Effect of oil rich in monounsaturated fatty acid and polyunsaturated fatty acids on lipid profile and glucose level in male Wistar rats

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Abstract

Dietary fats and oils are responsible for concentrated source of energy for human metabolic processes. This study was carried out to determine the effects soybean (SOBO), olive (OLVO) and hazelnut (HAZO) on lipid profile and glucose level in male Wistar rats. Fifteen male Wistar rats weighting between 150-170 grams were divided randomly into three groups of five rats each. Groups 1 (Control group, SOBO) was assigned to receive 30 grams of the control diet with soybean oil per day. Group 2 was allocated to take 30 grams of the diet with olive oil per day and group 3 was allocated to receive 30 grams of the diet with hazelnut oil per day. Initial weight of rats was highest in soybean group followed by olive and hazelnut oil (SOBO > OLVO > HAZO). Similar trend was observed in final weight, weight gain and growth rate of rats (SOBO > OLVO > HAZO). Statistically insignificant difference was observed between control (SOBO group) and experiments groups (OLVO and HAZO) for all growth parameters. Least value of TC was observed in olive group but the difference was insignificant between the groups. Similarly the difference for TG, LDL-C, VLDL-C and glucose was also statistically insignificant the groups. Only for HDL-C the difference between the groups found was statistically *significant. To summarize, in this study; different MUFA and PUFA rich oil did not significantly altered lipid profile of male Wistar rats. It also didn't exhibit any major effect on weight. Only for HDL-C the difference between the groups found was statistically significant.*

Keywords

Fats; fatty acids; lipid profile; glucose; soybean oil; olive oil

Introduction

Dietary lipids (fats and oils) are macronutrients and they are responsible for concentrated source of energy for human metabolic processes (Sanchez-Muniz and Bastida, 2006). The westernized diet is expanding the number of diseases such as obesity, diabetes, and cognitive dysfunction (Duavy *et al*., 2017). Cardiovascular disease (CVD) is accounting for 30% of global deaths and is becoming one of the prominent causes of death worldwide, (CVDs, 2011). It has been found that instead of the quantity of the fat, the type or form of dietary fats (SFA, MUFA, PUFA) has more significant role in the blood lipids and BP regulations (De Caterina, 2011; Simopoulos 2008). Dietary fats and oils also affect serum lipids and lipoproteins, which are leads to the development of atherosclerosis and CVDs (Simopoulos, 2008).

Olive oil and Hazelnut oil are good sources of MUFA (Perna *et al*., 2016). Consumption of diet comprising of important phenolic compounds has a remarkable capacity in reducing cholesterol level and platelet aggregation (Esfarjani *et al*., 2013). Since the suitable lipid diets could be used as nutritional substitutes to prevent lipid disturbances, this study was commenced to evaluate the effects soybean, olive and hazelnut on lipid profile and glucose level in male *Wistar* rats.

Material and methods

Experimental design

A total of fifteen male Wistar rats weighting between 150-170 grams has been supplied by the Experimental Animals Center, College of Pharmacy, King Saud University, Saudi Arabia. This study was conducted in accordance with research policies of the King Saud University Research Centre. Rats were kept separately throughout the experimental period of 6 weeks in polypropylene cages at 25^{0}C and 12/12 light / dark cycle with room temperature (25±2^{o}C), humidity (50±5%). Grain silos and flour mills, Riyadh Saudi Arabia provided commercial rodent diet. The experimental diets for the male Wistar rats were made by adding the oil (spraying under pressure with continuous mixing during the spraying) to the basal diet (Table 1). In order to evade oil oxidation; the fresh chow was weekly mixed with oil and stored at 4°C until fed. After the adaptation period of a week, the rats were arbitrarily divided into three groups of five each, as follows:

Groups 1: (Control group) assigned to receive 30 grams of the control diet with soybean oil per day.

Group 2: assigned to receive 30 grams of the diet with olive oil per day.

