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Determination and assessment of some physicochemical parameters of Bulgaria sunflower and polyfloral honey

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Abstract

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Honeybee products are highly valued food products in the nutrition and medicine.This work aims to determine physicochemical parameters of polyfloral and sunflower honey, which are produced in Bulgaria. Twelve sunflower and 17 polyfloral honey samples were used in this study. The parameters color, water content, electrical conductivity, specific optical rotation, pH, proline, invertase, diastase, hydroxymethylfurfural (HMF) were analyzed. Bulgarian sunflower and polyfloral honeys were characterized by main physicochemical parameters and compared to products from other countries. The color correlates with the electrical conductivity and diastase correlates with invertase in the sunflower honey. The results of the present study indicated that Bulgarian sunflower and polyfloral honey are known for its good quality since the criteria that were closely correlated with the honey's quality were measured.

Keywords*:* physicochemical parameters; sunflower honey; polyfloral honey

Introduction

Honeybee products are highly valued food products in the nutrition and medicine. Floral honey is produced from bees collect nectar from the flowers. It can be monofloral (the nectar is from one predominant flower) or polyfloral (the nectar is from different flowers) (Chin and Sowndhararajan, 2020). Honey contains mainly sugars (up to 80%) and water (10– 20%), but also a large number of minor components, such as amino acids, proteins, organic acids, mineral elements, enzymes, flavonoids, phenolic compounds and aromatic substances (Santos-Buelga and González-Paramás, 2017; Machado De-Melo et al., 2018). Honey composition and its health properties dependon the floral sources of the nectar and its chemical content (Elbanna et al., 2014). Furthermore, the chemical composition of honey is affected, as well as on climatic conditions of the region, where honey is produced, bee species, conditions of handling and storage of the product (Gündoğdu et al., 2019). From the consumer's point of view, honey properties, such color and aroma, are ones of themost important. These parameters are determined by the honey's botanical origin (Brščić et al., 2017; Cela et al., 2019). In addition to chemical composition, pollen analysis, also provides an opportunity to evaluate the honey's quality.

Bulgaria has an ancient tradition of beekeeping due to the variety of cultivated and spontaneous polliniferous and nectariferous plants and very rich flora (Grigorova et al., 2016). In

this respect, in some casespolyfloral honey is most common. Monofloral honey production in Bulgaria is challenging due to the small areas of certain plant types during the flowering period and changing weather conditionsin the last years. The main type of honeys produced in Bulgaria is polyfloral and from the monofloralthe most popular are sunflower (*Helianthus annuus*), rape (*Brassica spp.*), black locust honey (acacia honey,*Robinia pseudoacacia*), linden (*Tilia spp.*). These are ones of the most highly valued honey types. The recognition of Bulgarian sunflower and polyfloral honey can increase its commercial value. This information would have a positive economic impact for the Bulgarian polyfloral honey, where it is widely produced. The physicochemical characterisation of different honeys from Bulgaria has not been carried out extensively. There have been a few scientific studies on honeys investigating pollen analysis and physicochemical properties (Atanassova et al., 2012; Nikolova et al., 2014; Manolova et al., 2021). However, there has been no comprehensive survey on the quality properties of typical Bulgarian honeys. Therefore, this work aims to determine physicochemical parameters of polyfloraland sunflower honey which are produced in Bulgaria.

Materials and Methods

All honey samples were obtained from Bulgarian beekeepers during 2 years from different regions of Bulgaria. Twelve sunflower and 17 polyfloral honey samples were used in this study. The honey samples were stored in glass jars at room temperature in a dark place before the analysis.

The parameters water content, electrical conductivity, specific optical rotation, pH, proline, invertase, diastase, hydroxymethylfurfural (HMF) were analyzed according to Harmonized methods of the European Honey Commission (Bogdanov et al., 1997). The honey color was measured with Lovibond Honey Colorpod. The color grades were expressed in millimeter (mm) Pfund grades.

Pollen analysis was carried out using the method established by the Bulgarian State Standard for Bee Honey (3050-80).

The analyses were carried out in duplicate. Statistical analyses of data were performed using IBM SPSS Statistics version 21 for Windows. Data was expressed as means ± standard deviations (SD). Correlation analyses between the antioxidant activity of honey dew honey and polyfloral honey samples were done. Level of statistical significance was defined as $p<0.05$.

