International Journal of Pharmaceutical Science Invention
ISSN (Online): 2319 – 6718, ISSN (Print): 2319 – 670X
www.ijpsi.org Volume 3 Issue 8 ‖ August 2014 ‖ PP.47-54

Hypolipidemic Properties of Four Varieties of Eggplants (*Solanum melongena* L.)

[1,]OSSAMULU, Ifeanyi Famous; [2,]AKANYA, Helmina Olufunmilayo; [3,]JIGAM, Ali Audu; [4,]EGWIM , Evans Chidi [5,]ADEYEMI, Henry Yemi
Department of Biochemistry, School of Natural and Applied Science, Federal University of Technology, P.M.B 65, Minna, Niger State, Nigeria.

ABSTRACT : *The effects of four eggplant varieties on lipid indices in albino rats were evaluated. A total of 108 adult albino rats were used for this study which lasted for 4 weeks (30days). They were randomly distributed into two major blocks of treatments (10% and 20% eggplant supplementation) with each having four sub groups (Groups A-D) based on the eggplant varieties. Each sub group had a total of 12 rats. Rats in group A were fed with diet supplemented with 'S. macrocapron (round), groups B, C and D were fed with diets supplemented S. atheopicum, S. macrocapron (oval), and S. gilo respectively. A general control group labelled 'control' was fed with normal commercial feed. At the end of every week, three rats from each group were weighed and sacrificed. The lipid profile was determined using AGAPE commercial kit. Rats placed on 10% and 20% S. aetheopicum and S. gilo supplemented diets had the highest (9.92±0.47g and 9.53±0.21g) and lowest (7.65±0.12g and 5.95±0.69g) weight gain respectively. The mean weight gain in all the groups was significantly ($p<0.05$) lower than the control group. Rats fed with 20% S. gilo supplemented diet had the lowest cholesterol concentration (60.76±1.7mg/dl) and was significantly ($p<0.05$) lower than the control group. The HDL concentration significantly increased in rats placed on 10% and 20% S. macrocarpon (oval) and S. gilo supplemented diet respectively relative to the control group. The varieties displayed weight reducing and hypolipidemic properties. Although Solanum gilo and S. macrocarpon (oval) displayed higher hypocholesterolemic, increased HDL and reduced weight gain effects and therefore can be employed in the management of overweight and several cardiovascular diseases.*

KEY WORDS: *Eggplant, High density lipoprotein, Low density lipoprotein, Cardiovascular disease, cholesterol*

I. INTRODUCTION

Diseases such as cardiovascular diseases (CVDs), among others are presently the leading cause of deaths globally. Elevation of serum cholesterol, basically low-density lipoprotein cholesterol (LDL-c), is a major risk factor for cardiovascular disease. Reduction of LDL-c levels and the increase of high-density lipoprotein cholesterol (HDL-c) reduce the risk of cardiovascular events and overall mortality [1]. Artheriosclerosis is a disorder of lipid transport and metabolism in which cholesterol by-product forms a thick, tough deposit called plague on the inner wall of the arteries, stiffening them and then starving the heart of blood, creating choke point where a clot could stop the flow entirely [2]. Apart from the lipid from the diet source (exogenous cholesterol), the body in turn manufactures its own cholesterol (endogenous). Ineffective clearance of excess cholesterol for reasons that are largely genetic [3], results in accumulation of cholesterol in the blood, and deposition of lipid in the arterial wall which leads to artherosclerosis. About 31% of ischemic heart disease and 11% of stroke globally could be associated with low fruit and vegetable intake. It is estimated that up to 2.7 million lives could potentially be saved each year if fruit and vegetable consumption was sufficiently increased [4]. Intake of a minimum of 400g of fruit and vegetables daily (excluding potatoes and other starchy tubers) may be helpful in several chronic disease prevention, as well as for the alleviation of several micronutrient deficiencies, especially in less developed countries [5].

Olusanya [6], described garden egg (*Solanum melongena*) as a fruit vegetable which is botanically classified as a berry containing numerous, soft and small sized seeds. Eggplants possess various nutritional and medicinal uses that make them valuable addition to diets. This is basically because they have appreciable reserve of nutrients and loads of phytochemical compounds. The fruit is a fairly good source of iron, calcium, vitamin B groups. Its fresh weight has about 92.7% moisture, 1.4 % protein, 1.3% fiber, 0.3% fat, 0.3% ash and the remainder consist of different carbohydrates [7], and vitamins [8]. Since garden egg plants have low fat content, they may therefore be good food for obese and individuals with cardiovascular challenges. Eggplants are nutrient dense food (because of the high moisture and fiber contents) consequently increasing satiety, thereby preventing overeating [9]. It is a good source of minerals and vitamins and amide proteins. Oblong-fruited eggplant cultivars are rich in total soluble sugars, whereas the long-fruited cultivars contain a higher content of free reducing sugars, anthocyanin, phenols, glycoalkaloids (such as solasodine), dry matter, and amide proteins [10].

