Egg Yolk increases Lipid Profile in Wistar Rats; Protective Effect of *Carica papaya* seed extract

Inneh C. A and Momodu O. I

Department of Physiology, School of Basic Medical Sciences, College of Medical Sciences, University of Benin, Benin City.

***Corresponding author**
Email: churchill.inneh@uniben.edu

Abstract
Background: Egg yolk has been reported to contain a significant amount of cholesterol. There have been controversies with repect to the impact of dietary egg yolk on plasma cholesterol. This study was carried out to investigate the effect of egg yolk on the lipid profile and the hypolipidemic potential of *Carica papaya* seed extract in Wistar rats.
Method: Thirty five (35) Adult Wistar rats weighing between 150-200g were assigned into seven groups with five (5) animals per group. Rats in group A served as control while group B1 animals were administered with 2ml of egg yolk for two weeks. Group B2 animals were administered with 2ml of egg yolk for four weeks; group C1 and C2 were administered with 400mg/kg body weight (bwt) of aqueous seed extract of *Carica papaya* for two weeks and four weeks respectively; while group D1 and D2 were co-administered with 2ml of egg yolk and 400mg/kg bwt of aqueous seed extract of *Carica papaya* for two weeks and four weeks respectively. At the end of the experimental period, the rats were sacrificed and blood samples were collected into plain sample bottles. Lipid profile (Total cholesterol (TC), triglycerides (TG), high density lipoprotein (HDL-C), low density lipoprotein (LDL-C), Very low density lipoprotein (VLDL-C) were analyzed using spectrophotometric methods
Results: There was a significant increase in total cholesterol, triglycerides, low density lipoproteins (LDL), very low density lipoproteins (VLDL) and a significant decrease in high density lipoproteins (HDL) in rats administered with egg yolk for two weeks and four weeks when compared with those of the control. In rats that were co-treated with egg yolk and *Carica papaya* there was a significant decrease in total cholesterol, triglycerides, low density lipoproteins (LDL), very low density lipoproteins (VLDL) and a significant improvement in high density lipoproteins (HDL) when compared to those that were treated with egg yolk only for two weeks and four weeks respectively. **Conclusion:** This study has shown egg yolk increases serum lipids and *Carica papaya* seed extract possesses hypolipidemic effect and could be of therapeutic benefit in the management of dyslipidemia and other lipid associated disorders.

Keywords: Egg yolk, Lipid profile, *Carica papaya*

Received: *11th March, 2023* ***Accepted:*** *2nd May, 2023*

Introduction

Hypercholesterolemia is a lipoprotein metabolic disorder characterized by high serum cholesterol and low density lipoprotein (1). Hypercholesterolemia is risk factor for the development and progression

of atherosclerosis and other cardiovascular diseases (2). Several studies have linked dietary cholesterol to the risk of developing cardiac diseases (3, 4). Plasma cholesterol level, particularly the low-density lipoprotein (LDL) cholesterol has been reported to be directly associated with cardiovascular diseases (5). This relationship between blood cholesterol and heart disease was first established by the Framingham Heart Study (6). Egg yolk has been reported to contain a significant amount of cholesterol (7, 8). A single egg yolk contains approximately 215 to 275mg of cholesterol (depending on the size) which is more than the 200mg/day limit recommended by the National Cholesterol Education Program (NCEP) for patients with cardiovascular disease (9). The daily recommended limit for cholesterol intake is 300mg/day (10).

There have been conflicting reports over the years on the impact of dietary egg yolk on blood cholesterol. Some studies have reported egg yolk does not significantly alter plasma total cholesterol and other lipids (11, 12, 13, 14) while others have reported egg yolk increases blood cholesterol levels (15, 16, 17). Several drugs help to reduce plasma LDL-C levels, but these synthetic medications also produce adverse effects such as diarrhoea, nausea, myositis and abnormal liver function (18). Hence the search for alternative compounds with hypolipidemic potential.

Carica Papaya is a fast growing tropical perennial tree that is mainly cultivated for its nutritional, medicinal and industrial properties (19). It is popularly known as pawpaw or *papaya* and belongs to the family *Caricaceae*. Its fruits are edible, sweet and juicy and contain more than 1000 seeds which are embedded in the fruit pulp (20). The seeds have been reported to contain oleic acid, Vitamins A, B, C and E (21), flavonoids, saponins, tannins (22). The seeds are black in color and are often considered as a by-product. However, *Carica papaya* seed extracts have been reported to have several medicinal properties notably antibacterial activity (23), anti-helminthic (24), nephro-protective activity (25), anti-fertility effect (26), antioxidant effect (27) and relatively few reports on its hypolipidemic effect. With conflicting reports on the impact of egg yolk on plasma lipids, this study was carried to investigate the effect of dietary egg yolk on lipid profile and the hypolipidaemic effect of *Carica papaya* seed extract.

Materials and Method

Experimental animal

Thirty five (35) adult Wistar rats weighing 150-200g were purchased from the animal house of the Department of Anatomy, School of Basic Medical Sciences, University of Benin. These animals were kept in well cleaned plastic cage with wire mesh cover and had free access to clean water and mash *ad libitum* in accordance with the guidelines of National Research Council Guide for the care of laboratory animals (28), They were allowed to acclimatize for two weeks with free access to food and water before the commencement of the experiment.

Experimental Design

Rats were assigned into seven groups with five (5) rats per group. Group A served as control while group B1 rats were administered with 2ml of raw egg yolk for two weeks. Group B2 animals were administered with 2ml of raw egg yolk for four weeks. Group C1 and C2 were administered with 400mg/kg bwt of aqueous seed extract of *Carica papaya* for two weeks and four weeks respectively. Group D1 and D2 animals were co-administered with 2ml of raw egg yolk and 400mg/kg bwt of aqueous seed extract of *Carica Papaya* for two weeks and four weeks respectively.

Collection of Plant Material

Nine mature, ripe fruits of *Carica papaya* were collected from the farm of Faculty of Agriculture, University of Benin, Benin City, Edo – State, Nigeria.

