THE EFFECT OF OLIVE-POMACE OIL ON DIFFERENT BLOOD PARAMETERS IN STREPTOZOTOCIN INDUCED DIABETIC RATS

Muhammad Javad Yousaf, Abdul Khaliq Naveed, Shakir Khan, Tausif Ahmed, Syed Zubair Hussain Shah

Army Medical College, National University of Sciences and Technology (NUST), Islamabad

ABSTRACT

Objective: To determine the effects of olive-pomace oil on glycemic status and lipid profile in diabetes.

Study Design: Randomized controlled trial.

Place and Duration of Study: Department of Biochemistry, Army Medical College, Rawalpindi in collaboration with Centre for Research in Experimental and Applied Medicine, Army Medical College, Rawalpindi and National Institute of Health, Islamabad from March 2010 to June 2011.

Material and Methods: Seventy male albino rats of Sprague-Dawley strain were randomly divided into two groups of 35 rats each. Rats were rendered diabetic by injecting streptozotocin. Group 1 and group 2 were given normal rodent diet and olive pomace oil supplemented diet respectively for 6 weeks. At the end of the experiment fasting blood glucose and lipid profile were measured for comparison.

Results: There was significant increase in high density lipoprotein and significant decrease of blood glucose, total cholesterol and low density lipoprotein of group II rats when compared with group I (control).

Conclusion: Olive pomace oil can significantly improve fasting blood glucose and lipid profile in diabetic rats.

Keywords: Diabetes mellitus, Dyslipidemia, Hyperglycemia, Olive pomace oil.

INTRODUCTION

Since the time man has been crowned for the kingdom of earth he has been suffering from multiple diseases and their respective complications. An appreciation of the characteristics of diabetes mellitus (DM) was identified as early as the time of Hippocrates. DM is a chronic metabolic disease characterized by hyperglycemia with disturbances of fat, protein and carbohydrate metabolism. Globally, DM is ranked as the fifth leading cause of death, which is causing a huge burden on the world's economic resources[1].

Uncontrolled hyperglycemia and dyslipidemia in diabetics would lead to chronic complications. Mortality due to DM is more often attributed to the complications than from a direct cause such as hyperglycemia or ketoacidosis. Effective glycemic control is the key to improving the quality of life in diabetic patients. Olive oil is one of richest sources of monounsaturated fatty acids (MUFA), whose effect on glycemic status and lipid profile is well documented but very few studies are available regarding its refined types[2,3].

Olive-pomace oil is a blend of refined olive-pomace oil and virgin olive oil. Refining is done by filtering, charcoal & chemical treatment and heating of raw pomace oil, obtained from the solid extract residue of olive fruit from which the olive oil has been extracted. Olive-pomace oil contains MUFA and chemically its fat composition is quite similar to regular olive oil. It is cheaper than extra virgin olive oil, having a high smoke point and commonly used for frying purpose. Present study is designed to evaluate the effect of this MUFA enriched olive pomace oil on correction of hyperglycemia and dyslipidemia in diabetic rats.

MATERIAL AND METHODS

This randomized controlled trial was conducted in the Department of Biochemistry and Molecular Biology, Army Medical College, Rawalpindi in collaboration with Centre for Research in Experimental and Applied Medicine (CREAM), Army Medical College and National

Correspondence: Dr Prof Abdul Khaliq Naveed, AM College, Rawalpindi
Email: khaliqnaveed2001@yahoo.com
Received: 14 Jan 2013; Accepted: 25 Feb 2014

Institute of Health (NIH), Islamabad. This study was carried out on 70, (60-90 days) old male Albino rats of Sprague Dawley strain, weighing between 200-250 g. Rats were obtained and kept in the animal house of the NIH, Islamabad. They were rendered diabetic by injecting streptozotocin (STZ) 40 mg/kg/body weight intraperitoneally dissolved in citrate buffer (pH 4.6). On the third day, their fasting blood glucose levels were measured by taking blood from tail veins under aseptic conditions. Rats with blood glucose level more than 126 mg/dl were considered as diabetic and were used in the study. These diabetic rats were randomly divided into two groups of 35 rats each:

Group-1 (Diabetic control group)

Thirty five diabetic rats in group –I served as control animals for the experimental group of study. They were fed standard pelleted diet as per requirement, prepared at NIH, Islamabad, for 06 weeks.

Group-2 (Diabetic experimental group)

Thirty five diabetic rats in group –II fed with olive pomace oil supplemented diet as per requirement, prepared at NIH, Islamabad, for 6 weeks. Olive pomace oil supplemented diet is the diet containing 100 grams olive pomace oil per kilogram of pelleted diet.

