INFLUENCE OF BARLEY COFFEE ON BLOOD CHOLESTEROL LEVEL

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ABSTRACT
The current study presents an application of barley coffee as new drink including chemical composition and nutritive value of barley. The effect of barley on reducing total LDL cholesterol and serum cholesterol levels were studied. Three mixes were prepared from ground barley grain (BG) and ground roasted barley grain (RBG). The treatment combinations were: T1 (90% BG + 10% RBG), T2 (85% BG + 15% RBG) and T3 (80% BG + 20% RBG). The sample with 20% ground roasted barley grain (RBG) classified as the highest value of overall acceptability products, with no significant effect of HDL concentration during for 20 days with 10% concentration of barley coffee. But 10% of barley coffee reduced total cholesterol TC (43.2%), triglyceride TG (38.1%) and low density lipoprotein LDL (61%).


1. INTRODUCTION
It has been proven that the soluble fiber can lower cholesterol levels in the blood, which may help in reducing the risk of heart disease. Research has shown that a healthy diet for the heart, such as reducing the amount of saturated fat, unsaturated fat, cholesterol and increased amounts of soluble fiber can greatly improve cholesterol levels. These results indicate that additional 5-10 grams of soluble fiber a day can lead to a reduction of 3-5% in LDL ("bad") cholesterol. [3] Since soluble fiber does not dissolve in water, the gel-like material, it forms binds to cholesterol in the intestinal tract and helps eliminate it from the body. Think of
soluble fiber like a sponge, “soaking up” cholesterol and preventing it from being absorbed. By doing this, soluble fiber help in reducing the amount of cholesterol.

The blood, which, in turn, reduces cholesterol deposits on artery walls and plaque build-up that can lead to heart disease.[4,16] Barley healthy foods and additives in the diet. The barley component's whole grain was low-fat and high in fiber, making it ideal for individuals following the recommendations of the 2005 Dietary Guidelines for Americans. Barley as food has many of the features of health promotion, in addition to providing proper nutrition. Fiber contents recoverable Barley beta-glucan gives products with cholesterol lowering properties similar to oat. Emerging data also indicate that the benefits exceed the level of cholesterol, including a reduction the level of sugar in the blood and insulin levels after eating, and increase the feeling of fullness after barley consumption.[20]

Coffee is one of the most widely consumed beverages in the world. The high acceptability of coffee is due to many factors, Most of the contributory factors being its flavor.[11] Commercial coffee beverage is made from Arabica or Robusta beans or blends of them.[15] The quality of coffee used for beverages is strictly related to the chemical composition of the roasted beans.[9,24]

This implies controlling the roasting time and temperature so that they are sufficient for the required chemical reactions to occur, without burning the beans and compromising the flavor of the final beverage.[13] In general, in conventional roasting process, the temperature is in the range from 200 to 230°C, and the process time is ranging from 12 to 20 minutes. However, these values can vary greatly, depending on the degree of roast required (light, medium or dark), on the type of roaster used, and also on the variety, age, moisture content, etc. of the coffee beans.[17]

2. MATERIALS AND METHODS
2.1 Preparation of Barley Coffee
2.1.1 Cleaning of Raw Material
Barley grains (Giza 130 as hulled barley) were obtained from agriculture research center-Dokki – Giza - Egypt's barley grain was cleaned manually. After removal of foreign material, weeds and non-grain matters, samples were stored in polythene bags until used.
2.1.2 Barley Seeds Roasting
High degrees of roasting temperatures lead to a series of physical and chemical changes in the seed. These changes have a strong influence on the bioactivity and flavor of the drink. Roasting drum in a way that makes seeds are in direct contact with the fire or hot surface and makes the colors of roasted seeds more homogeneous than other methods of roasting. The temperatures used to roast the seeds 200°C for 20 minutes.

In the first phase of roasting, the water evaporates. When the temperature reaches seeds 130°C happens, caramelizes sucrose, then the seeds swell. Chemical changes in this initial phase are relatively small compared with those that occur at the end of the roasting process. At temperatures higher than 160°C heat, a series of interactions occur transform seeds to light brown color and increases the size of the seed and begins the formation of the smell. Where start the chemical reactions responsible for the formation smell and flavor in roasted seeds at 190°C. These reactions stop at a certain degree based on of seed color desired. Seeds are then cooled rapidly through the air. After roasting and ground used the production of coffee.

2.1.3 Coffee Producing
Three mixes were prepared from ground barley grain (BG) and ground roasted barley grain (RBG). The treatment combinations were:
T1 (90% BG + 10% RBG)
T2 (85% BG + 15% RBG)
T3 (80% BG + 20% RBG).