Group 3: assigned to receive 30 grams of the diet with hazelnut oil per day

Assessment of body weight and food consumption

Growth: In the non-fed state weight was noted at the commencement and at the end of study.

Weight gain (g) = final body weight (g)-initial body weight (g)

Growth rate=total weight gain (g)/duration

Biochemical analyses

The rats were anesthetized with pentobarbital sodium (60 mg/kg body weight) after six weeks of experimental period. Blood was withdrawn from the heart of each rat into EDTA Tubes and then centrifuged at 3500 rpm for 10 minutes. The supernatant was separated after centrifugation and stored at -80°C and used for total cholesterol, HDL-C, LDL-C, VLDL-C and Triglycerides analyses. Kits for the analysis of lipid profile was obtained from Randox Laboratories Ltd. Crumlin, UK.

Statistical analysis

SPSS statistical software package was used to analyse the data. Data were expressed as mean ± standard deviation. One way ANOVA at a significance level of $p \leq 0.05$ was used to analyse the differences among the treatment groups and if differences were found to be significant then a Post-hoc analysis using Duncan's multiple range tests was performed.

Results

Effect of different oil (soybean oil, olive oil, hazelnut oil) on growth of male Wistar rats

In this study the effect of different oils (soybean, olive and hazelnut) on weight gain and growth rate has been investigated (Fig.1). Initial weight of rats was highest in SOBO group followed by and group (SOBO > OLVO > HAZO). Similar trend was observed in final weight, weight gain and growth rate of rats (SOBO > OLVO > HAZO). Statistically insignificant difference was observed between control (SOBO group) and experiments groups (OLVO and HAZO) for all growth parameters.

Effect of different oil (soybean oil, olive oil, hazelnut oil) on lipid profile and glucose level of male Wistar rats

In table 2 the effect of different oils (SOBO, OLVO and HAZO) on lipid profile (TC, TG, LDL-C, VLDL-C and HDL-C) has been reported. Least value of TC was observed in olive group but the difference was insignificant between the groups. Similarly the difference for TG, LDL-C, VLDL-C and glucose was also statistically insignificant the groups. Only for HDL-C the difference between the groups found was statistically significant.

Discussion

Both dietary lipids kind and its amount have a vital effect on lipid nutrition (Duavy *et al.*, 2017). Various studies have concerted on the evaluation of dietary FA composition, since its alterations in FA composition may cause alterations in the lipid composition of cellular structures and lipoprotein synthesis (Ooi *et al.*, 2015; Lawrence, 2013). Unlike this study, in a study on male Wistar rats fed with casein standard diet, 1% high cholesterol diet+ 12% olive oil and 1% high cholesterol diet+ 12% sunflower oil significant alterations were observed in weight gain from the different treatment regimens (Duavy *et al*., 2017).

This study has shown that incorporation of olive and hazelnut oil into diet significantly increased HDL-C level but insignificant differences has been observed between control and treated groups for TC, TG, LDL-C, VLDL-C and glucose. Rezq *et al*., (2010) also did not observed any significant difference in TG and LDL-C content in mice fed on SOBO and OLVO and as like in this present study, the difference was significant for HDL-C content. Since monounsaturated fatty acid (MUFA) has been found to be main FA in fruits and seeds, so Dubois and colleague classified vegetable oils in the MUFA group (Dubois et al., 2007). PUFAs are the major FA in soy bean oil and MUFA is the main fatty acids in olive oil and hazelnuts. Various studies has reported the similarity between the lipid profile of hazelnut oil and olive oil (Javidipour *et al*., 2017; Lecerf and Borgies, 2002; Aparicio, 2000,) and both of them contain oleic acid (18:1, n-6) as the major fatty acid (Vingering *et al.*, 2010).

