Hulled Roasted Barley Drink as an Alternative to Coffee: Sensory Evaluation, Chemical Composition and Caffeine Content, Antioxidant Activity and Economic Evaluation

Ghazza Mahfooz Ali 1

ABSTRACT

In this research, the chemical composition, caffeine content, antioxidant activity, and sensory and economic evaluations of hulled roasted barley grains as an alternative coffee drink, were studied. Hulled barley grain variety Giza 134 was cleaning and roasting at about 200 °C for 35,45 and 55 minutes and compared to a sample of Brazilian coffee. The sensory evaluation results, of roasted barley coffee drink at a temperature of 200 °C for a period of 35,45 and 55 minutes, and compared to the Brazilian coffee drink, showed that roasted barley coffee drink at 200 °C for 55 minutes received the highest scores compared to both roasted coffee drink at 200°C for 45 and 35 minutes, and was very near to Brazilian coffee drink. Also, color evaluation was performed for each sample of roasted barley and that of the Brazilian coffee sample. The percentages of protein, fat and ash in hulled roasted barley grains were lower than that of the Brazilian coffee, as these percentages reached 13.20%, 3.84%, and 3.33% in hulled roasted barley grains, while those percentages in Brazilian coffee reached 17.54%, 18.23% and 4.31%, respectively. The moisture, total carbohydrate and starch contents of hulled roasted barley grains were higher than those found in Brazilian coffee. The percentage of crude and dietary fiber decreased in roasted barley grains compared to that in Brazilian coffee. Also, total phenols and antioxidant activity decreased in hulled roasted barley grains compared to Brazilian coffee, reaching 166.22 mg gallic acid/100g and 52.18% in hulled roasted barley grains, while they reached to 1577 mg gallic acid/100g and 90.20% in the Brazilian coffee. The caffeine content of hulled roasted barley grains was zero per cent, while its percentage in Brazilian coffee was 0.87%. The results showed that the mineral contents (magnesium, calcium, iron, potassium and sodium) were higher in the Brazilian coffee (160.67, 57.30, 21.30, 2200 and 93.33 mg / 100 g) compared to hulled roasted barley grains (149.69, 32.97, 15.03, 700 and 76.67 mg / 100 g), respectively. On the other hand, the global production of coffee is about 6 million tons, produced in 9 countries, and Egypt imports about 137 thousand tons, representing about 2.30% of that production, with a cash value estimated at 2.10 billion pounds. It can be provided through a barley coffee drink, with complete replacement, while it can be reduced to about 1.04 billion pounds in the case of 50% replacement, and about 0.50 billion pounds in the case of 25% replacement only. So, consuming barley coffee instead of natural coffee beans in different proportions can lead to the provision of hard currency.

Keywords: Coffee, Barley, Roasting, Chemical composition, Dietary fibers, Antioxidant activity, Sensory evaluation.

INTRODUCTION

Coffee is one of the most popular beverages in the world due to the organoleptic and stimulating properties of its beans (Ballesteros et al., 2014 and Shalaby & Elhassaneen, 2021). Coffee beverages represent 75% of the total non-alcoholic beverage market and their consumption is increasing (Reguengo et al., 2022). The world coffee production reaches about 6 million tons in 2022, and that production is concentrated in 9 countries (FAO, 2022). Barley (Hordeum vulgare L.) also has been used as a coffee-like beverage. In Ethiopia, barley is roasted and served as a coffee-like beverage. Barley is a type of cereal that has high dietary fiber content and is often used as traditional medicine in China (Zeng et al., 2020). Some studies showed that barley is effective in controlling blood glucose levels (Minaiyan et al., 2014), atherosclerotic and cardiovascular disease (Gangopadhyay et al., 2015), and cancers such as colon and lung (Czerwonka et al., 2017).

