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Physicochemical Characteristics of Astragalus Honey Obtained from Erzurum Province

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Abstract: Astragalus ponticus PALL (Leguminosae), known as Black Sea Astragalus (Laz Geveni), was described in 2016 from the Erzurum thermal spring road. Astragalus, which closely rivals the quality of the world-famous Anzer honey, is one of the most preferred sources for beekeepers due to its rich taste and aroma. Consequently, honey producers in Erzurum have favored Astragalus for honey production. Therefore, this study discusses the physicochemical properties of the Astragalus honey sample obtained from the Erzurum province. The following parameters were measured: pollen, moisture, and sugar contents, diastase number, hydroxymethyl furfural (HMF), and proline content. The moisture content of the sample was found to be 15.2%, which is lower than the Codex limit of less than 20%. No sucrose was detected in the sample. Other values were as follows: glucose (27.1%), fructose (41.54%), maltose (0.74%), HMF (39.25 mg/kg), and proline (584.6 mg/kg). The diastase value (7) was below 8 specified in the Turkish Food Codex Honey Communiqué. The results showed that Astragalus honey produced in the Erzurum province meets the limits set by the Turkish Food Codex Honey Communiqué in terms of pollen, moisture, HMF, maltose, and proline contents. It was concluded that the geographical origin plays an important role in the physicochemical characteristics of honey.

Keywords: Astragalus honey, Chemical composition, Sugar content

Introduction

Astragalus (Fabaceae) is the world's largest flowering plant genus, with up to 3,000 annual and perennial species (Podleh & Zarre 2013; Kucukaydın, et al., 2023; Djozan et al., 2008). In Türkiye, the Astragalus genus is represented by 469 species across 62 sections (Chamberlain & Matthews, 1970). According to the Turkiye Plant List, 217 taxa of Astragalus are endemic, constituting 46.2% of the species (Kucukaydın, et al., 2023; Adıguzel et al., 2009; Davis et al., 1988). According to Turkiye Plant Lits Astragalus 217 taxons endemic and is 46.2% (Aytac et al., 2012). The Black Sea Astragalus, also known as 'Laz geveni,' was identified on the Erzurum Ilıca road as Astragalus ponticus PALL. (Leguminosae) in 2016 (Krasteva et al., 2009).

Astragalus species have been utilized in the medicine and food industries. (Kucukkaydın, et al., 2023; Salehi et al., 2021). In vitro and in vivo bioactivities of secondary metabolites from Astragalus species have demonstrated anti-aging, anti-inflammatory, anti-diabetic, cytoprotective, anti-tumor, antioxidant, antimicrobial, antiviral, cardioprotective, anticancer, and immune-enhancing capabilities (Kucukaydın et al., 2023; Li et al., 2014; Salehi et al., 2021). Furthermore, the cytotoxic activities of Astragalus honey against cancer have been investigated (Sadeghi-Aliabadi et al., 2015). The Astragalus plant is effective in strengthening the immune system and increasing the production of antibodies against the flu, enhancing its ability to fight diseases. It not only increases resistance to the flu but also shortens the duration of the illness. It has been determined that this pharmacological activity is due to three groups of chemicals: polysaccharides, saponins, and phenolics (Rios & Waterman, 1997).

Astragalus also provides an important source of nectar and pollen for honeybees. As is known, honey contains mainly carbohydrates (70–76%) and water (16–21%). Moreover, it contains more than 200 compounds such as various organic acids, amino acids, vitamins, polyphenols, and minerals (Kucukaydın et al., 2023; Mărgăoan, et al., 2021). The amounts of these compounds vary according to the nectar source, the honey type, and environmental factors, and accordingly, distinctive features such as color, taste, and biological activity occur. According to scientific studies, honey provides a wide variety of health benefits, including antibacterial, antioxidant, anti-inflammatory, antiviral, and wound-healing properties (Tas-Küçükaydın et al., 2023). Physicochemical properties, phenolic profiles, antioxidant, and antimicrobial activities of different types of honey, including Astragalus honey, have been reported by various research groups (Kucukaydın, et al., 2023; Sagdic et al., 2013; Can et al., 2015).

