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Cholesterol lowering effect of *Malabar spinach* (Amunututu) on egg yolk induced hyper cholesterolaemic rabbits

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ABSTRACT

Background

Basella alba (amunututu) is a common leafy vegetable commonly prepared as soup among the Yoruba ethnic groups. It contains phytochemicals such as tannin, saponin, alkaloid, terpenoid, flavonoid, glycoside, phenolic, vitamins and minerals.

Aim and Objective

This study was designed to determine the lowering effect of ethanolic and aqueous extract *Basella alba* on Total cholesterol(CHOL-T), Low Density Lipoprotein-cholesterol(LDL-C),Total Triglycerides(TG-T), High Density Lipoprotein-cholesterol (HDL-C).

Materials and Methods

Twenty five rabbits weighing 0.7-1.3Kg classified into five experimental groups of 5 rabbits each labeled A, B, C, D(D1, D2), E(E1 and E2) were studied. Control group A were fed with normal feed and water. The extract was carried out using sterile distilled water and ethanol. Each of the extract was administered into some rabbits and was used to treat hypercholesterolemia. The normal rabbit meal was reconstituted to contain 20% egg yolk used for the induction of hypercholesterolemia in some of the rabbits. Plasma concentration of CHOL-T, LDL-C, TG-T, HDL-C was determined using CABAS C111 auto-Chemistry analyzer.

Results

The result obtained showed a significant decrease in the plasma value of CHOL-T, LDL-T, TG-T after the administration of either ethanolic or aqueous extract in hypercholesterolaemic rabbits and non-hyper cholesterolaemic rabbits($p<0.05$). A significantly higher mean plasma value of HDL-C was obtained in hyper cholesterolaemic rabbits fed with 20% egg yolk after the administration of either ethanolic or aqueous extract than in rabbits fed with normal meal with $p<0.05$.

Conclusion

The ethanolic or aqueous extracts of Malabar Spinach were found to have a lowering effect on plasma lipids.

Keywords: Total Cholesterol, Total triglycerides, LDL-C, HDL-C Malabar Spinach extract, Rabbits, Hyper cholesterolaemia, Egg Yolk.

INTRODUCTION

The phytochemical analysis of the leaves of Malabar Spinach (Amunututu in Yoruba) - *Basella alba*, revealed the presence of tannin, saponin, alkaloid, terpenoid, flavonoid, glycoside and phenolic compounds at varied composition in both aqueous and ethanol extract of the sample. Quantitatively phytochemical analysis of ethanolic extract of *Basella alba* showed alkaloid to be 3.24%, glycoside 1.34%, Saponin 2.45%, tannin 0.69%, terpenoids 0.04%, flavonoids 1.32% and phenolic compound 0.35% Typical of leaf vegetables, Malabar spinach is high in vitamin A, vitamin C, iron, and calcium. It is low in calories by volume, but high in protein per calorie. The succulent mucilage is a particularly rich source of soluble fiber [1].

Due to presence of strong antioxidants, basela is effective to protect damage of heart muscles and even arteries and nerves damage from free radicals. Basella is very low in calories and fats (100 g of raw leaves provide just 19 calories). It contains good amount of vitamins, minerals, and antioxidants. Fresh leaves are rich sources of several vital carotenoid pigment anti-oxidants such as ß-carotene, lutein, zea-xanthin. Together, these compounds help act as protective scavengers against oxygen-derived free radicals and reactive oxygen species (ROS) that play a healing role in aging and various disease processes [2].

Basella hashigh content of vitamin C. 100 g of fresh greens contains 102 mg or 102% of daily recommended levels of vitamin C. Vitamin-C is a powerful antioxidant, which helps the body develop resistance against infectious agents and scavenge harmful oxygen-free radicals [2].

Leaves of Malabar Spinach (Amunututu in Yoruba) - *Basella alba,*is an excellent source of iron. 100 g fresh leaves contain about 1.20 mg or 15% of daily intake of iron. Iron is an important trace element required by the human body for red blood cell (RBC's) production. Additionally, this element acts as a co-factor for oxidation-reduction enzyme, cytochrome-oxidase, during the cellular metabolism [2].

