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FS and HA designed the study; MMB and HA conducted all the fieldwork; HA and FS wrote all sections of the manuscript; MMB conducted the interviews; HA and MMB identified the plant specimens; FS, HA, and MMB constructed the database, analyzed the data, and generated all the tables, graphs, and map of the study area; MK and BB studied the biochemical analyses of Gezo molasses; and all authors contributed to the discussion section of the manuscript during the revisions

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ORIGINAL RESEARCH PAPER in ETHNOBOTANY

# Ethnobotanical and Chemical Studies on Gezo Molasses From *Quercus brantii* Lindl. Acorns in Turkey

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## Abstract

Oak molasses, called "Gezo," have been produced by the local people of Southeastern Anatolia. In this study, the ethnobotanical characteristics, production stages, health effects, and chemical composition of Gezo were determined. Traditional Gezo molasses is produced from the acorn of *Quercus brantii* Lindl. The survey was carried out in seven provinces with large populations. Molasses samples were collected from local producers in the region alongside the local names, usage, sorting, and grading methods used by the local people. The total contents of phenolics and flavanoids were found to vary between the range of 1.60–2.56 mg gallic acid equivalents (GAE) and 0.62–0.72 mg rutin (RE) per g of Gezo molasses, respectively. Gezo displayed scavenging activity against DPPH radicals ranging from 7.57 to 9.44 μM Trolox/g. The CUPRAC assay results showed that molasses also possessed reducing power activity with a value of 8.57–10.20 μM Trolox/g. Gezo is typically consumed by local people as a breakfast food. However, it is also used for medical purposes to treat bronchitis, cough, asthma, and diabetes. The region's oak species are used by locals for fuel, feed, handicrafts, and games.

## Keywords

ethnobotany; traditional molasses; medicinal plants; Anatolia

## 1. Introduction

Molasses, which has been produced for a long time in Turkey, is a popular traditional Turkish food. The production technique of traditionally produced molasses has not changed much over the course of time in Turkey. There are numerous types of molasses with different names and flavors, structures, textures, and appearances, with some variations in production techniques across different regions of Turkey (Karababa & Develi, 2005).

Molasses is most often made from grapes, but there are also local forms of molasses made from other materials, including mulberries, plums, apples, pears, sugar beets, watermelon, sorghum, and pomegranates. As a traditional product, molasses is produced by using fruits that are primarily grown within the local region (Keleş et al., 2019; Tüzün et al., 2020). Pekmez, a type of concentrated fruit juice, is produced from a variety of fruits, such as grapes, mulberries, figs, and apples, and is an important source of dietary carbohydrates, minerals, and organic acids (Karababa & Develi, 2005).

Oak molasses are obtained from acorn secretions and oak leaves (Mason & Nesbitt, 2009). Oak molasses has been produced from *Quercus brantii* Lindl. and locally named as "Gezo molasses" by the natives of Southeastern Anatolia, Turkey (Bursal & Boğa, 2018). *Quercus brantii* is distributed in southern and western Turkey.

Its growth has been observed in the region between the sea level to 350 m and up to 1,700 m in the southern parts.

Molasses is also obtained from the secretions formed by the leaves of *Quercus robur* subsp. *pedunculiflora* (K. Koch), and is called "Gezo molasses" by local people of East Anatolia (Bursal & Boğa, 2018; Ekin & Çelikezen, 2015). *Quercus robur* subsp. *pedunculiflora* has is naturally distributed in eastern Turkey from 1,200 m to 1,800 m a.s.l.

The sweet secretions from the leaves and acorns of *Quercus infectoria* G. Olivier have also been reported to be used by the Kurdish population in Northern Iraq. In that area, the honeydew from the leaves is called "Gazo," and the acorn secretions are called "Şoka" (Pieroni et al., 2019). The use of oak honeydew in this region was previously described by Bodenheimer (1951) in his monograph of edible insects in the world.

