

## ARAŞTIRMA MAKALESİ / RESEARCH ARTICLE

# CHEMICAL INVESTIGATIONS ON HONEY PRODUCED IN BINGOL AND SURROUNDINGS

Bingöl ve Yöresinde Üretilen Balların Kimyasal İncelenmesi

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Geliş Tarihi / Received: 02.04.2020

Kabul Tarihi / Accepted: 06.05.2020

DOI:10.31467/uluaricilik.713308

### ABSTRACT

Bingol and the surrounding vicinity with its climatic conditions and rich flora is a convenient area for beekeeping. In this region, beekeeping activities are increasing day by day. In this study, by analyzing saccharose, invert sugar, pH, moisture and diastase enzyme activity, it is aimed to determine the conformity of the flower honey with standards that are produced in Bingol and its surrounding area. For this purpose, 7 honey samples were collected from seven distinct areas of Bingol and its surrounding (Bingol - Central, Kigi, Solhan, Karliova, Yayladere, Genc, Adakli) and analyzed. The average contents of sucrose, invert sugar, pH, moisture and amylase enzyme activity in honey samples were determined to be 1.65%, 80.23%, 2.81, 15.43% and 0.074 units mL<sup>-1</sup>, respectively. When the biochemical analysis average of all the regions was taken into consideration, the honey was found to comply with the Turkish Food Codex, and TS 3036 criteria in terms of the examined parameters. In order to develop the beekeeping industry and high quality honey production in this region, educational activities and financial support -with various projects - should be increased. The next step is to announce the findings obtained here about Bingol honey to the whole country and even abroad, with adequate advertising activities.

Key Words: Flower honey, Invert sugar, pH, Moisture, Sucrose.

### ÖZ

Bingöl ve yöresi zengin florası ve iklim koşulları ile arıcılığa oldukça elverişli bir bölgedir. Bölgede arıcılık faaliyetleri gün geçtikçe artmaktadır. Bu çalışmada Bingöl ve yöresinde üretilen çiçek ballarının sakkaroz, invert şeker, pH, nem ve diastaz enzim aktivitesi analizlerinin yapılarak sonuçların standartlara uygunluğunun belirlenmesi amaçlandı. Bu amaçla Bingöl ve yöresindeki 7 ayrı bölgeden (Bingöl Merkez, Kiğı, Solhan, Karlıova, Yayladere, Genç, Adaklı) 7 adet bal örneği toplanarak analizleri yapıldı. Bal örneklerindeki sukroz, invert şeker, pH, nem ve amilaz enzim aktivitesinin ortalama içeriği sırasıyla %1,65, %80,23, 2.81, %15,43 ve 0,074 birim mL<sup>-1</sup> olarak belirlenmiştir. Tüm bölgelerin biyokimyasal analizlerinin ortalaması incelendiğinde bakılan parametreler bakımından balların Türk Gıda Kodeksi ve TS 3036 kriterlerine uyduğu tespit edildi. Bölgede arıcılığın gelişmesini ve kaliteli bal üretimini sağlayabilmek için eğitimsel faaliyetlerin ve çeşitli projelerle mali desteğin artırılması gerekmektedir. Bundan sonraki en büyük adım Bingöl balı markasının yeterli reklam faaliyetleri ile tüm yurda ve hatta yurtdışına duyurulmasıdır.

Anahtar Kelimeler: Çiçek balı, invert seker, Nem, pH, Sakkaroz.

### GENİŞLETİLMİŞ ÖZET

**Amaç:** Bal, içeriğinde bulunan amino asitler, şekerler, karotenoidler, enzimler, mineraller, organik asitler, aromatik maddeler ve vitaminler gibi birçok yapı bulunan doğal bir besin maddesidir. Yapısında farklı biyolojik etkiler gösteren pek çok antioksidan madde içermektedir. Türkiye bal üretimi için çok uygun mevsim şartlarına ve bitki örtüsüne sahiptir. Bal, üretim esnasında üzerinde oynanması mümkün bir gıdadır. Bu sebeple üretilen balların kalitesi sağlık açısından da önem arz etmektedir. Bu çalışmada Bingöl ve yöresinde üretilen balların bazı kimyasal özelliklerinin tesbit edilmesi amaçlanmıştır.

