Support to Sustainable Honey Value Chain in Turkey through Geographical Indications

Literature Review Report

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Aim of the literature review;

- to help the product characterisation study;
- to support the drafting of the products code of practice; and
- to provide a basis for the application form, in particular for the sections on general information, history and reputation of the product.

The reviewed literature includes national and international scientific studies (thesis, articles, books etc.), historical archives, newspapers, magazines and internet sources.

Results of the literature review have been summarized below:

REFERENCE	KEY FINDINGS/INFORMATION
(Yücel & Şahinler, 2016)	Pine honeydew honey is obtained from South-west coast of Turkey from *Marchalina hellenica* insect lives in *Pinus brutia* trees by honey bees. This geography is unique for handling of 92% of the World pine honeydew honey production. Pine honeydew is very special honey needs to distinctive codex standardization for evaluating of some biochemical characteristics. *Marchalina hellenica* lives only on *Pinus brutia*. The advantage of pine honey is that it can be stored for a long time without losing its consistency or without crystallizing. C4 sugar is naturally high in pine honeydew honey, but if considered as it like flower it creates risk for evaluation as tricky.
(Öztürk, Efil, & Bekdemir, 2015)	Pine honey ranks 6th among the honeys with the highest phenol content among 30 different honey samples. Pine honey shows high bioactivity potential. Honeys can be sold as medicinal honey at higher value in the market if they have high phenol and Gallic acid contents.
(Durovic & Ülgentürk, 2014)	Turkey is one of the largest honey producers. Approximately 15000 tons of pine honey is produced each year. Sugar and amino acid content of honey that produced from *Marchalina hellenica* (Gennadius) (Marchalinidae) are; Glucose, Fructose 24.8%, Sucrose 44.2%, Melesitose 17.5%.
(Tananaki, Thrasyvoulou, Giraudel, & Montury, 2007)	Pine honey is produced from honeydew secreted by the insect *Marchalina hellenica* (Gennadius) which is restricted to Pinus brutia Ten and *Pinus halepensis* Miller. This type of honey is produced only in Greece and Turkey. The annual Greek honey production is estimated to be 12,000 tons, 60–65% of which is honeydew honey from pine trees. Pine honey became gradually accepted as honey of good quality. It has no incisive taste or aroma, a very low tendency to crystallize, is very thick, stores well, and is produced from pine forests far away from any environmental pollution. It is less sensitive to heating because of its low rate of forming HMF. These characteristics are very desirable in monofloral honeys and also in blends. Comparative analytical studies of Greek and Turkish honeys of the same floral source can vary due to the different geographical origins.
(Çınar & Ekşi, 2012)	Chemical composition and electrical conductivity of 100 Turkish pine honey samples were investigated. The samples were collected from different 9 localities in Mugla province at 2006, 2007 and 2008. The results showed that honey samples contained 14.40-16.80% water, 25.97- 36.38% fructose and 18.97- 35.10% glucose. The ratio of fructose/glucose changed between 1.01-1.44. The major mineral constituent of pine honey was potassium (1236- 2554 mg/kg), and it was followed by magnesium (40.1- 77.4 mg/kg), calcium (25.6-93.6 mg/kg) and sodium (21.8- 80.8 mg/kg). The ratio of K/Na was found between 21.2 and 80.9. Electrical conductivity of samples varied from 0.82 to 1.82 m^{S}/cm. Total acidity of samples changed between 19.98- 35.59 meq/kg while proline content varied between

