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**TITLE:**
Regular Consumption of Aqueous Extract of Raphia Hookeri Fruit on Plasma Lipid Profile of Male Wistar Rats

**AUTHOR NAMES:**
**1) *Egbono, F. F * (Corresponding author)**
**2) Obomanu-Tamunotonjo, R**
**3) Ogbonna, U. N**
**4) Nwiko, K .M**

**AFFILIATIONS OF AUTHORS:**
**1) *Egbono, F. F** (corresponding author)
Lecturer, Department of Human Physiology, Faculty of Basic Medical Sciences, College of Health Sciences, University of Port Harcourt, Choba, Nigeria.
Email Address: frank.egbono@uniport.edu.ng, 08059211504.

**2) Obomanu-Tamunotonjo, R**
Lecturer, Department of Medical Biochemistry, Faculty of Basic Medical Sciences, College of Health Sciences, University of Port Harcourt, Choba, Nigeria.
Email Address: ruth.omimi-inabuaye@uniport.edu.ng, 07063673827.

**3) Ogbonna, U. N**
Lecturer, Department of Medical Biochemistry, Faculty of Basic Medical Sciences, College of Health Sciences, University of Port Harcourt, Choba, Nigeria.
Email Address: ugorji.ogbonna@uniport.edu.ng, 08066452598.

**4) Nwiko, K .M**
Department of Human Physiology, Faculty of Basic Medical Sciences, College of Health Sciences, University of Port Harcourt, Choba, P.M.B 532,Port Harcourt, Nigeria. Email Address: martins.nwiko@uniport.edu.ng, Tel No.: 0806336802.



## ABSTRACT

This research is aimed at the evaluating of the effects of regular consumption of aqueous extract Raphia Hookeri fruit pulp (mesocarp) on lipid profile in male wistar rats. A total of 36 apparently healthy male wistar rats weighing 130g to 190g were grouped into 4, group1 as control fed with feed and water while group 2 given 500mg/kg, group3 given 1000mg/kg, group 4 given 2000mg/kg body weight of the extract for 28days. The animals sacrificed and serum samples analysed for lipid profile via randox analysis. The statistical tool SPSS version 21.0 was used, one-way ANOVA followed by Post-Hoc multiple comparison test and $p< 0.05$ considered significant, values expressed as mean, standard error of mean (SEM). The outcome displayed an increased total cholesterol (TC) levels in groups 2, 3 and 4, but only group 3 was actually significant when compared to control. Triglyceride (TG) levels decreased across all treated groups, but groups 2 and 4 were significant when compared to control. High density lipoprotein cholesterol (HDL-C) indicated a dose-dependent significant decrease when compared to control. The variations in the levels of low density lipoprotein cholesterol (LDL-

C) in groups 2, 3 4 showed remarkable decrease in all treated rats when compared to control. Very low density lipoprotein (VLDL) cholesterol levels in all the groups 2, 3, 4 did not vary significantly. It can therefore be concluded that aqueous extract of Raphia Hookeri fruit pulp when consumed regularly is capable to ameliorate effect hyperlipidaemias and normalise plasma lipid profile in male wistar rats.

## INTRODUCTION

Humans are faced with multifaceted health challenges over the ages and this has motivated and increased the curiosity of medical professionals and even the natives/ herbalists in world to look for solution/remedy via natural plants consumption, Raphia Hookeri plants is one of such plants whose fruit mesocarp commonly called Ogbusi when processed for consumption by the people Abua/Odual LGA, Rivers state, Niger Delta Region, southern Nigeria is hypothesized to have ameliorative effect on hyperlipidaemia, boost immunity, inhibit plasma glucose, reduce blood pressure and boost haematopoiesis, etc. The Raphia hookeri plant belongs to the family of Raphia palm trees and are found in abundance in the south-eastern southern part of Nigeria, especially in the southern part, Rivers state, Abua/Odual LGA, Emoh Community. The fruit whose pulp is considered edible in some parts of Nigeria like Rivers state, Abua/Odual LGA, Emoh Community and not edible in other parts which made its consumption rate low or none in such parts. The boiled fruit pulp is commonly called 'Ogbusi' by the Abua people and mostly eaten with tapioca (processed cassava) commonly known as 'Ataka' by the Abua people of Rivers state in Nigeria. Raphia Hookeri fruit pulp is a good source of phytochemicals and some micronutrients and is locally consumed as a snack (Tatianan et al, 2023). Its fruit is large, cone-shaped with a single hard nut having an outer layer of overlapping reddish brown scales and in-between the outer layer of scales and the hard seed is a yellow, mealy, oil-bearing mesocarp or pulp (Mbaka et al., 2012). Similarly, Ndon (2003) described raphia hookeri fruit as large, cone-shaped with a hard nut having an outer layer of rhomboid-triangular and overlapping reddish-brown scales. Between the outer layer and the seed, is a yellow, oil-bearing mesocarp or pulp (Ndon, 2003). The pulp extract of Raphia hookeri was shown to contain vitamins C and E, carotenes, niacin, alkaloid, saponins, flavonoids and phenols which explains its antioxidant activity (Edem et al., 1984; Akpan and Usoh, 2004; Dada et al., 2017). Flavonoids and tannins as phenolic compounds in plants are a major group of compounds that act as primary antioxidants by scavenging free radicals (Polterait, 1997).

The pulp has been reported to contain useful and therapeutic nutrients and chemicals. It is hard and often boiled before consumption. The oil processed from this plant is used for cooking and making margarine while the pulp is usually consumed with boiled cassava Mbaka, et al, 2012. Given its hard and relatively dry nature attributed to its high fiber content, it could be conveniently processed into flour, as an alternative form for consumption or added to pastries that are less diversified in nutrients. The pulp is known by locals as an appetizer and aphrodisiac (Mphoweh et at, 2009). Many uses it for medicinal purposes and it has been reported to contain phytochemicals with antimicrobial properties (Ogbuagu, 2008). The investigation carried out by Ogbuagu, 2008 showed that the pulp has higher concentrations of vitamin E (1.04 mg·100 g–1), niacin (0.2 mg·100 g–1), alkaloid (5 g·kg–1), saponins (3.6 g·kg–1), flavonoids (4 g·kg–1) and phenols (4.1 g·kg–1) than the seed, but the seed has higher values of vitamin A (0.16 mg·100g–1), thiamine (0.07 mg·100 g–1), riboflavin (0.07 mg·100 g–1), nitrates (3.05 mg·100 g–1) and nitrites (0.29 mg·100 g–1), and of the toxic elements: lead (0.03 µg·g–1), mercury (0.04 µg·g–1), arsenic (0.23 µg·g–1) and cadmium (0.04 µg·g–1) than the pulp and the pulp and seed of *R. hookeri* are non-toxic and can serve as food as well as in medicine.

Investigations carried out by Edem et al, 1984 to determine the chemical composition of the fruit of the raffia palm (*Raphia hookeri:* Family, Palmaceae or Palmae) and the peel and pulp (edible portion) were analysed. The effect of boiling on the chemical composition of the pulp was also investigated, it revealed that the peel contained more moisture (62·4%) than the pulp

(38·0%) in terms of wet weight. Again, the protein and ether extract contents of the peel were found to be 3·2% and 1·8% of dry material, respectively. The ash content was 5·5%. Crude fibre gave a very high value of 70·3% for the peel, but the carbohydrate content was low (19·3%). There were decreases in the values of some nutrients after boiling the edible pulp of the fruit. Protein content decreased from 6·1% to 4·4% upon boiling. Ether extract and carbohydrate contents decreased from 11·8% to 11·3% and from 61·4% to 58·8%, respectively. Boiling increased the crude fibre and ash contents of the pulp from 17·7% and 3·0% to 21·2% and 4·3%, respectively. The calorific value decreased from 380·5 kcals to 354·7 kcals. Also revealed that tannin content was highest of all the toxic substances evaluated, there was a decrease from 597 to 360mg100g on boiling. The peel contained 234mg100g tannins and 24·3mg100g hydrocyanic acid. Boiling the pulp resulted in reduction of the HCN from 12·4 to 9·2mg100g, phytic acid from 1·0 to 0·4mg100g, and oxalate from 26·4 to 17·6mg100g. The peel had more oxalate (39·6mg100g) and cyanide (24·3mg100g) but less phytic acid (0·6mg100g) than the pulp (Edem et al, 1984). Also, ascorbic acid and carotene contents decreased upon cooking the pulp from 63·0mg100g and 33·4 μg100g to 28·3mg100g and 10·6 μg100g, respectively. The peel had an ascorbic acid content of 37·2mg100g and carotene content of 8·6 μg100g, Also Calcium, potassium, sodium and phosphorus decreased with cooking, while magnesium, zinc and iron contents were increased. Potassium had the highest level followed by calcium. The pulp had (mg/100 g): K, 1075; Ca, 875; Mg, 315; Zn, 9·6; P, 76·8; and Na, 16. The peel had (mg/100 g): Ca, 250; Mg, 450; K, 700; Na, 8; Zn, 3·5; and P, 37·7. Copper, chromium and cobalt were not detected in the fruit (Edem et al, 1984). Due to little or no scientific report/finding about the medicinal benefits of consuming fruits of this plant and the high rate of consumption of this fruit by people of Emoh community and Abua/Odual LGA of Rivers State, Niger Delta region, southern Nigeria prompted the lead researcher who is from Emoh community to carry out this research work to ascertain among other aspects the effect of this on lipid profile after intermittent consumption of raphia hookeri fruit pulp aqueous extract for twenty eight days.



## MATERIALS AND METHODS

### Materials

The following materials were used for the study

1. Animal cages
2. feeding and drinking plates
3. brooms and parkers
4. disinfectants
5. animal feed
6. laboratory coats
7. hand sanitizers
8. face mask
9. masking tape
10. weighing balance
11. baskets
12. hand gloves
13. water
14. Hand towel
15. Syringe
16. Dry saw dust

**Animal Preparation**

A total of thirty six (36) apparently healthy male wistar rats of weights ranging between 130g and 190g were used for this study. These rats were all housed in the preclinical animal house in the Faculty of Basic Medical Sciences, University of Port Harcourt, Nigeria. The animals were maintained in a well-ventilated animal house under optimum condition of humidity, temperature and natural light-dark cycle were allowed free access to food and water. The experimental protocols and procedures used conform to the international guidelines of the care and use of animals in research and teaching. (American Physiological Society, 2002).