Roasting is an important processing step to develop the unique physical, chemical and sensorial characteristics of roasted coffees (Wang and Lim, 2015). During the roasting process, the coffee bean is subjected to high temperatures, resulting in chemical-physical changes in its structure. Initially, when the coffee bean reaches temperatures above 180°C the coffee bean begins to form the compounds responsible for the color, flavor, and aroma of roasted coffee beans (Ebrahimi-Najafabadi et al., 2012). Different roasting
parameters give different results based on the physical-chemical and sensory evaluation properties of the roasted sample. In general, the color of roasted coffee beans ranges from light-dark brown to black depending on the roasting temperature. Increasing roasting parameters will affect moisture content, fat, peroxide value, acid value, furan and sensory. Roasted barley grains from covered barley are used to prepare non-alcoholic beverages such as coffee substitutes and roasted barley tea, called mugi-cha in Japan (Tatsu et al., 2020). The coffee substitutes based on roasted barley were developed to reduce the potential risks of coffee consumption associated with high caffeine content (Majcher et al., 2013).

Caffeine is an alkaloid compound with antibacterial and antifungal activity against various microorganisms (Dziki et al., 2015). Caffeine has been mostly used as a dietary ingredient and psychostimulant by about 80% of the world’s population (Willson, 2018). Caffeine has been associated with some beneficial effects in adults; however, regular consumption higher than the recommended intake may cause undesirable effects such as anxiety and tension (Jin et al., 2016), and headache (Espinosa Jovel and Sobrino Mejía, 2017). Caffeine intake higher than 300 mg a day, also lead to spontaneous abortion in pregnant women, and affect foetal growth and lactating conditions (Lyngsø et al., 2017). The negative effects of caffeine are more obvious in older adults under medication as a high concentration of caffeine in plasma could increase the risk of interaction with the drugs. Some medications such as cimetidine, disulfiram, oestrogens, and quinolone class antibiotics have the potential to increase caffeine-related side effects (Higdon and Frei, 2006). Excessive coffee consumption and caffeine-containing products may increase the likelihood of adverse effects (Jagim et al., 2020). This study focused on roasted barley drink usage as an alternative to coffee for nutritional, health and economic reasons.

MATERIALS AND METHODS

Materials
Three kilograms of hulled barley grains (Hordeum vulgare L.) Giza134 was obtained from the Agricultural Research Center, Giza, Egypt.

One kilogram of Brazilian coffee was purchased from Carrefour in Alexandria City, Egypt.

Methods
Barley grains roasting:
The hulled barley grains were carefully cleaned to be free from broken grains and extraneous matter. Barley grains were divided into three sections when roasted at 200 °C with a difference in the period. The first section was for 35 minutes, the second section for 45 minutes, and the third section for 55 minutes, and then cooled to room temperature, hulled roasted barley grains were milled using a high-speed blender to a fine powder and stored in polythene bags in the refrigerator at 4-5 °C until used.

Preparation of barley coffee drink:
A small spoon of roasted barley coffee was added to a cup of water with a little sugar, mixed and then boiled. The samples were prepared hot for a group of ten coffee drinkers.

Analytical methods
Physical methods:
Color measurement was estimated using the Hunter color difference meter. (Ultrascan VIS) Measurements for (yellow), (red), and lightness. Hue and purity values were recorded.

Chemical methods:
Proximate composition of roasted barley coffee and Brazilian coffee including moisture content, crude protein, crude fat, total ash, starch content and crude fiber contents, were carried out according to the Association of Official Analytical Chemists (AOAC, 2000), procedures and total carbohydrates were calculated by difference.

Dietary fiber:
The dietary fiber fractions including neutral detergent fiber (NDF), and acid detergent fiber (ADF) were determined as described by Van Soest et al. (1991), using an Ankom 200 fiber analyzer unit (ANKOM Technology Corporation Maced on, NY, USA). Acid detergent lignin (ADL) was determined according to Van Soest and Mcqueen (1973) by solubilization of ADF with 720ml/L sulfuric acid. The concentration of cellulose and hemicellulose were calculated as follows

\[ \text{The concentration of cellulose} = (\text{ADF-ADL}) \]

\[ \text{The concentration of hemicellulose} = (\text{NDF- ADF}) \]

Mineral content:
Minerals including (Mg, Ca, Fe, K and Na) were estimated using Atomic Absorption Spectroscopy Thermoscientific ICE 3000 Series. Potassium and sodium were determined by Flame Photometer, Jen Way, as described in the A.O.A.C (2000).