**Gereç ve yöntem:** Bingöl, Türkiye'nin Doğu Anadolu Bölgesi sınırları içerisinde yer alan bir ilidir. Çalışma için bal numuneleri 2013 yılı Ağustos-Ekim ayları arasında bölgede bal üretimi yapan arıcılardan temin edildi. Bu çalışmada materyal olarak 7 adet çiçek balı örneği kullanıldı. Temin edilen bal numuneleri, ağız kapalı kaplar içersine alındı ve analizler bitinceye kadar oda ısısında (22°C'de) saklandı. Bu bal örneklerinde invert şeker, sakkaroz, diastaz enzim aktivitesi, pH ve nem değerleri incelendi.

**Bulgular:** Bingöl ve yöresinden temin edilen ballarda invert şeker, sakkaroz, pH, nem ve diastaz aktivitesi analizleri yapıldı. Analizler sonucunda ortalama invert şeker %80.23, sakkaroz %1.65, pH 2.81, nem %15.43 ve amilaz enzim aktivitesi 0.074 units mL<sup>-1</sup> olarak tespit edilmiştir.

**Sonuç:** Bu çalışmada incelenen 7 farklı bal numunesinin tümü invert şeker, sakkaroz ve nem değerleri açısından standartlara uygun sonuçlar göstermiştir. Amilaz enzim aktivitesi için belirli bir standart yoktur, ancak tesbit edilen sonuçlar daha önce yapılmış çalışmalara yakın bulunmuştur. Ülkemizde işsizlik büyük bir problemdir. Bu sebeple doğu illerinden batıdaki büyük şehirlere göç gün geçtikçe artmaktadır. Arıcılık bölge insanı için iyi bir iş alanı oluşturmaktadır. Ancak bu işin bilinçsiz yapılması insan sağlığını tehlikeye atabilmektedir. Bu sebeple arıcılık yapmayı düşünen kişiler için eğitim kursları düzenlenerek konu hakkında bilgili kişilerin bu alanda çalışmaları sağlanmalıdır. Bölgede arıcılığın teşvik edilmesi bölge ekonomisini olumlu yönde etkileyecektir. Yaptığımız çalışmada sadece bu bölgede üretilen balların bazı kimyasal özellikleri ortaya konmuştur. Bölge balı ile ilgili daha farklı analizler içeren çalışmaların planlanarak yapılması ve Bingöl balının diğer bölge ballarından farklı yönleri olup olmadığı ortaya konmalıdır. Devlet

eli ile bölgeye gerekli yatırımların yapılmasıyla bölgede Bingöl balı markasının oluşumu şehrin ekonomisine olumlu etkiler yapacaktır.

### INTRODUCTION

Honey is a sweet nutritional substance formed through the chemical transformation of nectar collected by bees from flowers and fruit buds. This transformation takes place in a specialized organ of the bee called "the honey stomach" (sometimes also called the "crop") and is performed by invertase enzyme activity. Bees then store this substance into honeycomb cells in their hives. The Turkish Food Codex defines honey as: "The natural product matured in the honeycomb by the honey bees (*Apis mellifera*), which is formed it by collecting the plant nectars or the secretions of the plant-sucking insects living on the organic parts of plants, and this is transformed using certain specific substances which reduce its water content" (TFC) (Rescript of Honey with date and no: 2012/58). According to this rescript, the sucrose content of the flower honey should not be higher than 5-10%, its invert sugar volume should higher than 60%, and its moisture content should not be above 20%. The rescript does not specify any pH or amylase enzyme activity limits for honey (TFC 2012).

Honey is a natural sustenance that contains numerous components like sugars, enzymes, amino acids, organic acids, carotenoids, vitamins, minerals, and aromatic substances. It is also quite rich in terms of flavonoids and phenolic acids, which have natural antioxidant properties in addition to their numerous biological effects (Alqarmi et al. 2012). The content, color, aroma, and taste of the honey are in essence dependent upon the flowers, geographical region, climate, and the honeybee species that produce it. The properties of honey are also influenced by environmental conditions, processing methods, adulteration and other types of manipulations, packaging, and the duration of its storage period (Tornuk et al. 2013, Escuredo et al. 2014).