**Acclimatization of the Animal**

The animals were purchased from the animal house in the University of Port Harcourt rivers state having acclimatized to the environment

**Collection and Preparation of plant materials**

**Collection of Extracts**

Raphia Hookeri Fruit was gotten from Emoh community, Okpeden (ward 8) in Abua/ Odual Local Government Area, Rivers state, Niger Delta region, southern part of Nigeria.

**Preparation of Raphia Hookeri Fruit Extract**

**Extraction type**

The extraction type used is aqueous extraction

**Extraction Method**

Maceration method was used, the fruits were air- dried in other not to kill the active ingredients, then it was finally crushed and soaked in a maceration jar about 1000gram of the extract was dissolved in 2000ml of water and allowed to stand for 72 hours with a continuous agitation to enable a good yield after which, it was filtered and the filtrate was mounted on a water bath to evaporate the liquid content at temperature of 65 degrees Celsius after evaporation,the weight of the extract was taken and it was stored for use.

**Image 1: Ripe Boiled Raphia Hookeri fruit pulp (Ogbusi as commonly called by Abua people) by Egbono, Frank .F, 2022.**

**Administration of the Extract**
The Raphia Hookeri fruit extract was orally administered via a syringe to the rats for 28 days
**Study Design**

A total of thirty six (36) healthy male wistar rats weighing 137-183 g were used for this study. The animals were divided into two major groups

**Control group and Test group**

The Test groups were further divided into 3 groups, each of the 3 groups contained nine animals in each cage compartment.

**Lipid profile Parameters Tested**

After the study design of the male wistar rats the rats were dissected and weighed and the blood was extracted. The lipid profile parameters that were measured and studied includes:

1. High density lipo protein concentration HDL
2. Low density lipo protein concentration LDL
3. Total blood cholesterol
4. Triglyceride
5 very low density lipo protein

**Mode of Administration of extract**

In the course of oral administration of extract to the animals the following doses were administered for each group except the control group for 28 days the Lethal dose of the aqueous extract of Raphia Hookeri fruit was 5000mg/kg body weight therefore the male wistar rats were not given extract beyond 2000mg/kg body weight

**Group 1(Control):** Were given animal feed and water
**Group 2:** Were given 500mg/kg body weight of the extract
**Group 3:** Were given 1000mg/kg body weight of the extract.
**Group 4:** Were given 2000mg/kg body weight of extract

**Dissection of Specimen**

After the rats were fed for 28 days, they were all dissected and the blood sample was collected for analysis.



**ANALYSIS OF SAMPLE-LIPID PROFILE ESTIMATION**

**Estimation of Serum Cholesterol**

Serum cholesterol was estimated or assayed via enzymatic calorimetric method

**Principle of the Method**

The Cholesterol Is Determined after enzymatic hydrolysis and oxidation the indicator quinoneimine was formed from hydrogen peroxide and 4-aminoantipyrine in the presence of phenol and peroxidase [Trinder and Ann 1996]

Cholesterol ester + water =cholesterol +fatty acids

Cholesterol + oxygen =cholesterol-3-one+hydrogen peroxide

Hydrogenperoxide+phenol+4-aminoAntipyrineperoxidase=Quinonemine+4Hydrogen peroxide

| **REAGENT COMPOSITION CONTENTS [R1 Reagent** | **CONCENTERATION IN THE TEST** |
|---|---|
| Pipes buffer | 80mmol/,PH 6.8 |
| 4amino nantipyrine | 0.25mmol/l |
| Phenol | 6mmol/l |
| Peroxides [E.C,1,11,7,Horse | 0.5U/ml |
| Radish+25C | 0.15U/ml |

| | |
|---|---|
| Cholesterol esterase E,C,3,1,1,1,13, Pseudomanas, | 37C |
| Cholesteroloxidase E,C,1,1,3,6,Nocardia,37C | 0.10U/ml |

**Procedure**

Reagent blank test tube standard test-tube and each sample test tube were arranged in a test tube rack of 10Ul of distilled water and 1000Ul of Reagent was dispensed into standard test tube and 10Ul of each plasma sample and 1000Ul of reagent were dispensed into each of the sample test tube using automated pipette. the reagent blank, standard and sample test tube were mixed and incubated at 37C for 5 minutes the absorbant of each sample the standard and the reagent blank were measured using the VIS spectrophotometer [S23A] at a wavelength of 500nm using a cuvette of 1cm light path

| Type | Reagent | blank standard | sample | |
|---|---|---|---|---|
| Distilled water | 10 | | ---------- | ---------- |
| Standard | ---------- | 10 | ---------- | |
| Sample | ---------- | ---------- | 10 | |
| Reagent | 1000 | 1000 | 1000 | |

Calculation

Concentration of cholesterol in sample [mmol/l] =absorbance of Test X Concentration of standard [mmol/l]

Standard concentration of cholesterol in mmol/l=5.44mmol/l



**ESTIMATION OF TRIGLYCERIDE METHOD**

**Principle**

The triglyceride was determined enzymatic hydrolysis with lipases the indicator quinoneimine formed from hydrogen peroxide, 4-amino phenazone and 4 chloro phenol under characteristics influence of peroxidase [kodischeck, et al, 1996]

Triglycerides + water =glycerol +fatty acids

Glycerol +ATP=Glycerol-3-P+ADP

Glycerol-3-p+G-3-P-Oxidase = dihydroxy acetone +p+hydrogen peroxide 2moles of hydrogen peroxide +4chloro phenol=peroxidase+quinoneimine+4moles of hydrogen peroxide

**REAGENT COMPOSITION**

| | **Contents in the test tube** | **Concentrations** |
|---|---|---|
| 1. | Ria, Buffer | |
| 2. | Pipes Buffer 7.6 | 40mmol/l,PH |
| 3. | 4chloro-phenol | 5.5mmol/l |
| 4. | magnesium ions | 17.5mmol/l |
| 5. | Rib, Enzyme Reagent 4 Amino phenazone | 0.5mmol/l |
| 6. | ATP | 1.0mmol/l |
| 7. | Lipases | 150U/ml |
| 8. | Glycerol-kinase | 0.4U/ml |
| 9. | Glycerol-kinase | 1.5U/ml |
| 10. | Glycerol-3-phosphate oxidase | 0.5U/ml |

11. Peroxidase
12. CAL.Standard

**Procedure**
Triglyceride was estimated when 1000Ul of reagent were pipette into a reagent blank test tube 10Ul of standard and 100Ul of reagent RI was also pipette into the standard test tube and 10 Ul each of the subjects plasma sample and 1000Ul of the reagent RI were pipette into separate sample test tube each the reagent blank test tube and each of the sample test tube were mixed and incubated at 37C For 5 minutes the absorbent of each sample, the standard and the reagent blank were measured using the VIS spectrophotometer [S23A] at a wavelength of 500nm using 1cm cuvet

| | Reagent Blank | Sample | Standard |
|---|---|---|---|
| Sample | ---------- | ---------- | 10 |
| Standard [CAL] | ---------- | 10 | --------- |
| b Reagent[RI] | 1000 | 1000 | 1000 |

Calculation
Absorbance of test/standard X concentration of standard mmol/l=mmol/l/1
Standard concentration of triglyceride in mmol/l =2.25mmol/l

**ESTIMATION OF SERUM HIGH DENSITY LIPO PROTEIN**

**CHOLESTEROL**
The phosphotungstate/magnesium chloride oxidase/peroxidase method for the determination of HDL cholesterol

**Principle**
Low density lipo protein and chylmicrons fractions are precipitated quantitatively by addition of phosphotungstic acid in the presence of magnesium ions after centrifugation, the cholesterol concentration in the HDL Fraction which remains in the supernatant is determined

**REAGENT COMPOSITION**

| **Contents** | **Initial concentration of solution** |
|---|---|
| RI, phosphotungstic Acid | 0.55mmol/l |
| Magnesium chloride | 25mmol/l |

**Procedure**
200Ul of sample and 500Ul of sample of diluted precipitate (RI) pipette into centrifuge tubes it was mixed and allowed to settle for 10minutes at room temperature and it was then centrifuged for 10 minutes at 4000 rpm a bucket centrifuge model 800 D then the clear supernatant was separated within 2 hours using semi micro method of precipitation
The HDL cholesterol was estimated when 100 Ul of distilled water and 1000Ul of reagent were placed in the standard test tube using a micro pipette and 100Ul of each subject supernatant and 1000Ul reagent wet placed in each sample test tube. The test tube were mixed and incubated for 5 minutes at 30C the absorbent of each sample, the standard and reagent blank were measured using the VIS spectro photometer (S23A) at a wavelength of 500nm using equivalent of 1cm light path within 60minutes

| | Reagent | blank sample | Standard |
|---|---|---|---|
| Distilled water | 100 | ---------- | ---------- |
| Supernatant | ------- | 100 | ---------- |
| Standard Supernatant | --------- | ---------- | 100 |

Reagent 1000 1000 1000

Calculation
A sample /standard X standard concentration (mmol/l) =mmol
Standard concentration of HDL cholesterol in mmol/l=5.43

## ESTIMATION OF LOW DENSITY LIPO PROTEIN

### Cholesterol

Low density lipo protein cholesterol was estimated from the measured value of triglyceride, total cholesterol and high density lipo protein cholesterol (Richmond 1973)
LDL Cholesterol =Total Cholesterol –Triglyceride –HDL Cholesterol 2.2

### Precaution

The following precautions were taken in the study.

1. It was ensured that all experimental materials were available before the start of the research.
2. It was ensured that the weighing scale was functional.
3. It was ensured that the syringe were adequately cleansed.
4. The presence of air bubbles were checked in the syringe.
5. During the plasma analysis eye contact or inhalation of the reagent used was avoided.

## STATISTICAL ANALYSIS

The data obtained from the present study were subjected to statistical analyses using the Statistical Package for Social Sciences (SPSS) version 21.0. Statistical significance was determined using one-way analysis of variance (ANOVA) followed by Post-Hoc multiple comparison test and $p< 0.05$ was considered statistically significant. The values were expressed as mean ± standard error of mean (SEM).



## ETHICAL CONSIDERATIONS

This research work was approved by the center for Research ethics.