The acorn is a nut produced by oaks which contains a single seed. Acorns are frequently used as food and food substitutes. The nutritional composition of acorns was determined to consist of large amounts of water, proteins, carbohydrates, fats, and some minerals (Bursal & Boğa, 2018; Li et al., 2015). Acorns contain plant polyphenols known as tannins which can be found in several beverages, including red wine, beer, coffee, black tea, green tea, and many foodstuffs such as grapes, pears, bananas, sorghum, black-eyed peas, lentils, and chocolate (Gülçin et al., 2010; Mason & Nesbitt, 2009; Łuczaj et al., 2014).

Gezo is not available to make molasses on an annual basis; production generally occurs in intervals of 10–15 years. Locals look forward to the appearance of the Gezo molasses on the oaks that form honeydew on their leaves and acorns. To date, there has been very little research on the Gezo molasses which are viewed as a source of healing by the native populations. "Gezo" is a kind of molasses which is also referred to as "oak kudret helvası" in Turkey (Çevik, 2021; Çolak, 2019; Ekin & Çelikezen, 2015; Önler, 1990). This name gave rise to the belief that the secretion, which is formed by the oak's acorns, rains from the sky, and this belief has led to the molasses also being called "Kudret Halva." The word "Kudret" translates to "power and strength." However, the manna lichen *Lecanora esculenta* (Pall.) Eversm. (Manna) is also called "kudret helvası" in Turkey (Öztürk et al., 2013; Tutel, 1986) due to its high nutritional value and is often confused with the oak molasses product.

This study characterized the ethnobotanical characteristics, production stages, effects on human health, and chemical properties of Gezo molasses from *Quercus brantii*.

## 2. Material and Methods

### 2.1. Plant Material and Production of Oak Molasses

The plant materials and acorns of oak trees (*Quercus brantii* Lindl.), were gathered from the Midyat District of Mardin, which is located in the Southeastern Anatolia region of Turkey. The acorns were transported to the villages of Midyat for the production of traditional oak molasses by local producers (Figure 1, Figure 2). During oak molasses production, the acorn excretions are melted and passed into warm water. Filtration via a fine strainer or cheesecloth is then employed to separate waste products from oak molasses, and the separated molasses products are boiled in large containers (Figure 3) to allow for water evaporation until the product reaches the desired viscosity. Processed oak molasses samples were collected and shipped to the laboratory where they were stored at 4 °C until they were used in the experiments.

The plant samples were gathered from Midyat, Mardin, and Maruf Balos; the samples were authenticated by Dr. Hasan Akan. These voucher specimens were identified using the *Flora of Turkey* (Hedge & Yaltırık, 1982). The collector number was Akan 6095, and samples were kept in the HARRAN Herbarium.

**Figure 1** A large population of *Quercus brantii* in Mardin (photo by H. Akan).


**Figure 2** Distribution map of *Quercus brantii* in Turkey and places where ethnobotanical studies were conducted (Bizimbitkiler, 2013).

## 2.2. Biochemical Analyses of Gezo Molasses

Biochemical analyses were carried out on the Gezo molasses samples that were obtained from four different villages in the Midyat region. Six Gezo molasses samples prepared from *Q. brantii* acorns were used to determine the chemical composition and biological activity of the molasses.

## 2.3. Ethnobotany

The ethnobotanical information and illustrations presented in this study were collected from 2019 to 2020 through interviews with and observation of the villagers