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**Table 1:** The specifications of honey according to the Rescript of Honey (2012/58; TFC, 2012)

Feature (per 100 g of honey)	Flower Honey	Secretion Honey	Mixture
Moisture (max, g)	20	20	20
Sucrose (max, g)	5-10	5-10	5-10
Fructose + glucose (at least, g) (at 100 g)	60	45	45
Water insoluble substance (max, g)	0.1	0.1	0.1
Free acidity (max, meq kg <sup>-1</sup> )	50	50	50
Number of diastasis (minimum)	8	8	8
HMF (max, ppm)	40	40	40
Proline (minimum, ppm)	300	300	300
Naphthalene (max, ppb)	10	10	10

Turkey is geographically quite suitable for honey production in terms of climate conditions and stands forth as one of the prominent honey producer countries due to its rich plant fauna. The province of Bingol is located towards the eastern regions of Turkey, which has rich plant diversity. These properties help make it a province in which high-quality honey is produced in general (Bilgen Çınar 2010).

This study aims to determine certain chemical properties of honey produced in the Bingol Province of Turkey.

### MATERIALS AND METHODS

The province of Bingol is located in the Eastern Anatolian region of Turkey and has a surface area of 8.004 m<sup>2</sup> and an altitude of 1159 m. To determine the invert sugar, sucrose, diastase enzyme activity, pH, and moisture content of the honey produced in the province, honey samples were obtained directly from producers between August – October, 2013. Honey samples were collected from producers in the provincial center, Adakli, Karliova, Genc, Solhan, Kigi and Yayladere regions. In the initial feeding of the bees, the producers in Kigi, Adakli and Genc regions said that they used honey, producers in other regions used sugar solutions. A total of 7 different types of honey samples were obtained, which were collected in lid cups and were kept at room temperature (22°C) during the analysis period. No physical or chemical process was applied to the honey samples during the storage.



**Figure 1:** Regions where honey samples were collected

Invert sugar content analysis of honey samples were determined according to the TS 3036 honey standard using Carrez-1, Carrez-2, Fehling-A and Fehling-B solutions (Anonymous 2002).

Determination of sucrose content in honey samples was performed according to the amount of invert sugar calculated using Fehling-A and Fehling-B solutions according to the TS 3036 honey standard (Anonymous 2002).

pH level analysis of honey samples was completed using a pH meter (Selecta Spain) (Anonymous 2002).

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Moisture amounts in honey samples were determined using a refractometer (Optic Ivymen System Spain) (Anonymous 2002).

Determination of amylase enzyme activity was carried out using the Harmonized Methods of the International Honey Commission (Anonymous, 2020) method which involved using a UV-Spectrometer (Boeco S-22 UV/Vis Germany) method.

All analyzes were performed in 3 replicates. The results were averaged across the 3 replicates.

### RESULTS

The results of the sucrose, invert sugar, moisture content, pH, and amylase enzyme activity of honey samples collected from the Bingol province are provided below.

**Table 2:** The analysis results for honey samples produced in the Bingol Province.

	Sucrose (%)	Invert Sugar (%)	pH	Moisture (%)	Amylase Activity (units mL <sup>-1</sup> )
Bingol Adakli	1.83	83.33	2.91	15.40	0.0043
Bingol Karliova	1.63	78.43	2.69	15.00	0.0100
Bingol Genc	1.61	79.68	2.71	15.60	0.0080
Bingol Solhan	1.58	79.05	2.91	16.20	0.0046
Bingol Downtown	1.86	84.03	2.88	15.80	0.0060
Bingol Kigi	1.76	81.63	2.68	15.20	0.0120
Bingol Yayladere	1.31	75.47	2.86	14.80	0.0067
Average value	1.65	80.23	2.81	15.43	0.0074

The sucrose percentage was found to be the highest in downtown areas whereas it was lowest in Yayladere. The average sucrose percentage for Bingol sampling sites was found to be 1,65%.

The highest invert sugar percentage was found in downtown areas, whereas the lowest was found in Yayladere. The average amount of invert sugar of all samples in the region was calculated to be 80.23%.

Among the regions, the pH value was measured to be the lowest in Kigi and the highest in Solhan and Adakli region. The average pH value of the entire region was found to be 2.81.

The humidity percentage was measured to be the highest in Solhan and the lowest from the Yayladere region. The average humidity value in the Bingol region was calculated to be 15.43.

According to the amylase enzyme activity results, the highest value was measured from the Kigi region and the lowest from the Adakli region. The average amylase enzyme activity was determined to be 0.0074 units mL<sup>-1</sup> across all of the regions.