Results and Discussion

Sunflower and polyfloral honey samples were tested in this study in order to assess their physicochemical parameters. The results from the pollen analysis of rape honey are summarized in Table 1. All monofloral samples meet the minimum pollen content requirements above 40%. The other honeys analysed could be considered as polyfloral honeys according to the pollen contribution of the botanic species under 40%. The main families and species found in polyfloral honey are: *Fabaceae*, *Trifolium spp.,Melilotus spp.*, *Rosaceae*, *Brassicaceae*, *Lamiaceae*, *Asteraceae*, *Helianthus annuus (sunflower)*, *Taraxacum spp., Cichorium spp.*, *Carduus spp.,Tiliaceae*.

The average physicochemical values are reported in Table 2.

Color is the first characteristic evaluated by consumers of the honey quality. This is connected with their preference and acceptance of different honey types (Dominguez and Centurion, 2015; Ortega-Bonilla et al., 2021). The color of the sunflower honey in this study is light, because the values on the Pfund scale varied between 4and 21 mm Pfund. The average values

Table 1. Pollen content in sunflower honey

Value	Sunflower honey (n=12)
Min	42
Max	79
Mean±SD	61±12

Table. 2. Physicochemical parameters of sunflower (n=11) and polyfloral honey (n=17)

Parameters	Sunflowerhoney mean±SD	Polyfloral honey mean±SD
Colour, mm Pfund	14±5	22±8
Electrical conductivity, mS/cm	0.306±0.059	0.472±0.078
Water content, %	17.44±0.76	17.92±0.26
Specific optical rotation, - $[\alpha]_D^{20}$	-18.33±1.17	-15.82±3.28
pH	3.56±0.12	3.86±0.30
Proline, mg/kg	212.92±31.46	266.54±62.22
Invertase, U/kg	115.31±24.03	97.26±13.40
Diastase, Gothe units	15.54±2.98	17.23±3.42
HMF, mg/kg	5.74±1.42	5.30±2.07

Legend: mean±SD = mean±standard deviation

are presented in Table 2. In the recent study Pauliuc and Oroian (2020) reported higher values for color in Romanian sunflower honeys. According to the Pfund scale, honey color preferences fall into large ranges from water white to dark amber. In the present study color in polyfloral honey samples ranges from 13 to 41 mm Pfund.

Electrical conductivity provides information on the botanical origin of honey. Blossom honeys should have less than 0.8 mS/cm and honeydew honeys have more than 0.8 mS/cm (Nigussie et al., 2012). This parameter has the lowest average of 0.306 mS/cm in sunflower honey, then increased in polyfloral ones to 0.472 mS/cm (Table 2). Also, Pauliuc and Oroian (2020) and Czipa and Kovács (2014) obtained similar electrical conductivity values for sunflower honey (314.82 – 440.55 μS/cm) and (311 – 470 μS/cm), respectively. According to the result obtained, polyfloral honeys do not have mixture with honey dew honeys. Our results for the polyfloral honeys are in agreement with those of Albu et al. (2021).

The water content of honey is one of the most important parameters for honey quality and stability against fermentation. It is well known that this parameter is related to freshness of samples, regardless of their botanic origin (Manzanares etal., 2011). For all honey samples the water content is under 20%, which is in accordance to with Directive 2014/63/EU (2014).

Optical activity depends on the carbohydrates in honey (Dimins et al., 2008). Due to the higher fructose content, nectar honey rotates the polarised light angle to the left and it has negative optical activity. Alternatively, honey dew positive optical activity. In this respect optical rotation is used to distinguish nectar and honey dew honey (Bogdanov et al., 2004). In the recent study, the values of the optical rotation of the Bulgarian honey samples were negative, as was expected for nectar honey. The average values are presented in Table 2. Our results confirmed the results of Lazarević et al. (2012). The mean values for specific optical rotation for sunflower honey were −16.50.

The acidic pH prevents the growth of bacteria in honey (Almasaudi, 2021). In this study, the pH of rape honey ranged from 3.20 to 4.00. These results are similar to the pH values of polyfloral honey (3.50 – 4.50). The highest maximum values of pH in polyfloral honey might be due to different mixtures of nectar in this honey. The pH values are similar to those estimated in polyfloral honeys (ÁlvarezSuárez et al., 2018; DogoMračevićet al., 2020). Honey pH is of great importance during storage and it influences shelf-life of the product. The pH values decreased during storage (Živkov Baloš et al., 2023).

The measured proline content of the sunflower and polyfloral honeys is shown in Figure 1.

The polyfloral honeys exhibited the highest proline content (average 266.54 mg/kg). In addition, we observed large proline variation for monofloral honey samples. The range of proline content for sunflower honeys was from 156.98 to 263.59 mg/kg. Wen et al. (2017) received higher values for sunflower honeys (400.75 mg/kg) and for polyfloral honey (440.02 mg/kg). The analysed multifloral honey showed low proline content (168.05 mg/kg) studied by Nayik et al. (2015).