As is known, various recognized parameters are used for the evaluation of honey freshness (Can et al., 2015; Mendes et al., 1998). The chemical composition of honey is affected by its botanical and geographical origins, as well as by climate factors, harvesting, handling, processing, and storage (Seraglio et al., 2021; Kucukaydın et al., 2023). For this purpose, Astragalus honey samples collected from the Erzincan province of Türkiye were examined in terms of pollen content, moisture content, sugar content, diastase number, HMF, and proline content. The results were compared with the contents given in the Turkish Food Codex Honey Communiqué (No: 2020/7) and other recent studies.

Method

An Astragalus honey sample, which was produced in Erzurum (Thermal Spring Road), was collected from a local producer in 2021. The location of the obtained Astragalus honey sample is depicted on the geographical map of Türkiye (see Figure 1).

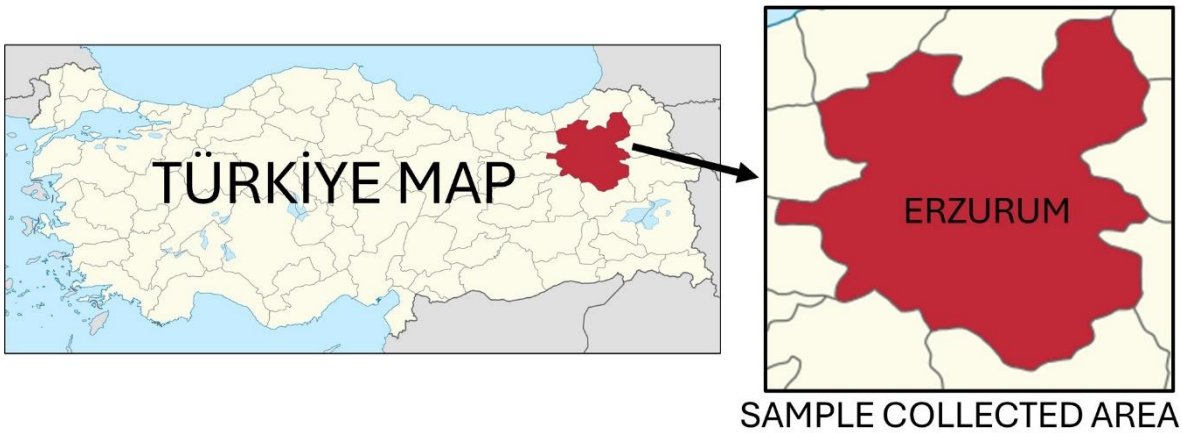

Figure 1. Geographical location of collected Astragalus honey sample.

TS 13363 was used to determine the relative pollen content of the honey. The water content of the honey was determined by the refractometric method TS 13365, and the amount of moisture was presented as a percentage of the weight. The standard method TS 13364 was used to determine the diastase activity. Fructose, glucose, sucrose, and maltose in the honey were determined by high-performance liquid chromatography (Method TS 13359) with service purchase. Standard TS 13356 was used to determine the HMF content by using high-performance liquid chromatography with service purchase. The spectrometric method TS EN 1141 was applied to determine the proline content.

Results

Relative Pollen Content

In recent times, various techniques have been explored to determine the botanical origin of honey. However, pollen content analysis, which relies on identifying pollen types in honey samples using light microscopy, remains a widely used method (Corvucci et al., 2015; Hailu & Belay, 2020). Through relative pollen content analysis, the botanical origin of honey can be determined based on the plants that provide pollen for the honey. Additionally, pollen analysis can offer insights into the crystallization rates of honey (Ozkok & Bayram;