It also contains good amounts of many B-complex vitamins such as folate, vitamin-B6 (pyridoxine), and riboflavin. 100 g fresh leaves provide 140 µg or 35% of folates. This vitamin is one of the essential compounds for DNA production and growth. Folate deficiency in during very early stages of pregnancy might results in the neural tube defects in the newborn baby. Anticipating and pregnant women are therefore, advised to include a lot of fresh greens in their diet to help prevent neural tube defects in the offspring [3].

Further, leaves of Malabar Spinach (Amunututu in Yoruba) - *Basella alba,*are good sources of minerals like potassium (11% of RDA/100 g), manganese (32% of RDA/100 g), calcium, magnesium, and copper. Potassium is an important component of cell and body fluids that helps controlling heart rate and blood pressure. Manganese and copper are used by the body as a co-factor for the antioxidant enzyme, superoxide dismutase [4].

Potassium also plays a vital role by maintaining blood fluid level. It also helps control heart rate and blood pressure [5].

Low Density Lipoproteins (LDL) are synthesised in the liver by the action of various Lipolytic enzymes on triglyceride rich Very Low Density Lipoproteins (VLDLs). Specific LDL receptors exist to facilitate the elimination of LDL from plasma by liver parenchymal cells. It has been shown that most of the cholesterol stored in atherosclerotic plaques originates from LDL. For this reason the LDL-Cholesterol concentration is considered to be the most important clinical predictor, of all single parameters, with respect to coronary atherosclerosis [6, 7].

Risk factors for heart disease include age, family history, smoking, low HDL levels, diabetes and high blood pressure. If an individual has no other risk factors an LDL concentration of 160 – 189 mg/dl or 4.15 – 4.90 mmol/L is considered high. Accurate measurement of LDL-Cholesterol is of vital in therapies which focus on lipid reduction to prevent atherosclerosis or reduce its progress and to avoid plaque rupture. It is recommended a patient get tested when aged 40; as part of a routine CV health check; if they are already thought to be at risk of CVD for another reason; or to monitor their response to treatments which lower LDL Cholesterol [7].

High-density lipoproteins (HDL) are one of the major classes of plasma lipoproteins. They are composed of a number of heterogeneous particles, including cholesterol and vary with respect to size and content of lipid and Apolipoprotein [8]. HDL serves to remove cholesterol from the peripheral cells to the liver, where the cholesterol is converted to bile acids and excreted into the intestine. Accurate measurement of HDL-C is of vital importance when assessing patient risk from CHD [6]. Direct measurement gives improved accuracy and reproducibility when compared to precipitation methods. HDL is usually requested with other tests, either with cholesterol or as part of a lipid profile, including LDL and triglycerides. The combination of total cholesterol and HDL is very useful for screening for the risk of heart disease [8].

Cholesterol is a waxy, fat-like substance that your body needs. When you have too much cholesterol in your blood, it can build up on your artery walls. Too much cholesterol puts you at risk for heart disease and stroke, two leading causes of death in the United States. But you can take steps to manage your cholesterol levels and lower your risk [9].Total Cholesterol measures all lipoprotein sub-classes to assess a patient's overall cholesterol level [6]. High levels of cholesterol in the blood are associated with atherosclerosis and an increased risk of heart disease. As such cholesterol testing plays a vital role in preventative health care. Total Cholesterol measurement alone cannot accurately predict CVD risk; however Total Cholesterol is useful as an initial screen, with elevated levels suggesting that a full lipid profile is required [9].

Triglyceride measurements are used in the diagnosis and treatment of diseases involving lipid metabolism and various endocrine disorders e.g. diabetes mellitus, nephrosis and liver obstruction [6].High levels of triglycerides in the blood are associated with an increased risk of developing cardiovascular disease (CVD). Certain factors can contribute to high triglyceride levels, including lack of exercise, being overweight, smoking cigarettes, consuming excess alcohol, and medical conditions such as diabetes and kidney disease [6].

Triglycerides are another type of fat. They are composed of high-energy fatty acids, and provide much of the energy needed for your tissues to function. Triglycerides are comprised of three fatty acids attached to a glycerol backbone [6].

This work is therefore designed to determine the Cholesterol lowering effect of Malabar spinach (amunututu) on egg yolk induced hyper cholesterolaemic rabbits.