Total phenol and antioxidant activity:
The total phenolic in the methanolic extracts was assayed colorimetrically using the Folin–Ciocalteu method, according to Lime et al. (2006). Antioxidant activity of roasted barley coffee and Brazilian coffee were studied by evaluating the free radical scavenging activity of the 1,1-Diphenyl-2-picryl-hydrazyl (DPPH) radical according to the modified method, described by
Brand-williams et al. (1995). The IC50 value is defined as the concentration of the sample (mg/ml) containing mg ascorbic acid equivalent (AAE) for 50% inhibition of DPPH free radical.

**Caffeine content:**

The caffeine content of the tested samples was determined according to the method of AOAC (1995, No.960.25).

**Sensory evaluation:**

The sensory evaluation method was conducted according to the samples that were prepared hot for a group of ten coffee drinkers. The panelists were subjected to sensory evaluation using a 10-point hedonic scale for color, flavor, taste, texture and total acceptability, according to described by Mirghani (2012).

**Statistical analysis**

The determinations were performed in triplicate (n=3) and the data were expressed as average ± standard deviation (SD). Data were statistically analyzed using the statistical analysis system (Al- Bashir, 2007).

**RESULTS AND DISCUSSION**

<table>
<thead>
<tr>
<th>Roasted barley coffee</th>
<th>Color</th>
<th>Flavor</th>
<th>Taste</th>
<th>Texture</th>
<th>Total acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roasting at 200°C for 35 min.</td>
<td>5.60±0.52</td>
<td>5.60±0.52</td>
<td>5.50±0.71</td>
<td>5.80±0.63</td>
<td>5.60±0.52</td>
</tr>
<tr>
<td>Roasting at 200°C for 45 min.</td>
<td>6.80±0.48</td>
<td>7.10±0.47</td>
<td>7.00±0.67</td>
<td>7.20±0.42</td>
<td>7.00±0.00</td>
</tr>
<tr>
<td>Roasting at 200°C for 55 min.</td>
<td>8.10±0.57</td>
<td>8.40±0.97</td>
<td>8.20±0.92</td>
<td>8.20±0.79</td>
<td>8.10±0.74</td>
</tr>
<tr>
<td>Brazilian coffee</td>
<td>9.19±0.12</td>
<td>9.30±0.16</td>
<td>9.40±0.08</td>
<td>9.24±0.14</td>
<td>9.28±0.15</td>
</tr>
</tbody>
</table>

**Fig.1.** Photographs of hulled roasting barley grains at 200°C for 35, 45 and 55 min. and Brazilian coffee
Table (1) and Figure (1), show the sensory evaluation of roasted barley coffee drinks at 200°C with different roasting times, which included 35 minutes, 45 minutes, and 55 minutes, respectively, and compared to Brazilian coffee drinks. The sensory evaluation included color, flavor, taste, texture and overall acceptability. The results of the sensory evaluation of roasted barley coffee at 200°C for 55 minutes received the highest evaluations of all the aforementioned sensory evaluations, with an average of 8.10, 8.40, 8.20, 8.20, and 8.10, respectively, while the sample which was roasted at 200°C for 35 minutes, has been received the lowest values being 5.60, 5.60, 5.50, 5.80, and 5.60, respectively. The sensory evaluation resulted in not discriminating the adulterated coffee samples by 5%, 10% and 20% with barley despite pure coffee being presented as a reference (Daba 2017). Moreover, it can be seen from the results of Table (1) that the panelists gave the barley drink which was roasted at 200°C for 55 minutes high score and was very near to the Brazilian coffee drink. Therefore, based on these results roasted barley sample (200°C for 55 min.) was chosen to conduct the following analysis in this research.

Color values of hulled roasted barley grains and Brazilian coffee were measured using Hunter Color Difference Meter. The data are shown in Table (2). The lightness value (L) was 56.45 for roasted barley and 43.38 for Brazilian coffee. It could be concluded that the roasted barley is more luminant compared to Brazilian coffee since a high L value indicates lightness. Also, as noticed from the a, and b values in Table (2), the color of both roasted barley and Brazilian coffee samples tend to be red to yellow. However, the roasted barley sample has a lower value for red (a) and higher yellow value (b) 6.83 and 17.26 respectively, compared with those of Brazilian coffee which tends to be higher for red value (a) and lower for the yellow value being 8.73 and 11.83 for red and yellow respectively. The dominant wavelengths (hue) for the two samples are shown in Table (2) the hue value is 0.40 for roasted barley, while it was 0.74 for the Brazilian coffee sample. The purity (saturation) which is the degree of purity of the samples, and how much color is mixed with white color was measured. It was found that the purity value was 18.56 for roasted barley, while that of the Brazilian coffee sample was 14.70. These results mean the roasted barley color is purer than that of Brazilian coffee. Torma et al. (2019) reported that the brightness shows significantly lower values for coffee samples, 100% arabica coffee was (22.2) and 100% robusta coffee was (24.1), while, roasted barley was (33.2).