II. MATERIALS AND METHODS

Plant Material : The different Eggplants cultivars used were obtained from a farmland in kudenda Kaduna, Nigeria. The samples were transported to the laboratory and were identified by a taxonomist in the department of Biological Science, Federal University of Technology Minna Niger State, Nigeria. The samples were washed with water, sliced into pieces, dried at room temperature for three weeks, ground into powder and stored in an air tight container for further use.

Experimental Animals : Adult Swiss albino rats weighing between 130g - 150g were used for this study. The rats were obtained from a private farm (Ijeoma Rodent Farms) in Zaria, Kaduna state and transported to the research site (Biochemistry department, Federal University of Technology Minna, Nigeria).

Management of Experimental Animals : The animals were allowed to acclimatize for 2 weeks under standard laboratory conditions. They were maintained on standard rat feed and potable water *ad libitum*. They were handled in strict compliance with international guidelines as prescribed by the Canadian Council on the Care and Use of Laboratory Animals in Biomedical Research [11]. After the acclimatization period, the rats in the treatment groups were kept under the formulated diets four days before commencement of the experiment.

Feed Preparation : The four eggplant samples (*S. macrocapron* (round), *S. Atheopicum*, *S. macrocapron* (oval), and *S. gilo*,) were separately supplemented into standard commercial feed at two different concentrations (10% and 20%). 10% eggplant supplemented diet had 10g of the eggplant sample mixed with 90g of standard feed while 20g of the sample was mixed with 80g of the commercial chow for 20% supplementation. These were thoroughly mixed with water and made into pellets.

Experimental Design : A total of 108 adult Swiss albino rats were used for this study which lasted for 4 weeks (30days). They were randomly distributed into two major blocks of treatments (10% and 20% eggplant supplementation) with each having four sub groups (Groups A-D) based on the eggplant cultivar. Each sub group had a total of 12 rats. Rats in group A were fed with diet supplemented with '*S. macrocapron* (round),' eggplant. Similarly, rats in groups B, C and D were fed with diets supplemented *S. atheopicum, S. macrocapron* (oval), and *S. gilo* respectively. A general control group labelled 'control' was fed with normal commercial feed. The rats were allowed food and water freely throughout the experimental period after a seven (7) days adaptation period with the various supplemented diets. All the rats were weighed before the commencement of the work. During the study, the weight gain by each rat was recorded at the end of every week. At the end of each week, three rats from each group of both 10 and 20% supplementation groups were fasted for about 12 hours, weighed and sacrificed under chloroform anaesthesia and blood samples collected for further analysis.

Blood Sample Collection : While under chloroform anaesthesia, blood was collected from each rat via heart puncture and transferred into lithium heparin bottle. The collected blood samples were immediately spun at 3000 rpm to collect the plasma portion which was used for biochemical analysis.

Lipid Profile Analysis : Total cholesterol, Triglyceride, Low Density Lipoprotein (LDL) and High Density Lipoprotein (HDL) level were estimated using a commercial kit (AGAPE, Switzerland) based on enzymatic end point method.

Statistical Analysis : The statistical package of social sciences (SPSS) software version 18.0 (SPSS) was used.The results were evaluated using analysis of variance (ANOVA) and were presented as the mean value ± SEM (standard error of mean) for the control and experimental rats. Differences among the means for the groups were assessed using the Duncan's Multiple Range Test to determine which mean values were significantly different at $p<0.05$ [12].

III. RESULTS

The body weight gain of the rats at the end of a 30 days feeding exercise is presented in Table 1. The results obtained showed that rats kept on the control diet had the highest weight gain of 15.30±1.37g while the rats fed with 10% eggplant supplemented diets gained more weight than those placed on 20% supplemented feeds. Rats fed with *S. aetheopicum* supplemented diets had the highest weight gain for both 10% (9.92±0.47g) and 20% (9.53±0.21g) treatments while those fed with *S. gilo* supplemented diets had the least values for the two treatments; 7.65±0.12g and 5.95±0.69g respectively. There was significant difference ($p<0.05$) between the weight gain in the control group and both experimental groups i.e between 10% and 20% eggplant supplementations The group placed on *S. macrocarpon* (round) supplemented diet had lower cholesterol concentration than the control group (96.71±2.55mg/dl).