2.2 Determination of chemical composition and changes in chemical composition during roasting of barley grain
Determination chemical composition of barley grain and their content of carbohydrate content, protein, crude fat, crude fiber, ash, moisture and β-glucan and determination of changes during roasting as a consequence of pyrolysis, caramelization and Maillard reactions for this compound using the method.[2]

2.3 Sensory evaluation of characteristics of coffee products
Sensory evaluation was carried out by a panel of six judges with experience in the field of food science and technology. Sensory analysis of coffee prepared with ground barley grain (BG) – ground roasted barley grain (RBG) blends was conducted for various sensory parameters by assigning scores for color: 1 = light brown, 10 = dark brown; aroma
characteristics: 1 = light aroma of coffee, 10 = tantalizing aroma of coffee; acceptance of
taste: 1 = difference from coffee, 10 = near coffee. The overall quality score (30) is the
combined score of all these parameters.[22,23]

2.4 Experimental design
2.4.1 Induction of hypercholesterolemia
One hundred (100) male rats weighing between 250 to 300g were selected for the
experiment. The rats was divided into four groups each group consists of twenty-five rats.
The animals were individually housed in metabolic cages of dimensions 33 cm×20.5 cm×19
cm under standard conditions (12-h light:12-h dark, 28°C±3°C and 40–55% humidity). They
were allowed free access to normal rat chow and distilled. The acclimatization was done for
seven days before the start of the experiment. The rat made hypercholesterolemia diets were
enriched with 0.25g cholesterol/100g diet for 10 days.[7,18]

2.4.2 Dietary Intake
Equip the boiled of barley coffee by mixing selected according to good sensory
characteristics explained below.
• 1g barley coffee in 30ml water (A)
• 2g barley coffee in 30ml water (B)
• 3g barley coffee in 30ml water (C)
and it was fed to rats as two doses per day each dose 15 ml for 20 days explained below
• Group 1: was fed by basic meals only as a control sample.
• Group 2: was fed by basic meals + two doses of barley coffee (A)
• Group 3: was fed by basic meals + two doses of barley coffee (B)
• Group 4: was fed by basic meals + two doses of barley coffee (C)

2.4.3 blood cholesterol level
The blood samples were analyzed by Egyptian National Cancer Institute. Serum triglyceride
(TG), total cholesterol (TC), low dynasty lipoprotein (LDL) and high dynasty lipoprotein
(HDL) were determined using a biochemical analyzer (Hitachi7600-300S).

2.5 Statistical analysis
The data were subjected to analysis of variance (ANOVA) using Co Stat-2003 software. The
Duncan multiple ranges were used to determine the level of significance between samples
and examine the effect of treatment on the different parameters measured. Differences were
considered significant at P < 0.05. Linear regressions were calculated between the total cholesterol, triglyceride, HDL and LDL for fed the four concentrations of barley coffee during for 20 days.

2. RESULTS AND DISCUSSION

3.1 Changes in chemical composition during roasting of barley grain and coffee producing

During roasting barley grain barley to produce coffee many chemical changes were accidents as shown in Table (1) below. Loss of some compounds or cracking occurs to other vehicles during heat, and it depends on the degree of roasting. However, the chemical composition of coffee reflects the composition of the coffee mixture and the degree of roasting. The goal of the manufacturers is to create a barley coffee drink with a chemical composition similar to that of roasted ground coffee beans, which must contain moisture up to 5%, sugars (50-60 g) and protein (12.6 to 21 g) and fat (0.2 to 1.6 g) and oligosaccharides (5.2 to 7.4 g) per 100 grams of dry weight.\cite{1,21}

<table>
<thead>
<tr>
<th>Parameter (%)</th>
<th>Barley grain</th>
<th>Roasted barley grain</th>
<th>Coffee (T1)</th>
<th>Coffee (T2)</th>
<th>Coffee (T3)</th>
</tr>
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<tr>
<td>Moisture</td>
<td>11.6</td>
<td>6.4</td>
<td>11.2</td>
<td>10.8</td>
<td>10.3</td>
</tr>
<tr>
<td>Ash</td>
<td>2.3</td>
<td>3.2</td>
<td>2.5</td>
<td>2.6</td>
<td>2.8</td>
</tr>
<tr>
<td>Protein</td>
<td>12.4</td>
<td>9.6</td>
<td>11.8</td>
<td>11.6</td>
<td>11.2</td>
</tr>
<tr>
<td>Fat</td>
<td>2.3</td>
<td>1.9</td>
<td>2.2</td>
<td>2.2</td>
<td>2.1</td>
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<tr>
<td>Fiber</td>
<td>17.3</td>
<td>10.8</td>
<td>12.4</td>
<td>13.1</td>
<td>13.9</td>
</tr>
<tr>
<td>Carbohydrate</td>
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<td>53.7</td>
<td>65.3</td>
<td>64.7</td>
<td>62.6</td>
</tr>
<tr>
<td>Beta-Glucan</td>
<td>4.8</td>
<td>2.3</td>
<td>4.6</td>
<td>4.5</td>
<td>4.3</td>
</tr>
</tbody>
</table>

(RBG) Roasted Barley Grain, T1(10% RBG), T2 (15% RBG), T3 (20% RBG).