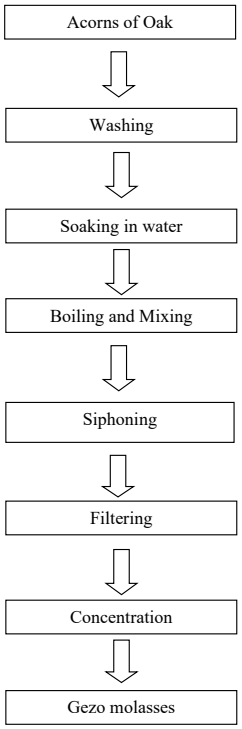


**Figure 3** Stages of traditional Gezo molasses production from *Quercus brantii* acorns.

in Southeast Anatolia. The local names of the oak molasses, usage, sorting, grading, and production methods were ascertained from local marketplaces distributed around the region. Fact-to-face interviews with the local people were conducted in the seven provinces where the research was conducted. Interviews were conducted with 50 individuals (30 men and 20 women). The mean age of the respondents was 49 years (range, 27–99 years). The highest educational level completed by the 50 individuals interviewed varied; 21 had completed primary school, six had completed secondary school, nine had completed high school, six had graduated university, and eight individuals reported having completed no education. Interviews were conducted during peak busy hours within common areas (bazaars, tea houses, farms, gardens, etc.) frequented by the village citizens. Ethnobotanical studies were carried out in Mardin, Şırnak, Bitlis, Muş, Elazığ, Diyarbakır, and Bingöl, which are situated in the East and Southeast Anatolia regions where *Quercus brantii* and *Q. robur* subsp. *pedunculiflora* have a large population (Figure 2).

## 2.4. Phytochemical Studies

### *2.4.1. pH and Titratable Acidity*

The six Gezo molasses were analyzed to determine their total soluble solid content (Brix°), pH, and acidity using a refractometer, pH meter, and titrimetric application (Association of Official Analytical Chemists, 2000).

### *2.4.2. Color Analysis*

The lightness ($L$), redness ($a$), and yellowness ($b$) values of the Gezo molasses were measured using HunterLab (Duangmal et al., 2008).

### *2.4.3. Phenolic Extraction*

Phenolic extraction from six Gezo molasses was conducted as described in a previous study (Tüzün et al., 2020). The Gezo molasses (1 g) was combined with 10 mL of a water-ethanol combination (50/50 v/v) at 24 °C (relative humidity:

35% ± 1.41%). This mixture was vortexed and incubated at room temperature for 30 min. After centrifugation at 1,420 *g* for 15 min, the resulting supernatant was filtered and stored at −18 °C until it was used for analysis (total phenolic content, total flavonoid content, and antioxidant activity).

#### *2.4.4. Total Phenolic Content*

The total phenolic content of the Gezo molasses was detected spectrophotometrically using Folin–Ciocalteu's reagent (Singleton et al., 1999). The diluted extract (0.4 mL) was combined with 2 mL Folin–Ciocalteu's phenol reagent (tenfold diluted) and 1.6 mL sodium carbonate solution (7.5%, w/v). The mixture was then maintained at room temperature for 1 hr. After incubation, the absorbance was read at 765 nm using a UV–VIS spectrophotometer (UV-1280; Shimadzu, Kyoto, Japan). The results are expressed as mg gallic acid equivalents per gram of sample (mg GAE/g).

#### *2.4.5. Total Flavonoid Content*

The total flavonoid content of the samples was determined using the methods described by Zhishen et al. (1999). A 10-mL volumetric flask containing 1 mL diluted extract, 4 mL distilled water, and 0.3 mL sodium nitrite (5%, w/v) were kept at room temperature. After 5 and 6 min, 0.3 mL aluminum chloride (10%, w/v) and 2 mL sodium hydroxide (1 M) was added into this mixture, respectively. Next 2.4 mL of distilled water was added, and the absorbance was determined using a UV–VIS spectrophotometer at 510 nm. The results are expressed as mg rutin equivalents per gram of sample (mg RE/g).

#### *2.4.6. Antioxidant Activity*

The antioxidant activity of the Gezo molasses was analyzed using a UV–VIS spectrophotometer. Two methods, 2,2 diphenyl-1-picrylhydrazyl (DPPH) (Çam et al., 2009) and cupric reducing antioxidant capacity (CUPRAC) (Apak et al., 2008) were used to measure the antioxidant activities of the samples. The results were expressed as μmol Trolox equivalent antioxidant activity (TEAC/g) using the two methods. For DPPH analysis, a volumetric flask containing 3.9 mL DPPH solution (25 mg/L) and 0.1 mL diluted extract were incubated at room temperature for 30 min and then the absorbance was read using a UV–VIS spectrophotometer at 515 nm. For CUPRAC analysis, 0.1 mL diluted extract was added to a volumetric flask containing CUPRAC solution [1 mL 0.01 M copper (II) chloride, 1 mL $7.5 \times 10^{-3}$ ethanolic neocuproine solution, and 1 mL 1 M ammonium acetate solution]. The volume of this mixture was completed to 4.1 mL with distilled water, and the incubation period was completed at room temperature for 30 min. Absorbance was measured using a UV–VIS spectrophotometer at 450 nm.