Table 2. Color values of hulled roasted barley grains and Brazilian coffee as measured using the Hunter Color Difference Meter

<table>
<thead>
<tr>
<th>Sample</th>
<th>L</th>
<th>a</th>
<th>b</th>
<th>*Hue</th>
<th>*Purity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hullled roasted barley grains at 200 °C for 55 min.</td>
<td>56.45</td>
<td>6.83</td>
<td>17.26</td>
<td>0.40</td>
<td>18.56</td>
</tr>
<tr>
<td>Brazilian coffee</td>
<td>43.38</td>
<td>8.73</td>
<td>11.83</td>
<td>0.74</td>
<td>14.70</td>
</tr>
</tbody>
</table>

*Hue = a/b
Purity = \sqrt{a^2 + b^2}

Chemical composition:
Table 3. Chemical composition of hulled roasted barley grains and Brazilian coffee

<table>
<thead>
<tr>
<th>Sample</th>
<th>Moisture %</th>
<th>Crude protein %</th>
<th>Crude fat %</th>
<th>Total ash %</th>
<th>*Total carbohydrates %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hullled roasted barley grains at 200°C for 55 min.</td>
<td>2.43±0.06</td>
<td>13.01±0.09</td>
<td>3.84±0.09</td>
<td>3.33±0.06</td>
<td>77.40±0.15</td>
</tr>
<tr>
<td>Brazilian coffee</td>
<td>1.21±0.10</td>
<td>17.53±0.10</td>
<td>18.23±0.06</td>
<td>4.32±0.04</td>
<td>58.71±0.04</td>
</tr>
</tbody>
</table>

*Carbohydrate content was estimated by difference 100 - % of (moisture + protein + fat + ash)
Data in Table (3) show that the percentages of protein, fat and ash in hulled roasted barley grains were lower than those in Brazilian coffee, where the average of those percentages was 13.01%, 3.84%, 3.33% in hulled roasted barley grains, while the average of those percentages in Brazilian coffee was 17.53%, 18.23% and 4.32%, respectively. Also, it was found that the moisture content in hulled roasted barley grains was higher, reaching 2.43% than that in Brazilian coffee, which amounted to 1.21%, carbohydrate content (77.40%) was higher than that in Brazilian coffee (58.71%). Mohd Jamil et al. (2022) showed that the moisture content of Arabica coffee powder was 3.3% and roasted barley powder was 1.9%. Also, roasted barley powder contained lower protein and fat, and higher carbohydrate as compared to Arabica coffee powder. On the other hand, Makpoul (2016) reported that the ash content of roasted barley grains was 3.2%.

Table 4. Starch and crude fiber content of hulled roasted barley grains and Brazilian coffee

<table>
<thead>
<tr>
<th>Sample</th>
<th>Starch %</th>
<th>Crude fiber %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hullled roasted barley grains at 200°C for 55min.</td>
<td>49.26±0.83</td>
<td>6.54±0.09</td>
</tr>
<tr>
<td>Brazilian coffee</td>
<td>33.13±0.67</td>
<td>8.60±0.10</td>
</tr>
</tbody>
</table>

Data in Table (4) presented the content of starch and crude fiber in hulled roasted barley grains and Brazilian coffee. It could be observed that the percentage of starch is higher in the hulled roasted barley grains compared to that in Brazilian coffee, where the average of these percentages was 49.26% and 33.13%, respectively, while the percentage of crude fiber is lower in hulled roasted barley compared to Brazilian coffee, where the average of these percentages was 6.54% and 8.60%, respectively. Asaied et al. (2017) showed that the starch content in roasted barley at 200 °C for 35 min. was 32.75%. Also, Makpoul (2016) reported that the crude fiber content of roasted barley grains was 10.8%.