3.2 Sensory evaluation of characteristics of coffee products

Ground barley grain (BG) mixes with different levels of roasted ground barley grain (RBG) were sensory evaluated to choose the best treatment of color, taste, flavor and overall acceptability as a product little like coffee and not similar to coffee. Data indicated that the coffee containing 20% roasted ground barley grain (RBG) was found to be the most acceptable. At 20% level of incorporation, all the attributes scored highest level. The color scores of coffee with 20% (RBG) reached a maximum than to the rest of the proportions similar to the control sample. Thus, incorporation of (RBG) at 20% level improved the sensory attributes namely color, taste, odor and overall acceptance for product. As a result,
the sensory evaluation fig (1) depicts that highest amount of roasted ground barley grain that can be incorporated to develop acceptable coffee T3 was the best regarding all sensory attributes.

The result of the sensory evaluation is shown in fig (1) below. The result the appearance of the coffee samples was fairly good. The results; it was observed that the best color which had a mean value of 8.5 as indicated by the panelist. Based on appearance the sample with 20% (RBG) classified highest with value of 8. The odor of the products was fairly accepted at up to 20% substitution with (RBG) which had 9 a mean value.

![FIG (1): Sensory Evaluation Of Coffee Products](image)

(RBG) Roasted Barley Grain, T1(10% RBG), T2 (15% RBG), T3 (20% RBG).

3.3 Blood cholesterol level

Blood analysis research conducted to estimate an effect of barley coffee on the cholesterol level in mice. Results is shown in figures (2, 3, 4, 5 and 6) below a significant decrease was observed in a group (4) which content concentration of 10% of the barley coffee (3g / 30 ml) greater than the rate of cholesterol in group 2, and 3 are clearly decreased cholesterol level in mice compared with a group1 (control).
Fig 2: Effect of barley coffee on Total Cholesterol (mg/dl) in rats.

(G1) control sample, (G2) 1g barley coffee, (G2) 2g barley coffee, (G3) 3g barley coffee.

Data were presented as mean ± SEM P-value < 0.05.

TC, TG, HDL and LDL concentrations are listed in Table (2). Repeated measure's ANOVA revealed that barley coffee concentration was significantly an effect on total cholesterol (TC) (P=0.0034), triglyceride (TG) (P=0.0064) and low-density lipoprotein (LDL) (P=0.0164). Total cholesterol, triglyceride and low-density lipoprotein were significantly affected by time (P= 0.0064), (P=0.0021) and (P=0.0155) respectively. HDL was not significantly affected by barley coffee concentration and time.

In group 1 (control) were slightly a variation in cholesterol level from day 1 to 20 as appear with mean value of total cholesterol (TC), triglyceride (TG), low-density lipoprotein (LDL) and high-density lipoprotein (HDL) levels at day 0 (baseline), 5, 15 and 20 the experiment which was observed insignificant.

Fig 3: Effect of barley coffee on Triglyceride (mg/dl) in rats.

(G1) control sample, (G2) 1g barley coffee, (G2) 2g barley coffee, (G3) 3g barley coffee.

Data were presented as mean ± SEM P-value < 0.05.
Group 2 (concentration 1g) the mean value of blood lipids level at day 0 (baseline) to 20 days was tended to lower total cholesterol TC to (26.5%), triglyceride TG to (17.5%) and low-density lipoprotein LDL to (29.2%). However, they were slightly a variation in high-density lipoprotein (HDL) level at a day 0 (baseline), 5, 15 and 20 level which was insignificant. Concentration 2g of barley coffee in 30 ml water in a group 2 decreased cholesterol level through baseline to 20 days, (37.5%) of TC, (31.3%) of TG and (39.5%) of LDL, But a non-significant effect of HDL through time. HDL concentration during 20 days with 10% concentration of barley coffee in group 4 (3g barley coffee / 30ml water) no significant decreased. However, 10% of barley coffee reduced total cholesterol TC (43.2%), triglyceride TG (38.1%) and low-density lipoprotein LDL (61%) as shown in fig (6) below.

Coffee barley is rich in dietary fiber soluble (β-glucan). These fibers help in reducing the level of blood cholesterol because it is associated with bile acids in the intestine and prevents re-absorbed and then removed from the body through the stool, so the liver converts more cholesterol to bile acids and therefore, less level cholesterol in the blood. This process causes to reduce the level of bad cholesterol in the range of 20-40%. [3,4]
Fig 5: Effect of Barley Coffee on Low Dynasty Lipoprotein (mg/dl) in rats.