	301-977 mg/kg. The glucose, sucrose and maltose content and electrical conductivity of the samples showed significant differences in terms of harvest year (P<0.01). However, moisture, fructose, ash, potassium magnesium, calcium, sodium and proline amounts as well as total acidity of the samples did not show any significant differences due to harvest year (P>0.01).
(Dimou, Katsaros, Klonari, & Thrasyvoulou, 2006)	73 samples of fir and pine honey has been analysed from four regions of Greece. It was found that spores of the genus Coleosporium were present only in pine honeys. The results showed that the botanical origin of pine and fir honeydew honeys could be distinguished by microscopic analysis. Discrimination based on the geographical origin of the honeys was not accomplished. On the other hand it concluded that using a combination of fungal spores and pollen grains would lead to better discrimination of samples. A critical result of the research was the presence of Coleosporium. This spore was absent in fir honey samples, while it was present in relatively large numbers in all pine honey samples. the presence of a relative large number of Coleosporium spores in a honeydew honey could be a strong indicator of the botanical origin of the sample. However, it should be noticed that the absence of Coleosporium spores does not necessarily mean that a honey is not a pine honey.
(Yıldız, Rasgele, & Kekeçoğlu, 2016)	The study were conducted with pine honey samples (n=89) produced in the Aegean Region, cotton honey samples (n=12) produced in the Mediterranean Region, multifloral honey samples (n=43) produced in the Central Anatolia Region and sunflower honey samples (n=67) produced in the Thrace Region. According to results of the physicochemical analyses, the average contents of moisture 17.12±0.09%, acidity 27.90±0.53 meq/kg, sucrose 0.44±0.08%, fructose + glucose 56.37±0.54 %,fructose/glucose 1.15±0.01, conductivity 1.04±0.02 m^S/cm, diastase 15.51±0.50 DN and 5-hydroxymetylfurfural (HMF) 4.63±0.31 mg/kg in pine honey samples were determined. The same components for cotton honey samples were determined as 17.88±0.57 %, 13.92±1.11 meq/kg, 2.04±0.74 %, 61.30±1.08 %, 1.19±0.02 %, 0.24±0.03 m^S/cm, 10.92±0.64 DN, 3.86±0.04 mg/kg, multifloral honey samples 19.03±0.15 %, 26.92±1.17 meq/kg, 3.08±0.08%, 70.71±0.69 %, 1.13±0.02, 0.32±0.03 m^S/cm, 20.72±0.82 DN, 2.73±0.06 mg/kg, sunflower honey samples 20.13±0.21 %, 30.81±0.78 meq/kg, 2.99±0.01 %, 72.69±0.39 %, 1.13±0.01, 0.44±0.01 m^S/cm, 25.61±1.11, 2.58±0.03 mg/kg respectively.
(Koç, Karacaoğlu, Nadem, & Doğan, 2017)	There are significant differences between natural and commercial processed honeys in terms of quality criteria. HMF and diastase levels of natural and commercial pine honeys have a big variation. This variation is usually due to the heating of honeys. In the study shelf lives of the natural pine honeys were estimated as 46.9, 22.4 and 27.2 months whereas the commercial pine honeys had 24.1, 16.0 and 17.9 months.
(Ülgentürk, Kıran, Ayhan, Civelek, & Eskin, 2012)	Marchalina hellenica Gennadius (Hemiptera: Marchalinidae) is a common scale insect species in Turkish pine forests mainly in Aegean region, Turkey. Its honeydew has great economic importance because it is collected by honeybees and made into “pine honey" in Turkey.
(Bacandritsos , 2004)	Apart from Greece, *M. hellenica* has been recorded in Turkey, Italy and the islands of the Eastern Mediterranean. Average values of Greek pine honey; Fructose + Glucose (%) 48,5±2,2; Sucrose (%) 0,16 ±0,05; Water (%) 16,2±0,1; El. Conductivity (mS/cm) 1,3±0,1; Total acidity (meq/kg) 36,1±4,0; Diastase (DN)20,8±1,2; HMF (mg/kg) 2,9±1,0.
(Topal, Özsoy, & Şahinler, 2016)	Climate change; It reduces survival, reproduction and habitat. The change in temperature and humidity poses a threat to pine honey production. Flight efficiency and honey yield levels of Italian hybrid bees are higher than Muğla ecotype. However, it was found that Muğla ecotype showed better adaptation to environmental conditions than Italian hybrid.
(Hatjina & Bouga, 2009)	Marchalina hellenica is the main honeydew producing insect of pine trees. It Is endemic to Greece and Turkey and introduced to the Italian island of Ischia. It has one generation