Table (5), which includes an analysis of the percentages of each dietary fiber, neutral detergent fiber (NDF), acid detergent fiber (ADF), hemicellulose, cellulose and acid detergent lignin (ADL) in the samples of hulled roasted barley and Brazilian coffee, showed a decrease in the average of these percentages in the samples of hulled roasted barley compared to Brazilian coffee, as the average of these percentages in the hulled roasted barley were 27.74%, 12.10%, 15.51%, 8.25%, and 3.80%, respectively, while they were 39.42%, 17.34%, 21.79%, and 10.34%, 7.14%, respectively, in Brazilian coffee. It is well known that the higher content of dietary fibers has provided various therapeutic functions against diabetes, obesity, hypertension, and coronary heart diseases (Fikry et al., 2019). Untreated barley contained more insoluble dietary fiber (12.00–12.40 g/100g dry matter basis) than soluble dietary fiber (4.73–5.70 g/100g dry matter basis), while roasting barley showed significant results, that is, a 53.91% increase in soluble dietary fiber and 8.79% decrease in insoluble dietary fiber according to Bader et al. (2019). On the other hand, Djurle et al. (2016) and Messia et al. (2017) reported that the total dietary fiber content of dehulled barley ranges from 10 to 28% (on a dry matter basis).

Table 5. Dietary fiber of hulled roasted barley grains and Brazilian coffee

<table>
<thead>
<tr>
<th>Sample</th>
<th>Neutral detergent fiber (NDF) %</th>
<th>Acid detergent fiber (ADF) %</th>
<th>Hemicellulose %</th>
<th>Cellulose %</th>
<th>Acid detergent lignin (ADL) %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hullled roasted barley grains at 200°C for 55min.</td>
<td>27.74±0.14</td>
<td>12.10±0.10</td>
<td>15.51±0.09</td>
<td>8.25±0.06</td>
<td>3.80±0.02</td>
</tr>
<tr>
<td>Brazilian coffee</td>
<td>39.42±0.13</td>
<td>17.34±0.16</td>
<td>21.79±0.01</td>
<td>10.34±0.06</td>
<td>7.14±0.06</td>
</tr>
</tbody>
</table>

Table 6. Total phenols content and antioxidant activity of hulled roasted barley grains and Brazilian coffee

<table>
<thead>
<tr>
<th>Sample</th>
<th>Total phenols (mg gallic acid /100g)</th>
<th>Radical scavenging activity DPPH (%)</th>
<th>IC 50 (mg/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hullled roasted barley grains at 200°C for 55min.</td>
<td>166.21±6.04</td>
<td>52.18±1.23</td>
<td>19.18±0.45</td>
</tr>
<tr>
<td>Brazilian coffee</td>
<td>1577±36.00</td>
<td>90.20±0.46</td>
<td>11.09±0.06</td>
</tr>
</tbody>
</table>
Table (6) shows the average contents of total phenols and antioxidant activity. It is clear that the content of total phenols was higher in the Brazilian coffee sample (1577 mg gallic acid / 100g) compared to that of hulled roasted barley grains (166.21 mg gallic acid / 100g). According to Table (6) Brazilian coffee has higher antioxidant activity (90.20%) inhibition of DPPH with an IC$_{50}$ value of (11.09 mg/ml) compared to that of hulled roasted barley grains (52.18%) inhibition of DPPH with an IC$_{50}$ value of (19.18 mg/ml). The phenolic compounds play important roles in protecting against free radicals (Rahmani et al., 2014), hypercholesterolemia (Takaeidi et al., 2014), cancers, asthma, and coughing (Fikry et al., 2019). Contreras-Calderón et al. (2016) reported that the total polyphenol content (TPC) of roasted barley had a lower value (13.2 GAE/100 ml coffees) than 100% Arabica coffee (70.3 GAE/100 ml coffees). Also, Bobková et al. (2020) showed that aqueous coffee extracts possess variable antioxidant activity based on the roasting process and the activity reaches a maximum in light roasted coffees (DPPH inhibition ranging from 69.08 ± 1.33% to 78.55 ± 0.89%). On the other hand, it can be said that roasted barley grains are characterized by good antioxidant activity (52.18 % with 19.8 mg/ml of IC$_{50}$).