The group fed with 20% *S. gilo* supplemented diet had the least cholesterol concentration (60.76±1.7mg/dl). The cholesterol concentration of rats in the groups placed on both 10% and 20% *S. macrocarpon* (*oval*) and 20% *S. gilo* supplemented diets were significantly ($p<0.05$) lower than those in the control group (Figure 1). The triglyceride concentration was highest in the experimental groups fed with both 10% *S. macrocarpon* (oval) supplemented fed (98.45±2.07mg/dl) while those placed on 20% *S. aetheopicum* supplemented diet had the least concentration of triglyceride (72.00±2.51mg/dl). The triglyceride concentration obtained in rats fed with *S. aetheopicum* supplemented diets was significantly lower ($p<0.05$) than the control group (Figure 2). The mean HDL-cholesterol concentration as shown in Figure 3 indicated that the control group had a mean concentration of 36.13±2.92mg/dl; rats fed with 20% *S. gilo* supplemented feed had the highest mean HDL concentration (47.41±3.52mg/dl) while those on 20% *S. macrocarpon* (round) supplemented diet had the lowest mean concentration (33.94±3.02mg/dl). Rats fed 10% and 20% *S. macrocarpon* (oval) and *S. gilo* had higher high density lipoprotein (HDL) concentration which differs significantly from those in the control group. There was no significant difference ($p<0.05$) in the HDL concentration between rats placed on 10% and 20% eggplant supplementations.

Figure 4 shows the Mean LDL concentration in rats placed on diets supplemented with 10% and 20% *S. melongena* varieties. The Low Density Lipoprotein concentration ranged from 41.23±1.35mg/dl in 20% *S. gilo* Supplemented diet fed rats to 70.29±1.67mg/dl in rats placed on 10% *S. aetheopicum* supplemented diet. There was no significant difference ($p>0.05$) in the LDL concentration between the control group with LDL concentration of 64.02±0.77mg/dl and other treatment groups except the group placed on 20% *S. gilo* Supplemented diet (41.23±0.85mg/dl).

Table 1: Mean weight gain and food intake of rats placed on 10% & 20% *S. melongena* supplemented diets

	10%	**20%**
Treatments	Average weight gain (g)	Average weight gain (g)
Control	10.46 ± 1.59^{d}	11.12 ± 0.66^{d}
Group A	7.05 ± 0.24^{c}	6.62 ± 0.17^{c}
Group B	6.86 ± 0.28^{c}	6.45 ± 0.33^{c}
Group C	7.11 ± 1.05^{c}	5.81 ± 1.05^{c}
Group D	5.18 ± 0.44^{bc}	4.11 ± 0.44^{bc}

Values are mean ± standard error of mean (SEM) of triplicate determinations. Mean ± SEM followed by different letter(s) on a column are significantly different ($p<0.05$).

Group A – Rats fed with *Solanum macrocarpon* (round) supplemented diet, **Group B** – Rats fed with *S. aetheopicum* supplemented diet, **Group C** – Rats fed with *S. macrocarpon* (oval) supplemented diet, **Group D** – Rats fed with *S. gilo* supplemented diet

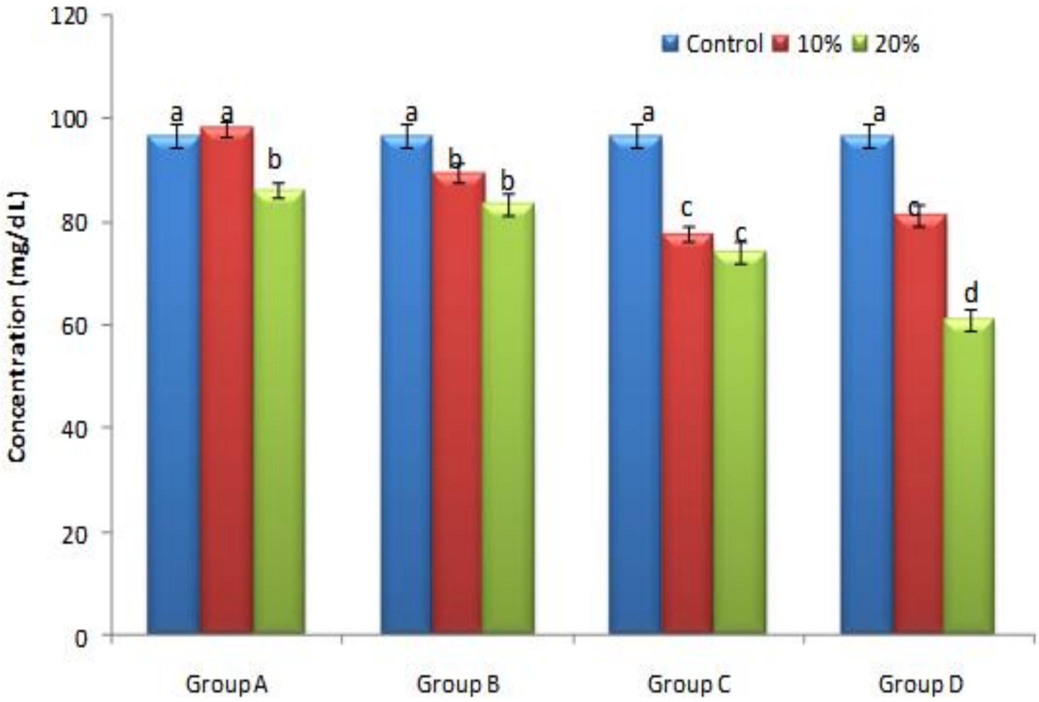

Figure 1: Mean Cholesterol concentration of rats placed on diets supplemented with 10% and 20% of the *S. melongena* varieties.

