other similar studies documented significant reductions in the mean plasma glucose levels in subjects studied following the consumption of soya bean [40, 21, 41]. This disparity in results may be attributed to the disparity in the duration of the study employed by the different researchers.

Furthermore, there were significant positive correlations observed in parameters studied before soya bean consumption between SBP Vs DBP (r=0.390; p=0.033), SBP *vs* HDL-C (r=0.477; p=0.008) and BMI *vs* Glucose (r=0.421; p=0.020) respectively, while other remaining parameters did not show significant correlations (p>0.05). Also, there were significant positive correlations observed in parameters studied after soya bean consumption between SBP Vs DBP (r=0.298; p=0.033) and SBP *vs* HDL-C (r=0.437; p=0.008) and negative correlation between BMI Vs Glucose (r=0.421; p=-0.020) respectively, while other remaining parameters did not show significant correlations (p>0.05).

CONCLUSION: The current study showed no significant alterations in the mean body mass index, plasma glucose, and some lipid parameters(total cholesterol, high-density lipoprotein cholesterol

(HDL-C), and low-density lipoprotein cholesterol (LDL-C) levels in participants studied post soya bean consumption, but there were significant decreases in the mean systolic and diastolic blood pressures with significant positive correlations between SBP *vs.* DBP; SBP Vs. HDL-C (r=0.477; p=0.008) and BMI *vs.* Glucose respectively. It is therefore recommended that further studies in this respect involving a larger sample size and longer-term of study be carried out in order to better ascertain the claims laid down in the present study as well as help in further unraveling the mechanisms behind the present findings.

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