### 2.5. Statistical Analyses

The data provided by this investigation are the mean values ± standard deviation (*SD*) of the three replicates. The statistical significance of variances among the assayed samples was assessed by the least significant difference (LSD) according to the general linear model (GLM) procedure using the SAS software. Statistical significance was set at $p < 0.05$.

## 3. Results

Acorns of *Q. brantii* were collected from the above-mentioned locations along with information regarding local names, usage, sorting, and grading methods obtained from interviews with the local people. The production of Gezo molasses is an important source of income for the region's population. Gezo is gathered directly by local villagers, particularly by unemployed people with financial difficulties. The ethnobotanical features of traditional Gezo molasses are listed in Table 1.

**Table 1** Summary of ethnobotanical information of traditional Gezo molasses in the study area.

| Vernacular names of Gezo Molasses | | | | | Used plant species | Used parts | Used functions | Study area |
|---|---|---|---|---|---|---|---|---|
| **Kurdish names** | **Turkish names** | **English names** | **Arabic names** | **Assyrian name** | | | | |
| Gezo, Dımsa beruya, Dımsa gezoyé | Kudret helvası, Meşe pekmezi, Gezo pekmezi | Oak molasses | Men, Mana, Manne, Dimsul manne | Aruro | *Quercus brantii* | Acorn | Food: molasses, energizing Medicinal: bronchitis, cough, asthma, nutritive | Mardin: Midyat (Acırlı, Bozkır, Danışman, Güngören Keferbe, Konur, Yeşilöz), Artuklu, Mazıdağı Şırnak: İdil |

### 3.1. Traditional Oak Molasses (Gezo) Production

Stages of traditional oak molasses (Gezo) production are schematically presented in Figure 3. The traditional method consists of five stages: gathering, obtaining raw material, boiling and melting, filtering, and packing and selling (using).

Gathering: The raw material used for "Gezo" is obtained from *Q. brantii*. It is typically referred to as "Gezo" in Kurdish. When the people of the village observe that oak leaves are sticking to the goats and sheep that have been sent to the forest, they realize that secretions are being produced by the oak trees.

Typically, the gathering period of Gezo is between September and November. The gathering of plants was exclusively men's work (Figure 4). A knife is used to gather acorns from trees and a basket is used for transporting collected acorns.


**Figure 4** (**A–C**) Gathering of the raw materials used for Gezo molasses (photo by F. Alpsoy).


**Figure 5** (**A–I**) Stages of Gezo molasses production (photo by F. Alpsoy).

The raw material for molasses was obtained from the villages of Midyat, southeast Anatolia.

Obtaining the raw materials used for Gezo molasses: The acorns, which are covered with the honeydew upon collection, are placed in containers. Water is added to these containers, and the resulting juice obtained is filtered and transferred to cauldrons fired by wood fire (Figure 5).

Boiling and melting: The total raw material collected in cauldrons was boiled for approximately 4–5 hours based on the size of the wood fire. While the mixture was boiling, the foamy substance that rises to the top was removed. This process was continued until the color of the molasses became light and bright (Figure 5).
The molasses was stirred with a wooden spoon until it reached a viscosity similar to honey or jam (Figure 5).

Filtering: Once the molasses reaches a fluid consistency, it is strained through a piece of cloth to separate the foreign materials, and the product is collected in a plate (Figure 5).

Packing and Selling: Molasses may be packaged in a variety of forms. Molasses with different patterns are sold by women in local markets (Figure 5). A total of 20 L of molasses was obtained from an average of three trees.