Each bar is the mean ± standard error of mean (SEM) of triplicate determinations. Different alphabet(s) on the bars show significant difference ($p<0.05$). **Group A:** Rats fed with *Solanum macrocarpon* (round) supplemented diet, **Group B** – Rats fed with *S. aetheopicum* supplemented diet, **Group C** – Rats fed with *S. macrocarpon* (oval) supplemented diet, **Group D** – Rats fed with *S. gilo* supplemented diet

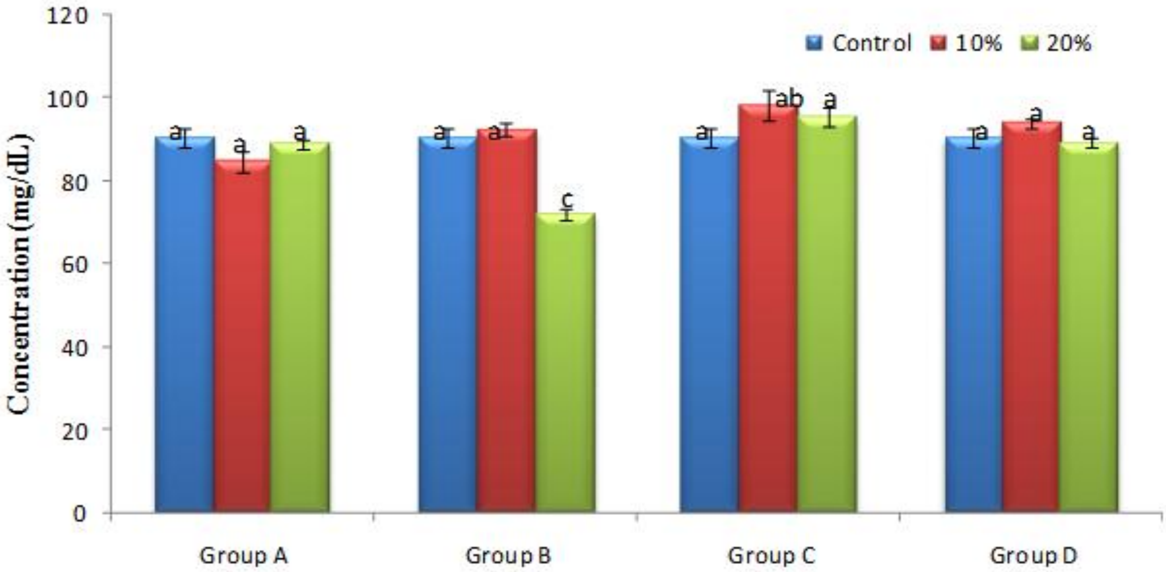

Figure 2: **Mean Triglyceride concentration (mg/dl) of rats placed on diets supplemented with 10% and 20% of the *S. melongena* varieties**

Each bar is the mean ± standard error of mean (SEM) of triplicate determinations. Different alphabet(s) on the bars show significant difference ($p<0.05$). **Group A** – Rats fed with *Solanum macrocarpon* (round) supplemented diet, **Group B** – Rats fed with *S. aetheopicum* supplemented diet, **Group C** – Rats fed with *S. macrocarpon* (oval) supplemented diet, **Group D** – Rats fed with *S. gilo* supplemented diet