MATERIALS AND METHODS

Study area

Animal house of Achievers University, Owo-Nigeria equidistant between Nigeria Federal capital territory-Abuja and former Federal capital-Lagos.It has Latitude: 6.98575, Longitude: 5.27103 and Time Zone: UTC+1, Africa/Lagos.

Study population

Rabbits were bought from OjaIkokoamajor Owo market and were identified and confirmed having same sex in the Department of Biological Sciences, Achievers University, Owo-Nigeria. These include 25 rabbits of the same sex with weight ranging from 0.7-1.3Kg grouped as follows:

Group A

Five rabbits weighing 1.1 ±0.1 Kg fed with normal meal and water were studied as control group A.

Group B

Five rabbits weighing 1.1 ±0.1 Kg fed with 400mg/Kg of ethanolic extract, normal meal and water were studied experimental group B.

Group C

Five rabbits weighing 1.0 ±0.2 Kg fed with 400mg/Kg of aqueous extract, normal meal and water were studied as experimental group C.

Group D_1

Five rabbits weighing 1.0 ±0.3 Kg fed with normal meal containing 20% of powdered egg yolk of the total meal weight and water for seven days

Group D_2

Five rabbits weighing 1.0 ±0.3 Kg fed with normal meal containing 20% of powdered egg yolk of the total meal weight and water for seven days followed by the administration of with 400mg/Kg of ethanolic extract for another seven days.

Group E_1

Five rabbits weighing 1.0 ±0.2 Kg fed with normal meal containing 20% of powdered egg yolk of the total meal weight and water for seven days

Group E_2

Five rabbits weighing 1.0 ±0.2 Kg fed with normal meal containing 20% of powdered egg yolk of the total meal weight and water for seven days followed by the administration of 400mg/Kg of aqueous extract for another seven days (groupE_2).

Preparation of the *Basella alba* Extracts

Malabar Spinach (Amunututu In Yoruba) was purchased from OjaIkoko, Owo-Nigeria and was identified by the Department of Biological Sciences. The leaves of Malabar Spinach (Amunututu In Yoruba) - *Basella alba* was air dried for 14 days, Ethanolic and aqueous extraction was carried out by soaking 50g of powers of *Basella alba* into 500ml of each of ethanol and sterile distilled water for 24hours. Following the report of Das *et al.*,[10] that solvent to sample ratio of 10:1 (v/w; solvent to dry weight ratio) has been used as ideal. Each extract was filtered through Whatmann filter paper No.1 and filtrates concentrated at room temperature in order to reduce the volume. Further concentration and drying by volume extraction was carried out using rotary evaporator and stored in refrigerator prior to use. Four hundred milligramme of the extract powder was dissolved in 2ml of distilled water for administration.

Preparation of egg yolk powder

Local eggs were purchased from OjaIkoko, Owo-Nigeria and presented to the Biological sciences department of Achievers University, Owo-Nigeria for identification. The shell of the egg was removed and the egg yolk was extracted. The egg yolk was air dried and grinded into powder.

Preparation of 20% egg yolk powder of normal rabbit meal

The normal meal was weighed. 20% of the weight was removed using weighing balance the 20% was replaced by egg yolk powder and this was used to induce hypercholesterolemia observed in D_1 and E_1.

Blood specimen

Blood samples were collected from the veins lining the ear of the rabbits after each treatment into lithium heparinized bottles for the estimation of Total cholesterol, LDL cholesterol and Total triglycerides.

Determination of Biochemical Parameters

Plasma concentration of Total cholesterol, Low Density Lipoprotein-cholesterol (LDL_{CL}), Total Triglycerides, High Density Lipoprotein-cholesterol (HDL_{CL}) was determined by CABAS C111 auto-Chemistry analyzer using Roche reagent.

Method of Data analysis

The results obtained was subjected to statistical analysis using SPSS 20.0

RESULTS

The results obtained showed no significant difference in the plasma mean values of total cholesterol when control group A was compared with group D2 fed with normal meal containing 20% egg yolk followed by the administration of 400mg/Kg of ethanolic extract of Malabar Spinach , E2 fed with meal containing 20% egg yolk followed by the administration of 400mg/Kg of aqueous extract and also when group B administered with ethanolic extract of Malabar Spinach was compared with Group C administered with aqueous extract of Malabar Spinach and in the values obtained from D2fed with meal containing 20% egg yolk followed by the administration of 400mg/Kg of ethanolic extract compared with E2 fed with meal containing 20% egg yolk followed by the administration of 400mg/Kg of aqueous extract with $p>0.05$(tables 1 &2).