### 3.2. Usage of Gezo Molasses by Local People

Each family makes 150–200 kg of molasses. Some families can produce up to 1,000 kg of Gezo molasses. However, in the years with lower yields, families may only produce 30–50 kg of molasses. Gezo can be consumed with any meal. Additional additives are typically not used, unlike in the consumption of other molasses. For example, Gezo is not added to yoghurt and is consumed plain. Individuals with diabetes can easily consume Gezo molasses. Our informants claimed that Gezo is helpful for conditions such as bronchitis and cough. It is said that Gezo molasses gives individuals strength to keep the person vigorous. Gezo does not burn the throat when consumed in large quantities, unlike other molasses (Table 1).

### 3.3. Biochemical Properties of Gezo Molasses

In this study, the physicochemical properties of Gezo molasses obtained from Midyat District of Mardin, Turkey were assessed. Gezo molasses is traditionally produced in the region and consumed because of its desirable taste and health-promoting features. The pH of the samples ranged from 5.77 to 5.95 (Table 2). The differences in the pH values of molasses produced in different regions were statistically significant and may have resulted from the plant materials used in the production of molasses and variations in traditional molasses processing practices. The Brixo values of the Midyat Gezo molasses ranged from 66.00% to 69.70%. The titratable acidity of Midyat Gezo molasses ranged from 0.19% to 0.26% in tartaric acid and from 0.16% to 0.22% expressed in citric acid (Table 2). We also measured the color characteristics of Gezo molasses and found that the *L* value (lightness) of samples were in between 20.12 and 22.18, where the *a* value (redness) of samples was between 0.41 and 0.74, and the *b* value (yellowness) of samples was between 0.79 and 1.39 (Table 2). The biological values of the plant extracts and their health-promoting nature are primarily attributable to their phenolic compound contents and antioxidant values. Therefore, in the context of this study, we determined the phenolic and flavonoid contents of Midyat Gezo molasses and assessed their antioxidant activities. The flavonoid contents of the Gezo molasses investigated in this study ranged from 0.62 to 0.72 mg/g RE (Table 2). DPPH radical scavenging and CUPRAC reducing power activity tests were performed to investigate the antioxidant nature of the samples. Commonly, the use of more than one antioxidant activity determination test is preferable to better examine the antioxidant power of plant extracts. It was observed that DPPH radical scavenging activity of the samples ranged from 7.57 μmol Trolox/g to 9.44 μmol Trolox/g.

**Table 2** Physicochemical properties of Gezo molasses obtained from *Quercus brantii* acorns.

| Sample No. | Sample name | pH | Brix° | Titratable acidity (tartaric acid %) | Titratable acidity (citric acid %) | *L* | *a* | *b* |
|---|---|---|---|---|---|---|---|---|
| 1 | Halim Alpsoy | 5.82 ± 0.01ab | 68.60 ± 0.10ab | 0.23 ± 0.01a | 0.19 ± 0.01a | 21.55 ± 0.46a | 0.49 ± 0.09ab | 0.79 ± 0.06a |
| 2 | Bozkır Bazaar | 5.78 ± 0.04c | 67.00 ± 0.10cd | 0.19 ± 0.02a | 0.16 ± 0.02a | 20.12 ± 0.27a | 0.54 ± 0.07ab | 1.27 ± 0.04a |
| 3 | Faysal Alpsoy | 5.95 ± 0.03a | 67.90 ± 0.40bc | 0.26 ± 0.01a | 0.22 ± 0.02a | 21.10 ± 0.65a | 0.68 ± 0.07a | 1.36 ± 0.03a |
| 4 | Mehmet Salih Alpsoy | 5.89 ± 0.00ab | 69.70 ± 0.30a | 0.24 ± 0.01a | 0.21 ± 0.01a | 20.80 ± 0.26a | 0.26 ± 0.05c | 1.22 ± 0.02a |
| 5 | Nizamettin Alpsoy | 5.77 ± 0.04c | 68.50 ± 0.20ab | 0.21 ± 0.02a | 0.18 ± 0.01a | 20.38 ± 0.47a | 0.41 ± 0.02ab | 1.39 ± 0.01a |
| 6 | Şefik Alpsoy | 5.91 ± 0.01ba | 66.00 ± 0.30d | 0.22 ± 0.01a | 0.19 ± 0.02a | 22.18 ± 0.42a | 0.74 ± 0.04a | 1.27 ± 0.03a |

Results are presented as the mean ± standard deviation of three replicates. Different lowercase letters (a–d) in the same column represent differences ($p < 0.05$). *L* – lightness; *a* – redness: green to red; *b* – yellowness: blue to yellow.