(G1) control sample, (G2) 1g barley coffee, (G2) 2g barley coffee, (G3) 3g barley coffee.

Data were presented as mean ± SEM P-value < 0.05.

Fig (6) Remaining percentage (%) of (TC) total cholesterol, (TG) triglyceride, HDL and LDL after using different concentration of barley coffee for 20 days.

(G1) control sample, (G2) 1g barley coffee, (G2) 2g barley coffee, (G3) 3g barley coffee.

Daily consumption of barley coffee with 10% concentration can providing enough amounts of β-glucan which reduced the serum TC, LDL and TG levels significantly during the trial. The mechanisms by barley coffee β-glucan reduces a serum cholesterol level are similar to those by which water-soluble fibers do. [6,10]

Continued use of barley coffee with 10% concentration makes a ratio of high-density cholesterol to total cholesterol up to 30% approximately as shown results in Table (2), High-density cholesterol (HDL) to total cholesterol (TC) is considered a crucial factor in determining the gravity of total cholesterol in the body on human health. Where that if the good cholesterol (HDL) ratio equal to 0.3 of total cholesterol (TC) and more be enough to
prevent total cholesterol from sticking to the coronary heart.\textsuperscript{[10]} The increased viscosity due to high $\beta$-glucan content in barley coffee slows gastric emptying, digestion, and absorption.\textsuperscript{[19]} This leads to a reduction of insulin after meals, which have positive effects on the various procedures in which insulin affects such as increasing the synthesis of glycogen, fatty acid synthesis and esterification of fatty acids. Increased secretion of bile acids, Insulin priority interest in the energy metabolism of glucose or stored in the form glycogen and fat, as soon as the low percentage of insulin in the blood from the body turns directly to the metabolism of blood fats for energy, leading to reductions in TC, LDL and TG levels.\textsuperscript{[12,14]}

Table (2) significance and different parameters between samples of (TC) total cholesterol, (TG) triglyceride, HDL and LDL for different concentration of barley coffee during 20 days.

<table>
<thead>
<tr>
<th></th>
<th>Effect ratio of barley coffee (%)</th>
<th>Mean difference</th>
<th>Significant with concentration</th>
<th>Significant with time</th>
</tr>
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<tbody>
<tr>
<td><strong>TC</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G 1 (control)</td>
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<td>.0000</td>
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<tr>
<td>G 2 (1g/30ml)</td>
<td>26.5</td>
<td>14.123444</td>
<td>.0007 *</td>
<td>.0001</td>
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<tr>
<td>G 3 (2g/30ml)</td>
<td>37.5</td>
<td>19.120337</td>
<td>.0021 **</td>
<td>.0008</td>
</tr>
<tr>
<td>G 4 (3g/30ml)</td>
<td>43.2</td>
<td>22.777076</td>
<td>.0034 ***</td>
<td>.0046***</td>
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<td><strong>TG</strong></td>
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<td></td>
</tr>
<tr>
<td>G 1 (control)</td>
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<td>1.9015345</td>
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<td>.0000</td>
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<tr>
<td>G 2 (1g/30ml)</td>
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<td>9.163782</td>
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<td>.0000</td>
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<tr>
<td>G 3 (2g/30ml)</td>
<td>31.3</td>
<td>16.309047</td>
<td>.0011 *</td>
<td>.0006*</td>
</tr>
<tr>
<td>G 4 (3g/30ml)</td>
<td>38.1</td>
<td>21.183523</td>
<td>.0027**</td>
<td>.0021**</td>
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<td><strong>HDL</strong></td>
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<td><strong>LDL</strong></td>
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<td>G 3 (2g/30ml)</td>
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<td>15.468666</td>
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<td>.0025 **</td>
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<tr>
<td>G 4 (3g/30ml)</td>
<td>61</td>
<td>19.240864</td>
<td>.0146***</td>
<td>.0155 ***</td>
</tr>
</tbody>
</table>

*P<0.05, **P<0.01, ***P<0.001, Changes from baselines by different concentration.

4. CONCLUSION

It can be concluded from the present study that the highest soluble fiber in barley coffee had a greatest effect on the cholesterol level. The data demonstrates that barley coffee has a cholesterol-lowering effect as results appear reduced in cholesterol level. The overall data suggest that barley coffee possible delays the amount of cholesterol to the liver by affecting the rate of cholesterol absorption and by interrupting the enterohepatic circulation of bile salts, despite no compensatory increase in bile acid synthesis was found. This mechanism is probably related to cholesterol solubilization. In addition, the high fermentability of soluble...
fiber in barley coffee could indirectly act on hepatic cholesterol synthesis by generation short chain fatty acid.

REFERENCES