## RESULTS AND ANALYSIS

**Table 1: Effect of administration of aqueous fruit extract of *Raphia hookeri* on lipid profile in male Wistar rats**

| Group and Treatment | TC (mmol/L) | TG (mmol/L) | HDL-C (mmol/ L) | LDL-C (IU/L) | VLDL (mmol/L) |
|---|---|---|---|---|---|
| **Group 1: Control Group** | 2.30 ± 0.40 | 4.10 ± 0.20 | 1.35 ± 0.23 | 283.50 ± 1.50 | 1.99 ± 0.22 |
| **Group 2: Low Dose treated (500mg/kg b.w AFERH)** | 3.77 ± 0.40 | 2.65 ± 0.22 [a] | 0.71 ± 0.18 [a] | 219.00 ± 44.20 [a] | 1.21 ± 0.10 |
| **Group 3: Medium Dose treated (1000mg/kg b.w AFERH)** | 4.53 ± 0.03 [a] | 3.00 ± 0.47 | 0.50 ± 0.08 [a] | 256.33 ± 11.97 [a] | 1.36 ± 0.21 |

| | | | | | |
|---|---|---|---|---|---|
| **Group 4: High Dose treated (2000mg/kg b.w AFERH)** | 2.95 ± 0.80 | 2.52 ± 0.37 [a] | 0.34 ± 0.05 [a] | 219.50 ± 51.07 [a] | 1.14 ± 0.17 |

Values represent mean ± SEM, n=5; [a] Significant at p<0.05 compared to Group 1; [b] Significant at p<0.05 when compared to group 2; [c] Significant at p<0.05 when compared to group 3.
TC= total cholesterol; TG= Triglyceride; HDL-C= high density lipoprotein cholesterol; LDL-C=low density lipoprotein cholesterol; VLDL= very low density lipoprotein cholesterol.

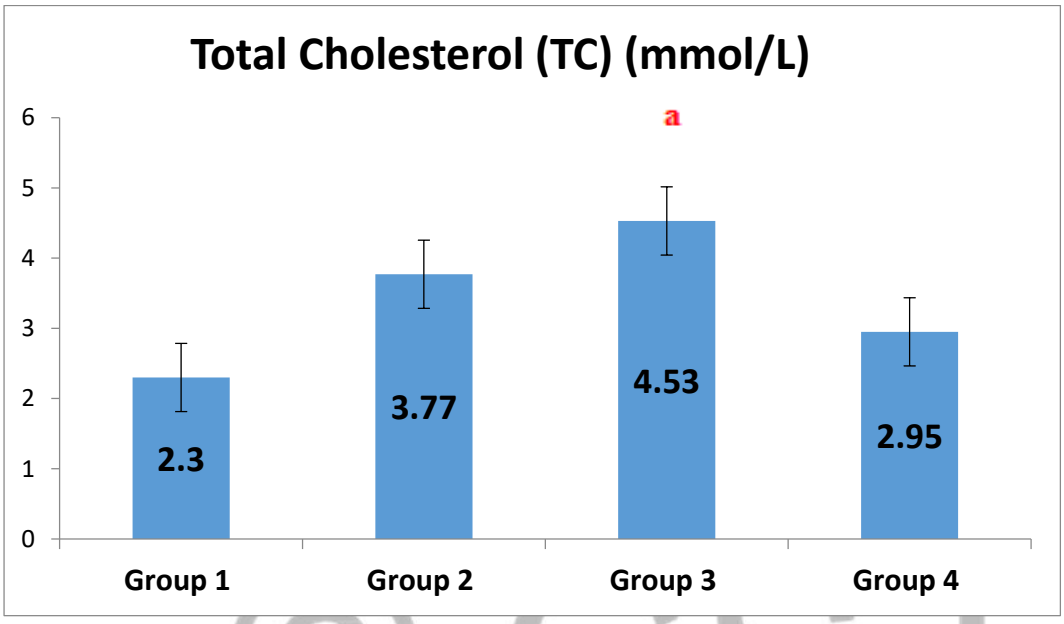


**Figure 1: Effect of administration of aqueous fruit extract of *Raphia hookeri* on Total Cholesterol in male Wistar rats**

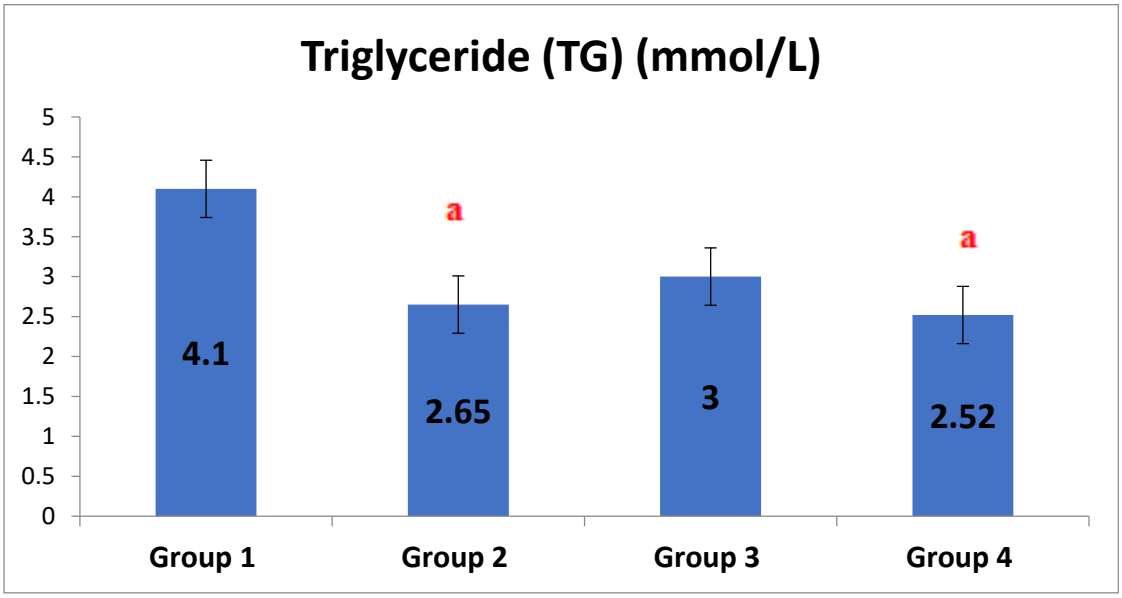


**Figure 2: Effect of administration of aqueous fruit extract of *Raphia hookeri* on Triglyceride in male Wistar rats**

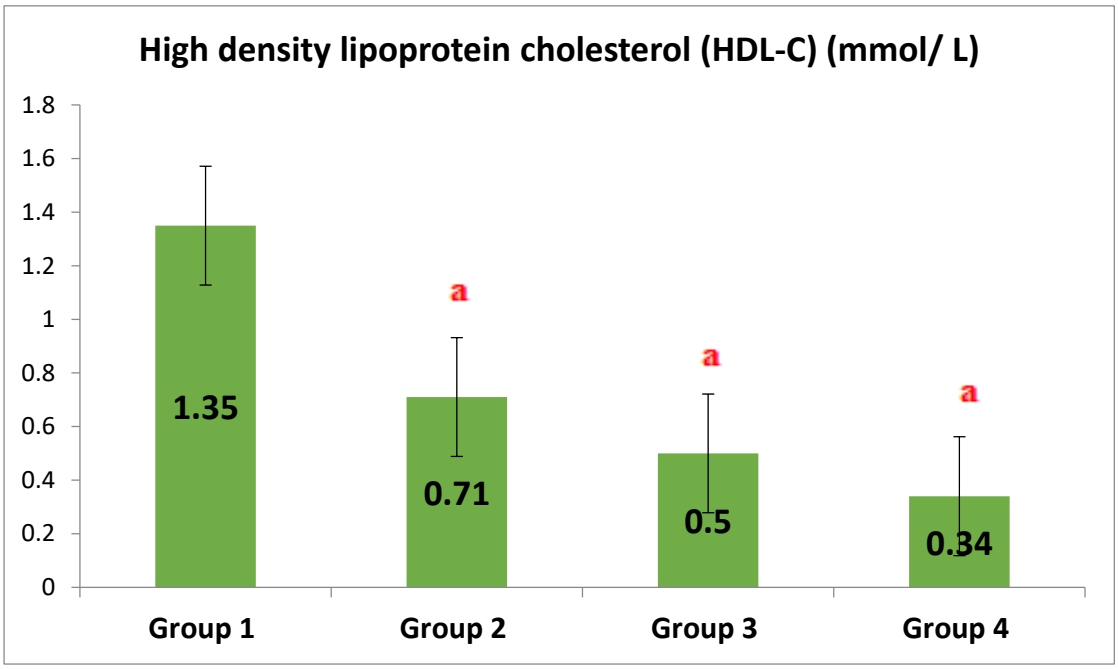


**Figure 3: Effect of administration of aqueous fruit extract of *Raphia hookeri* on High density lipoprotein cholesterol in male Wistar rats**



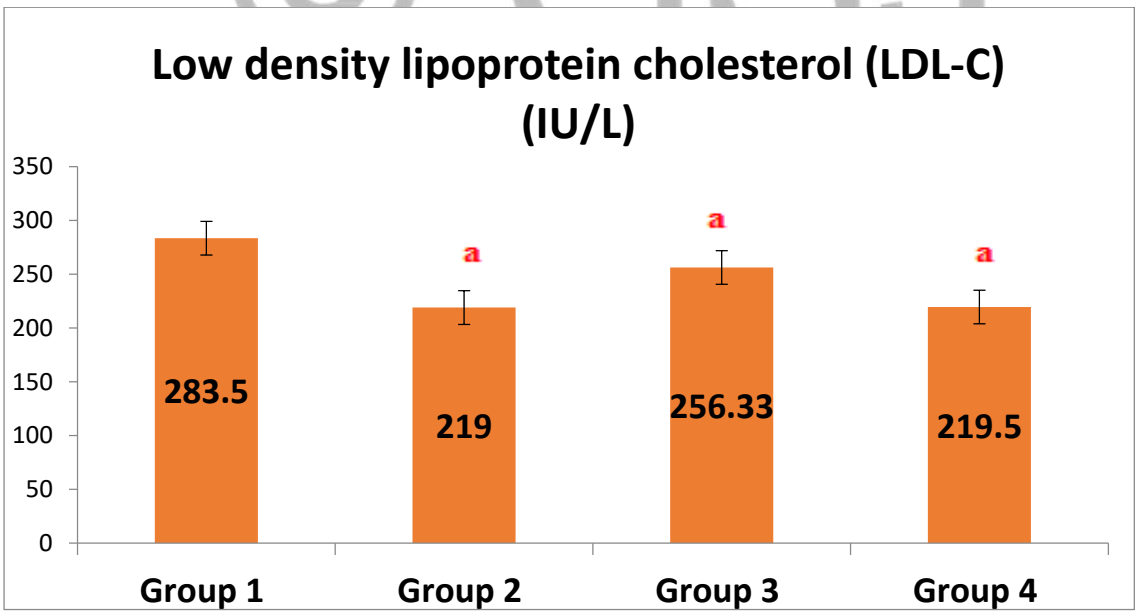


**Figure 4: Effect of administration of aqueous fruit extract of *Raphia hookeri* on Low density lipoprotein cholesterol in male Wistar rats**