### DISCUSSION

Honey has been a valued sustenance consumed by humans for a long time. Its economic value makes it a target for certain types of adulteration that aim to cheat the consumers. Pure honey consists only of the honey produced by the bees from the flower nectars and contains no additives. Producers sometimes use various sugar syrups during the honey production to increase the yield (Pradkar and Irudayaraj 2001). All types of products obtained from bees represent a great importance in terms of human health. These products are called "honey products", and include honey, pollen, royal jelly, beeswax, bee venom, and propolis (Armon 1980; Padilla et al. 1992). The quality and standardization of honey is therefore very important for public health. Considering this, Turkey has established quality control standards for honey. These are the Honey Rescript of the Turkish Food Codex (TFC 2012) and the Turkish Standards referred to as the 3036 Honey Standard (Anonymous 2002).

According to the specifications provided in these standards, flower honey can not have more than 5% sucrose, while this limit increases to 10% for

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honeydew honey (TFC 2012). A high level of sucrose is an unwanted property in a high quality honey. The nectar that forms the basic content of honey usually contains around 20% sucrose. This ratio changes as the honey matures. This alteration occurs as a significant portion of sucrose hydrolyzes into fructose and glucose. During the maturation, therefore, the sucrose levels decrease, as the fructose and glucose levels increase (Aydoğan 1990.)

A study performed on honey samples collected from different regions of Turkey has presented the average sucrose level as 2.24%. The same study presents the sucrose levels for the Eastern Anatolian region of Turkey (consists of the provinces of Erzincan, Elazığ, Erzurum, Kars, Tunceli, Malatya, and Bingöl) as “between 1.06% and 23.20%” (Gül 2008). Another study performed on Eastern Region honey samples presents the sucrose levels for Semdinli and Yuksekova honey as 3.01% and 2.71%, respectively (Sunay 2006). A study performed on Black Sea Region honey samples present the average sucrose level as 1.54% (Güler 2005). Another study performed on Black Sea Region honey samples, however, reports the same value as 3.62% (Derebasi et al. 2014).

Hatay region sunflowers and highland honey samples were also evaluated in a study, which report the sucrose levels as 2.84% and 1.9%, respectively (Sahinler and Gül 2004). Blackthorn and sunflower honey samples of the Edirne province were also tested in another study, and the average sucrose level was given as 1.67% (Akdeniz et al. 2013). A study performed on Erzurum province honey samples presents the average sucrose level to be between 1.8 and 2.45% (Erdogan et al. 2005). A study focusing on Kars province honey presents the sucrose level to vary between 0.95% and 18.05% (Duman Aydın et al. 2008). Batu et al. (2013) have investigated the honey produced in Eastern Anatolia and Eastern Black Sea Regions and reported that average sucrose levels varied between 2.19% and 5.25% (Batu et al. 2013). Domestic and Iran-based honey offered for consumption in market in the province of Van were investigated in a study, which report the sucrose levels as 6.69% and 12.77%, respectively (Akyuz 1996). Another study which tested the honey in the market in the same province reports the sucrose level as 2.37% (Mis, 2010).

In the present study, the sucrose levels of all 7 different Bingöl region honey samples inspected

were found sucrose levels below 5%. The lowest sucrose level (1.31%) was found in the Bingöl-Yayladere sample, while the highest (1.86%) was found in the Bingöl-Downtown sample. The average of all samples in terms of sucrose levels was determined as 1.65%. None of the samples inspected in our study had sucrose levels beyond the limits set forth in the relevant standards.

When the sucrose levels of the regional honey are examined, it is seen that there are no big differences between the regions although there was only one sample from each site. This shows that the level of maturation of honey in the region is close to each other.

The primary content of honey consists of sugars. The majority of sugars found in honey are monosaccharides (glucose and fructose), while a small portion is made up of other sugars (disaccharides, trisaccharides, tetrasaccharides). The invert sugars found in the honey (glucose and fructose) are formed as the sucrose in the nectar is decomposed into glucose and fructose due to invertase enzyme activity. Approximately 69-78% of honey consists of invert sugars. Extended periods of storage cause the invert sugar levels of the honey to drop (Tolon 1999). Turkish Food Codex (TFC 2012) states that invert sugar content of honey should be above 60%.