Preparation of Extract

The *Carica Papaya* seed extraction was carried out according to the methods previously described by Adeneye et al. (29). The fruits were first cut into pieces and the seeds were separated out from the fruit. The seeds were gently but thoroughly rinsed in tap water and completely air-dried at room temperature for 3 weeks (29). The dried seeds were pulverized into fine powder using a new domestic mixer grinder (Kanchan Tycoon®, Kanchan International Limited Unit III, Daman, India). 60 g of the powdered *Carica Papaya* seeds was boiled in 500 mL of distilled water for 40 minutes after which it was filtered using a piece of clean white cotton gauze. The filtrate was evaporated to complete dryness at 40 ºC, producing a fine chocolate color solid residue (29). The extraction process was repeated 4 times and the solid residue was weighed after extraction and pooled together in an air- and water-proof container kept in a refrigerator. Fresh preparations were made from the stock whenever required. The various dose calculations were done based on the average mg/kg body weight of the animals.

Collection of blood samples

At the end of the experimental period, the final weights of the rats were recorded before being subjected to an overnight fast. The rats were anesthetized under chloroform sedation and a midline cut was made through the anterior abdominal wall of the rats with a dissecting scissors. Blood samples were collected by cardiac puncture and then kept in plain bottles. The blood samples were allowed to clot, and then serum was obtained by centrifugation which was utilized for biochemical analysis.

Assays for the Serum Lipid Profiles

The serum levels of cholesterol, triglyceride, and HDLC were measured spectrophotometrically, using enzymatic colorimetric assay kits (Randox, Northern Ireland). Total Serum Cholesterol was analyzed using the method of Allain (30) while HDL-C was analyzed using the method of Lopes (30). Serum triglyceride was determined by the enzymatic method of Stein, (32) low-density lipoprotein cholesterol (LDLC) and very low-density lipoprotein cholesterol (VLDLC) was extrapolated from total cholesterol, triglyceride and HDL by the method of Friedwald (33).

Statistical analysis

Statistical analysis was carried out using the Graphpad Prism 6 software, version 6.1. One-way Analysis of variance (ANOVA) was used to assess the significant differences among multiple groups under various treatments. Results were expressed as Mean ± SEM and P values ≤ 0.05 or $p \leq 0.01$were considered statistically significant.

Results

Effect of egg yolk and *Carica papaya* on total cholesterol

The total cholesterol (TC) was significantly higher in rats feed with 2ml of egg yolk for 2 weeks (group B1) and 4 weeks respectively (group B2) when compared to those of the control (group A) (figure 4.1 and figure 4.2). However, in rats co-administered with aqueous extract of *Carica papaya* seeds and 2ml of egg yolk for 2 weeks (group D1) and 4 weeks (group D2), there was a significant reduction ($P< 0.01$) in the serum total cholesterol when compared with those treated with egg yolk only for 2 weeks (group B1) and 4 weeks (group B2) respectively (see figure 4.1 and figure 4.2).

Effect of egg yolk and *Carica papaya* on triglycerides

Triglycerides(TG) concentration was significantly higher in rats fed with 2ml of egg yolk for 2 weeks (group B1) and 4 weeks (group B2) when compared to those of the control (group A) respectively. In rats co-administration of aqueous extract of *Carica papaya* seeds and 2ml of egg yolk for 2 weeks (group D1) and 4 weeks (group D2) there was a significantly reduction ($P < 0.01$) the serum triglyceride concentration when compared with those treated with egg

yolk only for 2 weeks (B1) and 4 weeks (B2) respectively (see figure 4.3 and figure 4.4).

Effect of egg yolk and *Carica papaya* on Low density lipoprotein cholesterol (LDL-C)

There was a significant increase in the LDL-C in rats fed with 2ml of egg yolk for 2 weeks (group B1) and 4 weeks (group B2) when compared to those of the control (group A) respectively. However, in rats co-administered with aqueous extract of *Carica papaya* seeds and 2ml of egg yolk for 2 weeks (group D1) and 4 weeks (group D2), *Carica papaya* was able to significantly reduce ($P < 0.01$) the LDL-C when compared with those treated with egg yolk only for 2 weeks (group B1) and 4 weeks (group B2) respectively (See figure 4.7 and figure 4.8).

Effect of egg yolk and *Carica papaya* on Very Low density lipoprotein cholesterol (VLDL-C)

VLDL was significantly higher in rats fed with 2ml of egg yolk for 2 weeks (B1) and 4 weeks (B2) when compared to those control (group A) respectively. In rats co-administered of aqueous extract of *Carica papaya* seeds and 2ml of egg yolk for 2 weeks (group D1) and 4 weeks (group D2), there was a significantly reduction ($P <0.01$) of VLDL (group D1) when compared with those treated with egg yolk only for 2 weeks (B1) and 4 weeks (B2) respectively (See figure 4.9 and figure 4.10).

Effect of egg yolk and *Carica papaya* on High density lipoprotein cholesterol (HDL-C)

There was a significant increase in the HDL-C in rats fed with 2ml of egg yolk for 2 weeks (group B1) and 4 weeks (group B2) when compared to those of the control (group A) respectively. In rats co-administered of aqueous extract of *Carica papaya* seeds and 2ml of egg yolk for 2 weeks (group D1) and 4 weeks (group D2),, there was a significantly improvement ($P < 0.01$) in HDL (group D1) when compared with those treated with egg yolk only for 2 weeks (B1) and 4 weeks (B2) respectively.

Discussion

High dietary fat intake is a major risk factor for the development of obesity and cardiovascular diseases (34). Lipid profile measurement is a valuable tool for the assessment of cardiovascular health as well as risk of liver, cardiovascular and metabolic diseases (35). Atherosclerosis, coronary artery disease and other cardiovascular diseases are often associated with increased serum lipids except high density lipoproteins (36). There has been conflicting reports on the association of dietary egg yolk (which contains a significant amount of cholesterol) on plasma total cholesterol over the years with some studies reporting egg yolk has no effect on plasma total cholesterol (11,12) and others reporting a significant effect of dietary egg yolk on total cholesterol (37,15). This necessitated this study which was carried out to investigate the effect of egg yolk on the lipid profile of Wistar rats and the hypolipidemic effect of *Carica papaya* seed extract.