Escuredo et al., 2014). Pollen analysis also plays an important role in evaluating certain types of honey that may have toxic effects from a food safety perspective. Moreover, in honeys adulterated with sugar, the total pollen count is detected to be low, which can be considered one of the benefits of applying relative pollen content analysis. In other words, pollen analysis contributes to assessing the quality of honey from various angles. In Türkiye, the minimum representation of pollen grains from the relevant plant required for labeling certain unifloral honey types with the name of that plant is specified in the Codex 2020/7, updated by the Ministry of Agriculture and Forestry in 2020. According to this regulation, unifloral honey types are classified into three different groups: normal, intense, and scarce unifloral honey varieties. For Astragalus, categorized as a normal unifloral species, honey samples must contain at least 45% of the relevant plant's pollen to be labeled with its name (Turkish Food Codex Communiqué on Honey (No: 2020/7)). According to relative content analysis, the botanical origin of Astragalus honeys is the Fabaceae family, with the primary pollen type being Astragalus spp. The density of the primary pollen ratio was 84%.

Moisture Content

Controlling moisture content is vital for honey quality, preventing fermentation, and preserving its shelf life. Fermentation is a natural process that occurs when the sugar in honey reacts with yeast and bacteria, resulting in the production of alcohol and carbon dioxide. Honey with a high moisture content is more prone to fermentation over time, which can negatively impact its taste and stability. When honey has an optimal moisture level, it remains stable and resists spoilage by yeast fermentation during storage. Maintaining the right moisture balance ensures that honey retains its nutritional value over time (Shakoori et al., 2023; Prica et al., 2014; Singh & Singh, 2018). It was determined that the moisture content of the studied honey was 15.2% (See Table 1). Can et al. (2015) found 17.0% moisture in similar honey obtained from *Astragalus microcephalus*. In a study by Uckun (2011), the moisture content of Astragalus honey from Elazı pgrovince was found to be 13.1% (Uckun, 2011). In a study conducted to investigate the physical and chemical properties of honey produced in Erzurum, 20 honey samples obtained from beekeepers were used, and the moisture content levels of 18 samples varied between 13.80% and 20.00% (Sengul et al., 2006). Considering previous studies and the Codex limit of 20%, our results were in accordance.

Table 1. Comparasion of some of the parameters of the Astragalus honey obtained from different regions in Türkiye

Parameter	Erzurum	Canakkale, Diyarbakır, Elazıg	Cukurova	Erzincan	
	Our Study	Can et al. (2015)	Uckun (2021)	Kara et al. (2020)	Codex
Moisture %	15.2	17	13.1	16.4	Max 20
Diastase Activity	7	9.05	-	18	Min 8
Maltose %	0.74	0.16	-	-	Max 4
HMF mg/kg	39.25	4.6	10.7	0	Max 40
Proline mg/kg	584.6	755	-	640	Min 300

Sugar Content

The basic monosaccharides of honey are the reducing sugars fructose and glucose (Uckun, 2011; Can et al., 2015). Honey may also contain sucrose, maltose, galactose, ribose, and xylose (Uckun, 2011). Fructose is generally the most abundant monosaccharide in all types of honey. Only rapeseed, dandelion flower and blueberry honeys contain slightly more glucose than fructose (Uckun, 2011; Hısıl & Borekcioglu, 1986). In our study, fructose (41.54%) and glucose (27.10%) were determined to be the sugars in the highest amounts. Therefore, the fructose+glucose levels in the current study were 68.64 g/100g, while the fructose/glucose ratio was 1.53. In a study by Can et al. (2015), the fructose+glucose and fructose/glucose ratio in Astragalus honey was reported as 57.96 g/100g and 1.28, respectively. In another study, the invert sugar ratio of Astragalus honey obtained from the Çukurova region was found to be 77.6% (Uckun, 2011). These results confirm that honey's sugar values may depend on the floral and regional origin (Can et al., 2015; Andrade et al., 1997; Mendes et al., 1998). Therefore, the reason for higher values in the current study could be attributed to the various sections of Astragalus in Anatolia, Türkiye (Tas-Kucukkaydın et al., 2023). According to the current results, the measured values were higher than the Codex limits. However, mean values for the fructose/glucose ratio of different kinds of honeys were also found to be higher (1.98) than the Codex limits in a study by Can et al. (2015). In the same

study, they detected maltose at levels of 0.16%. Maltose was detected at levels of 0.74% in our study, which is also in accordance with the Codex limit of 4%. Since sucrose is converted to invert sugar by the invertase enzyme produced by bees, most of the sugar in honey is in inverted form. This could be the reason that we couldn't find any sucrose in the sample.