Rats were kept under standard conditions with a daily photo period of 12 hours light and 12 hours dark at 23 ± 2^0 C. All groups had free access to food and water. At the end of experiment, fasting blood samples were drawn through intracardiac puncture for measurement of blood glucose and lipid profile. Serum lipid profile and blood glucose were measured by enzymatic colorimetric and glucose/oxidase method respectively.

Statistical Analysis

The data was entered and analyzed using SPSS version 15.0. The arithmetic mean and standard deviation (SD) of blood glucose, total cholesterol (TC), triglycerides (TG), low density lipoproteins (LDL) and high density lipoproteins (HDL) were calculated. The statistical significance of difference across the groups was determined by applying independent sample's t test. The difference was considered significant if *p* value was found less than 0.05.

Table-1: Comparison of fasting blood glucose and lipid profile between group-1 and group-2.

Parameters	Group-1 (n=35)	Group-2 (n=35)	*p* value
Fasting blood glucose (mg/dl)	457.78 ± 95.47	385.59 ± 115.52	< 0.05*
Total Cholesterol (mg/dl)	153.89 ± 16.94	131.328 ± 19.18	< 0.05*
Triglyceride (mg/dl)	106.58 ± 12.32	96.62 ± 25.72	> 0.05
High Density Lipoproteins (mg/dl)	77.67 ± 5.89	90.30 ± 8.04	< 0.05*
Low Density Lipoproteins (mg/dl)	51.33 ± 6.18	46.58 ± 7.63	< 0.05*

*$p < 0.05$ is considered significant. The values are expressed as mean ± SD.

RESULTS

There was a significant increase of HDL and significant decrease of serum glucose, TC, and LDL of group II rats when it was compared with group I (control), (table-1 and figures 1,2).

DISCUSSION

Streptozotocin (STZ) is a commonly employed compound for the induction of DM in experimental animals[4,5,6]. It has a high affinity for cells of the islets of Langerhans and achieves hyperglycemic status in a short period of time. Mechanism of action of STZ is not known exactly but; it might be responsible for the damage to pancreatic ß-cell membrane or depleting the nicotinamide dinucleotide in islet cells[6,7,8]. It may even cause DNA strand breakage in pancreatic cells.

Olive oil is associated with a lower incidence of diabetes, obesity, atherosclerosis, cardiovascular disease, metabolic syndrome and certain types of cancer mainly breast, colorectal and prostate cancers[2,3,9,10,11]. Experimental studies

both in vivo and in vitro show that olive oil improves cardiovascular risk factors, such as lipid profiles, blood pressure, hyperlipidemia, oxidative stress and antithrombotic profiles but very limited studies are available regarding olive-pomace oil[10-16].

In our study, olive pomace oil induced significant improvement in fasting blood glucose between hypercholesterolemia and ischemic heart disease[25,26].

In our study, olive pomace oil showed significant increase of HDL and significant decrease of total cholesterol and LDL. These finding are strengthened by multiple series of research work carried by Tsantila and his colleagues in cholesterol-fed rabbits, in which

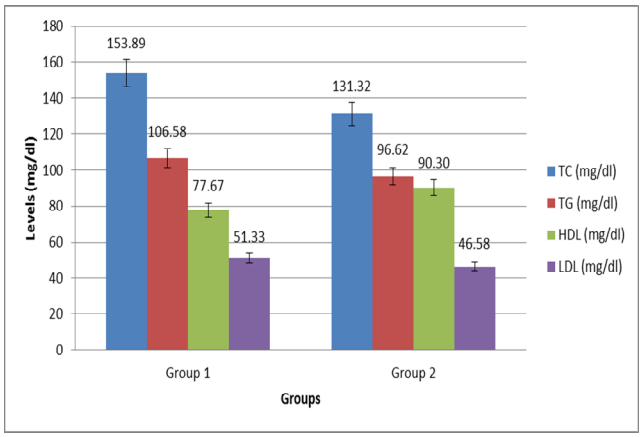

Figure-1: Comparison of serum total cholesterol, triglycerides, low density lipoprotein and high density lipoprotein between group 1 and group-2.