In this study, the total cholesterol, triglyceride, low density lipoprotein and very low density lipoprotein were significantly ($P<0.01$) increased in rats administered with 2ml of egg yolk exclusively for the two weeks and four weeks respectively. This finding is in tandem with the findings of Chakrabarty *et al*., (38); Weggemans *et al.* (15); Sacks *et al.* (39) and Djousse *et al.* (17) who have similarly reported that egg yolk to increases serum lipids. The increase in total cholesterol, low density lipoprotein (LDL) and very low density lipoprotein (VLDL) can be attributed to the significant amount of cholesterol contained in egg yolk. Egg yolk contains 275mg of cholesterol (9). Dietary cholesterol has been shown to increase LDL, VLDL in numerous studies (40, 41). Egg yolk has also been reported to

contain significant amount of saturated and trans-fats, which can increase triglyceride levels considerably (42). High density lipoprotein (HDL) was significantly reduced in rats administered with egg yolk for 2 weeks and 4 weeks. HDL is termed the good cholesterol and plays an important role in removing cellular cholesterol and transporting them to the liver where it is converted to bile acids and eventually excreted from the body (43). Thus they are very beneficial and reduce the risk of cardiovascular diseases. The significant reduction in HDL and increase in cholesterol, LDL, VLDL and triglycerides in rats treated with egg yolk thus further highlights the negative impact of excessive consumption of egg yolk and their increase risk in inducing dyslipidemia

However, there was a significant reduction ($P < 0.01$) in the mean level of total cholesterol (TC), triglycerides (TG), low density lipoprotein (LDL), very low density lipoprotein (VLDL) and a significant improvement in high density lipoprotein (HDL) in rats that were co-administered with 2ml of egg yolk and 400mg/kg body weight of aqueous seed extract of *Carica papaya* for two and four weeks respectively when compared with rats treated with 2ml of egg yolk only. The result indicates that *Carica papaya* seed extract possess hypolipidemic effect. The hypolipidemic effect of *Carica papaya* seed extract has been previously reported by (44, 45). The hypolipidemic effect of *Carica papaya* can be attributed to its chemical composition, which shows the presence of alkaloids, flavonoids, tannins, saponin and cardiac glycosides (46, 22). Flavonoids, saponins and tannins have been reported to play significant roles in the metabolism of lipids (47) and reduce serum lipid level in animals (48). Inhibition of hepatic cholesterol biosynthesis, enhanced plasma lecithin: Cholesterol acyl transferase activity or reduction of lipid absorption in the intestine has also been reported as mechanisms by which *Carica papaya* induce hypolipidaemia (49). The reduction in the serum triglyceride level by *Carica papaya* seed extract has been attributed to its ability to inhibit lipolysis (50, 45). In the co-treatment protocol between egg yolk and *Carica papaya* there was a significant improvement in HDL in these rats when compared to rats that received egg yolk only for two and four weeks. This significant improvement in HDL by *Carica papaya* thus indicates that it could be beneficial in the management of hypercholesterolemia and other cardiovascular disorders.

Conclusion

This study has shown egg yolk increases serum lipids and *Carica papaya* seed extract possesses hypolipidemic effect and could be of therapeutic benefit in the management of dyslipidemia and other lipid associated disorders

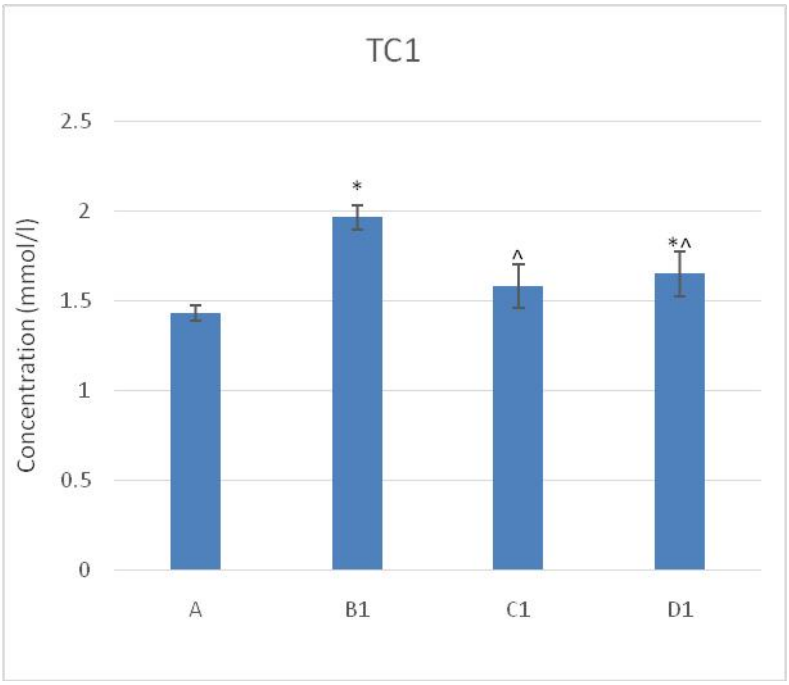

Figure 4.1: Serum Total cholesterol (TC) in rats for the first two weeks. The data are represented as Mean ± SEM. n=5; * represents significant (P<0.01) difference compared with group A; ^ represents significant (P<0.01) difference compared with group B1.