As for the caffeine content in the two study samples (hulled roasted barley and Brazilian coffee), Table (7), shows that the hulled roasted barley sample was zero per cent, while the average percentage in the Brazilian coffee sample was 0.87%. Coffee has been found to contain 31 to 124 mg of caffeine for each 100 g of coffee, according to Higdon and Frei (2006). Also, Tarawneh et al. (2021) reported that caffeine was found in all coffee samples whereas roasted barley contains no caffeine. The highest concentration of caffeine was found in roasted coffee (Saudi habshi) with 7.3 mg/5g coffee followed by roasted coffee (Colombian) (6.4 mg/5g coffee) and green coffee (Colombian) (5.8 mg/5g coffee). Since roasted barley grains are caffeine-free, this is considered a great health advantage for human health.

Table (8) presents the content of minerals (magnesium, calcium, iron, potassium and sodium) in the two samples namely hulled roasted barley and Brazilian coffee. As for magnesium, it was 149.66 and 160.66 in the two samples, respectively, while the average for calcium was 32.96 and 57.81, and iron was 15.02 and 21.31. As for potassium, its content reached 700 and 2200, while the sodium content reached 76.66 and 93.32 mg/100g, respectively, for the hulled roasted barley sample and the Brazilian coffee sample. Tarawneh et al. (2021) reported that the iron content of roasted coffee (Saudi Habshi) was 1.10 mg/kg, while the roasted barley was 1.01 mg/kg. Fe is an essential element for all living organisms, as it is involved in many metabolism processes in the cell. It is a component of some proteins and enzymes that possess a vital role in the electron transport system and synthesis of DNA. Also, it is involved in oxygen transfer from the lungs to all body parts. Despite hulled roasted barley grains containing lower amounts of the studied minerals than Brazilian coffee, the results of Table (8) confirm that hulled roasted barley grains contain good amounts of the studied minerals nutritionally.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Caffeine content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hulled roasted barley grains at 200°C for 55min.</td>
<td>0.00</td>
</tr>
<tr>
<td>Brazilian coffee</td>
<td>0.87±0.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sample</th>
<th>Magnesium mg/100g</th>
<th>Calcium mg/100g</th>
<th>Iron mg/100g</th>
<th>Potassium mg/100g</th>
<th>Sodium mg/100g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hulled roasted barley grains at 200°C for 55min.</td>
<td>149.66±0.37</td>
<td>32.96±0.17</td>
<td>15.02±0.01</td>
<td>700.10±0.10</td>
<td>76.66±0.01</td>
</tr>
<tr>
<td>Brazilian coffee</td>
<td>160.66±0.37</td>
<td>57.81±1.00</td>
<td>21.31±0.02</td>
<td>2200.01±0.01</td>
<td>93.32±0.01</td>
</tr>
</tbody>
</table>
Table 9. The most important indicators and parameters of world coffee production, quantity and value of Egyptian imports from it in 2022

<table>
<thead>
<tr>
<th>States Production</th>
<th>Production Quantity (1000 Tons)</th>
<th>%</th>
<th>Coffee Kinds</th>
<th>Egyptian Imports Quantity (Tons)</th>
<th>Value (Millions L.E.)</th>
<th>Mean of Ton Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>2551</td>
<td>42.74</td>
<td>Roasted</td>
<td>110534</td>
<td>1802</td>
<td>16.30</td>
</tr>
<tr>
<td>Vietnam</td>
<td>900</td>
<td>15.08</td>
<td>not roasted</td>
<td>26863</td>
<td>268</td>
<td>9.98</td>
</tr>
<tr>
<td>Colombia</td>
<td>696</td>
<td>11.66</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indonesia</td>
<td>411</td>
<td>6.89</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethiopia</td>
<td>390</td>
<td>6.53</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>India</td>
<td>300</td>
<td>5.03</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mexico</td>
<td>270</td>
<td>4.52</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guatemala</td>
<td>240</td>
<td>4.02</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peru</td>
<td>210</td>
<td>3.52</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>World Production</td>
<td>5968</td>
<td>100.0</td>
<td>Total</td>
<td>137397</td>
<td>2070</td>
<td>15.07</td>
</tr>
</tbody>
</table>