Various studies performed at different times in our country report the average invert sugar level of honey as the following: Mis (2010) as 68.58%, Sahinler and Gül (2004) as 66.20% and 69% for highland and sunflower honey, respectively, Akyuz (1996) as 70.71% and 65.10% for domestic and Iran-based honeys, Gül (2008) as 72.16% for Eastern Anatolian region honey, Güler (2005) as 68.42% for the Black Sea Region honey, Unal and Kuplulu (2006) as 71.56% for honey sold at the market for consumption, Sunay (2006) as 73.16% and 72.88% for Semdinli and Yuksekova honeys, respectively, Erdogan et al. (2005) as “between 69.68% and 74.12%” for the honey samples obtained from Erzurum region, Duman Aydın et al. (2008) as “between 51% and 85%” for the honey samples of Kars province, while Batu et al (2013) reported the average invert sugar content for honey samples as “between 62.38% and 79.97%”.

In the present study, the highest invert sugar content for the Bingöl province honey samples were determined in the Bingöl-Downtown sample with 84.03%, while the lowest was determined in the

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Bingol - Yayladere sample with 75.47%. Average invert sugar content in all the honey samples was determined as 80.23%. These results indicate that all the honey samples obtained from the region are in line with the specifications of the Turkish Food Codex (TFC 2012). Comparing these results to the findings of other studies performed on the Eastern Anatolian region honey samples reveals that the average invert sugar levels of the honey samples inspected as part of this study are higher than the findings of 72.16% determined by Gul (2008) and of 69.68% and 74.12% by Erdogan et al. (2005) for Erzurum region honey samples.

The calculated invert sugar levels of honey in all regions were very close to each other even though one sample was taken from each region. Since honey samples were taken directly from the producer, the storage time was not extended. This value may decrease when the storage time increases.

Honey is naturally acidic, and its pH value often varies between 3.2 and 4.5. The acidity of honey is basically caused by its gluconolacton and gluconic acid content (White 1975). Honey has an acidic pH and this property prevents most types of bacteria to develop in its environment, particularly that of pathogens of animal origin, as these bacteria require an optimum pH level of 7.2 to 7.4 (Molan 1992). The pH values of honey are dependent upon the level of the various acids they contain, along with their mineral contents (calcium, sodium, potassium, and other ash compounds). Honeys with rich mineral salt content usually have higher pH values (Lawless et al. 1996).

Various studies performed in Turkey report the average pH levels for honey as the following: Gul (2008) as 3.34 for the honey samples obtained from Eastern Anatolian region, Yilmaz (2000) as 3.8, Ilgin (2010) as 2.95 on average, Guler (2005) as 4.96 on average, Sahinler and Gul (2004) as 6.36 and 5.6 for highland and sunflower plant honey samples, respectively, Gundogan (2009) as "between 4.29 and 4.89" for Muğla pine honey, Haroun (2006) as 3.38 for sunflower plant honey, Duman Aydın et al. (2008) as "between 2.21 and 3.54", Erdogan et al. (2005) as "between 3.90 and 4.35", Kurt and Yaman Karadeniz (1982) as 4.32 on average, Akyuz et al. (1995) as 4.11 on average, Batu et al. (2013) as 4.1 on average, and Kaplan (2014) as "between 3.58 and 6.45".

In the present study, the highest pH value for the honey samples obtained from Bingol province was determined from the Bingol-Solhan sample as 2.91, while the lowest value was determined from the Bingol - Kigi sample as 2.68. The average pH value for all regions was determined as 2.81. Turkish Food Codex (TFC 2012) specifies no standard pH value for the honey. The findings in our study in terms of pH levels were lower compared to the findings of other studies performed on Eastern Anatolian region honeys, like the pH findings of Gul (2008) with 3.34, of Ilgin (2010) with 3.95, and of Erdogan et al (2005) with 3.90 and 4.35. While the distance between the study areas of these studies is small, the difference found can still be attributed to differences in environmental conditions, and the genetic properties of the bees that produced the honey.

High values of moisture content in honey can result in crystallization, and facilitates bacterial deterioration, leading to reduced shelf life (Tosi et al. 2002; Rodriguez et al. 2004). The moisture content of honey should stay below 20%, or the honey becomes susceptible to fermentation from osmophilic yeasts (Krell 1996; Belitz et al. 1999).