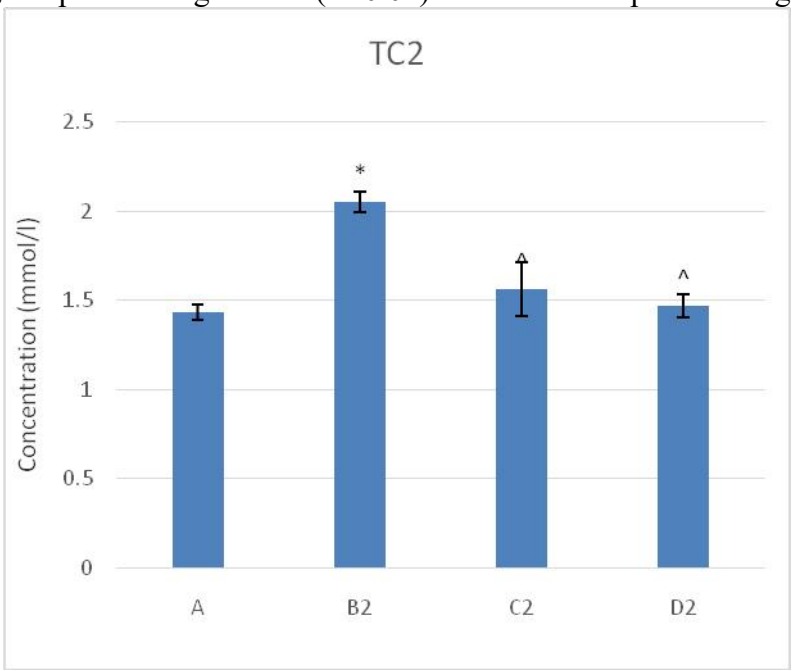

Figure 4.2: Serum Total cholesterol (TC) in rats for the four weeks. The data are represented as Mean ± SEM. n=5; * represents significant (P<0.01) difference compared with group A; ^ represents significant (P<0.01) difference compared with group B2.

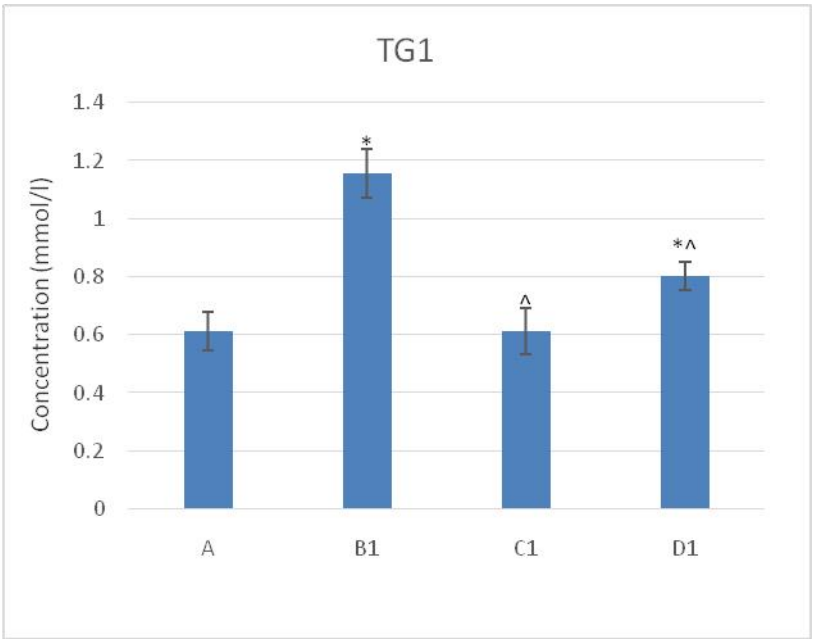

Figure 4.3: Serum Triglyceride concentration (TG) for the first two weeks. The data are represented as Mean ± SEM in the Bar Charts, n=5; * represents significant (P<0.01) difference compared with group A; ^represents significant (P<0.01) difference compared with group B1.

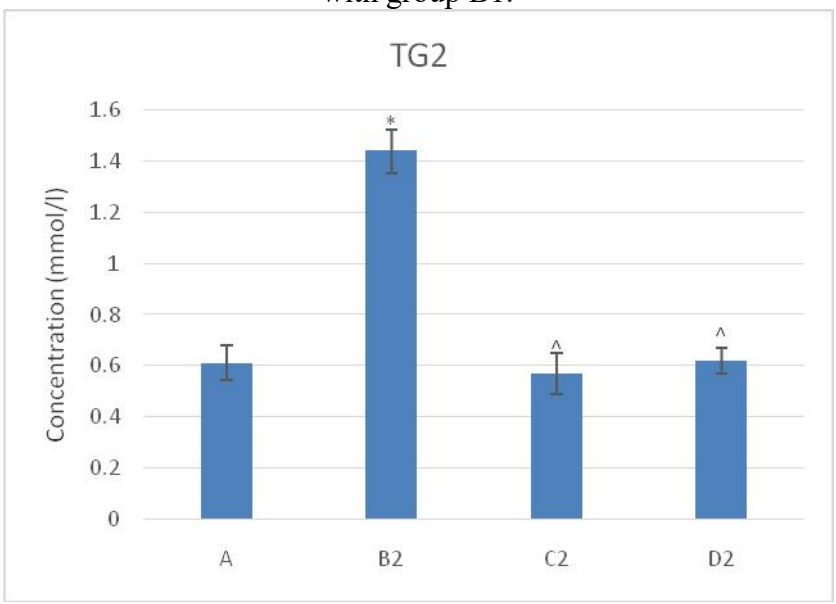

Figure 4.4: Serum Triglyceride concentration (TG) for four weeks. The data are represented as Mean ± SEM in the Bar Charts, n=5; * represents significant (P<0.01) difference compared with group A; ^represents significant (P<0.01) difference compared with group B2.