A significantly higher difference was obtained in the plasma value of cholesterol in: control group A than group C administered with aqueous extract of Malabar Spinach; groupD2fed with meal containing 20% egg yolk followed by the administration of 400mg/Kg of ethanolic extract than group B administered with ethanolic extract of Malabar Spinach; , groupE2 fed with meal containing 20% egg yolk followed by the administration of 400mg/Kg of aqueous extract than group B administered with ethanolic extract of Malabar Spinach; group D2 fed with meal containing 20% egg yolk followed by the administration of with 400mg/Kg of ethanolic extract than group C administered with aqueous extract of Malabar Spinach and group E2fed with meal containing 20% egg yolk followed by the administration of with 400mg/Kg of aqueous extract than group administered with aqueous extract of Malabar Spinach with $p<0.05$ (tables 1 &2).

There was no significant difference in the mean plasma value of LDL-C in group group A compared with groups B administered with ethanolic extract of Malabar Spinach, C administered with aqueous extract of Malabar Spinach ,D2 fed with meal containing 20% egg yolk followed by the administration of 400mg/Kg of ethanolic extract and E2fed with meal containing 20% egg yolk followed by the administration of 400mg/Kg of aqueous extract and when values of the parameter in group B administered with ethanolic extract of Malabar Spinach was compared with group and in D2fed with meal containing 20% egg yolk followed by the administration of with 400mg/Kg of ethanolic extract compared with C and E2fed with meal containing 20% egg yolk followed by the administration of 400mg/Kg of aqueous extract with $p>0.05$ (tables 1 &2).

There was no significant difference in the mean plasma value of LDL-C in group E2 fed with meal containing 20% egg yolk followed by the administration of 400mg/Kg of aqueous extract than the result obtained in groups B administered with ethanolic extract of Malabar Spinach and C administered with aqueous extract of Malabar Spinach ($p>0.05$; tables 1 &2).

The plasma concentration of total triglyceride obtained in group D2 fed with meal containing 20% egg yolk followed by the administration of 400mg/Kg of ethanolic extract was significantly higher than in group A, the value was also significantly higher in E2 fed with meal containing 20% egg yolk followed by the administration of 400mg/Kg of aqueous extract than control group A, D2 fed with meal containing 20% egg yolk followed by the administration of 400mg/Kg of ethanolic extract than B administered with ethanolic extract of Malabar Spinach, E2 fed with meal containing 20% egg yolk followed by the administration of with 400mg/Kg of aqueous extract than B administered with ethanolic extract of Malabar Spinach, D2 fed with meal containing 20% egg yolk followed by the administration of 400mg/Kg of ethanolic extract and E2fed with meal containing 20% egg yolk followed by the administration of with 400mg/Kg of aqueous extract than C with $p<0.05$(tables 1&2). However there was no significant difference in the mean plasma value of the parameter in group A compared to groups B administered with ethanolic extract of Malabar Spinach and C administered with aqueous extract of Malabar Spinach , B administered with ethanolic extract of Malabar Spinach compared with group C administered with aqueous extract of Malabar Spinach and D2 fed with meal containing 20% egg yolk followed by the administration of 400mg/Kg of ethanolic extract compared with E2 fed with meal containing 20% egg yolk followed by the administration of with 400mg/Kg of aqueous extract with $p>0.05$(tables 1 &2).

There was no significant difference in the mean plasma value of HDL_{CL} in the result obtained from group A compared with groups B administered with ethanolic extract of Malabar Spinach, C administered with aqueous extract of Malabar Spinach, D2fed with meal containing 20% egg yolk followed by the administration of 400mg/Kg of ethanolic extract, E2 fed with meal containing 20% egg yolk followed by the administration of with 400mg/Kg of aqueous extract, also in B administered with ethanolic extract of Malabar Spinach compared with group C administered with aqueous extract of Malabar Spinach with $p>0.05$(tables 1& 2).