**Table 3** Total phenolic content, total flavonoid content, and antioxidant capacity of Gezo molasses obtained from *Quercus brantii* acorns.

| Sample No. | Sample name | Total phenolics (mg GAE/g) | Total flavanoids (mg rutin/g) | DPPH (µmol Trolox/g) | CUPRAC (µmol Trolox/g) |
|---|---|---|---|---|---|
| 1 | Halim Alpsoy | 2.56 ± 0.45a | 0.64 ± 0.10a | 9.44 ± 0.18a | 8.57 ± 0.89a |
| 2 | Bozkır Bazaar | 1.60 ± 0.30a | 0.72 ± 0.09a | 7.97 ± 0.07b | 8.57 ± 0.89a |
| 3 | Faysal Alpsoy | 2.28 ± 0.54a | 0.65 ± 0.12a | 9.17 ± 0.12a | 9.12 ± 0.11a |
| 4 | Mehmet Salih Alpsoy | 2.30 ± 0.30a | 0.62 ± 0.08a | 9.10 ± 0.30a | 10.20 ± 0.32a |
| 5 | Nizamettin Alpsoy | 2.42 ± 0.80a | 0.62 ± 0.07a | 9.09 ± 0.12a | 9.51 ± 0.4a |
| 6 | Şefik Alpsoy | 2.05 ± 0.06a | 0.64 ± 0.06a | 7.57 ± 0.19b | 10.06 ± 0.95a |

Results are presented as the mean ± standard deviation of three replicates. Different lowercase letters (a, b) in the same column represent differences ($p < 0.05$).

CUPRAC reducing antioxidant power assay was the second method that was utilized to assess the antioxidant potential of the molasses samples. The CUPRAC reducing power results were in between 8.57 and 10.20 µmol Trolox/g (Table 3).

In the study area, two different taxa of oak were used by the public for different purposes (Table 4). The branches and trunks of *Q. robur* subsp. *pedunculiflora* and *Q. brantii*, which are widely distributed in eastern and southern Anatolia, are used for fuel purposes. In both regions, acorns were also used in children's ball games. Children play by spinning top with the ping-pong ball sized acorns. Oak galls are also used as balls by children. Children also use the acorns as whistles; they are crafted by cutting the bottom part off and hollowing out the inside of the acorn using a thin knife. The wood of oak trees is also used as fuel, and oak leaves were fed to animals in winter. To treat diabetes, the fruit of the plant is pounded into flour and consumed with water. Additionally, the plant leaves are used to make an infusion as a kidney stone reducer. During the leather tanning process, the cupule of the oak acorns are left steep in water for 2–3 days, and the leather is then placed in this water for 2 days. This process causes the smell to disappear and the color of the leather to become darker. In addition, the fruit of the plant is buried under the ground for a month where it becomes sweet for raw consumption. The stem of the oak is also used for building materials.

## 4. Discussion

Every 5 to 20 years, molasses production can be much lower than usual due to weather conditions such as excessive rain or extreme temperatures (Vecel, 2009). Further research is needed to assess annual fluctuations in the availability of this product.