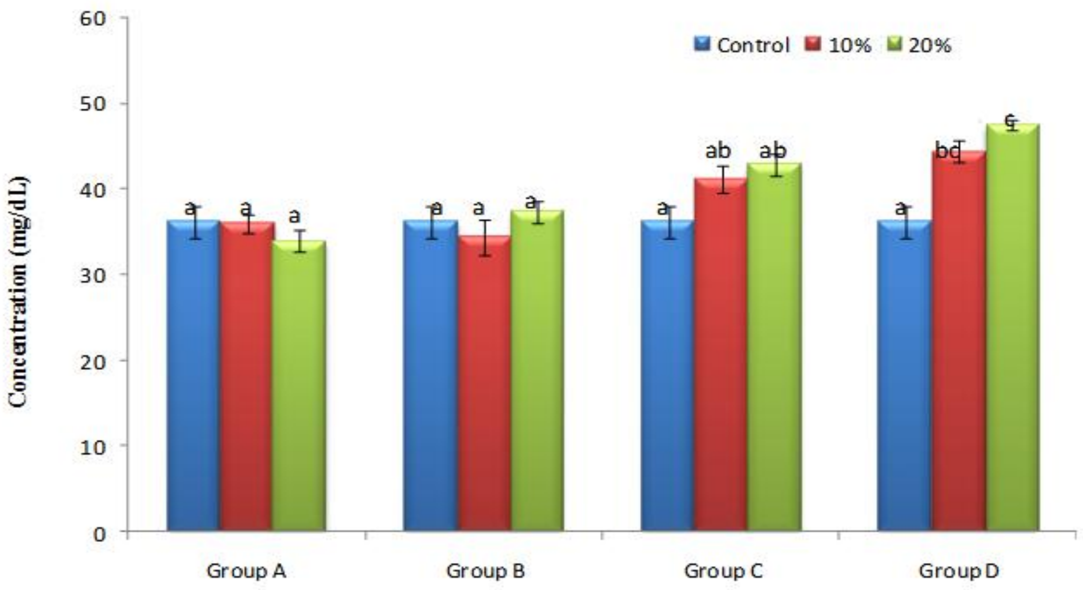

Figure 4: **Mean HDL concentration of rats placed on diets supplemented with 10% and 20% of the *S. melongena* varieties**

Each bar is the mean ± standard error of mean (SEM) of triplicate determinations. Different alphabet(s) on the bars show significant difference (p<0.05). **Group A** – Rats fed with *Solanum macrocarpon* (round) supplemented diet, **Group B** – Rats fed with *S. aetheopicum* supplemented diet, **Group C** – Rats fed with *S. macrocarpon* (oval) supplemented diet, **Group D** – Rats fed with *S. gilo* supplemented diet

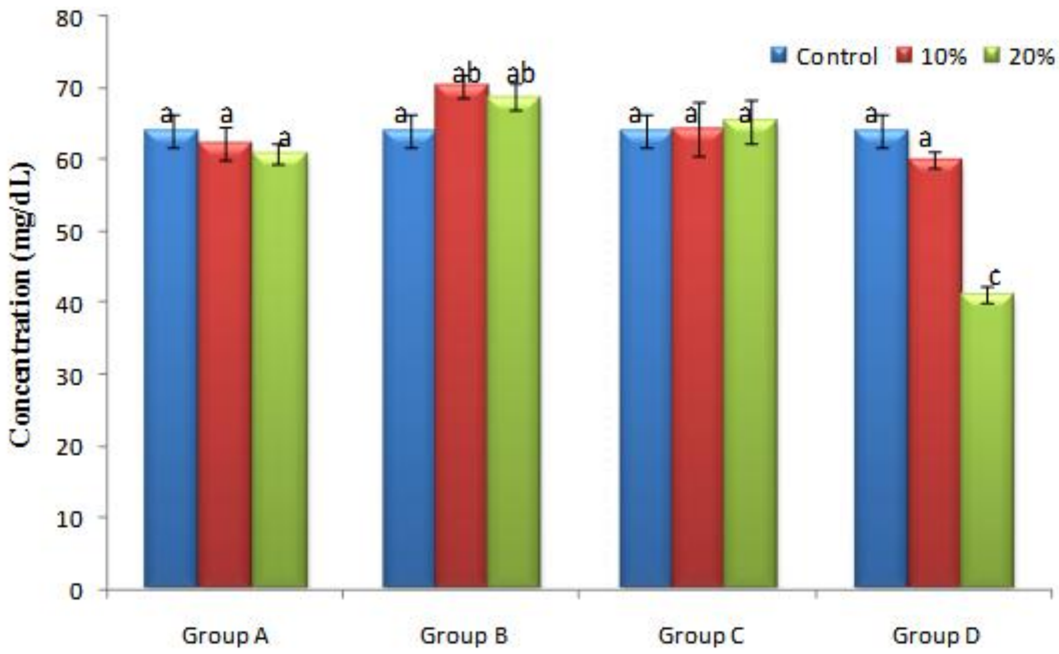

Figure 5: Mean LDL concentration in rats placed on diets supplemented with 10% and 20% of the *S. melongena* varieties

Each bar is the mean ± standard error of mean (SEM) of triplicate determinations. Different alphabet(s) on the bars show significant difference (p<0.05). **Group A** – Rats fed with *Solanum macrocarpon* (round) supplemented diet, **Group B** – Rats fed with *S. aetheopicum* supplemented diet, **Group C** – Rats fed with *S. macrocarpon* (oval) supplemented diet, **Group D** – Rats fed with *S. gilo* supplemented diet

IV. DISCUSSION

Hyperlipidemia is one among other risk factors that contribute and predisposes people to cardiovascular diseases [13]. Excessive levels of total cholesterol and low density lipoprotein cholesterol (LDL-C) promote artheriosclerosis and other heart related disorders. It is therefore important that approaches to lower these lipid concentrations are employed.