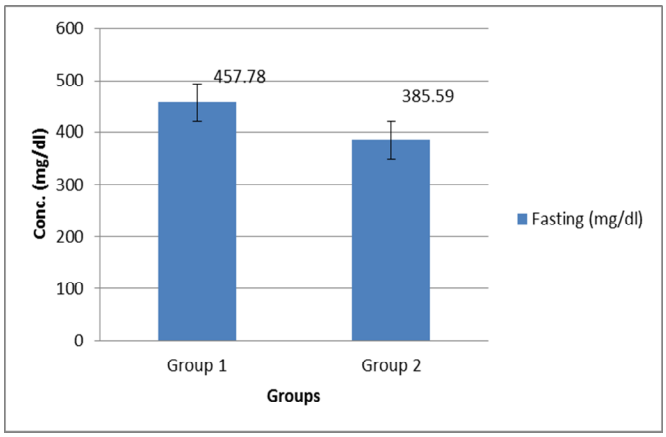

Figure-2: Comparison of serum blood glucose levels between groups 1 and 2.

in diabetic rats. It contains MUFA, which may regulate blood glucose level by enhancing secretion of glucagon-like peptide-1 (GLP-1) from intestinal cells. GLP-1 is the potent antihyperglycemic hormone, which stimulates the proliferation and differentiation of insulin-secreting β-cells, insulin biosynthesis, glucose - dependent insulin secretion, restores glucose sensitivity of pancreatic β-cells and also suppress glucagon secretion[17-20].

Cardiovascular disease is the major source of mortality both in developed and under developed countries[21-23]. Atherosclerosis is caused by deposition of lipids, mainly cholesterol and cholesterol ester, in the connective tissue of arterial wall. HDL is considered as good cholesterol because it plays a key role in reverse cholesterol transport, while LDL is considered as bad cholesterol because it delivers cholesterol to peripheral tissues[24]. A positive correlation exists they found that olive pomace polar lipid extract have antithrombotic and antiatherosclerotic properties[13,15]. So olive pomace oil has cardioprotective effects and decreases the chances of ischemic heart diseases.

These findings are in accordance with those reported by Paniagua et al, who proposed that MUFA-rich diet improves blood glucose and lipid profile in diabetic patients[16]. Our study also synchronizes with Gorinstein et al, and Garg`s research work in experimental animals and diabetic humans, which concluded that MUFAs enriched diets have anti-hyperlipidemic and anti-hyperglycemic action[2,27]. So MUFA enriched diets are preferred over carbohydrates (CHO) enriched diets because of their lipid and glucose lowering effects[16].

Findings of present study are partially in contrast with Visioli et al., studies in mildly dyslipidemic persons, which showed that MUFA

enriched olive oil, had no significant hypolipidemic action[28].

CONCLUSION

Olive pomace oil significantly improves glycemic status and lipid profile in diabetic rats. Future implications of this study suggest the use of MUFA enriched olive pomace oil in daily diet especially in diabetic patients for better prognosis and control of glycemic profile and lipid index.

Acknowledgement

We are extremely obliged to Dr. Hussain Ali, Senior veterinary officer, NIH, Islamabad and his staff for their steady support during the study.