Diastase Activity

Some of the important properties that distinguish honey from other sweet products (such as jam and syrup) are the enzymes present in the honey. Diastase is one of the main enzymes in honey. Its activity can vary between fresh and old honey, and this can be affected by heat treatment. Especially, pasteurized honey have almost no activity of diastase and invertase due to heat treatment. Therefore, high diastase and invertase activities imply that the honey is raw and has not been heated (Sahin & Kolaylı, 2020).

Diastase plays a role in the digestion of starch and is secreted from the honeybee's stomach. Honeys with relatively low diastase activities in this study, such as heather, common eryngo, and clover honeys, were older, and their activities gradually decreased. In this study, the diastase activity was 7, which is close to the threshold Codex limit of 8. The number of diastase enzymes, responsible for the hydrolysis of starch in honey, should be at least 8 (Türk Gıda Kodeksi, 2020). During the transfer of nectar from bee to bee, the enzyme content increases. For this reason, the diastase level may change depending on the nectar source and colony (Can et al., 2015). In a study by Can et al. (2015), Astragalus honey's diastase activity was also close to the threshold limit but was found to be 9.05.

HMF

All pure honeys gradually darken in color due to various non-enzymatic caramelization reactions, known as Maillard reactions. HMF is one such reaction product that affects honey darkening (Can et al., 2015; Zalibera et al., 2008). Generally, dark-colored honeys have been reported to possess high levels of Maillard reaction products (Can et al., 2015). HMF, a non-enzymatic Maillard reaction product, is indicative of the freshness of honey and whether it has been subjected to heat treatment (Kara et al., 2020). HMF is accepted at values below 40 mg/kg according to the Turkish Food Codex Communique on Honey. The HMF value was 39.25 mg/kg in the current study. Prolonged storage or exposure to high temperatures increases the level of HMF. This result may indicate that the collected sample was stored for some time before analysis. Studies have shown that the half-life of diastase activity decreases while the HMF level increases (Korkmaz & Kuplulu, 2017). Since a decrease in diastase activity could be associated with increased HMF, the obtained results are compatible with the diastase value.

Proline

Honey contains 20 amino acids, but proline is the amino acid present in the highest quantities (Uckun, 2011; Can et al., 2015). The amount of proline in honey is a marker of purity, and the level decreases significantly in adulterated honey. The level of proline has been reported to vary according to the honey's flora, but it is also associated with the bees' work performance. Experimental studies have reported that honeys from bees fed on sugar water exhibit low proline values (Can et al., 2015). According to the Honey Codex, the required minimum level of proline in honey is 300 mg/kg. It was determined that the proline level in honey is (584.6 mg/kg) suitable according to the Turkish Food Codex Communique on Honey. Comparing all previous studies, moisture and proline results were closer to those of Astragalus honey obtained from the Erzincan province. This showed that the geographical location of Astragalus could have an important role in the chemical parameters of honey.

Conclusion

Since honey is a natural nutrient that has been consumed by human beings for centuries, determining its quality criteria is very important. This study aimed to determine the suitability of Astragalus honey samples produced in Erzincan province according to the Turkish Food Codex Communiqué on Honey. The study revealed the importance of pollen analysis in the floral origin determination studies of honey. The results showed that the Fabaceae sativa pollen count was at 84%. The collected sample was compatible with the pollen content criteria

given for honey samples in the Turkish Food Codex Honey Communiqué. The Astragalus honey samples were also investigated in terms of moisture and maltose content, which were in accordance with the regulation. Although the diastase activity was under the Codex limit, when compared with HMF, its value may be considered consistent because the HMF level was acceptable but also close to the threshold. It has been concluded that depending on the geographical location, some differentiation in the physicochemical properties of Astragalus honey can be observed.

Scientific Ethics Declaration

The authors declare that the scientific ethical and legal responsibility of this article published in EPSTEM journal belongs to the authors.

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