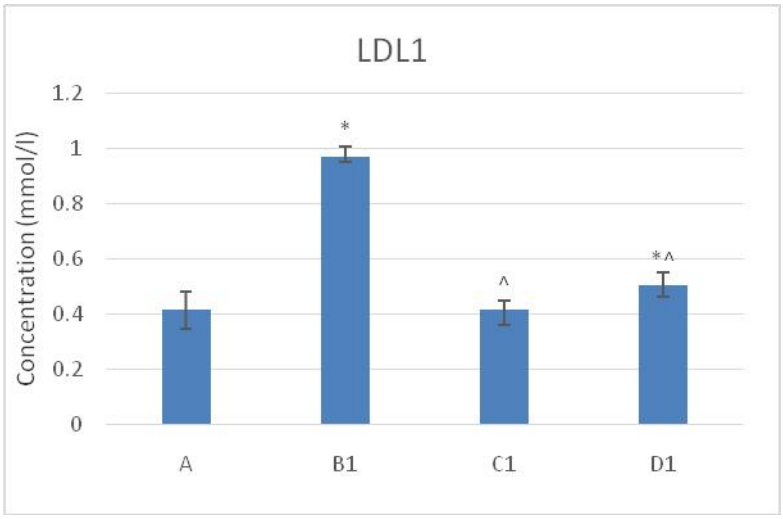

Figure 4.7: Serum Low Density Lipoprotein Cholesterol (LDL-C) in rats for the first two weeks. The data are represented as Mean ± SEM in the Bar Charts, n=5; * represents significant (P<0.01) difference compared with group A; ^represents significant (P<0.01) difference compared with group B1.

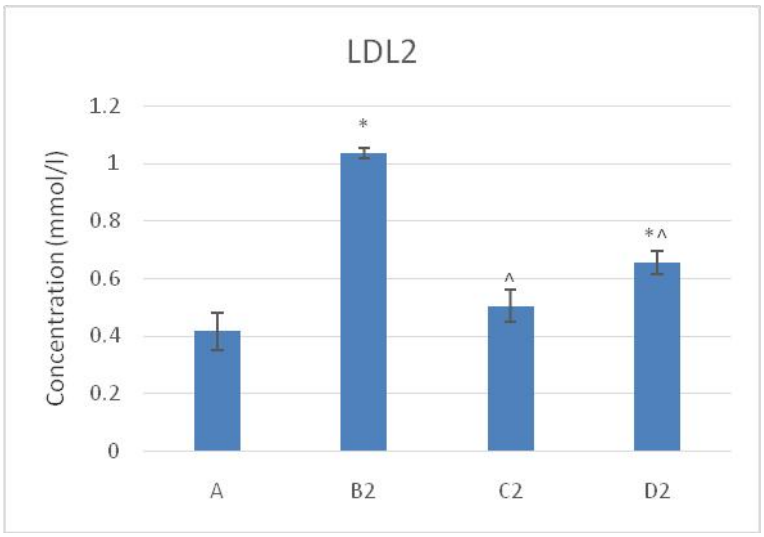

Figure 4.8: Serum Low Density Lipoprotein Cholesterol (LDL-C) in rats for four weeks. The data are represented as Mean ± SEM in the Bar Charts, n=5; * represents significant (P<0.01) difference compared with group A; ^represents significant (P<0.01) difference compared with group B2.

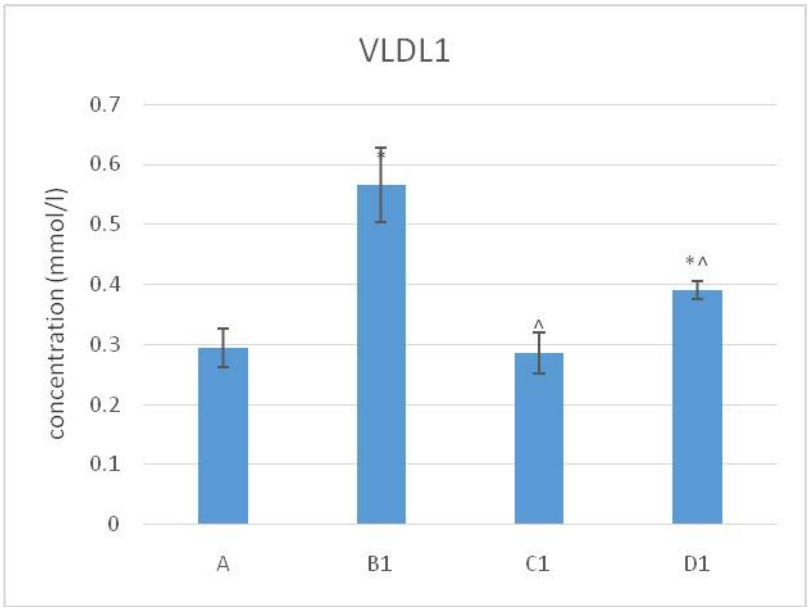

Figure 4.9: Serum Very Low Density Lipoprotein Cholesterol (VLDL-C) in rats for the first two weeks. The data are represented as Mean ± SEM in the Bar Charts, n=5; * represents significant (P<0.01) difference compared with group A; ^represents significant (P<0.01) difference compared with group B1

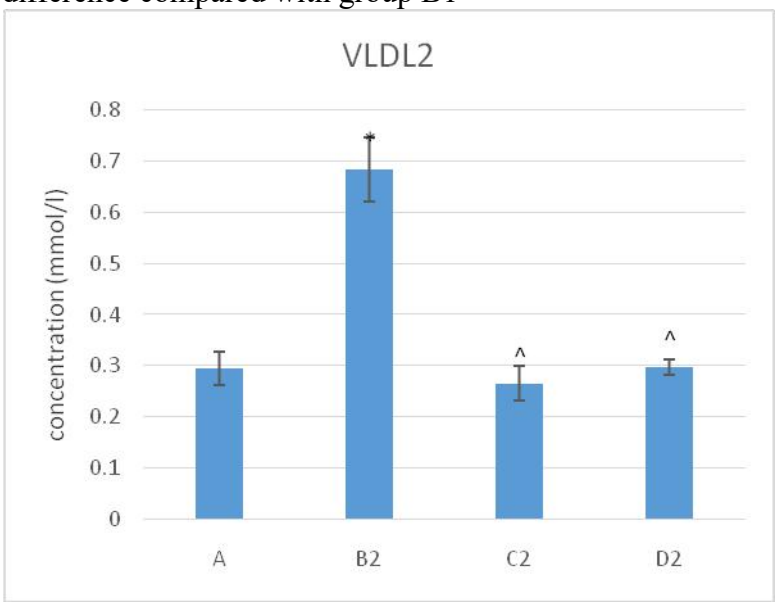

Figure 4.10: Serum Very Low Density Lipoprotein Cholesterol (VLDL-C) in rats for four weeks.. The data are represented as Mean ± SEM in the Bar Charts, n=5; * represents significant (P<0.01) difference compared with group A; ^represents significant (P<0.01) difference compared with group B2.