REFERENCES

1. Roglic G, Unwin N, Bennett PH, Mathers C, Tuomilehto J. The burden of mortality attributable to diabetes: realistic estimates for the year 2000. Diabetes Care 2005; 28(9): 2130-5.
2. Gorinstein S, Leontowicz H, Lojek A, Leontowicz M, Krzeminski R, Gralak M, et al. Olive oils improve lipid metabolism and increase antioxidant potential in rats fed diets containing cholesterol. J Agric Food Chem 2002; 50(21):6102-8.
3. Cancelas J, Prieto PG, Villanueva-Peñacarrillo ML, Valverde I, Malaisse WJ. Effects of an olive oil-enriched diet on glucagon-like peptide 1 release and intestinal content, plasma insulin concentration, glucose tolerance and pancreatic insulin content in an animal model of type 2 diabetes. Horm Metab Res 2006; 38(2):98-105.
4. Mitra SK, Gopumadhavan S, Muralidhar TS, Anturlikar SD, Sujatha MB. Effect of D-400, a herbomineral preparation on lipid profile, glycated haemoglobin and glucose tolerance in streptozotocin induced diabetes in rats.Indian J Exp Biol 1995; 33(10):798-800.
5. Coskun O, Ocakci A, Bayra K, traroglu T. Exercise Training Prevents and Protects Streptozotocin- Induced Oxidative and ß- Cell Damage in Rat. Tohoku J Exp Med 2004; 203:145-54.
6. Szkudelski T. The mechanism of alloxan and streptozotocin action in B cells of the rat pancreas. Physiol Res 2001; 50(6):537-46.
7. Ramesh B, Saravanan R, Pugalendi KV. Effect of dietary substitution of groundnut oil on blood glucose, lipid profile, and redox status in streptozotocin-diabetic rats. Yale J Biol Med 2006; 79(1):9-17.
8. Rerup CC. Drugs producing diabetes through damage of the insulin secreting cells. Pharmacol Rev 1970; 22(4):485-518.
9. Perez-Jimenez F, Alvarez de Cienfuegos G, Badimon L, Barja G, Battino M,Blanco A, et al. International conference on the healthy effect of virgin olive oil. Eur J Clin Invest 2005; 35(7):421-4.
10. López-Miranda J, Pérez-Jiménez F, Ros E, De Caterina R, Badimón L, et al. Olive oil and health: summary of the II international conference on olive oil and health consensus report, Jaén and Córdoba (Spain) 2008. Nutr Metab Cardiovasc Dis 2010; 20(4):284-94.
11. Pérez-Martínez P, García-Ríos A, Delgado-Lista J, Pérez-Jiménez F, López-Miranda J. Mediterranean Diet Rich in Olive oil and Obesity, Metabolic Syndrome and Diabetes Mellitus. Curr Pharm Des 2011; 17(8):769-77.
12. Chan YM, Demonty I, Pelled D, Jones PJ. Olive oil containing olive oil fatty acid esters of plant sterols and dietary diacylglycerol reduces low-density lipoprotein cholesterol and decreases the tendency for peroxidation in hypercholesterolaemic subjects. Br J Nutr 2007; 98(3):563-70.
13. Tsantila N, Karantonis HC, Perrea DN, Theocharis SE. Antithrombotic and antiatherosclerotic properties of olive oil and olive pomace polar extracts in rabbits. Mediators Inflamm 2007; 2007:36204.
14. Assy N, Nassar F, Nasser G, Grosovski M. Olive oil consumption and non-alcoholic fatty liver disease. World J Gastroenterol 2009; 15(15):1809-15.
15. Tsantila N, Karantonis HC, Perrea DN, Theocharis SE, Iliopoulos DG, Iatroue C. Atherosclerosis regression study in rabbits upon olive pomace polar lipid extract administration. Nutr Metab Cardiovasc Dis 2010; 20(10):740-7.
16. Paniagua JA, de la Sacristana AG, Sánchez E, Romero I, Vidal-Puig A, Francisco J. A MUFA-rich diet improves posprandial glucose, lipid and GLP-1 responses in insulin-resistant subjects. J Am Coll Nutr 2007; 26(5):434-44.
17. Doyle ME, Egan JM. Mechanisms of action of glucagon-like peptide 1 in the pancreas. Pharmacol Ther 2007; 113(3):546-93.
18. Abraham EJ, Leech CA, Lin JC, Zulewski H, Habener JF. Insulinotropic hormone glucagon-like peptide-1 differentiation of human pancreatic islet-derived progenitor cells into insulin-producing cells. Endocrinology 2002; 143(8):3152-61.
19. Nauck MA. Glucagon-like peptide 1 (GLP-1) in the treatment of diabetes. Horm Metab Res 2004; 36(11-12):852-8.
20. Nauck MA, Meier JJ. Glucagon-like peptide 1 and its derivatives in the treatment of diabetes. Regul Pept 2005; 128(2):135-48.
21. Barnes VA, Orme-Johnson DW. Prevention and Treatment of Cardiovascular Disease in Adolescents and Adults through the Transcendental Meditation(®) Program: A Research Review Update. Curr Hypertens Rev 2012; 8(3):227-242.
22. Roger VL, Lloyd-Jones DM, Emelia J, William B, Earl S, Heather J. Heart disease and stroke statistics-2012 update: a report from the American Heart Association. Circulation 2012; 125(1):e2-e220.
23. Heidenreich PA, Trogdon JG, Khavjou OA, Butler J, Dracup K, Michael D. Forecasting the future of cardiovascular disease in the United States: a policy statement from the American Heart Association. Circulation 2011; 123(8):933-44.
24. Annema W, Tietge UJ. Regulation of reverse cholesterol transport-a comprehensive appraisal of available animal studies. Nutr Metab (Lond) 2012; 9(1):25.
25. Seo YH, Lee CS, Yuk HB, Yang DJ, Park HW. Hypercholesterolemia and in-vivo coronary plaque composition in patients with coronary artery disease: a virtual histology - intravascular ultrasound study. Korean Circ J 2013; 43(1):23-8.
26. Fuster V, Badimon L, Badimon JJ, Chesebro JH. The pathogenesis of coronary artery disease and the acute coronary syndromes. N Engl J Med 1992; 326(4):242-50.
27. Garg A. High-monounsaturated-fat diets for patients with diabetes mellitus: a meta-analysis. Am J Clin Nutr 1998; 67(3 Suppl):577S-582S.
28. Visioli F, Caruso D, Grande S, Bosisio R, Villa M, Galli G, et al. Virgin Olive Oil Study (VOLOS): vasoprotective potential of extra virgin olive oil in mildly dyslipidemic patients. Eur J Nutr 2005; 44(2):121-7.