However, a significantly higher mean plasma value of HDL-C was obtained in rabbitsfed with meal containing 20% egg yolk followed by the administration of 400mg/Kg of either ethanolic or aqueous extract than in rabbits administered with either ethanolic or aqueous extract of Malabar Spinach with $p<0.05$(tables 1&2).

Significantly higher plasma value of Total cholesterol in control rabbits than rabbits fed with normal diet and aqueous extract but lower than rabbits fed with meal containing 20% egg yolk followed by the administration of 400mg/Kg of aqueous extract of Malabar Spinach. Significantly higher plasma value of Total Triglycerides in rabbits fed with meal containing 20% egg yolk followed by the administration of 400mg/Kg of aqueous extract of Malabar Spinach compared with control rabbits($p<0.05$).

There was a significantly higher mean plasma total cholesterol, LDL-C and HDL-C in the results obtained in group D1 fed with normal meal containing 20% of powdered egg yolk than groupD2 fed with meal containing 20% egg yolk followed by the administration of 400mg/Kg of ethanolic extract and in mean plasma total cholesterol, Total triglycerides and HDL-C obtained in E1fed with normal meal containing 20% of powdered egg yolk of the total meal for aqueous extract than E2 fed with meal containing 20% egg yolk followed by the administration of 400mg/Kg of aqueous extract with p<0.05(tables 1&3) . A significantly higher mean value of HDL-C was obtained in group D1 compared with group E1(p<0.05). No significant difference was obtained in the plasma value of HDL-C in group D2 compared with groups D1 and E2 and in E1 compared with E2(p>0.05).Furthermore, no significant difference was obtained in the results obtained in the plasma value of plasma total cholesterol, Total triglycerides and LDL-C from group D2 fed with meal containing 20% egg yolk followed by the administration of with 400mg/Kg of ethanolic extract and D1 fed with normal meal containing 20% of powdered egg yolk compared with E2 fed with meal containing 20% egg yolk followed by the administration of 400mg/Kg of aqueous extract and E1 fed with normal meal containing 20% of powdered egg yolk of the total meal for aqueous extract respectively with p>0.05(tables 1&3).

Table 1: The mean and standard deviation values of Plasma concentration of Total cholesterol, Low Density Lipoprotein-cholesterol (LDL-C), Total Triglycerides, High Density Lipoprotein-cholesterol (HDL-C)

	Group A	Group B	Group C	Group D_1	Group D_2	Group E_1	Group E_2
Total Cholesterol(mg/dl)	70.40±4.6	65.10±2.0	67.0±2.3	107.0±2.0	78.0±3.0	105.1±2.4	95.1±2.3
LDL cholesterol(mg/dl)	24.6±2.5	18.2±2.0	20.0±1.0	38.0±3.1	14.1±3.0	26.2±3.1	23.1±1.5
Total Triglycerides(mg/dl)	36.0±2.0	33.7±3.0	35.0 ±2.3	61.0±2.1	53.2±2.1	63.2±1.5	51.0±2.5
HDL cholesterol(mg/dl)	28.0±4.4	29.1±1.5	29.5±1.2	39.1±2.0	38.1±2.1	48.1±2.0	47.2±2.0

Table 2: Comparative analysis of the values of the Plasma concentration of Total cholesterol, Low Density Lipoprotein-cholesterol (LDL-C), Total Triglycerides, High Density Lipoprotein-cholesterol (HDL-C) across the experimental groups and control