The hazelnut fatty acid composition which is typically based on MUFA that protects LDL against oxidation can be associated with the prevention of CVD. It is rich source of numerous bioactive constituents, gallic acid, caffeic acid, fibers selenium, epicatechin, and quercetin that could have anti-atherogenic effects by means of biological mechanisms acting on various pathways in CVD development (Perna *et al*., 2016). In a previous study the outcome of nuts intake on blood lipid levels exhibited a dose-dependent pattern, and it has been found that they could be beneficial in decreasing TC and LDL-C if they replace 20% of total daily calorie intake (Sabaté *et al*., 2007). Mukuddem-Petersen and colleague showed that consumption of nuts over 8 weeks significantly raised FBS concentrations in comparison with control diets however in this study no deleterious effect of olive oil and hazelnut has been reported (Mukuddem-Petersen *et al*., 2007). NCEP i.e National Cholesterol Education Program has suggested that increased LDLc should be used for the early detection of potential heart related issues and decline in LDLc should be used as a treatment of choice for heart disease (Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults, 2001). Oils apart from their FA content also provide various micronutrients and both the micronutrient component and FA content of oil may have valuable effects on the cardiovascular system and various studies have shown that the oil may be viewed as a cocktail of active ingredients that often have a synergistic effect on health (Schroeder *et al*., 2006; Stahl and Sies; 2005; Age-Related Eye Disease Study Research Group, 2001; Bo¨hm *et al*., 1998). Insignificant differences reported in this study for lipid profile between oils might be because of the similarity in composition. Heyden, 1994 also concluded that MUFA do not play a significant role in reducing Cholesterol or LDL cholesterol.

Conclusion

To summarize, in this study; different MUFA and PUFA rich oil did not significantly altered lipid profile of male Wistar rats. It also didn't exhibit any major effect on weight. Only for HDL-C the difference between the groups found was statistically significant. However, further research is requisite to confirm the role MUFA and PUFA rich oil as a protective agent against CVD risk factors.

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References

1. *Age-Related Eye Disease Study Research Group, 2001, A randomized, placebo-controlled, clinical trial of high-dose supplementation with vitamins C and E, ß-carotene, and zinc for age-related macular degeneration and vision loss. AREDS report no. 8. Archives of Ophthalmology, Vol. 119, p. 1417–1436.*

2. *Aparicio R, 2000, Characterization: mathematical procedures for chemical analysis. In: Harwood J, Aparicio R (eds) Handbook of olive oil: analysis and properties. Aspen, Gaithersburg, Maryland Md. pp 285–354.*
3. *Bohm F, Edge R, McGarvey DJ, Truscott TG, 1998, ß-Carotene with vitamins E and C offers synergistic cell protection against NOx. FEBS Letter, Vol. 436, No.3, p. 387–389.*
4. *Cardiovacular Diseases (CVDs). Fact Sheet nº 317; 2011. Available from: http://www. who.int/mediacentre/factsheets/fs317/en/ index.html.*
5. *De Caterina R, 2011, N−3 Fatty acids and cardiovascular disease. New England Journal of Medicine, Vol. 364, No.25, p.2439–50.*
6. *Duavy SMP, Salazar GJT, Leite G deO Ecker A, Barbosa NV, 2017, Effect of dietary supplementation with olive and sunflower oils on lipid profile and liver histology in rats fed high cholesterol diet. Asian Pacific Journal of Clinical Nutrition, Vol. 10, No.6, p. 539-543.*
7. *Dubois V, Breton S, Linder M, Fanni J, Parmentier M, 2007, Fatty acid profiles of 80 vegetable oils with regard to their nutritional potential. European Journal of Lipid Science and Technology, Vol. 109, No.7, p. 710-32.*
8. *Esfarjani F, Mohammadi F, Khalafi M, Roustaee R, 2015, Olive Oil in the Diet of Obese Children. Clinical Nutrition, Vol. 34, No. Suppl 1, p. s211.*
9. *Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults, 2001, Executive Summary of the Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). JAMA, Vol. 285, No, 19, p.2486–2497.*
10. *Heyden S, 1994. Polyunsaturated and monounsaturated fatty acids in the diet to prevent coronary heart disease via cholesterol reduction. Annals of Nutrition and Metabolism, Vol.38, No.3, p.117–122.*
11. *Javidipour I, Erinç H, Baştürk A, Tekin A, 2017, Oxidative changes in hazelnut, olive, soybean, and sunflower oils during microwave heating. International Journal of Food Properties, Vol. 20, No. 7, 1582-1592.*
12. *Lawrence GD, 2013, Dietary fats and health: dietary recommendations in the context of scientific evidence. Advance Nutrition, Vol. 4, No. 3, p.294-302.*