Molasses is made from acorns collected in Mardin and its surroundings covered with juice, while the juice on leaves and branches in Bitlis and its surroundings is used to make molasses (Ekin & Çelikezen, 2015). The branches are immersed in boilers filled with water, and the water in the cauldron becomes sherbet with the effect of the juice. The water is mixed with sherbet and boiled over the fire until it evaporates, thickens, and turns into molasses. Cooking molasses is very popular among the inhabitants of Hasankeyf, Batman. Local people stated that they added the ash of some plants as a thickener to the molasses. These species include *Anchusa azurea* Mill., *A. strigosa* Banks & Sol., *Euphorbia craspedia* Boiss., *E. macroclada* Boiss., *Quercus brantii*, and *Q. libani* G. Olivier (Yeşil & İnal, 2019). While molasses is only produced from acorns in the provinces of Mardin and Şırnak, which were included in our field of study, molasses is also made from the liquid formed in the oak leaves due to a pathological reason in Bitlis, Bingöl, Elazığ, Muş and Diyarbakır provinces (Bursal & Boğa, 2018; Ekin & Çelikezen, 2015). Gezo molasses obtained from both acorns and leaves are widely used for both food and medicinal purposes in the field of research. In addition, the acorns of *Q. brantii* are consumed both raw and freshly cooked in the Mardin and Şırnak provinces.

**Table 4** Ethnobotanical features of oak species in the East and SE Anatolia.

| Vernacular names of oak species | | | | *Quercus* species | Used parts | Purpose of usage | Literature cited | Study area |
|---|---|---|---|---|---|---|---|---|
| **Kurdish** | **Turkish names** | **English names** | **Arabic names** | | | | | |
| Beru, Berüyė, Hırçė, Çilo | Karameşe, Saplı meşe | English oak, pedunculate oak | Men, Manna | *Q. robur* subsp. *pedunculiflora* | Leaves | Food: molasses<br>Fuel<br>Medicinal: nutritive, asthma, bronchitis, anticancer | Stomach, anemia (Önler, 1990) | Bitlis (Mutki) |
| Beru, Mazu, Mazı | | | | *Q. robur* subsp. *pedunculiflora* | Acorn, leaves | Food: molasses<br>Fuel<br>Medicinal: nutritive, antiseptic | Nutritive (Bursal & Boğa, 2018) | Muş (Hasköy, Karaağaç) |
| Beru, Mazu, Mazı | | | | *Q. robur* subsp. *pedunculiflora* | Leaves | Food: molasses<br>Fuel<br>Medicinal: stomach and anemia | Stomach and anemia (Önler, 1990) | Elâzığ (Palu) |
| Beru, Mazu, Mazı | | | | *Q. robur* subsp. *pedunculiflora* | Leaves | Food: molasses<br>Fuel<br>Medicinal: stomach and anemia, nutritive | Stomach and anemia (Önler, 1990) | Mardin, Diyarbakır, Muş (Malazgirt) |
| Beru, Mazu, Mazı, Mazi, Mazer, Welg | | | | *Q. robur* subsp. *pedunculiflora* | Leaves | Food: molasses<br>Fuel<br>Medicinal: stomach and anemia, nutritive | Stomach and anemia (Önler, 1990) | Bingöl |
| Beru, Ballot, Çilo, Dara berri, Berüyė, Hırçė, Berü, Ballot | Palamut, Palut | Persian oak, Brant's oak | Men, Manna | *Q. brantii* | Acorns, leaves, fruit, bark, shoot, branch | Food: molasses, acorns are eaten<br>Kid game<br>Fuel<br>Forage<br>Medicinal: diabetes, heart booster, asthma, bronchitis, for immune system health<br>Leather industry<br>Food: eaten fresh<br>Constructional material | Diabetes (Arasan & Kaya, 2015)<br>(Kaval et al., 2014)<br>Diabetes, fuel (Akgül et al., 2018) | Mardin (Artuklu), Şırnak (İdil)<br>Geçitli (Hakkari)<br>Midyat (Mardin) |

The acorns and leaves of oak trees (*Q. robur* subsp. *pedunculiflora*), as well as traditional "oak molasses," have high antioxidant potential for the food industry as a food ingredient to produce functional food products (Bursal & Boğa, 2018) and can be used to promote human health (Bahmani et al., 2015). Gezo molasses is believed to be a healing source in the region and has beneficial effects on human health. These beneficial effects can be ascribed to its bioactive compounds, including phenolics and flavonoids. Molasses are used for dietary consumption, as well as for traditional medicine as anticarcinogenic, antioxidant, antimicrobial, and antiseptic agents. Molasses is also used in asthma and bronchitis treatments as well (Bursal & Boğa, 2018; Ekin & Çelikezen, 2015; Önler, 1990).