The significant decrease in the weight gain by rats in the experimental groups correlates with the findings of Bello *et al.*, [14] and Odetola *et al*., [15] who reported that the decrease in weight gain as against an increasing weight gain of the control group indicates that the *Solanum melongena* varieties are efficient in weight management. According to the observation of Edijala *et al*., [1], garden egg plant significantly reduced weight gain in rats fed on eggplant fruit compared to those that had oat and apple in both the mid-term and full-term studies. The insignificant change in feed consumption as recorded in the Table 1 above is an indication that appetite was not a factor that influenced the observed effects. The effect of eggplants on weight reduction may be due to their low energy density which may be attributed to the high moisture, fiber and low fat contents they possess [16]. This agrees with previous findings in the study of Ossamulu *et al*., [7], who reported high moisture, fiber and low fat contents for all the eggplant varieties evaluated. Howarth *et al.,* [17] also found that consuming about 14g/day of fiber for more than two days caused with a 10% decrease in energy intake and a loss of 1.9kg in humans over 3.8 months.

Saponins, although not analyzed in this study have been described as an important therapeutic compound with anti-obesity potential [18] and hypolipidemic effects [19]. In a study that evaluated the anti-obesity role of diosgenin (a steroidal saponin) from *Dioscorea nipponica* Makino, Sprague-Dawley rats fed a diet containing 40% beef tallow and 5% freeze-dried extract of the yam gained less body weight and adipose tissue than those that received only the 40% beef tallow diet [20]. Previous study on the nutrient and phytochemical constituents of four eggplant varieties showed high saponin concentration where *S. gilo* had the highest concentration, followed by *S. Marcrocarpon* (oval) [7]. This trend was observed to be in consonance with the decrease in weight gain, total cholesterol and increase in high density lipoprotein as shown in Table 1, Figures 1 and 2 respectively. It may therefore be said that saponin have both weight reducing hypolipidemic potentials on the experimental rats. Han *et al*., [21] in a study that evaluated the anti-obesity effects in rodents of dietary teasaponin as a lipase inhibitor concluded that teasaponin may prevent the high-fat diet induced increases in both body and parametrial adipose tissue weights. A possible hypolipidemic potential of *Solanum* was similarly reported in the work of Sultana *et al*., [22], who concluded that the mixture of *Solanum* and cichorium containing calf thymus DNA has both hepatoprotective and hypolipidemic potentials. The hypolipidemic potential of saponins could be elicited by inhibiting intestinal absorption of dietary fat by halting or inhibiting the activity of pancreatic lipases [23].

Other bioactive constituents present in the eggplant varieties may also possess hypolipidemic properties. It has been reported that apple polyphenols may exhibit cholesterol lowering effect [24], *caripapaya* seed which is rich in phenols have also been shown to posses hypolipidemic potentials [25]. Odetola *et al.,* [15] investigated the possible hypolipidemic potentials of ripe *Solanum melongena* and *Solanum gilo* fruits in hypercholesterolemia rabbits and reported that *Solanum* cultivars had cholesterol reducing potential and this agrees with the current findings. The cholesterol-lowering effect of polyphenols results from its ability to bind cholesterol and bile acids, and increase their removal via the faeces. This will therefore result in a decreased cholesterol micelle formation and hence the uptake of lipids from the intestine to the blood is reduced [26]. Flavonoids have been reported to elicit hypolipidemic effects. The work of Sudheesh *et al.,* [27] indicated that flavonoids extracted from the fruits of *S. melongena* showed significant hypolipidemic action in normal and cholesterol fed rats. This may be due to the fact that flavonoids (which could act as an antioxidants), could resist LDL oxidation and this could inhibit atherosclerosis [13].

High amount of dietary fibre have been reported in eggplants [7] and several other fruits and vegetables [28, 29, 30], which have hypocholestrolemic effects. Studies have shown that high levels of insulin may promote dyslipidemia (abnormal lipid concentration), hypertension, abnormal clotting factors and atheriosclerosis. Dietary fiber has been reported to reduce the body’s insulinemic response to carbohydrates [31] hence combating abnormal lipid concentration in the blood. Soluble fibers have the potentials to lower the levels of blood cholesterol by 5 to 15% in experimental animals and in human subjects [32], this is elicited through the binding of bile acids and sequestration of cholesterol. Another possible mechanism is the fermentation of soluble fibers in the colon into short chain fatty acids (propionate) [33]. The fermentation product propionate, has been shown to reduce the hepatic production of cholesterol [1] by halting or inhibiting the. However, there are reports that increased HDL appears to slow down or prevent the development of artheriosclerosis since HDL cholesterol carry cholesterol away from the blood (in the artery) back to the liver as a result lowers the cholesterol in the artery for plaque formation.