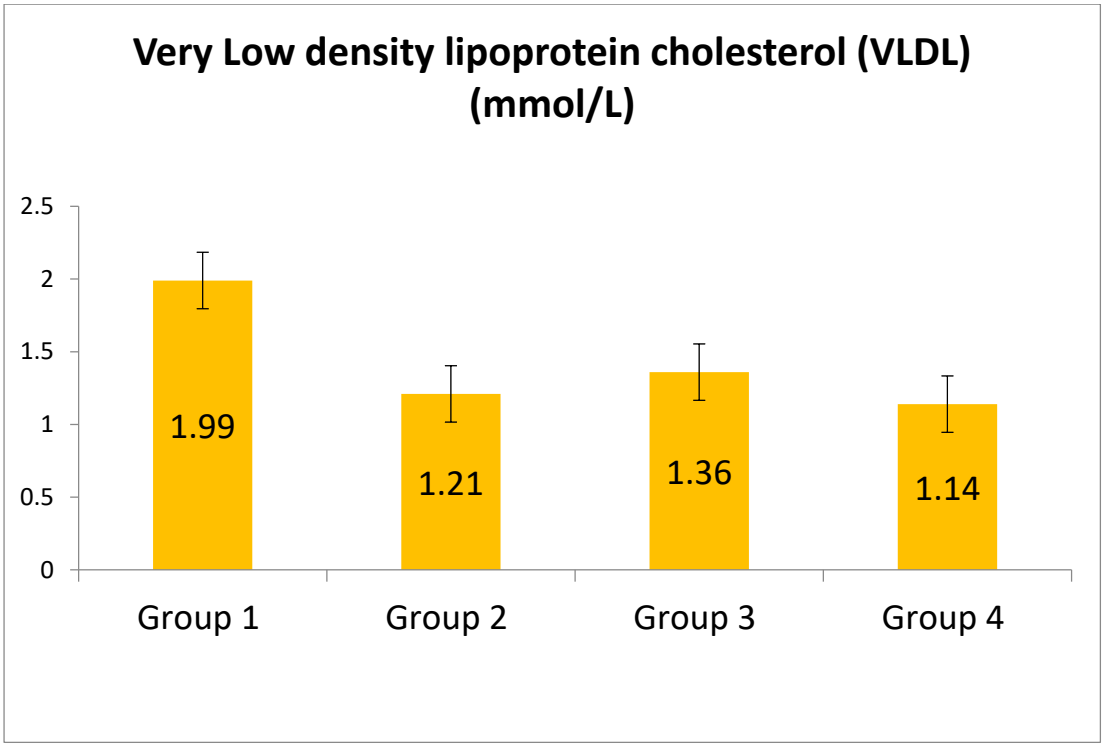


**Figure 5: Effect of administration of aqueous fruit extract of *Raphia hookeri* on very low density lipoprotein cholesterol in male Wistar rats**

## DISCUSSION OF RESULTS

The findings of the administration of aqueous fruit extract of *Raphia hookeri* on plasma lipid profile in male Wistar rats revealed a significant impact the various plasma lipid profile parameters tested except very low density lipoprotein when compared with the control (group 1) that were not administered with the extract at $P<0.05$. The total cholesterol (TC) levels of groups 2, 3 and 4 (treated with 500, 1000, and 2000mg/kg body weight Aqueous fruit extract of Raphia Hookeri respectively) were seen to increase, but only that of group 3 was actually significant ($p<0.05$) when compared to the of control group. Considering the changes in triglyceride (TG) levels following treatments with different doses of the Aqueous Fruit Extract of Raphia Hookeri in male Wistar rats, there were general decreases across all treated groups, but just those of groups 2 and 4 (treated with 500 and 2000mg/kg body weight aqueous Fruit Extract of Raphia Hookeri respectively) were significant ($p<0.05$) when compared to that of the control group.

On the levels of High density lipoprotein cholesterol (HDL-C), it was observed that the graded Aqueous Fruit Extract of Raphia Hookeri doses treatment in the rats indicated a dose-dependent significant decreases ($p<0.05$) when compared to that of the control group. The variations in the levels of low density lipoprotein cholesterol (LDL-C) in the rats treated with the different doses of Aqueous Fruit Extract of Raphia Hookeri showed statistically remarkable ($p<0.05$) decreases in all treated rats when compared to that of the control group. The very low density lipoprotein (VLDL) cholesterol levels of all the Aqueous Fruit Extract of Raphia Hookeri treated rats did not vary significantly ($p>0.05$). High levels of LDL are associated with a higher risk of heart attack and stroke. Higher levels of HDL, on the other hand, are associated with lower heart disease risks. Triglycerides help store fat in your cells that you can use for energy. Like LDL, high triglyceride levels appear to be linked to cardiovascular disease, which means they may raise the risk for heart attack and stroke (Sullivan, 2019). Hyperlipidaemia (Dyslipidaemia ) is a high level of lipids (cholesterol, triglycerides, or both) or a low high-density lipoprotein (HDL) cholesterol level Davidson & Pulipati (2021). The risk of

developing atherosclerosis increases as the total cholesterol level (which includes LDL, HDL, and VLDL cholesterol) increases, even if the level is not high enough to be considered dyslipidaemia. Atherosclerosis can affect the arteries that supply blood to the heart (causing coronary artery disease), those that supply blood to the brain (causing stroke), and those that supply the rest of the body (causing peripheral arterial disease). Therefore, having a high total cholesterol level also increases the risk of having a heart attack or stroke(Sullivan, 2019) .

Having a low total cholesterol level is generally considered better than having a high one. However, having a very low cholesterol level may not be healthy either (hypolipidemia). The total cholesterol level is only a general guide to the risk of atherosclerosis. Levels of the components of total cholesterol—particularly LDL and HDL cholesterol—are more important. A high level of LDL (bad) cholesterol increases the risk. A high level of HDL (good) cholesterol is not usually considered a disorder because it decreases the risk of atherosclerosis. However, a low level of HDL cholesterol (defined as less than 40 mg/dL [less than 1 mmol/L]) is associated with increased risk. Experts consider an LDL cholesterol level of less than 100 mg/dL (2.6 mmol/L) desirable, Davidson & Pulipati (2021).

Whether high triglyceride levels increase the risk of a heart attack or stroke is uncertain. Triglyceride levels higher than 150 mg/dL (1.7 mmol/L) are considered abnormal, but high levels do not appear to increase risk for everyone. For people with high triglyceride levels, the risk of heart attack or stroke is increased if they also have a low HDL cholesterol level, diabetes, chronic kidney disease, or many close relatives who have had atherosclerosis (family history). Hypolipidemia is abnormally low levels of lipids in the plasma (total cholesterol less than 120 mg/dL [3.1 mmol/L] or low-density lipoprotein (LDL) cholesterol less than 50 mg/dL [1.3 mmol/L]), Davidson & Pulipati (2021).The raphia hookeri fruit pulp regular consumption is seen to have the ability to ameliorate the effect of plasma cholesterols, triglycerides and lipoproteins.



## SUMMARY

The outcome of the administration of aqueous fruit extract of *Raphia hookeri* on lipid profile of male Wistar rats displayed the total cholesterol (TC) levels of groups 2, 3 and 4 (treated with 500, 1000, and 2000mg/kg body weight Aqueous fruit extract of Raphia Hookeri respectively) were seen to increase, but only that of group 3 was actually significant ($p<0.05$) when compared to the of control group. Considering the changes in triglyceride (TG) levels following treatments with different doses of the Aqueous Fruit Extract of Raphia Hookeri in male Wistar rats, there were general decreases across all treated groups, but just those of groups 2 and 4 (treated with 500 and 2000mg/kg body weight aqueous Fruit Extract of Raphia Hookeri respectively) were significant ($p<0.05$) when compared to that of the control group. On the levels of High density lipoprotein cholesterol (HDL-C), it was observed that the graded Aqueous Fruit Extract of Raphia Hookeri doses treatment in the rats indicated a dose-dependent significant decreases ($p<0.05$) when compared to that of the control group. The variations in the levels of low density lipoprotein cholesterol (LDL-C) in the rats treated with the different doses of Aqueous Fruit Extract of Raphia Hookeri showed statistically remarkable ($p<0.05$) decreases in all treated rats when compared to that of the control group. The very low density lipoprotein (VLDL) cholesterol levels of all the Aqueous Fruit Extract of Raphia Hookeri treated rats did not vary significantly ($p>0.05$).

## CONCLUSION

The lipid profile results of this study showed a decreased levels of lipids in the plasma low density lipo protein (LDL), high density lipo protein (HDL), cholesterol, triglyceride when compared with the control group and this indicates the ameliorating effect of Aqueous fruit extract of Raphia Hookeri on Lipid Plasma, while a non-significant increase in level of very low density lipoprotein (VLDL) was observed which means it does not really have an increasing effect. It can therefore be concluded that the aqueous extract of Raphia Hookeri fruit

pulp when consumed regularly has the capacity to ameliorate the effect hyperlipidaemias and normalise high plasma lipids in male wistar rats.

## RECOMMENDATION

It therefore recommended that the fruit pulp of raphia hookeri plant should be eaten regularly as staple food and widely cultivated in the society because of its medicinal or clinical importance in maintaining normal lipid profile to avoid the extinction of the this plant.

