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

Dina M Trabzuni

Department of Food and Nutrition Sciences, College of Food Science and Agriculture Sciences, King Saud University, Riyadh, Saudi Arabia

Corresponding Author
Dina M Trabzuni
Department of Food and Nutrition Sciences, College of Food Science and Agriculture Sciences, King Saud University
Riyadh, Saudi Arabia
Email: dina.trabzuni@gmail.com

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°C and 12/12 light / dark cycle with room temperature (25±2°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 ≤ 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.

Acknowledgement
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References


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

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

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

<table>
<thead>
<tr>
<th></th>
<th>SOBO Group</th>
<th>OLVO Group</th>
<th>HAZO Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC</td>
<td>55.20035±10.20393&lt;sup&gt;a&lt;/sup&gt;</td>
<td>48.98245±13.35431&lt;sup&gt;a&lt;/sup&gt;</td>
<td>74.35087±25.57415&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>HDL-C</td>
<td>39.5533±10.03937&lt;sup&gt;a&lt;/sup&gt;</td>
<td>55.53299±10.90792&lt;sup&gt;b&lt;/sup&gt;</td>
<td>44.67005±9.867319&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>TG</td>
<td>102.8572±3.878209&lt;sup&gt;a&lt;/sup&gt;</td>
<td>104.6808±10.77548&lt;sup&gt;a&lt;/sup&gt;</td>
<td>102.1277±11.29128&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>LDLC</td>
<td>33.244±17.7712&lt;sup&gt;a&lt;/sup&gt;</td>
<td>34.67115±17.42951&lt;sup&gt;a&lt;/sup&gt;</td>
<td>33.24373±16.12457&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>VLDL-C</td>
<td>20.57143±0.775641&lt;sup&gt;a&lt;/sup&gt;</td>
<td>20.93617±2.155097&lt;sup&gt;a&lt;/sup&gt;</td>
<td>20.42553±2.258256&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Glucose</td>
<td>86.47059±11.91086&lt;sup&gt;a&lt;/sup&gt;</td>
<td>80.70588±10.1067&lt;sup&gt;a&lt;/sup&gt;</td>
<td>80.70588±5.365533&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

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 <sup>ab</sup> 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;