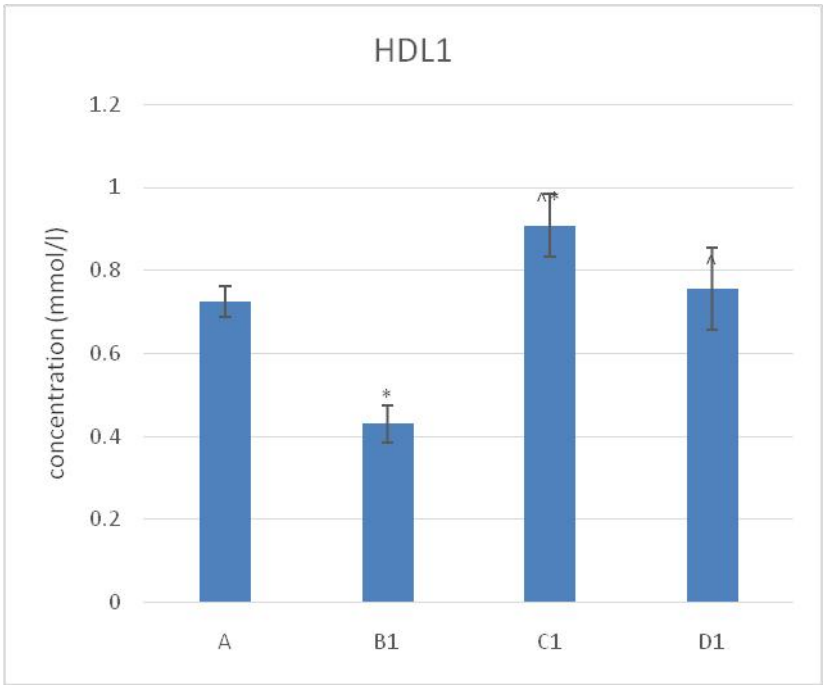

Figure 4.9: Serum High Density Lipoprotein Cholesterol (HDL-C) in rats for the first two weeks. The data are represented as Mean ± SEM in the Bar Charts, n=5; * represents significant (P<0.01) difference compared with group A; ^ represents significant (P<0.01) difference compared with group B1.

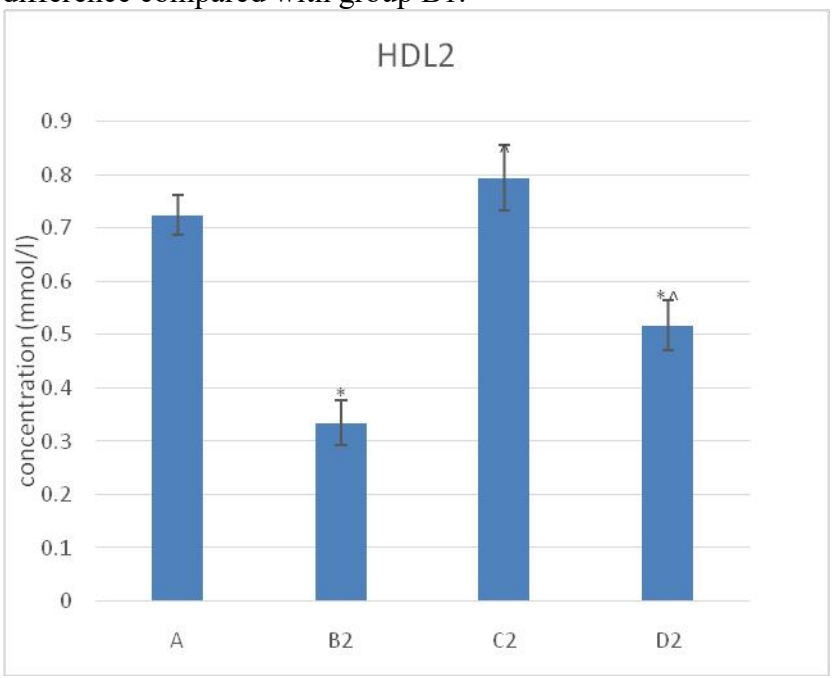

Figure 4.10: Serum High Density Lipoprotein Cholesterol (HDL-C) in rats for four weeks.The data are represented as Mean ± SEM in the Bar Charts, n=5; * represents significant (P<0.01) difference compared with group A; ^ represents significant (P<0.01) difference compared with group B2.