## REFERENCES

Abourbih S, Filion KB, Joseph L, Schiffrin EL, Rinfret S, Poirier P, Pilote L, Genet J. Eisenberg MJ. (2009). "Effect of fibrates on lipid profiles and cardiovascular outcome a systematic review". Am J Med. 122 (10): 962e1-962e8. PMID 19698935.

Adedeji OO, Onitiri AC. (1990). Lipids in Nigerian Hypertensives. Aft. J. Med. Sei. 19: 281-284. 21. Assmann G. Lipid metabolism and atherosclerosis. Schattier verling. Stuttgart, Germany.

Ahmed SM, Clasen MD, Donnelly. MD. (1998). Management of Dyslipidemia in Adults Amer, Family Physician; 57:1-16.

Ahotupa, Markku. (2017). "Oxidized lipoprotein lipids and atherosclerosis". Free Radical Research. 51 (4): 439-447. PMID 28412863.

Akpa Mr, Agomouh Dl, Alasia DD. (2006). Lipid profile of healthy adult Nigerians in Port Harcourt, Nigeria. Niger J Med 15: 137-40.

Aksoy N, Aksoy M, Bagci C, Gergerlioglu HS, Celik H, Herken E, Yaman A, Tarakcioglu M. Soydinc S, Sari I, Davutoglu V. (2007). "Pistachio intake increases high density lipoprotein levels and inhibits low-density lipoprotein oxidation in rats" Med. Science. 10:2682-7.

Alfred Thomas. (2002). "Fats and Fatty Oils". Ullmann's Encyclopedia of Industrial Chemistry Ullmann's Encyclopedia of Industrial Chemistry. Weinheim: Wiley-VCH. ISBN 3527306730.

Amit G, Vandana S, Sidharth M. (2011). Hyperlipidemia: An Updated Review. Inter 1 of Biopharma & Toxicol Res; 1:81-89.

Anderson, K.M., Castelli, W.P. Levy, D. (1999). "Cholesterol and Mortality. 30 years of follow-up from the Framingham study". JAMA 257 (16): 2176-2180.

Andrikopoulos, N. K. (2012). Chromatographic and spectroscopic methods in the analysismof triacylglycerol species and regiospecific isomers of oils and fats. Crit Rev Food Sci Nutr, 42, 473-505.

Ankur rohilla, Nidhi Dagar, Seema Rohilla, Amarjeet Dahiya, Ashok Kushnoor. (2012). Hyperlipidemia- a Deadly Pathological Condition. Inter J Curr Pharma Res; 4:15-18.

Anonymous, (2011). Comprehensive Lipid Profile Testing in the Evaluation of Cardiovascular Disease Protocol: CAR039. Sierra health and life A unitedhealthcare Company, 1-17.

Ansell BJ, Watson KE, Fogelman AE. (2005). High-density lipoprotein function: Recent advences. JACC. 46:1792-8.

Barbagallo CM, Rizzo M, Cefalu AB. (2002). Changes in plasma lipids and low-density lipoprotein peak particle size during and after myocardial infarction. Am J Cardiol. 89:460-2.

Barbara G Wells, Joseph T dipiro, Terry L Schwinghammer, Cindy Hamilton (2005). Pharmacotherapy Handbook, 6th ed.mcgraw-Hill publications. P. 89.

Bays H. (2003). Atherogenic dyslipidemia in type2 diabetes and metabolic syndrome: current and future treatment options. Br J Diabetes Vase Dis. 3(5): 356-360.

Berglund L, Brunzell JD, Goldberg AC. (2012). “Evaluation and treatment of hypertriglyceridemia: an endocrine society clinical practice guideline" J. Clin. Endocrinol. Metab. 97 (9): 2969-89. PMC 3431581 PMID 22962670.

Bibow S; (2017). "Solution structure of discoidal high-density lipoprotein particles with a shortened apolipoprotein A-I", Nature Structural & Molecular Biology, 24 (6): 187-93.

Birtcher, K. K., Bowden, C., Ballantyne, C. M. Huyen, M. (2000). Strategies for implementing lipid-lowering therapy: pharmacy-based approach. Am J Cardiol, 85, 30A-35A.

Birukov, K. G. (2006). "Oxidized lipids: The two faces of vascular inflammation". Current Atherosclerosis Reports. 8 (3): 223-31. PMID 16640959.

Bitcher, K.K. (2000). "Strategies for Implementing Lipid-Lowering Therapy: Pharmacy Based Approach". American Journal of cardiology; 85 (3): 30-35.

Blair HA, Dhillon S. (2014). Omega-3 carboxylic acids (Epanova): a review of its use in patients with severe hypertriglyceridemia. Am J Cardiovasc Drugs. Oct;14(5):393-400 PMID 25234378.

Boerwinkle E, Leffert CC, Lin J, Lackner C, Chiesa G, Hobbs HH. (1999). Apolipoprotein(a) gene accounts for greater than 90% of the variation in plasma lipoprotein(a) concentrations. J Clin Invest. 90:52-60.

Bolton-Smith, C., Woodward, M., Smith, W. C. Tunstall-Pedoe, H. (1991). Dietary and non-dietary predictors of serum total and hdlcholesterol in men and women: results from the Scottish Heart Health Study. Int J Epidemiol, 20, 95-104.

Briel M, Gonzalez IF, You JJ, Karanicolas PJ, Akl EA, Wu P, Blechacz B,Bassler D, Wei X, Alves da Silva S, Khalid K, Nordmann AJ, Zhou Q, Walter SD, Vale N, Bhatnagar N, (2009). Cardiovascular risk factors in school children in large urban areas of Turkey: Directions for public health policy. BMC Public Health 5:13 - 22.

Brown MS, Goldstein JL. (1997). "The SREBP pathway: regulation of cholesterol metabolism by proteolysis of a membrane-bound transcription factor". Cell. 89 (3): 331-40. PMID 9150132.

Burstein M, Scholnick HR, Morfin R. (1998). Rapid method for the isolation of lipoproteins from human serum by precipitation with polyanions. J. Lipid Res. 11(6):583-595,

C.M. Lok, J.P. Ward, D.A. van Dorp (2004). "The synthesis of Chiral Glycerides starting from D- and L-serine", Chemistry and Physics of Lipids, 16(2): 115-122.

Cameron AJ, Shaw JE, Zimmet PZ (2004). The metabolic syndrome: prevalence in worldwide populations. Endocrinol Metab Clin North Am 33: 351-375, table of contents.

Cannon CP, Blazing MA, Giugliano RP, mccagg A, White JA, Theroux P, Darius H, Lewis BS, Ophuis TO, Jukema JW, De Ferrari GM, Ruzyllo W, De Lucca P, Im K, Bohula EA. Reist C, Wiviott SD, Tershakovec AM, Musliner TA, Braunwald E, Califf RM. (2015). Investigators I-I. Ezetimibe Added to Statin Therapy after Acute Coronary Syndromes. The New England journal of medicine. 372:2387-2397.

Catapano AL, Reiner Z, De Backer G, Graham I, Taskinen MR, Wiklund O, Agewall S, Alegria E, Chapman M, Durrington P, Erdine S, Halcox J, Hobbs R, Kjekshus J, Filardi PP, Riccardi G, Storey RF, Wood D. (2011). ESC/EAS Guidelines for the management of dyslipidaemias The Task Force for the management of dyslipidaemias of the European Society of Cardiology (ESC) and the European Atherosclerosis Society (EAS).Atherosclerosis. 217:3-46.

Charbonnet, G. H.; Singleton, W. S. (2001). "Thermal properties of fats and oils". J. Am. Oil Chem. Soc. 24 (5): 140.

Chatterjee MN. Shinde R. (2005). Text book of medical laboratory technology. Metabolism of carbohydrates. (Jaypee Brothers Medical publisher) Sixth edition. 266-330, Delhi-India.

Clarke R, Peden JF, Hopewell JC, Kyriakou T, Goel A, Heath SC, Parish S, Barlera S, Franzosi MG, Rust S, Bennett D, Silveira A, Malarstig A, Green FR, Lathrop M, Gigante B. Leander K, de Faire U, Seedorf U, Hamsten A, Collins R, Watkins H, Farrall M. (2009). Genetic variants associated with Lp(a) lipoprotein level and coronary disease. The New England journal of medicine. 361:2518-2528.

Costet P. (2010). Molecular Pathways and Agents for Lowering LDL-Cholesterol in Addition to Statins. Pharmacol Ther; 126:263-78.

Crawford, H., Micheal. (2009). Current Diagnosis & Treatment Cardiology. 3rd ed. Mcgraw-Hill Medica. P21.

Cummings KC. (2003). Lipid and Cardiac Risk profiles. Clinical Chemistry. 47: 407-409.

Dashti M, Kulik W, Hoek F, Veerman EC, Peppelenbosch MP, Rezace F. (2011). "A phospholipidomic analysis of all defined human plasma lipoproteins". Sci. Rep. I (139): 139.Bibcode: 2011natsr...1E.139D. PMC 3216620. PMID 22355656.

Dashty M, Motazacker MM, Levels J, de Vries M, Mahmoudi M, Peppelenbosch MP, Rezace F. (2014). "Proteome of human plasma very low-density lipoprotein and low-density lipoprotein exhibits a link with coagulation and lipid metabolism".Thromb. Haemost. 111 (3): 518-530. PMID 24500811.

Davidson & Pulipati (2021). Dyslipidemia (Hyperlipidemia)

Davidson, Michael H. (2008). Davidson, Michael H.; Toth, Peter P.; Maki, Kevin C. (eds.). Therapeutic Lipidology "Pharmacological Therapy for Cardiovascular Disease". In Contemporary Cardiology. Cannon, Christopher P.; Armani, Annemarie M. Totowa, New Jersey: Humana Press, Inc. Pp. 141-142. ISBN 978-1-58829-551-4-

Debra Sullivan (2019). Lipid Disorder: What You Should Know About High Blood Cholesterol and Triglycerides

Defronzo RA, Ferrannini E. (1991). Insulin resistance: a multifaceted syndrome responsible for NIDDM, obesity, hypertension, dyslipidemia and atherosclerotic cardiovascular disease, Diabetes Care 14:173-94.