From the data presented in Table (9), it is shown that:
- Coffee cultivation and production worldwide is concentrated in 9 countries: Brazil, Vietnam, Colombia, Indonesia, Ethiopia, India, Mexico, Guatemala and Peru. These countries produce about 42.7%, 15.1%, 11.7%, 6.9%, 6.5%, 5.0%, 4.5%, 4.1%, 4.0%, 3.5% of the world production which reaches about 6 million tons in 2022 for each of them, respectively, Table (9).
- Egypt's imports reach about 137.4 thousand tons of worldwide output, and the value of Egypt's imports was estimated at 2.07 million pounds, with a mean ton price of about 15.07 thousand L.E. (This price was calculated based on customs dollar price equals about 16 pounds).

Through the view of these data, research results and technological points, replacing hulled roasted barley as a drink instead of coffee will achieve an economic return that saving reaches a maximum return estimated of about 2 milliards L.E or its equivalent dollars in the case of a complete replacement, and of about 1, and saving amounts to about 1 milliard L.E in the case of 50% replacement, and about 0.50 billion pounds in the case of 25% replacement.

CONCLUSION
- This study recommends the importance of hulled roasted barley drink in terms of its nutritional value, and this drink is considered less harmful to the consumer as an alternative to coffee, as it is caffeine-free. Potential for coffee consumption associated with higher caffeine content as the roasting process of barley grains improved the taste, flavor and appearance of coffee alternatives.
- The study recommends replacing roasted barley coffee as a complete substitute for regular coffee, as this leads to savings worth 2.10 billion pounds, or its equivalent in dollars.
- The study also recommends producing a mixture of regular coffee and hulled roasted barley as a gradual change in consumption and to reduce the harmful effects of coffee and as an idea for a new research study.

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تم في هذا البحث دراسة التركيب الكيميائي ومحتوى الكافئين ونشاط مضادات الأكسدة والتقييم الحسي والاقتصادي لحبوب الشعير المحمر كبدائل للقهوة، حيث تم تنظيف وتحميص حبوب الشعير المحمر صنف جيزة 134 عند حوالي 200 درجة مئوية لمدة 45 دقيقة ومقارنتها بعينة من البن البرازيلي.

أظهرت نتائج التقييم الحسي لمشروب قهوة الشعير المحمر على 200 درجة مئوية لمدة 45 دقيقة، ومقارنتها بمشروب البن البرازيلي، أن مشروب قهوة الشعير المحمر على 200 درجة مئوية لمدة 55 دقيقة حصل على أعلى الدرجات، ومقارنتها بحبوب الشعير المحمص عند 55 دقيقة وحوليا 124 درجة مئوية و35 دقيقة، وحققت نتائجها بحبو كافئين في حبوب الشعير المحمص على 200 درجة مئوية لمدة 45 دقيقة و35 دقيقة، ومحتوى الكافئين في حبوب الشعير المحمص عند 200 درجة مئوية لمدة 45 دقيقة حصل على أعلى الدرجات على 200 درجة مئوية لمدة 55 دقيقة حصل على أعلى الدرجات مقاولة لكل عينة من الشعير المحمص وعينة البن البرازيلي. وتزيد نسبة البروتين والدهون والرماد في حبوب الشعير المحمص عن مشروب البن البرازيلي، وأيضاً تم إجراء تقييم اللون لكل عينة من الشعير المحمص وعينة البن البرازيلي، وعانت نسبة البروتين والدهون والرماد في حبوب الشعير المحمص أقل من تلك الموجودة في البن البرازيلي، إذ بلغت هذه النسبة 13.2%, 3.84%, 3.3% في حبوب الشعير المحمص المشروحة، بينما بلغت النسبة في البن البرازيلي 10.5%, 2.5%, 2.3% على التوالي، وكان متواجدة الرطوبة والكروهيديات الكلية والنشا في حبوب الشعير المحمص أعلى من تلك الموجودة في البن البرازيلي، وأيضاً خفض نسبة الألياف الخام والغذائية في حبوب الشعير المحمر المعادن المعمال بحبو كافئين في حبوب الشعير المحمص مقارنة بعينة البن البرازيلي، وكم أيضًا خفض إجمالي نشاط الغليان ومضادات الأكسدة في حبوب الشعير المحمر مقارنة بعينة البن البرازيلي.