13. *Lecerf JM, Borgies B, 2002, Effects of soybean oil on plasma lipoproteins and cardiovascular risk in men and women. Oléagineux, Corps Gras, Lipides, Vol. 9, No. 2, p.96-99.*
14. *Mukuddem-Petersen J, Stonehouse Oosthuizen W, Jerling JC, Hanekom SM, White Z, 2007, Effects of a high walnut and high cashew nut diet on selected markers of the metabolic syndrome: A controlled feeding trial. British Journal of Nutrition, Vol. 97, No.6, p.1144–53.*
15. *Ooi EMM, Watts GF, Ng TWK, Barrett PHR, 2015, Effect of dietary fatty acids on human lipoprotein metabolism: a comprehensive update. Nutrients, Vol. 7, No. 6, p. 4416-4425.*
16. *Perna S, Giacosa A, Bonitta G, Bologna C, Isu A, Guido D, Rondanelli M, 2016, Effects of hazelnut consumption on blood lipids and body weight: a systematic review and bayesian meta-analysis. Nutrients, Vol. 8, No.12, p. E747.*
17. *Rezq AA, Labib FA, Attia AEM, 2010, Effect of some dietary oils and fats on serum lipid profile, calcium absorption and bone mineralization in mice. Pakistan Journal of Nutrition, Vol. 9, No. 7, p. 643-650.*
18. *Sabate J, Oda K, Ros E, 2010, Nut consumption and blood lipid levels: A pooled analysis of 25 intervention trials. Archives of internal medicine, Vol. 170, No. 9, p. 821–827.*
19. *Sanchez-Muniz FJ, Bastida, 2006, Effect of frying and thermal oxidation on olive oil and food quality. In: olive oil and human health. International Publishing, Oxford shire, pp: 74-108.*
20. *Schroeder MT, Becker EM, Skibsted LH, 2006, Molecular mechanism of antioxidant synergism of tocotrienols and carotenoids in palm oil. Journal of Agriculture and Food Chemistry, Vol. 54, No.9, p. 3445–3453*
21. *Simopoulos AP, 2008, The importance of the omega-6/omega-3 fatty acid ratio in cardiovascular disease and other chronic diseases. Experimental Biology and Medicine Vol. 233, No.6, p. 674–88.*
22. *Stahl W, Sies H, 2005, Bioactivity and protective effects of natural carotenoids. Biochimica et Biophysica Acta, Vol. 1740, No.2, p. 101–107.*
23. *Vingering N, Marine Oseredczuk, Laure du Chaffaut, Jayne Ireland and Martial Ledoux, 2010, Fatty acid composition of commercial vegetable oils from the French market analyzed using a long highly polar column. OCL, Vol. 17, No. 3, p. 185-192.*