Defronzo RA. (1998). The triumvirate: beta cell, muscle, livec a collusion responsible for NIDDM Diabetes. 37:667-687 17.

Del Prato S., Bonadonna, RC., Bosom, E. (1993). Characterization cellular defects of insulin action in type2 (noninsulin dependent) diabetes mellitus. I Clininvest. 91:4M-494.

Dert, A. M., Gatzka, C. D., Cameron, J. D., Kingwell, B. A., Liang, Y. L., Berry, K. L., Reid, C. M. Jennings, G. L. (2004). Large artery stiffness is not related to plasma cholesterol in older subjects with hypertension. Arterioscler Thromb Vasc Biol, 24, 962-8.

Després, Jean-Pierre. (2009). "The Atherogenic Triad of New Metabolic Risk Factors: Importance of Waist and Fasting Triglycerides as Screening Tools". Visceral Adipose Tissue and Cardiometabolic Risk. 15:862-70.

Diebold BA, Bhagavan NV, Guillory RJ. (1994). Influences of lovastatin administration on the respiratory burst of leukocytes and the phosphorylation potential of mitochondria in guinea pigs. Biochim Biophys Acta ; 1200(2): 100-8.

Dipietro L, Mossberg HO, Stunkard AJ. (1994). A 40 year history of overweight children in Stockholm: life-time mortality. Int J Obes 18: 585-90.

Donahue RP, Orchard TJ, Kuller LII, Drash AL. (1996). Lipids and lipoproteins in young adult population. J demiol 240:458-67.

Drummond, K. E.; Brefere, L. M. (2014). Nutrition for Foodservice and Culinary Professionals (8th ed.). John Wiley, Sons. ISBN 978-0-470-05242-6 Boston scientists say triglycerides play key role in heart health". The Boston Globe. 17:4006-18.

Ergou S, Kaptoge S, Perry PL, Di Angelantonio E, Thompson A, White IR, Marcovina SM, Collins R, Thompson SG, Danesh J. (2009). Lipoprotein (a) concentration and the risk of coronary heart disease, stroke, and nonvascular mortality. JAMA. 302:412-423.

Eriksson, L. T., Roscher, R., Ingemansson, R. Steen, S. (1999). Cardiovascular effects of induced hypothermia after lung transplantation. Ann Thorac Surg. 67,804-9.

Espenshade PJ, Hughes AL (2007). "Regulation of sterol synthesis in eukaryotes". Annu. Rev. Genet. 41: 401-27. PMID 17666007

Fahy, E., Subramaniam, S., Brown, H, A., Glass, C. K., Merrill, A. H., Jr., Murphy, R. C., Raetz, C. R., Russell, D. W., Seyama, Y., Shaw, W., Shimizu, T., Spener, F., Van Meer, G., Vannieuwenhze, M. S., White, S. H., Witztum, J. L. Dennis, E. A. (2005). A comprehensive classification system for lipids. J Lipid Res, 46, 839-61.

Fielding, C. J., Havel, R. J., Todd, K. M., Yeo, K. E., Schloetter, M. C., Weinberg, V. Frost, P. H. (1995). Effects of dietary cholesterol and fat saturation on plasma lipoproteins in an ethnically diverse population of healthy young men. J Clin Invest, 95, 611-8.

Fogoros, Richard N. (2005). "Raising Your HDL Levels Increasing the GOOD cholesterol" JAM. 286:785-71.

Fox C.S. (2015). Update on Prevention of Cardiovascular Disease in Adults With Type 2 Diabetes Mellitus in Light of Recent Evidence: A Scientific Statement From the American Heart Association and the American Diabetes Association. Diabetes Care. 38(9):1777-803.

Friedwald WT, Levy RI, Fredrichseon DS. (1997). Estimation of the concentration of low density lipoproteins in plasma without ultracentrifuge. Clin Chem., 18: 499-502.

Fryar CD, Hirsch R, Eberhardt MS, Yoon SS, Wright JD. (2010). Hypertension, high serum total cholesterol, and diabetes: racial and ethnic prevalence differences in U.S. adults. NCHS Data Brief; 36: 1-8.

Gardner CD, Fortmann SP, Krauss RM. (1996). Association of small low-density lipoprotein particles with the incidence of coronary artery disease in men and women. JAM. 276:875-81.

Garg, R. K. Arora, R. C. Agarwal, N. (1991). High density lipoprotein. J Assoc Physicians India, 39, 269-71.

Gaziano J.M. (2010). Randomized clinical trial of quick-release bromocriptine among patients with type diabetes on overall safety and cardiovascular outcomes. Diabetes Care.33 (7):1503-8.

Gaziano JM. (2004). Primary and secondary prevention of coronary heart disease. A Textbook of Cardiovascular Medicine, 7th ed.. 1057-1084.

Gill, Jason; Sara Herd; Natassa Tsetsonis; Adrianne Hardman (2002). "Are the reductions in triacylglycerol and insulin levels after exercise related?". Clinical Science .102 (2): 223-231. PMID 11834142.

Ginsberg HN, Goldberg IJ. (2001). Disorders of lipoprotein metabolism. In: Harrison's Principles of Internal Medicine. 15th Ed. New York: mcgraw Hill: 2245-2256.

Gould AL, Rossouw JE, Santanello NC, Heyse JF, Furberg CD. (1995), Cholesterol reduction yields clinical benefit. A new look at old data. Circulation, 91(8), 2274- 2282.9.

Gowri MS. Westhuyzem D. Bridges SR. Anderson JW. (1999). Deceased protection by HDL from poorly controlled type2 diabetic subjects against LDL oxidation may be due to the abnormal com position of HDL. Arteriosclerosis, Thrombosis, and Vascular Biology. 19:2226- 2233

Grundy SM, Stone NJ, Bailey AL, Beam C, Birtcher KK, Blumenthal RS, Braun LT, de Ferranti S, Faiella-Tommasino J, Forman DE, Goldberg R, Heidenreich PA, Hlatky

Grundy SM, Vega GL. (1998). Hypertriglyceridemia: causes and relation to coronary heart disease - Semin. Thromb. Hemost; 14:249-64.

Grundy SM. (1997). Small LDL, atherogenic dyslipidemia, and the metabolic syndrome. Circulation.95:1-4.

Haines TH. (2001). "Do sterols reduce proton and sodium leaks through lipid bilayers?". Prog. Lipid Res. 40 (4): 299-324. PMID 11412894

Haines, T.H. (2001). "Do sterols reduce proton and sodium leaks through lipid bilayers?". Prog. Lipid. Res. 40 (4): 299-324.

Hajian-Tilaki KO, Heidari B. (2007). Prevalence of obesity, central obesity and associated factors in urban population aged 20- 70 years, in the north of Iran. A population-based study and regression approach. Obes Rev 8:3-10.

Hanukoglu I. (1992). "Steroidogenic enzymes: structure, function, and role in regulation of steroid hormone biosynthesis". J Steroid Biochem Mol Biol. 43 (8): 779-804. PMID 22217824.

Hanukoglu, I. (1992). "Steroidogenic enzymes: structure, function, and role in regulation of steroid hormorn biosynthesis." J. Steroid. Biochem Mol. Biol. 43 (8): 779-804.

Hausenloy DJ, Yellon DM. (2008). "Targeting residual cardiovascular risk: raising high-density lipoprotein cholesterol levels".Heart. 94 (6): 706-14. MID 18480348

Havel, R. J. Hamilton, R. L. (2004). Hepatic catabolism of remnant lipoproteins: where the action is. Arterioscler Thromb Vasc Biol, 24, 213-5.

Hermansen K, Dinesen B, Hoie LH, Morgenstern E, Gruenwald J. (2003). "Effects of soy and other natural products on LDL:HDL ratio and other lipid parameters: a literature review". Advances in Therapy. 20 (1): 50-78. PMID 12772818.

Huang CX, Zhang YL. (2013). "The target of regulating the ATP-binding cassette Al protein (ABCA1): promoting ABCA1-mediated cholesterol efflux in different cells".Current Pharmaceutical Biotechnology .14 (6): 623-31. PMID 24016265

Incardona JP, Eaton S. (2001). "Cholesterol in signal transduction".Curr. Opin. Cell Biol. 12(2): 193-203. PMID 10712926.

Incardona, J.P. Eaton, S. (2000). "cholesterol in signal transduction". Curr. Opin. Cell Biol 12 (2): 193 - 203.

Ivanova EA, Myasoedova VA, Melnichenko AA, Grechko AV, Orekhov AN. (2017). "Small Dense Low-Density Lipoprotein as Biomarker for Atherosclerotic Diseases" Oxidative Medicine and Cellular Longevity. 2017: 127304. PMID 28572872.

Joseph T. Dipiro. (2005). Pharmacotherapy: A pathophysiological approach. 6th edition. The Mc Graw Hill companies, Inc. Pg. 429.

Jun M, Foote C, Lv J. (2010). "Effects of fibrates on cardiovascular outcomes: a systematic review and meta-analysis". Lancet. 375 (9729): 1804. PMID 20462635.

Kamstrup PR, Tybjaerg-Hansen A, Steffensen R, Nordestgaard BG. (2009). Genetically elevated lipoprotein(a) and increased risk of myocardial infarction. JAMA. 301:2331-2339.

Keene D, Price C, Shun-Shin MJ, Francis DP. (2014). "Effect on cardiovascular risk of high density lipoprotein targeted drug treatments niacin, fibrates, and CETP inhibitors: meta-analysis of randomised controlled trials including 117,411 patients". BMJ. 349: g4379. PMID 25038074.

Kelishadi R, Alikhani S, Delavari A, Alaedini F, Safaie A, Hojatzadeh E. (2008). Obesity and associated lifestyle behaviors in Iran: Findings from the first national non-communicable disease risk factor surveillance survey. Public health Natr 11: 246- 51.

Kelly RB. (2010). Diet and exercise in the management of hyperlipidemia. Am Fam Physician; 81: 1097-102

Khera AV, Everett BM, Caulfield MP, Hantash FM, Wohlgemuth J, Ridker PM, Mora S. (2014). Lipoprotein(a) concentrations, rosuvastatin therapy, and residual vascular risk: an analysis from the JUPITER Trial (Justification for the Use of Statins in Prevention: an Intervention Trial Evaluating Rosuvastatin) Circulation. 129:635-642.

