Effect of barley and oats on high-density lipoprotein cholesterol and triglycerides in rats

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Abstract

Introduction:
The role of plants in reducing blood fats and thus reduce the risk of heart disease - Coronary known. The main aim of this study barley and oat seed extract on blood factors and atherosclerosis in adult rat.

Material and Method:
In present study, 50 female Wistar rats, weighing approximately 300±20 g were included. Then, they are divided into 5 groups with 10 rats including control group (without any receiving any sustenance), instance group (1% weight of food is cholesterol), Experimental 1 group (daily 1% weight of food is cholesterol and also barley extract with BW dosage, 125mg/kg), Experimental 2 group (daily 1% weight of food is cholesterol and also oat extract with BW dosage, 125mg/kg), Experimental 3 group (daily 1% weight of food is cholesterol and also barley extract and oat extract each with BW dosage, 62.5mg/kg). At the end of the experiment, the animals were bled and factors (HDL, total cholesterol and triglycerides) were studied.

Results:
The results show that HDL levels in all experimental groups compared to the control group showed a significant decrease. Cholesterol levels in the experimental group received the extract of barley and oats simultaneously, had significant reduction compared to the control group (P<0.05). At the end of the experiment, the animals were bled and factors, HDL, total cholesterol, triglycerides were studied.

Conclusion:
According to above results of this study, it can be stated that barley and oat extract simultaneously cause reduction of blood fats and cholesterol. So the simultaneous use of these extracts is recommended. Also, barley extract has more useful effect than oat extract in reduction of blood lipid parameters.

Keywords: Barley, Oat, HDL, Cholesterol, Triglycerides, Female Rat

Introduction
Atherosclerosis, commonly referred to as "furring of the arteries" (2), is an arterial disease. Identifying and controlling its causing and exacerbating factors is highly crucial (1). The development of atherosclerosis follows a complex process in which many factors are involved; therefore, identifying a single risk factor for it is almost impossible (2). Significant
risk factors of this disease include, dyslipidemia, glycosylation events and all events increasing oxidative shock (3, 4 & 5). Since atherosclerosis is considered an inflammatory disease, inflammation and factors affecting it also count as potential risk factors that need to be controlled in order to prevent atherosclerosis (6, 7). Today, the use of medicinal herbs for controlling risk factors is highly emphasized (8). Atherosclerosis is responsible for most cases of myocardial infarction and strokes in Europe and the United States (9), and also causes the majority of cardiovascular diseases. Coronary heart diseases are the main cause of mortality in men over the age of 40 and women over the age of 65 in the United States (10). About 50% of deaths are caused by atherosclerosis (11). This disease is formed as fatty streaks beneath the endothelial layer lining the artery (12). Most varieties of barley, in particular the variety of barley cultivated in different regions of the world for producing seed, are of the Sativum species, while other varieties scattered across different regions and under different conditions are of the wild variety that cannot be domesticated. Barley cultivated in different regions of the world is divided into the spring variety and the autumn variety. (13). The main cultivars of barley currently cultivated in different regions of the country include, Aramir, Arivat, Aram, Star, Atlas 46, Sour barley, Tunisian barley, Golden barley, Sina, Sweet, Karoun 205, Californi, Gohar-Joe, Gorgan 4, Naked barley, Valfajr, Afzal barley, Turkmen barley, Southern barley, Plain barley, Reyhan barley, Kabir and Maku’ee (13). Past investigations on the effect of barley extract on renal nephropathy in diabetic patients have shown that barley reduces the volume and density of urinary protein. In addition, barley extract reduces glutathione and the catalase enzyme in diabetic rats, and also reduces triglyceride, cholesterol and LDL and is therefore effective in reducing diabetic nephropathy complications (14). Examining the effects of barley-derived and yeast-derived beta-glucan on the lipid profile of rats on a high-cholesterol diet showed that barley-derived beta-glucan has a better cholesterol and LDL reducing and HDL increasing effect. The anti-lipid effects of beta-glucan depend on the source from which it is derived (15). Studies have shown that HDL prevents lipid accumulation due to its ability to absorb intracellular lipids and that its serum level has an inverse relationship with the development of atherosclerotic diseases (16).

Barley has a strong cholesterol inhibiting effect on the body and causes a dramatic reduction in hepatic and total cholesterol levels and low-density lipoprotein cholesterol, and also increases high-density lipoprotein. This substance contains vitamin E, which is effective in reducing cholesterol (17).