	per year and the adult females appear on the trees only after mid-March. Studies on the genetic structure of the insect show that the low genetic variability may be due to the fact that it cannot be dispersed long distances in correlation with the parthenogenetic reproduction. The amount of honeydew produced by the insect varies over the year and mainly depends on the size and age of the nymphs. During summer, the body size of the nymphs increase and as well as their ability to suck and excrete honeydew improves. The amounts of honeydew are high enough for honey production after mid-August, and this is known to beekeepers as the first 'honeydew flow'. During September, and while the insects are gradually developing into 2""^ instar larvae, they stop feeding for a period of a few days. However, as not all of the insects undergo the ecdysis at the same time, honeydew production never completely stops but rather decreases slowly only to increase again after about 15-20 days. This is known as the 'second honeydew flow'. From that time on honeydew production is continuous till early spring, but honey bees are collecting it only when weather conditions permit it {usually till late November). Nevertheless, it is not a rare phenomenon to see honey bees collecting honeydew in a sunny winter day, even when the environment contains snow! Early spring, when the temperatures are rising again, is time for the 'third honeydew flow' which ceases when the insects become adults. From the above description it is evident that the main honeydew flow is from September to November, although times and dates can vary considerably due to geographic areas and climatic conditions.
(De-Miguel, Pukkala, & Yeşil, 2014)	Most pine honey is produced in eastern Mediterranean Pinus brutia forests, namely in Turkey and Greece. ‘‘Honeydew honey’’ refers to honey produced by bees that collect nectar secreted by another insect. The honeydew from P. brutia forests is produced by a scale insect, Marchalina hellenica Genn. (Hemiptera, Sternorrhyncha: Coccoidea, Margarodidae). This insect is endemic to the eastern Mediterranean and feeds on tree sap by inserting its rostrum into the cambium of the stem and main branches through crevices and folds of the bark. The insect excretes a white cotton-like fluff and exudates viscous sugary secretions (honeydew). Honeydew is collected by honeybees that process it to produce pine honey. Due to their excellent properties, honeys derived from honeydew have a considerable economic value.
(Silici, 2011)	The volatile compounds of 13 Turkish pine (Pinus brutia Ten.) honey samples (from Muğla – Marmaris) were characterized by solid phase microextraction (SPME) analysis, followed by gas chromatography-mass spectrometry (GC-MS) analysis. A total of 42 volatile compounds were identified, but volatile compounds such as **nonana1, benzene, 4-hexen-3-ol, alpha-pinene, and 2-heptanone were recognized to be specific floral origin markers of the pine honey**. The SPME extraction method was proposed as an alternative way to carry out pollen analysis for floral source detection, especially for products such as pine honey, by characterization of honeydew elements.
(Özkök, ve diğerleri, 2017)	10 pine honey samples from Muğla has been collected and researched by microscope. The quality of honey samples was determined by correlating NHE (Number of Honeydew Elements) to NTP (Number of Total Pollen) ratio and the honey which has NHE to NTP ration higher than 4,5 was accepted as a high density-superior quality pine honey. According to identifications, which have been made via microscope, pooled high quality honey sample was selected and analysed for dioxin. All the dioxin results were found lower than the European Union regulatory limits. According to research results, classification of honey samples by NHE/NTP ratio as follows; **NHE/NTP Identification Honey Type** 0 – 1,5 Low density Floral honey 1,5 – 3,0 Medium density Pine + floral honey 3,0 – 4,5 Dense Pine honey > 4,5 High dense Superior quality pine honey
(Ilgar, 2018)	Beekeeping activity in Anatolia extends to BC 1300. Honey and bee products production is an important socio-economic activity in rural Turkey since the ancient years. Turkey is