References

1. Goldstein J, Hobbs H, Brown M. Familial Hypercholesterolemia. In The Metabolic Basis of Inherited Disease. Edited by: Scriver C, Baudet A, Sly W, Valle D. *New York: McGraw Hill*: 2863-2913, 2014.
2. Rerkasem K, Gallagher PJ, Grimble RF, Calder PC, Shearman CP. Managing hypercholesterolemia and its correlation with carotid plaque morphology in patients undergoing carotid endarterectomy. Vascular health and risk management. 2008; 4(6): 1259-1264.
3. Dietschy JM, Siperstein MD. Effect of cholesterol feeding and fasting on sterol synthesis in seventeen tissues of the rat. *Journal of Lipid Research*, 1967; *8*(2): 97-104.
4. Wilson JD, Lindsey CA, Dietschy JM. Influence of dietary cholesterol on cholesterol metabolism. Ann. N. Y. Acad. Sci. 1968; 149: 808–821.
5. Berger S, Raman G, Vishwanathan R, Jacques PF, Johnson EJ. Dietary cholesterol and cardiovascular disease: a systematic review and meta-analysis. The American journal of clinical nutrition, 2015; *102*(2)**:** 276-294.
6. Mahmood SS, Levy D, Vasan RS, Wang T.J. The Framingham Heart Study and the epidemiology of cardiovascular disease: a historical perspective. Lancet (London, England), 2014; *383*(9921): 999–1008
7. US Department of Agriculture, Agricultural Research Service, Nutrient Data Laboratory. USDA National Nutrient Database for Standard Reference, 2018 [Internet]. Available from:https://ndbnalusdagov/ndb/.
8. Vorster HH, Beynen AC, Berger GM, Venter CS. Dietary cholesterol--the role of eggs in the prudent diet. *South African medical journal* 1995; *85*(4): 253–256.
9. Spence JD, Jenkins DJ, Davignon, J. Dietary cholesterol and egg yolks: not for patients at risk of vascular disease. The Canadian journal of cardiology, 2010; *26*(9): e336–e339.
10. Krauss RM, Eckel RH, Howard B, Appel LJ, Daniels SR, Deckelbaum RJ, Bazzarre TL. AHA Dietary Guidelines: revision 2000: A statement for healthcare professionals from the Nutrition Committee of the American Heart Association. *Circulation*, 2000; *102*(18): 2284-2299.
11. Dehghan M, Mente A, Rangarajan S, Mohan V, Lear S, Swaminathan S, Wielgosz A, Seron P, Avezum A, Lopez-Jaramillo P, Turbide G. Association of egg intake with blood lipids, cardiovascular disease, and mortality in 177,000 people in 50 countries. The American Journal of Clinical Nutrition. 2020; 111(4): 795-803..
12. Harman NL, Leeds AR, Griffin BA. Increased dietary cholesterol does not increase plasma low density lipoprotein when accompanied by an energy-restricted diet and weight loss. European journal of nutrition, 2008; *47*: 287-293.
13. Reaven GM, Abbasi F, Bernhart S, Coulston A, Darnell B, Dashti N, Segrest J. Insulin resistance, dietary cholesterol, and cholesterol concentration in postmenopausal women. Metabolism-Clinical and Experimental, 2001; *50*(5): 594-597.
14. Goodrow EF, Wilson TA, Houde SC, Vishwanathan R., Scollin PA, Handelman G, Nicolosi RJ. Consumption of one egg per day increases serum lutein and zeaxanthin concentrations in older adults without altering serum lipid and lipoprotein cholesterol concentrations. The Journal of nutrition, 2006; *136*(10): 2519-2524.
15. Weggemans RM, Zock PL, Katan MB. Dietary cholesterol from eggs increases the ratio of total cholesterol to high-density lipoprotein cholesterol in humans: a meta-analysis. The American journal of clinical nutrition, 2001; *73*(5): 885-891.

16. McGill HC. The relationship of dietary cholesterol to serum cholesterol concentration and to atherosclerosis in man. Am. J. Clin. Nutr. 1979; 32(12):2664–2702.
17. Djoussé L, Gaziano JM. Egg consumption in relation to cardiovascular disease and mortality: the Physicians' Health Study. The American journal of clinical nutrition, 2008; *87*(4): 964-969.
18. Zhang X, Wu C, Wu H, Sheng L, Su Y, Zhang X, Xu X. Anti-hyperlipidemic effects and potential mechanisms of action of the caffeoylquinic acid-rich Pandanus tectorius fruit extract in hamsters fed a high fat-diet. *PloS one*, 2013; *8*(4): e61922.
19. Chávez-Pesqueira M, Núñez-Farfán J. Domestication and genetics of papaya: a review. Frontiers in Ecology and Evolution, 2017; 5: 155.
20. Kadiri O, Olawoye B, Fawale OS, Adalumo OA. Nutraceutical and antioxidant properties of the seeds, leaves and fruits of Carica papaya: Potential relevance to human's diet, the food industry and the pharmaceutical industry-a review. *Turkish Journal of Agriculture-Food Science and Technology*, 2016; *4*(12): 1039-1052.
21. Muazu U, Aliyu-Paiko M. Evaluating the potentials of *Carica papaya* seed as phytobiotic to improve feed efficiency, growth performance and serum biochemical parameters in broiler chickens. IOSR J. Biotechnol. Biochem. *2020;* 6(1):8–18.
22. Salla S, Sunkara R, Ogutu S, Walker LT, Verghese M. Antioxidant activity of papaya seed extracts against H2O2 induced oxidative stress in HepG2 cells. LWT-Food Science and Technology. 2016; 66:293-297.
23. Dawkins G, Hewitt H, Wint Y, Obiefuna PC, Wint B. Antibacterial effects of Carica papaya fruit on common wound organisms. The West Indian Medical Journal. 2003; 52(4):290-2.
24. Okeniyi JA, Ogunlesi TA, Oyelami OA, Adeyemi LA. Effectiveness of dried Carica papaya seeds against human intestinal parasitosis: a pilot study. Journal of medicinal food. 2007;10(1):194-6
25. Olagunju JA, Adeneye AA, Fagbohunka BS, Bisuga NA, Ketiku AO, Benebo AS, Olufowobi OM, Adeoye AG, Alimi MA, Adeleke AG. Nephroprotective activities of the aqueous seed extract of Carica papaya Linn. in carbon tetrachloride induced renal injured Wistar rats: a dose-and time-dependent study. Biol Med. 2009;1(1):11-9..
26. Lohiya NK, Manivannan B, Goyal S, Ansari, AS. Sperm motility inhibitoryeffect of the benzene chromatographic fraction of the chloroform extract of the seed of Carica papaya in langur monkey, Presbytis entellus entellus. Asian J Androl*,* 2008; 10:298-306.
27. Maisarah AM, Asmah R, Fauziah O. Proximate analysis, antioxidant and antiproliferative activities of different parts of *Carica papaya*. *J. Nutr. Food Sci. 2014;* 4(2):267.
28. National Research Council. *National science education standards*. National Academies Press 1996
29. Adeneye AA, Olagunju JA, Banjo AA, Abdul SF, Sanusi OA, Sanni OO, Osarodion BA, Shonoiki OE. The aqueous seed extract of Carica papaya Linn. Prevents carbon tetrachloride induced hepatotoxicity in rats. International Journal of Applied Research in Natural Products. 2009; 2(2):19-32.
30. Allain CC, Poon LS, Chan CS, Richmond W, Fu PC. Enzymatic assay of Total Cholesterol. Clin. Chem.1974; 20: 470.
31. Lopes-Virella MF. Cholesterol determination in High-density Lipoproteins separated by three different methods. Clinical Chemistry, 1977; 23: 882
32. Stein EA, Lipids, Lipoprotein and Apolipoprotein in Fundamentals of Clinical Chemistry (3rd edn), Tietz NW Clinical Chemistry (3rd edn). WB Saunders: Philadelphia. 1987; 478-479.