Various studies have been performed all around Turkey to investigate the moisture content of honey specimens of different regions, and the results reported by the researchers are as follows: Akdeniz et al. (2013) as an average of 17.60%, Derebasi et al. (2014) as 16.66%, Ilgin (2010) as 19.65%, Unal and Kuplulu (2006) as an average of 15.62%, Bozkurt and Aydoğın (1986) as an average of 14.88%, Tolon (1999) as 17.05%, Akyuz et al. (1995) as 17.8%, Sahinler and Gul (2004) as 15.23% and 18.1% for highland and sunflower plant honeys, respectively, Erdogan et al. (2005) as "between 15.35% and 20.50%", Akyuz (1996) as 16.82% and 17.61% for domestic and Iran origin honeys, respectively, Aydogan et al. (1990) as 15.84%, Yilmaz (1994) as 16.0%, Gul (2008) as 17.92%, Duman Aydın et al. (2008) as "between 13.2% and 19.2%", Haroun (2006) as 16.49%, and Kutlu and Bengu (2015) as 15.35%.

In the present study, the highest moisture content amongst the inspected honey specimens obtained from the province of Bingol was determined from the Bingol - Solhan sample with 16.2%, while the lowest was determined from the Bingol - Yayladere sample with 14.8%. The average of all region samples in terms of moisture content was determined to be 15.43%. The Turkish Food Codex (TFC 2012)

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specifies the moisture content standard for honey should not exceed 20%. Accordingly, all samples obtained from the province of Bingol are within this standards.

As a result of the moisture analysis of the honey, it is seen that there is a small difference between the lowest (Yayladere) and the highest (Solhan) values even though only one sample was obtained from each region. This may be indicative that the honey was harvested at the optimum maturation period.

All 7 samples evaluated in this study were found to have properties that are within standards in terms of invert sugar, sucrose, and moisture content parameters.

It is believed that the amylase activity of honey is related to the temperature and maturation level of honey (White et al. 1964). A study has tested storage of different honey samples in temperatures varying between -20°C and 60°C, and the amylase enzyme was found to have reduced activity in higher temperatures (White et al. 1962). Amylase is an important enzyme within the honey that makes its digestion easier and it is secreted from the salivary glands of the bees. This enzyme is destroyed from thermal processing or if the storage period is long, and therefore can be used as an indicator for the freshness of honey (Kahraman and Kupullu 2011). Amylase destroys polysaccharides and is added to the honey by the bees during its storage period within the honeycomb. Its ratio within the honey can, therefore, change during the in-hive period. Any thermal process applied to the honey before it is being presented to the market lowers its diastase count (Artık and Poyrazoglu 2007). The term "diastase count" is used in honey, instead of "diastase (amylase) activity". This "diastase count" refers to the polysaccharide weight (in terms of grams) of 1 gram of honey that can be destroyed within 1 hour at 40°C (Sahinler et al. 2001). According to the Turkish Food Codex Rescript of Honey (2012/58), the "diastase count" of honey should at least be 8. Babacan and Rand (2007) have characterized the amylase enzyme of honey and have measured the enzymatic activity as 0.0134 units mL<sup>-1</sup>.

The highest enzymatic activity found in the present study as a result of the  $\alpha$ -amylase activity measurements was found in the Bingol - Kigi sample with 0.0120 units mL<sup>-1</sup>, while the lowest was determined from the Bingol-Adaklı sample of 0.0043 units mL<sup>-1</sup>. No standard has been specified for the

amylase enzyme activity in the Turkish Food Codex Rescript of Honey (TFC 2012; 2012/58).

Amylase enzyme activity results differ between regions. Low activities can be caused by problems that occur during the supply and transportation of honey. However, the lack of a standard for amylase enzyme activity and the inadequacy of studies make it difficult for us to explain the difference observed in our study.

### CONCLUSION

Unemployment causes a continuous wave of migration from eastern regions to the west of Turkey. The eastern regions have a rich variety of plant fauna, which is mostly due to different factors such as, climate, geographical variations and sunlight. The winters of the region are harsh, but the spring and summer months are quite warm due to the excessive amounts of sunlight available. The resulting rich plant fauna represents a great opportunity for beekeeping. Considering the fact that beekeeping is a business that requires relatively lower investment and no closed area, it also represents a great economic opportunity for the rural regions.

As a result of our analysis, it has been observed that all parameters measured are in compliance with TFC standards. These results are promising in terms of promoting regional beekeeping. However, it is still not sufficient. Microscopic and other analysis of honey obtained from the regions should be performed regularly. In this way, compliance with the standards can be tested and maintained. For this reason, it is important to increase the number of studies and financial support for these studies.

### ACKNOWLEDGMENTS

This study was supported by the Bingol University Coordination Unit of Scientific Research Projects, with project no: BAP-223-88-2011. This study was produced as a part of Yılmaz ATEŞ's master thesis.

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