Koschinsky MLB, MB, Marcovina, SM. (2015). Lipoprotein(a). In: Ballantyne CM, ed. Clinical Lipidology, a companion to Braunwald's Heart Disease. Vol Second Edition: Elsevier Saunders; 2017:109-127.

Krauss R. M. (1994). Heterogeneity of lipoproteins and atherosclerosis risk. Curr Opin Lipidol, 5(5), 339-349. 10.

Krauss R.M. (2004). Lipids and lipoproteins in patients with type 2 diabetes. Diabetes Care.27(6):1496-504.

Kritchevsky D. (1998). Cholesterol vehicle in experimental atherosclerosis. A brief review with special reference to peanut oil. Arch Pathol Lab Med; 112:1041-4.

Kronenberg F. (2014). Lipoprotein(a): there's life in the old dog yet. Circulation. 129:619-621.

Kumar V, Butcher SJ, Katrina O, Engelhardt P, Heikkonen J, Kaski K, Ala-Korpela M, Kovanen PT. (2011). "Three-Dimensional cryoem Reconstruction of Native LDL Particles to 16A Resolution at Physiological Body Temperature". Plos ONE. 6 (5): e18841.Bibcode: 2011ploso...618841K. PMID 21573056.

Kwiterovich PO. (2000). "The metabolic pathways of high-density lipoprotein, low-density lipoprotein, and triglycerides: a current review".The American Journal of Cardiology. 86 (12A): 5L-10L. PMID 11374859.

Kwon SW, Yoon S-J, Kang TS. (2006). Significance of small-dense low-density lipoprotein as a risk factor for coronary artery disease and acute coronary syndrome. Yonsei Med J. 47:405-414.

Laakso, P. Voutilainen, P. (1996). Analysis of triacylglycerols by silver-ion high- performance liquid chromatography-atmospheric pressure chemical ionization mass spectrometry. Lipids, 31, 1311-22.

Lampe, M. A. Burlingame, A. L. Whitney, J. Williams, M. L. Brown, B. E. Roitman, E. Elias, M. (2003). "Human stratum corneum lipids: characterization and regional variations". J. Lipid Res. 24 (2): 120-130. PMID 6833889.

Lecerf, J.M. Lorgeril, M. (2011). "Dietary cholesterol: from physiology to cardiovascular risk". Br. J. Nutr. 106(1):6-14.

Lewington, S. Whitlock, G. Clarke, R. Sherliker, P. Emberson, J. Halsey, J. Qizilbash, N. Peto, R. Collins, R. (2007). "Blood cholesterol, sex, and blood pressure: a meta-analysis of individual data from 61 prospective studies with 55,000 vascular deaths". Lancet. 370 (9602): 1829-1839.

Lewis GF, Rader DJ. (2005). "New insights into the regulation of HDL metabolism and reverse cholesterol transport". Circ. Res. 96 (12): 1221-32. PMID 15976321.

Libby P. (2005). Pathophysiology of coronary artery disease. Circulation. 111(25):3481-88.

Lind L. Lithell H, Pollare T. (1993). Is it hyperinsulinemia or insulin resistance that is related to hypertension and other metabolic cardiovascular risk factors? J Hypertens 11(suppl 4): S11-6.

Linton MF, Farese RV Jr, Chiesa G, Grass DS, Chin P, Hammer RE, Hobbs HH, Young SG. (1993). Transgenic mice expressing high plasma concentrations of human apolipoprotein B100 and lipoprotein(a). J Clin Invest. 92:3029-3037.

Lipman TH, Hayman LL, Fabian CV, difazio DA, Hale PM, Goldsmith BM. (2000). Risk factors for cardiovascular disease in children with type I diabetes. Nurs Res: 49:160-166.

Loose-Mitchell, D. S. Poorman, J. A. Smith, S. A. Overturf, M. L. Morrisett, J. D. Gotto, A.M. Jr.Soma, M.R. (1991). Cholesterol metabolism in hypercholesterolemia-resistant rabbits. Atherosclerosis, 87, 169-81.

Luke MM, Kane JP, Liu DM, Rowland CM, Shiffman D, Cassano J, Catanese JJ, Pullinger CR, Leong DU, Arellano AR, Tong CH, Movsesyan I, Naya-Vigne J, Noordhof C, Feric NT, Malloy MJ, Topol EJ, Koschinsky ML, Devlin JJ. Ellis SG. A. (2007). polymorphism in the protease-like domain of apolipoprotein(a) is associated with severe coronary artery disease. Arteriosclerosis, thrombosis, and vascular biology. 27:2030-2036.

Ma, Jones Dw, Lloyd-Jones D, Lopez-Pajares N, Ndumele CE, Orringer CE, Peralta CA, Saseen JJ, Smith SC Jr, Sperling L, Virani SS, Yeboah J (2018). AHA/ACC/AACVPR/AAPA/ABC/ACPM/ADA/AGS/apha/ASPC/NLA/PCNA Guideline on the Management of Blood Cholesterol: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. J Am Coll Cardiol.18:201-84.

Maher VM, Brown BG, Marcovina SM, Hillger LA, Zhao XQ, Albers JJ. (1995). Effects of lowering elevated LDL cholesterol on the cardiovascular risk of lipoprotein(a). Jama. 274:1771-1774.

Mahley, R. W. (2016). "Apolipoprotein E: From cardiovascular disease to neurodegenerative disorders" Journal of Molecular Medicine. 94 (7): 739-46. PMC 4921111. PMID 27277824.

Manninen V, Tenkanen L, Koskinen P, Huttunen JK. (1992). Joint effects of serum triglyceride and LDL cholesterol and HDL cholesterol concentrations on coronary heart disease risk. in the Helsinki Heart Study. Implications for Circulation. 85(1):37-45..

Manson JE, Tosteson H, Ridker PM, Satterfield S, Hebert P, O'Connor GT. (1992). The primary prevention of myocardial infarction. N Engl J Med 326:1406-16.

Martin-Timon I. (2014). Type 2 diabetes and cardiovascular disease: Have all risk factors the same. World J Diabetes.5(4):444-70.

Mcgowan MW. Trinder P. (1999). A per-oxidase coupled method for the colorimetric determination of serum triglycerides. Clin Biochem. 29:538.

Mensink RP, Zock PL, Kester AD, Katan MB. (2003). "Effects of dietary fatty acids and carbohydrates on the ratio of serum total to HDL cholesterol and on serum lipids and apolipoproteins: a meta-analysis of 60 controlled trials". The American Journal of Clinical Nutrition. 77 (5): 1146-55. PMID 12716665.

Miwa K, Memon RA, Staprans I. (2000). Low density lipoprotein particles are small in Infection and inflammation induce LDL oxidation in vivo. Arterioscler Thromb Vasc Biol. 20:1536-42.

Moliterno DJ, Jokinen EV, Miserez AR, Lange RA, Willard JE, Boerwinkle E, Hillis LD, Hobbs HH. (1995). No association between plasma lipoprotein(a) concentrations and the presence or absence of coronary atherosclerosis in African-Americans. Arteriosclerosis, thrombosis, and vascular biology. 1995;15:850-855.

Morris AD, Petrie JR, Connell JMC. (1995). Insulin and hypertension. J Hypertens 1994; 12: 633-42.

National Cholesterol Education Program (NCEP). (2002). Expert Panel on Detection, E. "Third Report of the national cholesterol Education Program, Expert Panel on Detection, Evaluation, and treatment of High blood cholesterol in Adults. (Adult treatment panel III), Final report". Circulation. 106 (25): 3143-3421.

Navab M, Amantharamaiah GM, Reddy ST. (2009). HDL as a biomarker potential therapeutic target and therapy. Diabetes.2009;58:2711-17.

Nelson, D. L. Cox, M. M. (2000). Lehninger, Principles of Biochemistry (3rd ed.). New York: Worth Publishing. ISBN 1-57259-153-6.

Nissen S.E. (2004). Effect of intensive compared with moderate lipid-lowering therapy on progression of coronary atherosclerosis: a randomized controlled trial. JAMA. 291(9):1071-80.

Nissen SE, Tuzcu EM, Schoenhagen P, Brown BG, Ganz P & Vogel RA. (2004). Investigators, Reversal. Effect of intensive compared with moderate lipid-lowering therapy on progression of coronary atherosclerosis: a randomized controlled trial. JAMA, 291(9), 1071-1080. 11.

Nnodim JK, Opara AU, Nwanjo HU. (2012). Plasma Lipid Profile in Sickle Cell Disease Patients in Owerri, Nigeria. Pakistan Journal of Nutrition. 11(1): 64-65.

Nordestgaard, BG; Varbo, A. (2014). "Triglycerides and cardiovascular disease". The Lancet .384 (9943): 626-35. PMID 25131982.

Ohvo-Rekil& H, Ramstedt B, Leppim&ki P, Slotte JP. (2000). "Cholesterol interactions with phospholipids in membranes". Prog. Lipid Res. 41 (1): 66-97. PMID 11694269.

Ohvo-Rekila, H., Ramstedt, B., Leppimaki, P. And Slotte, J.P. (2002). "cholesterol interactions with phospholipids in membranes". Prog. Lipid. Res. 41 (1): 66-97.

Omoigui, S. (2007). The Interleukin-6 inflammation pathway from cholesterol to aging-- role of statins, bisphosphonates and plant polyphenols in aging and age-related diseases. Immun Ageing, 4, 1:60-96.

Pari L, Latha M. (2002). Effect of Cassia auriculata flowers on blood sugar levels. serum and tissue lipids in streptozotocin diabetic rats. Singapore M ed J. 43:617-2.

Patton, Kevin T. Thibodeau, Gary A. (2010). Anatomy and Physiology (7 ed.). Mosby/Elsevier. ISBN 978-9996057762.

Paul SJ. (2000). Medical Guidelines for Clinical Practice for the Diagnosis and Treatment of Dyslipidemia and Prevention of Atherogenesis, AACA lipid guidelines. Endo Pract 6(2):162-213.

Paultre F, Pearson TA, Weil HF, Tuck CH, Myerson M, Rubin J, Francis CK, Marx HF, Philbin EF, Reed RG, Berglund L. (2000). High levels of Lp(a) with a small apo(a) isoform are associated with coronary artery disease in African American and white men. Arteriosclerosis, thrombosis, and vascular biology. 20:2619-2624.