	extremely suitable for the honey production in terms of climate conditions and rich flora. In Turkey has 9,000 plant species and 3000 of them are endemic.
(Öztürk, 2017)	It has been carried out a survey research with 40 beekeepers in Ula district of Muğla province. It has been found that, average hive number is 258, beekeeping is the main economic activity of 60% of beekeepers and main problem of beekeepers is low market prices (70%). 85% of beekeepers feed their bees with syrup and cake during spring and autumn. 20% of beekeepers feed their bees with pollen addition to syrup and cake.
(Alpat, 2018)	It has been determined that each type of honeys were statistically significantly different from other honeys, for pine honeys in terms of protocatechuic acid, syringic acid and taxifolin, for sunflower honeys in terms of 3-4 Dimethoxy Cinnamic Acid, Naringenin and Quercetin, for citrus honeys in terms of chlorogenic acid, and for polyfloral honeys in terms of high amount of gallic acid. The phenolic compounds in pine and sunflower honeys were identified as protocolatechic acid and quercetin, respectively. It has been determined that the pine honeys produced in our country are superior to other honey types in terms of bioactivity. Antiradical activities of Turkish honeys were determined between 9.7% and 81.5%. The honey type with the highest antiradical activity was found to be pine honey with 68.2 ± 6.51% (statistically significant $p < 0.05$). The total phenolic content of Turkish honey varies between 18.4-82.4 mg GAE / 100 g. The highest total phenolic content of honey was found to be pine honey with 65.8 ± 7.63 mg GAE / 100 g (statistically significant $p < 0.05$).
(Özkök, D'arcy, & Sorkun, 2010)	From September to November during the years between 2004 and 2006, 78 honey samples were collected from ten areas of the Muğla province. The mean total phenolic acids of the 50 examined pine honey samples was 155.55 mg GAE/kg. The minimum detected amount was 35.36 mg GAE/kg, while the maximum one was 365.94 mg GAE/kg. Regarding the total flavonoid content, it was determined at a mean of 22.80 mg QE/kg, with a minimum of 4.80 mg QE/kg and a maximum of 54.78 mg QE/kg.
(Akbulut, Özcan, & Çoklar, 2009)	15 pine honey samples from different parts of the Muğla province in Turkey were analysed. The antioxidant activities were evaluated based on the ability of the pine honey extracts to scavenge 1,1-diphenyl-2-picrylhydrazyl. Significant correlations were obtained between the antioxidant activity and phenolic content ($r = 0.887$). All samples indicated proper maturity, considering the high soluble solids. The values for ash and electrical conductivity were high (0.24–0.60% and 878–1463 µS/cm, respectively). The concentration of 14 minerals of pine honeys were determined by inductively coupled plasma-atomic emission spectrometry. All samples contained high amounts of potassium, calcium, phosphorus, sodium, iron, magnesium, aluminium, nickel, and zinc. Within the mineral contents, potassium was quantitatively the most important mineral, having an average content of 3,802 ppm, and accounted for 45% the minerals.
(Karabagias, Badeka, Kontakos, Karabournioti, & Kontominas, 2014)	39 pine honey samples were collected during the harvesting period 2011 from 4 different regions (Halkidiki, Evia, Thassos, Samos) in Greece known to produce good quality pine honey.
(Özkök, Yüksel, & Sorkun, 2018)	In the study, 26 pine honey samples from five different districts of Muğla were classified as high quality pine honey via melissopalynological analysis and subjected to chemical analysis to evaluate physicochemical parameters.

Additional links on Turkish Pine Honey

https://www.turkeyhomes.com/blog/post/the-buzz-around-honey-in-turkey

http://www.carfu.org/?p=524

https://www.dailysabah.com/feature/2017/08/11/the-story-of-honey

https://oddviser.com/turkey/marmaris/pine-honey

https://www.hpb.co.uk/blogs/marmaris-honey-house-osmaniye

https://books.google.com.tr/books?id=YHj-Mdv432UC&pg=PA38&lpg=PA38&dq=famous+turkish+pine+honey&source=bl&ots=_GSE9iduye&sig=ACfU3U1j7sQZzuLiZWNwNcn0zYl1GhAp1Q&hl=en&sa=X&ved=2ahUKEwj8nuC2v6rmAhXEoFwKHXV9AJo4HhDoATAEegQIChAB#v=onepage&q=famous%20turkish%20pine%20honey&f=false

https://books.google.com.tr/books?id=dYteDwAAQBAJ&pg=PA56&lpg=PA56&dq=famous+turkish+pine+honey&source=bl&ots=2ppWOqcOVt&sig=ACfU3U2lr2g5nfAdssNQU3D_kmt__OyVxQ&hl=en&sa=X&ved=2ahUKEwj8nuC2v6rmAhXEoFwKHXV9AJo4HhDoATAJegQICRAB#v=onepage&q=famous%20turkish%20pine%20honey&f=false

https://www.tridge.com/stories/tridge-market-update-fine-turkish-pine-honey

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