The average pH value of molasses produced in Bitlis City was 5.23 (Ekin & Çelikezen, 2015), which is slightly lower than the pH value determined in Midyat Gezo molasses. Both molasses can be defined as the sour molasses type. According to the Turkish Food Codex, molasses can be divided into two groups: sweet molasses and sour molasses. The pH of the sour molasses can be between 3.5 and 5.0, while the pH of sweet molasses can be between 5.0 and 6.0. According to the data obtained in this study, Gezo molasses can be classified as sweet molasses (*OTA levels of grape pekmez consumed in Turkey*, 2008). According to the Turkish Food Codex, liquid molasses should have a Brixo value above 68.00. The results showed that three of the assayed samples displayed a Brixo value above 68.00, and the other three samples had Brixo values below 68.00. One can conclude that half of the examined samples were in line with Turkish molasses standards in terms of their Brixo values (*OTA levels of grape pekmez consumed in Turkey*, 2008).

The titratable acidity of the Turkish molasses was found to be 0.24%–0.37% expressed in tartaric acid and 0.20%–0.31% expressed in citric acid (Ekin & Çelikezen, 2015). In another study, the titratable acidity in Andız molasses was found to be 0.75% expressed in citric acid (İzgi, 2011). Kaya et al. (2012) determined the titratable acidity of grape molasses to be 0.33%–0.95% expressed in tartaric acid. In general, the titratable acidity of Midyat Gezo molasses was found to be similar to that of Bitlis molasses and lower than that of grape molasses. It may be concluded that the acidity of Gezo molasses is lower than that of grapes and Andız molasses, and that Gezo molasses possesses a sweeter taste in comparison to that of grape molasses.

Phenolic compounds are a group of natural compounds, and more than 8,000 phenolic compounds are synthesized in plants. In recent decades, the demand for food commodities containing higher amounts of phenolic compounds has increased as they can efficiently scavenge free radicals generated within human cells. The phenolic contents of the Midyat Gezo molasses ranged from 1.21 to 2.56 mg/g GAE ($p < 0.05$) (Table 3). The variation in the phenolic content of the Gezo molasses can originate from the nonstandard local molasses production technique in the region or can be relevant to the compositional difference of raw materials used in molasses production. The grape molasses contains phenolic compounds in between 1.70 and 5.34 mg/g GAE in traditional molasses (Helvacıoğlu et al., 2018). The phenolic content of the grape molasses was similar to that determined in Gezo molasses and was higher in some of the samples assayed in their study.

Flavonoids have many beneficial effects on human health and inhibit tumor formation and cancer development in model systems (Chahar et al., 2011). Therefore, the presence of flavonoids within Midyat Gezo molasses could exploit local and global interest in Gezo molasses consumption. Flavonoids have important inhibitory effects on cancer cell proliferation (Ganai et al., 2021) and tumor formation. Oaks have been increasingly drawing attention as a source of sustainable food (Łuczaj et al., 2014; Mason & Nesbitt, 2009; Mayer, 2019).

The phenolic compounds and antioxidant activity of *Q. robur* methanol extracts have been previously investigated (Rakić et al., 2007). However, little information is available regarding the antioxidant activities of acorns and leaves of oak trees (*Q. robur* subsp. *pedunculiflora*). Therefore, we investigated the in vitro antioxidant activities of acorns and leaves of molasses obtained from oak trees (*Q. robur* subsp. *pedunculiflora*).

Antioxidant compounds may play a crucial role in the continuation of a healthy lifestyle by protecting the human body against the detrimental effects of free radicals and reactive oxygen species. Therefore, determination of the antioxidant activity of samples is required to determine the health-promoting nature of Gezo molasses. The DPPH radical scavenging activity results of the Gezo molasses indicate the high antioxidant potential of the investigated samples. The extracts from *Q. resinosa* leaves presented high phenolic content, antioxidant capacity, and cardioprotective effects (Rivas-Arreola et al., 2010).

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