The effect of the eggplant varieties on lipid concentrations is a result of the synergy between the nutrient related parameters such as fiber, low carbohydrate and fat levels, low metabolizable energy among others and several bioactive compounds present in them. More so, the variations noticed within the cultivars could be differences in the concentration of the nutrients and bioactive compounds embedded in them. Several factors combine to determine the amounts of core nutrients and other phytochemicals in a food. These include the variety/cultivar of the plant, variations in growing and harvesting seasons [34], agronomic issues such as soil type, cultivation protocols (irrigation, pest control, use of fertiliser), the degree of maturity at harvest [35], and processing practices (harvesting, storage, method of processing).

V. CONCLUSION

The results demonstrated that eggplants have great medicinal values such that they could be very useful raw material in health/pharmaceutical industries as all the cultivars displayed hypolipidemic and weight reducing potentials. Although *Solanum gilo* and *S. macrocarpon* (oval) displayed higher hypocholesterolemic, increased HDL and reduced weight gain effects and therefore would be better employed in the management of obesity and several cardiovascular diseases.

VI. ACKNOWLEDGEMENTS

This research was financed by the management of Liberty Works ltd. Headed by Mr. Heslope N. Imedegwu. Technological expertise was available through Mallam Dauda, Mallam Sani, Mr Prince Ossai and Mallam Shuaibu of the laboratory unit, Biochemistry department, Federal University of Technology Minna, Niger State Nigeria.

REFERENCES

[1] Edijala, J.K., S.O. Asagba, G.E. Eriyamremu and U. Atomatofa. Comparative Effect of Garden Egg Fruit, Oat and Apple on Serum Lipid Profile in Rats Fed a High Cholesterol Diet. Pakistan Journal of Nutrition, 4(4), 2005, 245-249.

[2] Goldstein, J.L. Y.K. HO., S.K. Basu and M.S. Brown. Binding site macrophage that medicate uptake and degradation of acetylated low density lipoprotein, producing massive cholesterol deposit. Proceedings of National Academy of Science, 1979.

[3] Lemonick, M.I. East yourself out. In Time Magazine, July 19, 1999

[4] World Health Organization Report, [WHO]. Reducing risks, promoting health. World Health Organization Report Geneva. 2002.

[5] Food and Agriculture Organization of the United Nations and the World Health Organisation [FAO/WHO]. Diet, nutrition and the prevention of chronic diseases. Report of a Joint FAO/WHO Expert Consultation. Geneva (WHO Technical Report Series, No. 916). 2003.

[6] Olusanya, J.O. Essentials of food and Nutrition. (1st edition Apex book limited, 2008). 62-78, 125-130.

[7] Ossamulu, I.F., H.O Akanya,. A.A. Jigam and E.C. Egwim,. Nutrient and phytochemical constituents of four eggplant varieties. Elixir Food Science, 73 (2014), 2014, 26424-26428.

[8] Lawande, K.F. and J.K. Chavan. Eggplant (Brinjal). In: Salunkhe DK, Kadam SS. Handbook of Vegetable Science and Technology: Production, Composition, Storage, and Processing. (New York: Marcel Dekker, 1998) 225–244.

[9] Zhu X.H., T. Ikeda and T. Nohara. Studies on the constituents of solanaceous plants. (46). Steroidal glycosides from the fruits of Solanum anguivi. Chemical and Pharmaceutical Bulletin, 48, 2000, 568-570.

[10] Bajaj, Y.P.S. Biotechnology in Agriculture and Forestry, Plant Protoplasts and Genetic Engineering. (Vol. 29, Berlin, Springer publication, 1979).

[11] Canadian Council on the Care and Use of Laboratory Animals in Biomedical Research. Guide to the Care and Use of Experimental Animals (Vol. 2, 1984)

[12] Sokal, R.R., and F.J. Rohlf. The principles and practice of statistics in biological research. (San Francisco: Freeman and Co., 1969) 469-484.

[13] Chen, J., and Li, X. Hypolipidemic effect of flavonoids from mulberry leaves in triton WR-1339 induced hyperlipidemic mice. Asian Pacific Journal of Clinical Nutrition, 16 (1), 2007, 290-294.

[14] Bello, S.O., B.Y. Muhammad, K..S. Gammaniel., I. Abdu-Aguye, H. Ahmed, C.H. Njoku et al. Preliminary Evaluation of the Toxicity and Some Pharmacological Properties of the Aqueous Crude Extract of Solanum Melongena. Research Journal of Agriculture and Biological Sciences, 1, 2005, 1-9.

[15] Odetola, A.A., Y.O. Iranloye and O. Akinloye. Hypolipidaemic Potentials of Solanum melongena and Solanum gilo on Hypercholesterolemic Rabbits. Pakistan Journal of Nutrition, 3 (3), 2004, 180-187.