		GROUP A vs. GROUPB	**GROUP A vs. GROUPC**	**GROUP A vs. GROUPD_2**	**GROUP A vs. GROUPE_2**	**GROUP B vs. GROUPC**	**GROUP B vs. GROUPD_2**	**GROUP B vs. GROUPE_2**	**GROUP C vs. GROUPD_2**	**GROUP C vs. GROUP E_2**	**GROUP D2 vs. GROUP E_2**
Total Cholesterol(mg/dl)	**"t"** **"p"**	0.93 0.23 p >0.05*	t- 3.58 0.04 p < 0.05**	-1.37 0.15 p >0.05*	-2.79 0 .054 p >0.05*	-0.45 0.35 p >0.05*	-3.61 0.04 p < 0.05**	-7.07.. 0.01 p < 0.05**	-3.05 0.05 p < 0.05**	-6.36. 0.01 p < 0.05**	-1.94. 0.10 p>0.05*
LDL cholesterol(mg/dl)	**"t"** **"p"**	2.12. 0.084 p >0.05	2.18 0.08. p >0.05*	-1.18 0.06 p >0.05*	0.35 0.38. p >0.05*	-0.73 0.27 p >0.05*	1.11 0..19 p >0.05*	-2.23 0.08. p >0.05*	1.81.. 0.11 p >0.05*	-1.70 0.12. p > 0.05*	-2.50 0.07. p>0.05*
Total Triglycerides(mg/dl)	**"t"** **"p"**	0.78. 0.26. p >0.05*	0.35 0.38 p >0.05*	-6.01 0.011 p < 0.05**	-4.16 0.03 p < 0.05**	-0.47 0.35 p >0.05*	-6.10 0.01 p < 0.05**	-4.48 0.02 p < 0.05**	-6.36 0.01 p < 0.05**	-4.44 0.02 p < 0.05**	0.56 0.32 p >0.05*
HDL cholesterol(mg/dl)	**"t"** **"p"**	-0.19 0.44 p >0.05*	-0.39 0.37 p >0.05*	-2.61 0.06 p >0.05*	-4.83736 0.020. p <0.05**	-0.45 0.35 p >0.05*	-3.18 0.04 p <0.05**	-6.36 0.01 p <0.05**	-4.12. 0.03 p <0.05**	-8.49 0.01 p < 0.05**	-3.18 0.04. p <0.05*.*

Table 3: Comparative analysis of the values of the Plasma concentration of Total cholesterol, Low Density Lipoprotein-cholesterol (LDL-C), Total Triglycerides, High Density Lipoprotein-cholesterol (HDL-C) after cholesterolaemia induction and administration of aqueos and ethanolic extract.

		D_1 Vs.D_2	E_1 Vs. E_2	D_2 Vs, E_2	D_1Vs E_1
Total Cholesterol(mg/dl)	**"t"**	8.04	7.42	-1.94	0.35
	"p"	.008	0.009	0.10	0.38
	Comment	$p < .05$**	$p < .05$**	$p > .05$*	$p > .05$*
LDL cholesterol(mg/dl)	"t"	5.66	0.83	-2.50	2.83
	"p"	0.02	0.25	0.07	0.053
	Comment	$p < .05$**	$p >.05$*	$p >.05$*	$p >.05$*
	"t"	1.43	3.32	0.56	-0.71
Total Triglycerides(mg/dl)	"p"	0 .15	0.04	0.32	0.28
	Comment	$p > .05$*	$< .05$**	$p > .05$*	$p > .05$*
HDL cholesterol(mg/dl)	"t"	0.35	0.35	-1.86	-3.18.
	"p"	0.38	0.38	0.10	0.04
		$p < .05$*	$p >.05$*	$p > .05$*	$p <.05$**