Table 1: Formulation of the AIN-93M diet for maintenance of rats

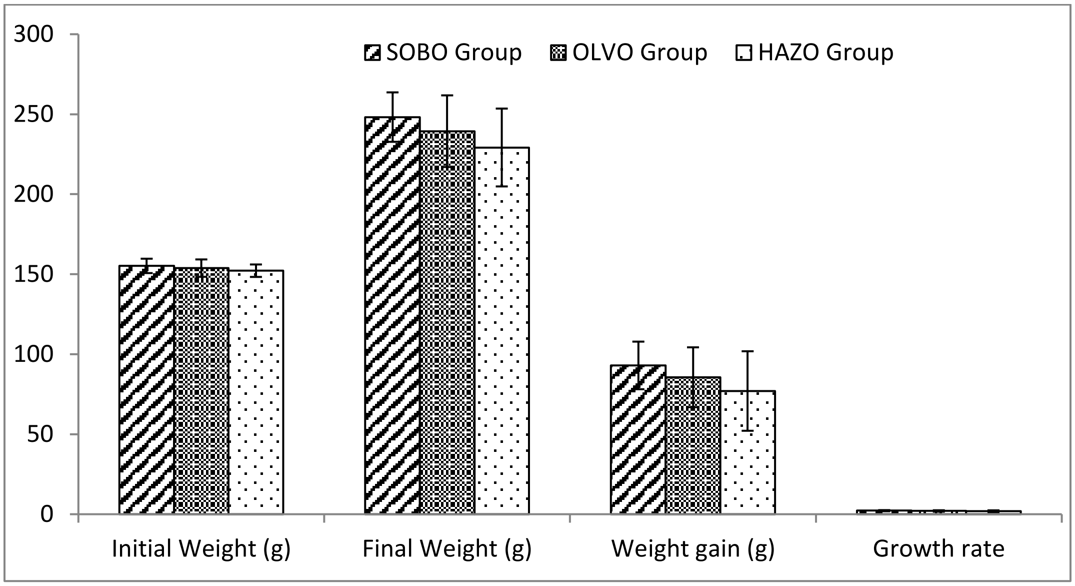
Ingredient	SOBO Group (g/kg diet)	OLVO Group (g/kg diet)	HAZO Group (g/kg diet)
Corn starch	465.6	465.6	465.6
Casein	140	140	140
Maltodextrin	145	145	145
Sucrose	100	100	100
Cellulose	50	50	50
Minerals mix (AIN-93-MX)	35	35	35
Vitamin mix (AIN-93-VX)	10	10	10
L-Cystine	1.8	1.8	1.8
Choline	2.5	2.5	2.5
tertiary-Butylhydroquinone (TBHQ)	8	8	8
Soya bean oil	50	0	0
Olive oil	0	50	0
Hazelnut oil	0	0	50

Where SOBO: soya bean; OLVO: olive; HAZO: hazelnut

Table 2: Effect of different oil (soybean oil, olive oil, hazelnut oil) on lipid profile and glucose level of male Wistar rats

	SOBO Group	OLVO Group	HAZO Group
TC	$55.20035 \pm 10.20393^{a}$	$48.98245 \pm 13.35431^{a}$	$74.35087 \pm 25.57415^{a}$
HDL-C	39.5533 ± 10.03937^{a}	$55.53299 \pm 10.90792^{b}$	$44.67005 \pm 9.867319^{ab}$
TG	$102.8572 \pm 3.878209^{a}$	$104.6808 \pm 10.77548^{a}$	$102.1277 \pm 11.29128^{a}$
LDLC	33.244 ± 17.7712^{a}	$34.67115 \pm 17.42951^{a}$	$33.24373 \pm 16.12457^{a}$
VLDL-C	$20.57143 \pm 0.775641^{a}$	$20.93617 \pm 2.155097^{a}$	$20.42553 \pm 2.258256^{a}$
Glucose	$86.47059 \pm 11.91086^{a}$	80.70588 ± 10.1067^{a}	$80.70588 \pm 5.365533^{a}$

Where SOBO: soya bean oil; OLVO: olive oil; HAZO: hazelnut oil. Data are expressed as the mean ± standard deviation; Model ANOVA, p values < 0.05 are significant. Superscript ^{ab} indicates significant differences among various groups as indicated by ANOVA followed by Duncan's multiple range test.



Graph 1: Growth indicators of male Wistar rats fed with different oil

Where SOBO: soya bean oil; OLVO: olive oil; HAZO: hazelnut oil. Data are expressed as the mean ± standard deviation;