Honey contains several enzymes in different concentrations (Akyıldız et al., 2023). One of the main enzymes present in honey are diastase and invertase (Alaerjani et al., 2022). Diastase is an indicator for assessing honey storage conditions. Invertase is not included as a honey quality parameter in the International Food Standards (Codex Alimentarius, 2022). Diastase activity is able to indicate overheating of the honey (Matović et al., 2018). The average values for sunflower honey and polyfloral honey are presented in Figure 2. Serrano et al. (2007) studied sunflower and polyfloral honey. The mean value for diastase was 20.48 expressed as diastase number in Gothe's scale. In a recent study Sedláčková et al. (2022) obtained similar results for diastase in sunflower and polyfloral honey compared to our results.

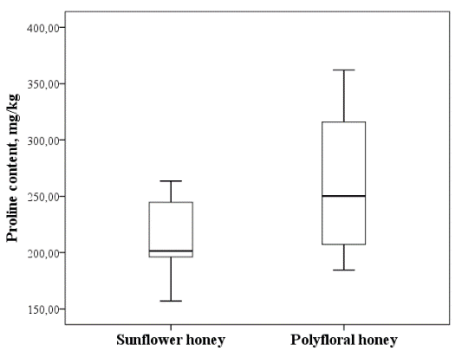
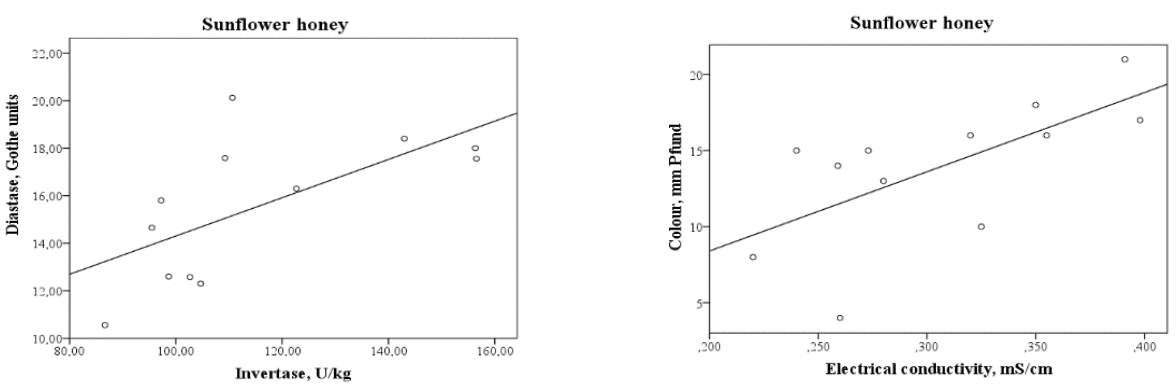


Figure 1. Box plot diagram of proline content in rape and polyfloral honey samples. Minimal, maximal and median value are shown

The correlation between diastase and invertase in sunflower samples are presented in Fig. 2A. The moderate correlation between these two parameters was found ($r=0.650$, $p<0.05$). Furthermore, in the current study, positive linear correlation between color and electrical conductivity in sunflower honey was found to be significant ($p<0.05$) with the coefficient of correlation ($r=0.663$) (Fig. 2B). The moderate correlation may be due to the low content of diastase in sunflower honeys. The reason can be due to the high nectar flow that does not allow bees to saturate it with the enzyme. Persano Oddo et al. (1999) and Serrano et al. (2007) reported positive correlations between diastase and invertase



A) *B*)

Figure 2. Correlations between diastase and invertase A) ($r=0.650$, $p<0.05$) and between color and electrical conductivity in sunflower honey B) ($r=0.663$, $p<0.05$)

in different honey samples including sunflower and polyfloral honeys.

The average value of HMF in rape and polyfloral honey samples is low under 6 mg/kg (Table 2). It can be concluded that these values are typical for unprocessed honey. In accordance with the current European legislation, HMF content should not exceed 40 mg/kg. This parameter does not relate to the origin of the samples (Anklam, 1998). Similar to diastase activity, HMF content can be used as an indicator of increased temperature and overheating.

Conclusion

Bulgarian sunflower and polyfloral honeys were characterized by main physicochemical parameters and compared to products from other countries. The color correlates with the electrical conductivity and diastase correlates with invertase in the sunflower honey. The results of the present study indicated that Bulgarian sunflower and polyfloral honey are known for its good quality since the criteria that were closely correlated with the honey's quality were measured.

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