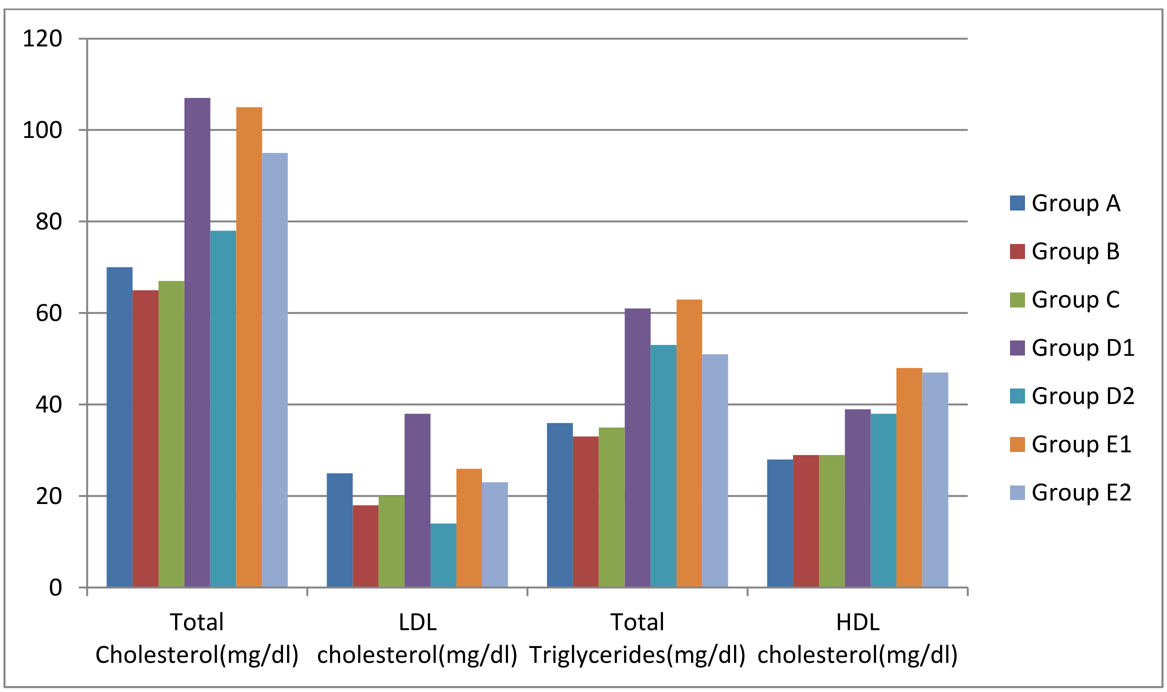

Figure 1: Column Chart of the mean ± SD values of Plasma concentration of Total cholesterol, Low Density Lipoprotein-cholesterol (LDL-C), Total Triglycerides, High Density Lipoprotein-cholesterol (HDL-C) obtained in experimental groups and control**.**

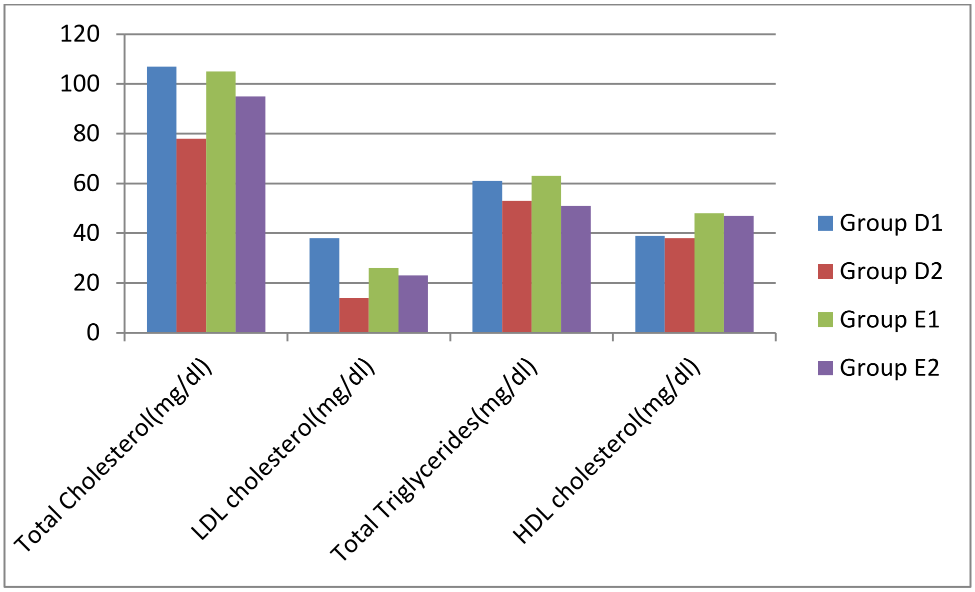

Figure 2: Column Chart showing comparative mean ± SD values of lipids following hyper cholestrolaemia inducement and treatment with the administration of with 400mg/Kg of ethanolic and aqueous extract