33. Frierdewald WT, Levy RL, Fredrickson DS. Estimation of the concentration of low-density lipoprotein cholesterol in plasma without use of the preparative ultracentrifuge. Clinical Chemistry, 1972; 18**:** 499.
34. Lavie CJ, Artham SM, Milani RV, Ventura HO. The obesity paradox: impact of obesity on the prevalence prognosis of cardiovascular diseases. Postgrad Med, *2008;* 120: 34-41.
35. Chawla R. Kidney Function Tests. In: Practical Clinical Biochemistry. Methods and Interpretation.*2nd edition.* JAYPEE Brothers Medical Publishers (P) Ltd., New Delhi, India*.* 1999 pp. 90-92.
36. Chang J, Chen T, Chan P, Chen Y, Hsu F, Lo M, Lin J. The in vitro inhibitory effect of tannin derivatives on 3-hydroxyl-3-methyglutaryl-Coenzyme A reductase on vero cells*.* Pharmacology 2001*;* 62: 224-228.
37. Clarke R, Frost C, Collins R, Appleby P, Peto R. Dietary lipids and blood cholesterol: quantitative meta-analysis of metabolic ward studies. BMJ (Clinical research ed.), 1997; *314*(7074): 112–117.
38. Chakrabarty G, Manjunatha S, Bijlani RL, Ray RB, Mahapatra SC, Mehta N, Lakshmy R, Vashisht S, Manchanda SC. (2004). The effect of ingestion of egg on the serum lipid profile of healthy young Indians. Indian journal of physiology and pharmacology, 2004; *48*(3), 286–292.
39. Sacks FM, Salazar J, Miller L, Foster JM, Sutherland M, Samonds KW, Albers JJ, Kass EH. Ingestion of egg raises plasma low density lipoproteins in free-living subjects. Lancet (London, England), 1984; *1*(8378): 647–649.
40. Herron KL, Lofgren IE, Sharman M, Volek JS, Fernandez ML. High intake of cholesterol results in less atherogenic low-density lipoprotein particles in men and women independent of response classification. Metabolism: clinical and experimental, 2004; *53*(6): 823–830.
41. Greene CM, Waters D, Clark RM, Contois JH, Fernandez ML. Plasma LDL and HDL characteristics and carotenoid content are positively influenced by egg consumption in an elderly population. Nutrition & metabolism, 2006; *3*:6.
42. Kuang H, Yang F, Zhang Y, Wang T, Chen G. The Impact of Egg Nutrient Composition and Its Consumption on Cholesterol Homeostasis. Cholesterol, 2018; 6303810.
43. Mayes PA. Lipid transport and storage. In: Harper's Biochemistry, 24th edition Murray RK, Granner DK, Mayes, PA, Rodwell VW. (eds*). Prentice Hall International, Inc., USA*. 1996; Pp 254.
44. Afolabi IS, Akuiyibo SM, Rotimi SO, Adeyemi AO. In vivo evaluation of lipid and antioxidants qualities of Carica papaya seed oil. Journal of Natural Products. 2011; 4:125-35.
45. Basha HS, Changamma C. Effect of *Carica papaya* seed extraction on liver and serum profiles with special reference to lipid metabolism in male albino rats." International Journal of Advanced Research in Pharmaceutical & Bio Sciences**,** 2013; 2(4): pp. 25
46. Nwangwa EK, Ekhoye EI. Anti-Hyperlipidemic Activity of Aqueous Extract of *Carica Papaya* Seed in Albino Rats fed with High Fat Diet. Current Trends in Technology and Science**, 2013;** 2(3): 262-266**.**
47. Abolaji AO, Adebayo AH, Odesanmi OS. Effect of ethanolic extract of *Parinari polyandra* (Rosaceae) on serum lipid profile and some electrolytes in pregnant rabbits. Research Journal of Medicinal Plants 2007; 1: 121-127.
48. Ezekwe CI, Obidoa O. (2001). Biochemical effect of Vernoniaamygdalina on rats liver microsome. Niger. J. Biochem. Mol. Biol. 2001; 16: 1745-1798.

49. Patil UK, Saraf S, Dixit VK. Hypolipidemic activity of seeds of Cassia tora Linn. J. Ethnopharmacol., 2004; 90: 249 – 252.
50. Owoyele BV, Yakubu MT, Alonge F, Olatunji LA, Soladoye AO. Effects of folic acid intake on serum lipid profile on apparently healthy young adult male Nigerians. African Journal of Biomedical Research. 2005; 8: 139-142.

How to Cite this article: Inneh, C. A., & Momodu, O. I. (2023). Egg Yolk increases Lipid Profile in Wistar Rats; Protective Effect of Carica papaya seed extract. *Journal of Basic and Applied Medical Sciences*, 3(1), 66-79.