Oats, with the scientific name of "Avena sativa L", are highly suitable for producing dry fodder for livestock consumption. In general, when there is a shortage of fodder or in absence of forage vegetation due to unfavorable environmental conditions, cereal grains can be grown and cultivated for livestock fodder (13). Due to the presence of Avenine, oats produce excessive heat and energy inside the animals' bodies. Young oat leaves contain adequate levels of protein. A special alkaloid called furfural with industrial uses is derived from oat straws, that is, aside from some other compounds that are used in pharmaceutical and hygiene products (13).

Considering the effects of barley and oat, and the significance of the prevention and control of cardiovascular diseases, and given the lack of studies on the effects of these two plants on changes in hematological parameters such as triglyceride and total cholesterol levels, the present study was conducted with the purpose of investigating the effects of barley and oat on stated parameters and on...
reducing the risk of cardiovascular diseases in hyper-cholesterolemic rats.

Materials and Methods
The present experimental, randomized study has abided by all codes of ethical conduct in working with laboratory animals. A total of 30 adult female Wistar rats weighing 300±20 grams and aged 100-120 days were procured from Jahrom Research Center and kept under laboratory conditions, that is, under 21±2 °C and in a cycle of 12 hours light 12 hours darkness for 21 days at the Islamic Azad University of Jahrom’s Animal House. During this period, the rats were fed standard pellet food, drank water from special glass bottles, and were kept in cages that were disinfected with alcohol 70% three times a week.

To prepare the extracts, Karoun barley (Hordeum Vulgare L) and wild oats (Avena Ludoviciana) were purchased from the market. After ensuring the grains' healthy appearance and receiving their scientific confirmation from a number of professors of plant biosystematics and professors at the Agricultural Botany Department of the Agriculture School of the Islamic Azad University of Jahrom, the aqueous extracts were prepared. First, the barley and oat grains were finely grinded to a powder. A water distillation device was used to prepare the aqueous extracts. 100 grams of barley and oat seeds were separately dissolved in 1000 ml of distilled water and then heated at 30-40 °C for 2 hours. The yielded extract was filtered and the residue left in the filter media was fully dried in an oven and the amount of dissolved powder was measured. The excess water in the solution was condensed using a rotary device and then kept inside dark containers for further experimentations (18). To prepare the cholesterol-containing meal, the rats’ standard food was first finely grinded to a powder. Then, 10 kg of the powder and 100 grams of cholesterol were mixed in water forming a pasty pellet dried in the sun.

Each group of animals was composed of 10 female rats as follows:
- The negative control group: received no particular substance and stayed on a normal diet
- The cholesterol group: received a high-fat diet (cholesterol content of food: 1% of total weight).
- Experimental group 1: cholesterol composed 1% of total weight of food consumed per day, and the group received an intraperitoneal injection of barley extract at a dose of 125 mg/kg of body weight.
- Experimental group 2: cholesterol composed 1% of total weight of food consumed per day, and the group received an intraperitoneal injection of oat extract at a dose of 125 mg/kg of body weight.
- Experimental group 3: cholesterol composed 1% of total weight of food consumed per day, and the group received an intraperitoneal injection of barley extract at a dose of 62.5 mg/kg of body weight and of oat extract at a dose of 62.5 mg/kg of body weight.

After the 21-day period ended, the rats were weighed in all the groups and then anesthetized with ether. Using a syringe, 5cc blood sample was drawn from their heart and their blood serum was then separated. Their HDL, cholesterol and triglyceride concentrations were then measured in the laboratory of Jahrom University of Medical Sciences using the enzymatic colorimetric method (GPO-PAP) for single-point measurement through a photometric method using an auto-analyzer device (Prestige, made in Japan). The one-way analysis of variance was used to compare the treatments, and then to make multiple comparisons between the different groups, the t-test and Duncan’s new multiple range test were used in SPSS 18 software. The level of statistical significance was set at P<0.05.
Results
Total cholesterol concentrations presented in figure 1 show that the group receiving both barley and oat extract has had a significant reduction in cholesterol concentrations compared to the negative control group. Also, the group receiving oat has had a significant increase in cholesterol concentrations compared to the group receiving both barley and oat (P<0.05), (table 1).

![Figure 1: Cholesterol concentration changes in the different groups](image1)

Triglyceride concentrations presented in figure 2 show that none of the experimental groups have significantly changed compared to the negative control group (P<0.05). The group receiving cholesterol showed a significant increase in triglyceride concentrations compared to the negative control group, (table 1).

![Figure 2: Triglyceride concentration changes in the different groups](image2)

Results shown in figure 3 show that, in the experimental group receiving both barley and oat, HDL concentration has significantly increased compared to the
negative control, while in the rest of the experimental groups, this measure has significantly reduced compared to the negative control group (P<0.05), (table 1).

According to Duncan’s test, there is no significant difference between the groups if there is at least one common letter between them.