DISCUSSION

The result obtained showed a significant decrease in the plasma value of Total cholesterol after the administration of 400mg/Kg of either ethanolic or aqueous extract of Malabar Spinach in rabbits fed with meal containing 20% egg yolk and those fed with normal rabbit meal. These findings could be attributed to the fact that the extract contains Saponins and fiber (roughage). The nutritional significance of Saponins for humans stems largely from their hypo cholesterolemic action, which has been extensively studied in laboratory animals. Saponins bind with cholesterol. Cholesterol is continually secreted into the intestine via the bile, with much of it subsequently reabsorbed. Saponins cause a depletion of body cholesterol by preventing its re-absorption, thus increasing its excretion in much the same way as other cholesterol-lowering drugs do. Its thick, fleshy leaves are a good source of non-starch polysaccharide, mucilage. In addition to regular fiber (roughage) that found in the stem and leaves of Malabar Spinach, mucilage facilitates in smooth digestion, bring reduction in cholesterol absorption, and help prevent bowel movement problems [11].Furthermore, Saponins bind with bile salt and cholesterol in the intestinal tract. Bile salts form small micelles with cholesterol facilitating its absorption. Saponins cause a reduction of blood cholesterol by preventing its re-absorption [11].

The result obtained showed a significant decrease in the plasma value of total triglycerides after the administration of 400mg/Kg of either aqueous extract of Malabar Spinach in rabbits fed with meal containing 20% egg yolk and those fed with normal rabbit meal. The result obtained also showed a significant decrease in the plasma value of LDL-C after the administration of 400mg/Kg of either ethanolic extract of Malabar Spinach in rabbits fed with meal containing 20% egg yolk. A significantly higher mean plasma value of HDL-C was obtained in rabbits fed with meal containing 20% egg yolk followed by the administration of 400mg/Kg of either ethanolic or aqueous extract than rabbits administered with either ethanolic or aqueous extract of Malabar Spinach.

The lipid lowering activities of Malabar Spinach on total cholesterol, triglycerides, LDL-C in hyper cholesterolaemic rabbits and elevated HDL-C in non-hyper cholesterolaemic rabbits could be associated with the phytochemical constituents in Malabar Spinach (amunututu) such as β- carotenes, tannins, saponin & polyphenols. This is because the lipid lowering activity of Malabar Spinach extract may be attributed to the phyto constituents present, such as β- carotenes, tannins, saponin & polyphenols ingredient present in it as reported for other plant extracts. Saponin derived from *Medicago sativa* were reported to reduce blood cholesterol by competing with cholesterol at binding sites or interfering with cholesterol biosynthesis in the liver. Phenolic active principles present in Anethumgraveolens were observed to be responsible for lowering TC and LDL-C and elevating HDL-C in hyper cholesterolaemic rats [11, 12, 13, 14]. This fact could also be generally associated with the findings of this work.

In addition, a review published in 2012 found insufficient consensus for the hypothesis that the specific intake of food and drink containing flavonoids may play a meaningful role in reducing the risk of cardiovascular disease which could also be attributed to the findings of this work, owing to the flavonoids phytochemical constituent of Malabar spinach [15].

Lipid lowering activities of the the Malanbarspinanch extract found in this work is consistent with the report of Adisakwattana and Chanathong,[16] that *Moringaoleifera* leaf extract containing phenolic, flavonoid, and condensed tannin was found to have a lipid lowering activities and prevention of hyperlipidaemia.

Findings of this work are in consistent with the report of Slavin and Lloyd [17] that fruits and vegetables supply dietary fiber, and fiber intake is linked to lower incidence of cardiovascular disease and obesity. Fruits and vegetables also supply vitamins and minerals to the diet and are sources of phytochemicals that function as antioxidants, phytoestrogens, and antiinflammatory agents and through other protective mechanisms. In addition foods rich in antioxidants and fiber as Malabar spinach are essential for optimum heart health [1].

CONCLUSION

It has been found that the ethanolic or aqueous extract of Malabar Spinach have a possible lowering effect on plasma value of Total cholesterol, Low Density Lipoprotein-cholesterol (LDL_{CL}), and Total Triglycerides in rabbits fed with meal containing 20% egg yolk and those fed with normal rabbit meal thereby revealing possible health benefit of Malabar Spinach (Amunututu in Yoruba) - *Basella alba* in the treatment and prevention of cardio vascular diseases among many other possibilities.

Recommendation

The ethanolic or aqueous extract of Malabar Spinach (Amunututu in Yoruba) - *Basella alba* is therefore recommended as a possible and alternative antidote for hyper cholesterolaemia

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