Pawlina W, Ross MW. (2006). Histology: a text and atlas: with correlated cell and molecular biology. Philadelphia: Lippincott Wiliams & Wilkins. P. 230. ISBN 978-0-7817-5056-1.

Pawlina, W. Ross, M.W. (2006). Histology: a text and atlas: with correlated cell and Pharmacotherapy Handbook, 6th ed.mcgraw-Hill publications. P. 89 prevention in the elderly: new evidence in hypertension and hyperlipidemia. Eur J Intern Med; 20:586-90.

Payne AH, Hales DB. (2004). "Overview of steroidogenic enzymes in the pathway from cholesterol to active steroid hormones". Endocrine Reviews 25 (6): 947-70. PMID 15583024.

Peter P (2005). The Good Cholesterol. Circulation.(111), 89-91.

Pfohl M, Schreiber I, Liebich HM, Hairing HU, Haffmeister HM. (1999). Upregulation of cholesterol synthesis after acute myocardialinfarction-is cholesterol a positive acute phase reactant ? Atherosclerosis. 142:389-393.

Rader DJ, Mann WA, Cain W, Kraft HG, Usher D, Zech LA, Hoeg JM, Davignon J, Lupien P, Grossman M. (1995). The low density lipoprotein receptor is not required for normal catabolism of Lp(a) in humans. J Clin Invest. 95:1403-1408.

Rader DJ. Cain W, Ikewaki K, Talley G, Zech LA, Usher D, Brewer HB Jr. (1994). The inverse association of plasma lipoprotein(a) concentrations with apolipoprotein(a) isoform size is not due to differences in Lp(a) catabolism but to differences in production rate. J Clin Invest. 93:2758-2763.

Rader, D. J. Ikewaki, K. Duverger, N. Feuerstein, I. Zech, L., Connor, W. & Brewer, H. B. Jr. (1993). Very low high-density lipoproteins without coronary atherosclerosis. Lancet, 342, 1455-8.

Rana JS, Bockholdt SM, Kastelein JJP, Shah PK. cholesterol in risk stratification for coronary artery disease. Curratheroscler. 14(2):130-4. 43. Asssmann G, Schulte H, Funke H, voncckardstein A. The (2012). The role of non-HDL emergence of triglycerides as a significant independent risk factor in coronary artery disease. Eur Heart J. 19(suppl M):M8-M14.

Razin S. Tully JG. (2003). "Cholesterol Requirement of Mycoplasmas". Journal of Bacteriology. 102 (2): 306-310.PMC 247552. PMID 4911537.

Richard MB. Cdemargaret AP. Alan W Adjust to Target in Type2 Diabetes. Comparison of a simple algorithm with Aleksandra V. Priscilla H. Marc R. (2008). carbohydrate counting for Adjustment of mealtime insulin glulisine Diabetes Care. 31:1305-131.

Ridker PM, Genest J, Boekholdt SM, Libby P, Gotto AM, Nordestgaard BG. (2010). HDL cholesterol and residual risk of first cardiovascular events after treatment with potent statin therapy: an analysis from the JUPITER trial. Lancet; 376:333-9.

Roe, M. T. Ou, F. S. Alexander, K. P. Newby, L. K. Foody, J. M. Gibler, W. B. Boden, W. E. Ohman, E. M. Smith, S. C. Jr. Peterson, E. D. (2008). Patterns and prognostic implications of low highdensity lipoprotein levels in patients with non-ST-segment elevation acute coronary syndromes. Eur Heart J, 29,2480-8.

Rosanoff A, Seelig MS. (2004). "Comparison of mechanism and functional effects of magnesium and statin pharmaceuticals". Journal of the American College of Nutrition. 23 (5): 501S-505S.PMID 15466951.

Ruidavets JB, Ducimetière P, Arveiler D, Amouyel P, Bingham A, Wagner A, Cottel D, Perret B, Ferrières J. (2002). "Types of alcoholic beverages and blood lipids in a French

population". Journal of Epidemiology and Community Health. 56 (1): 24-8. PMC 1732002. PMID 11801616.

Sacheck JM, Kuder JF. (2010). Economos CD. Physical fitness, adiposity, and metabolic risk factors in Young college students. Med Sci Sports Exerc. 2010;42(6):1039-44.

Sacks FM, Zheng C, Cohn JS. (2011). "Complexities of plasma apolipoprotein C-III metabolism" Journal of Lipid Research. 52 (6): 1067-1070. PMC 3090227 PMID 21421846.

Sadava D, Hillis DM, Heller HC, Berenbaum MR. (2011). Life: The Science of Biology 9th Edition. San Francisco: Freeman. Pp. 105-114. ISBN 978-1-4292-4646-0.

Salvaro RP, Avila Júnior S. (2009). Perfil lipídico e sua relação com fatores de risco cardiovascular em estudantes de nutrição. Rev SOCERJ. 22(5):309-17

Schneider M, Witztum JL, Young SG, Ludwig EH, Miller ER, Tsimikas S, Curtiss LK, Marcovina SM, Taylor JM, Lawn RM, Innerarity TL, Pitas RE. (2005). High-level lipoprotein [a] expression in transgenic mice: evidence for oxidized phospholipids in lipoprotein [a] but not in low density lipoproteins. J Lipid Res. 46:769-778.

Segrest JP, Jones MK, De Loof H, Dashti N. (2017). "Structure of apolipoprotein B-100 in low density lipoproteins". Journal of Lipid Research. 42 (9): 1346-67.

Shao, Baohai. Heinecke, Jay W. (2009). "HDL, lipid peroxidation, and atherosclerosis". Journal of Lipid Research. 50 (4): 599-601. PMC 2656652. PMID 19141435.

Shih KC. Kwak CF. Hwa CM. (1997). Acipimox attenuates hypertriglyceredem ia in dislipidemic Non-insulin dependent diabetes mellitus patients without perturbation of insulin sensitivity and glycemic control. Diabetic Res. Clin. Pract.1997, 36 (2), 113-119.

Sidhu, D. Naugler, C. (2012). "Fasting Time and Lipid levels in a community – Based population. Archives of Internal Medicine. 1-4:282.

Simons LA. Simons J. Friedlander T. Mcallum J. (2001). Cholesterol and other lipids predict coronary heart disease and ischem ic stroke in the elderly but in those be-low 70 years. Atherosclerosis. 12: 173-181.

Sinaiko AR, Donahue RP, Jacobs DR, Prineas RJ. (1999). Relation of weight and rate of increase in weight during childhood and adolescence to body size, blood pressure, fasting insulin and lipids in young adults. Circulation 99: 1471-6.

Smelt AH. (2010). Triglycerides and gallstone formation. Clin Chim Acta; 411:1625-31.

Soudijn W, van Wijngaarden I, Ijzerman AP. (2007). "Nicotinic acid receptor subtypes and their ligands". Medicinal Research Reviews .27 (3): 417-33. PMID 17238156.

Spate-Douglas T, Keyser RE. (1999).. "Exercise intensity: its effect on the high-density lipoprotein profile". Archives of Physical Medicine and Rehabilitation. 80 (6): 691-5. PMID 10378497.

Steinberg, S. J. Wang, S. J. KM, D. G. Mihalik, S. J. Watkins, P. A. (1999). Human very- long-chain acyl-coa synthetase: cloning, topography, and relevance to branched- chain fatty acid metabolism. Biochem Biophys Res Commun, 257, 615-21.

Stephens NA, Kieft R, Macleod A, Hajduk SL. (2012). "Trypanosome resistance to human innate immunity: targeting Achilles' heel". Trends in Parasitology. 28 (12) 539-45. PMID 23059119.

Stevenson, S. C., Wang, S., Deng, L. Tall, A. R. (1993). Human plasma cholesteryl ester transfer protein consists of a mixture of two forms reflecting variable glycosylation at asparagine 341. Biochemistry, 32, 5121-6.

Stocker, Roland; Keaney, John F. (2004). "Role of Oxidative Modifications in Atherosclerosis". Physiological Reviews. 84 (4): 1381-1478. PMID 15383655.

Taleb A, Witztum JL, Tsimikas S. (2011). Oxidized phospholipids on apob-100-containing lipoproteins: a biomarker predicting cardiovascular disease and cardiovascular events. Biomarkers in medicine. 5:673-694.

Tall, A. R. (1993). Plasma cholesteryl ester transfer protein. J Lipid Res, 34, 1255-74.

Thijssen, M.A, R.P. Mensink. (2005). Fatty Acids and Atherosclerotic Risk. In Arnold von Eckardstein (Ed.) Atherosclerosis: Diet and Drugs. Springer. Pp. 171-172. ISBN 978-3-540-22569-0.

Third Report of the National Cholesterol Education Program (NCEP). (2002). Expert panel on detection, evaluation and treatment of high blood cholesterol in adults (Adult Treatment Panel III) final report. Circulation. 106421.46.

Tsimikas S, Bergmark C, Beyer RW, Patel R, Pattison J, Miller E, Juliano J, Witztum JL. (2003). Temporal increases in plasma markers of oxidized low-density lipoprotein strongly reflect the presence of acute coronary syndromes. J Am Coll Cardiol. 41:360-370.

Tsimikas S, Clopton P, Brilakis ES, Marcovina SM, Khera A, Miller ER, de Lemos JA, Witztum JL. (2009). Relationship of oxidized phospholipids on apolipoprotein B-100 particles to race/ethnicity, apolipoprotein(a) isoform size, and cardiovascular risk factors: results from the Dallas Heart Study. Circulation. 119:1711-1719.

Tsimikas S, Mallat Z, Talmud PJ, Kastelein JJ, Wareham NJ, Sandhu MS, Miller ER, Benessiano J, Tedgui A, Witztum JL, Khaw KT, Boekholdt SM. (2012). Oxidation-specific biomarkers, lipoprotein (a), and risk of fatal and nonfatal coronary events. J Am Coll Cardiol. 56:946-955.

Tsimikas S, Viney NJ, Hughes SG, Singleton W, Graham MJ, Baker BF, Burkey JL, Yang Q. Marcovina SM, Geary RS, Crooke RM, Witztum JL. (2015). Antisense therapy targeting apolipoprotein(a): a randomised, double-blind, placebo-controlled phase 1 study.Lancet. 20:156-875.