[16] Yao, M., and S.B. Roberts. Dietary energy density and weight regulation. Nutrition Reviews, 59 (8), 2001, 247-258.

[17] Howarth, N.C., E. Saltzman, and S.B. Roberts. Dietary fiber and weight regulation. Nutrition Reviews, 59, 2001, 129-139.

[18] Jayadev, R and V.R. Chinthalapally. Diosgenin, a Steroid Saponin Constituent of Yams and Fenugreek: Emerging Evidence for Applications in Medicine, Bioactive Compounds in Phytomedicine, Prof. Iraj Rasooli., 2012, 126-142.

[19] Doughari, J.S. Phytochemicals: Extraction Methods, Basic Structures and Mode of Action as Potential Chemotherapeutic Agents, Phytochemicals - A Global Perspective of Their Role in Nutrition and Health (InTech publisher, 2012) 2-15.

[20] Kwon, H.Y., E.H. Kim, S.W. Kim, S.N. Kim, J.D. Park and D.K. Rhee. Selective toxicity of ginsenoside Rg3 on multidrug resistant cells by membrane fluidity modulation. Archives of Pharmaceutical Research, 31, 2008, 171–177.

[21] Han, L.K., Y. Kimura, M. Kawashima, T. Takaku, T. Taniyama, T. Hayashi et al. Anti-obesity effects in rodents of dietary teasaponin, a lipase inhibitor. International Journal of Obesity, 25, 2001, 1459–1464.

[22] Sultana, S., S. Perwaiz, M. Iqbal and M. Athar. Crude extracts of hepatoprotective plants, Solanum nigrum and Cichorium intybus inhibit free radical-mediated DNA damage. Journal of Ethnopharmacology., 45(3) , 1995, 189-192.

[23] Han, S.W., J. Tae, J.A. Kim, D.K. Kim, G.S. Seo, K.J. Yun, et al. The aqueous extract of Solanum melongena inhibits PAR2 agonist-induced inflammation. International Journal of Obesity, 328 (2), 2003, 39–44.
[24] Osada, K., T. Suzuki, Y. Kawakami, M. Senda, A. Kasai, M. Sami, et al. Dose-dependent hypocholesterolemic actions of dietary apple polyphenol in rats fed cholesterol. Lipids, 41, 2006, 133–139.
[25] Adeneye, A.A and J.A. Olagunju. Preliminary hypoglycemic and hypolipidemic activities of the aqueous seed extract of Carica papaya Linn. in Wistar rats. Biology and Medicine, 1(1), 2009, 1-10.
[26] Nagasako-akazome, Y., T. Kanda, M. Ikeda and H. Shimasaki. Serum cholesterol-lowering effect of apple polyphenols in healthy subjects. Journal of Oleo Science, 54, 2005, 143–151.
[27] Sudheesh, S., G. Presannakumar, S. Vijayakumar and N.R. Vijayalashmi. Hypolipidemic effect of flavonoids from eggplant. Plant foods for Human Nutrition, 51, 1997, 321-330.
[28] Osilesi, O., D.L. Trout, J.O. Ogunwole and E. Glover. Blood pressure and plasma lipid during ascorbic acid. Supplementation on boarder line. Hypertensive and normotensive adults Nutrition Research, 11, 1991, 405-412.
[29] Anderson, J.W., N. Zettwoch and T. Feldman. Cholesterol lowering effects of Psyllium hydrophilic mucilloid for hypercholesterolmic men. Archives of Internal Medicine, 148, 1998, 292-296.
[30] Adebawo, O., B. Salau, E. Ezima, O. Oyefuga, E. Ajani, G. Idowu et al.,. Fruits and vegetables moderate lipid cardiovascular risk factor in hypertensive patients. Lipids in Health and Disease, 5, 2006, 14-19.
[31] Anderson, J.W., D.S. O'Neal, S. Riddell-mason, T.L. Floore, D.W. Dillon and P.R. Oettegen. Postprandial serum glucose, insulin and lipoprotein responses to high and low fiber diets. Metabolism, 44 (7), 1995, 848-854.
[32] Behall, K.M. Dietary fiber: nutritional lessons for macronutrient substitutes. Annals of New York Academy of Science, 819, 1997, 142-154.
[33] Cummings, J.H and G.T. MacFarlene. The control and consequences of bacterial fermentation in the human colon. Journal of Applied Bacteriology, 70, 1991, 443-459.
[34] Howard, G and J. Bartram. Domestic Water Quantity, Service, Level and Health. World Health Organization, Ref Type: Report, 2003.
[35] Pandjaitan, N., L.R. Howard, T. Morelock and M.I. Gil. Antioxidant capacity and phenolic content of spinach as affected by genetics and maturation. Journal of Agricultural Food Chemistry, 53(22), 2005, 8618–8623.