Table 1: Mean concentrations measured in the experimental groups

<table>
<thead>
<tr>
<th></th>
<th>Negative Control</th>
<th>Cholesterol</th>
<th>Barley + Oat</th>
<th>Barley</th>
<th>Oat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Cholesterol</td>
<td>76.4±6.5</td>
<td>83.1±5.7</td>
<td>56.8±5.9</td>
<td>68±5.7</td>
<td>78.4±5.9</td>
</tr>
<tr>
<td>Triglyceride</td>
<td>69.8±18.9</td>
<td>90.5±22.6</td>
<td>63.1±8.1</td>
<td>68±25.8</td>
<td>78.4±12.06</td>
</tr>
<tr>
<td>HDL Concentration</td>
<td>16.2±1.43</td>
<td>14±1.4</td>
<td>24.8±1.6</td>
<td>15.12±1.4</td>
<td>13.7±1.6</td>
</tr>
</tbody>
</table>

**Discussion**

In the present study, the experimental group receiving both barley and oat showed a significant reduction in cholesterol levels compared to the negative control group (P<0.05). According to studies conducted, there is a relationship between mortality rates due to ischemic heart disease and a plasma cholesterol level of 150 mg/dl in humans (20). There is also evidence suggesting that increased triglyceride levels predispose humans to atherosclerosis (cardiovascular diseases) (19). Various studies have shown that, from the onset, atherosclerosis causes low-density lipoproteins to enter the arterial wall, accumulate and oxidize, and to then prevent the mechanisms of adhesion, migration and differentiation of monocytes from functioning, thus leading to inflammation (22). Atherosclerosis is also found to be an inflammatory process (21). Studies have shown that oat extract inhibits inflammatory processes by affecting the prostaglandins (23 & 24), and potentially reduces blood fat and the risk of cardiac diseases as a result. Furthermore, barley extract reduces cholesterol, as it contains vitamin E (25); however, beta-glucan extract (the active agent in barley) reduces cholesterol to a greater degree (15). Studies conducted on the blood-fat-reducing effects of some other plants such as alfalfa show that this plant has anti-cholesterol properties effective in apes due to its vitamin K, C, B
and E and beta-carotene content (26). The reduction of cholesterol in the experimental group receiving both barley and oat extract is probably due to the antioxidant vitamin content in their diet. It is evident that the simultaneous use of these two extracts has a greater cholesterol-reducing effect. According to figures 1 and 2, barley extract has proven more effective in reducing cholesterol levels than oat extract. Reports indicate that vitamin intake can reduce the risk of cardiovascular diseases and improve the endothelial function of the arteries in hyperlipidemic people through reducing free radicals (27).

There is a greater need for antioxidants in hyperlipidemic people, and the addition of these vitamins to the diet or medication regimen of these patients may reduce their blood fat. Vitamin C present in plant compounds is an antioxidant that reduces lipid-peroxidation and oxidative blood vessel damage. The consumption of vitamin C and diets rich in these antioxidant vitamins helps maintain health and reduces the risk of cardiovascular diseases (28). It is evident that oat extract contains various vitamins, such as vitamin C, that reduce blood fat through the stated mechanisms (29 & 30); results of previous studies are in line with results of the present study in this regard. In a study conducted on the effects of yeast-derived and barley-derived beta-glucan on lipid profile and cecum probiotic bacteria of rats on high cholesterol diets, barley-derived beta-glucan was found to reduce cholesterol and LDL and increase HDL to a greater degree, while yeast-derived beta-glucan reduced cholesterol to a lesser degree. It can therefore be argued that the anti-fat effects of beta-glucan depend on the source from which it is derived (31). Furthermore, the fibers present in oatmeal and oat flour are reported to reduce bad cholesterol by 20% and increase good cholesterol by at least 15% (32).

Vitamin C causes favorable changes in HDL and LDL levels by way of two main mechanisms, 1. Reducing LDL oxidation and increasing LDL identification by its receptors through its anti-oxidant effects; and 2. Increasing LDL catabolism and reducing HDL excretion by creating competition due to its structural similarity to glucose in the HDL and LDL glycation process (33). In the present study, high-density lipoprotein levels in the experimental group receiving both barley and oat extract showed a significant increase compared to the negative control group. This increase is beneficial, as this type of cholesterol carries bad cholesterol away from the arteries and prevents heart attack and stroke.

Conclusion
According to results of the present study, it can be concluded that, when taken together, barley and oat extract reduce blood cholesterol and triglyceride levels and increase HDL levels. The simultaneous use of these extracts is therefore strongly recommended. Moreover, barley extract is more beneficial than oat extract in reducing blood fat levels.

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References:


