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Effect of the duration of shelf life on some quality parameters related to bee honey

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Abstract. *The changes in some parameters determining the quality of bee honey are traced after one and two years of storage at room temperature (5 - 8°C in winter months and 25 - 35°C in summer months). On samples of multifloral and honeydew honey (n=27) the following quality parameters have been defined: water content (%), electrical conductivity (μS/cm), specific optical rotation ($[\acute{a}]_D^{20}$), pH, total acidity (meq/kg), diastase activity (units by Gote), hydroxymethylfurfural (HMF – mg/kg) content. It was found that the duration of storage at ambient conditions has a pronounced impact on the amount of HMF for copper samples analyzed. There were no significant changes in the amount of HMF in honeydew honey and in most of multifloral bee honey samples. Depending on the duration and storage conditions, the values from other quality parameters being within admissible limits stated in Bulgarian (BDS 3050/80, Decree 48/2003) and international regulations.*

Keywords: bee honey, storage, physical and chemical parameters

Introduction

According to the Regulation on requirements to bee honey for human consumption of 2002, the name «bee honey» is used to denote sweet product obtained by honey bees from plant nectar и secretions from the living parts of plants or excretions of sucking insects (aphids) on plants collected by bees, transformed by combining with specific substances in their organism, deposited, dehydrated, stored and kept in bee combs for ripening.

The physical and chemical parameters of bee honey and their limit values are defined in the Regulation on requirements to bee honey for human consumption (adopted by Decree of the Council of Ministers No. 196 in effect as of 01 Aug 2003), complying with EU Directive 110/2001. These basic parameters are included in almost all national and international standardization documents on honey and there are no significant differences in the limit values. The methods used for quality rating of honey (incl. physico–chemical analysis), for our country are published in BDS 3050-80 and Regulation No.48 of 2003 and for the EU countries the methods have been recommended by the European honey commission (Bogdanov et al., 1997).

Bee honey is used mainly as food. It is not a regulated remedy, but rather food with a certain dietary and medicinal action. Consumption of honey in many countries is high: in Germany the average annual consumption of honey is 2,4 kg per capita, in Serbia – 2,1 kg, in Greece – 2,0 kg. By this indicator Bulgaria ranks last in Europe (0,180 kg per capita), in recent years a trend for increased demand and consumption of honey has been observed. Establishment of bee honey as valuable food product and increase of its consumption require good knowledge of the storage conditions and possible changes in the composition. This product is available year-round on the market, which in turn requires prolonged storage. Pursuant to the requirements bee honey should be stored in dry, dark and well ventilated rooms at up to 25°C and humidity up to 80% (Regulation 9/2005). When purchasing honey in small containers for consumption at home very often it is not possible and the above conditions are not respected. In this respect there is a need to track changes of some parameters defining the quality of honey, after storage at ambient conditions. In Bulgaria it is required temperature treatments of honey up to 45C (Regulation 9/2005). It was proved that from these circumstances not found considerable changes from frequently used quality parameters (HMF and enzyme diastase), usually used for detection of temperature treatments of honey (Ivanov, 1978; Bogdanov et al., 1997; Dustmann, 1993). To this moment not found available scientific data for influence on different rooms temperatures with wide interval (between 7,8 and 34,7°C), usually used from consumers for storage on the main quality parameters for different types of bee honey.

All the above defined the objective of the present study, namely to trace the changes in some physical and chemical parameters determining the quality of bee honey after one and two years of storage at ambient conditions.

Material and methods

The study used representative samples of bee honey harvested in beekeeping seasons 2009, 2010 and 2011 (July) from 3 apiaries:

- Apiary Malko Tarnovo, Malko Tarnovo municipality, honeydew honey;
- Apiary Vetren, Bourgas municipality, multifloral honey;
- Apiary Badeshte, Stara Zagor municipality, multifloral honey.

From each apiary in different years three pooled honey samples were obtained, total for the study period 27 samples. Honey samples were kept in glass containers, in dark place, at room temperature from 7,8 to 34,7°C.

The physico–chemical study was performed in October 2011 in the laboratory of Department «Special branches-bees" at the Institute of Animal Science, Kostinbrod according to the harmonized methods of the International Honey Commission (Bogdanov et al., 1997) and the methods described in BDS 3050-80 and Regulation

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No. 48 of 2003. The following parameters were determined:

- refractive index and water content (%) by refractometer Abbé;
- electrical conductivity (μS/cm) using a Conductivity meter with a cell for electrical conductivity;
- specific optical activity ($[\acute{a}]^{20}_{D}$) by polarimeter;
- active acidity (pH) by pH meter;
- total acidity (meq/kg) by titration with 0.1 N sodium hydroxide with phenolphthalein indicator;
- diastase activity (units by Gote) according to BDS 3050-80;
- hydroxymethylfurfural content (HMF – mg/kg) by White (Bogdanov et al., 1997, Regulation 48/2003).

The results obtained were processed statistically – Excel software.

Results and discussion

The results from analysis of bee honey samples, stored 1 and 2 years at room temperature, are given in Table 1. The data show that water content is from 15,4% to 18,5% for nectar honey and from 14,6% to 18,6% for honeydew honey. The reported results are within the tolerances specified in the Bulgarian and European regulations (BDS 3050/80, Regulation 48/2003, Bogdanov et al., 1997) – less than 20%, irrespective of the duration of storage. The established narrow range of variation of water content for the three years (vintage 2009, 2010, 2011) show that temperature range 7,8 – 34,7°C is suitable for honey storage.

With regard to the parameter specific optical rotation for the honey samples in the present study the following comments can be made :

- for freshly harvested honey (vintage 2011) values are from -8.0 (samples from town of Malko Tarnovo) to -22.5 (village of Badeshte)
- for one–year storage – from -7.5 (town of Malko Tarnovo) to -17.25 (samples from village of Badeshte);
- for harvest 2009 (two-year storage) – from -2.25 (town of Malko Tarnovo) to -20.0 (samples from village of Badeshte).

Remarkable are the negative values for all samples of honeydew honey, which differs from the studies of other authors (Ivanov and Mitev, 1972; Ivanov, 1986; Persano et al., 1995; Ivanov, 2000; Dinkov, 2003; Dinkov, 2005 a,b). Reference data indicate that the values for the parameter specific optical rotation of honeydew honey are positive. The results obtained in the survey give us grounds to assume that honeydew honey samples from the town of Malko Turnovo are mixed honeydew and multifloral honey.

The values for active acidity (pH) of bee honey samples vary from 3,68 to 4,55 (Table 1) and they are within the range from 3,2 to 6,5 reported by Shkenderov and Ivanov (1983) and Ivanov (2006). The results obtained in this study regarding the negative values of optical activity and the relatively low pH values for samples of honeydew honey confirm our assumption that the honey samples from the town of Malko Tarnovo are mixed – mildew and nectar.

The results obtained for the parameter electrical conductivity vary from 291 to 1061 μS/cm for the freshly harvested honey (vintage 2011). After one year of storage (vintage 2010) values from 422,5 to 1041 μS/cm, and with two years of storage (vintage 2009) – from 371,5 to 1241 μS/cm, respectively (Figure 1). Permissible range (over 800 μS/cm for honeydew honey and below 800 μS/cm for nectar honey) specified in Bulgarian and European regulatory documents are complied with both for freshly harvested honey and for honey samples stored for one and two years. Values for electrical conductivity of honey samples obtained during analyses do not differ significantly from the results of Dinkov (2005a,b), Ivanov (2000), Dinkov (2007) for multifloral and honeydew bee honey. According to some authors (Dinkov, 2005a,b; Dinkov, 2007; Kirilov, 2007) determining the electrical conductivity parameter is easy to achieve and it serves to objectively distinguish pure honeydew honey from mixed and nectar honey, and for finding out the so-called "sugar honey", obtained after intensive feeding of bee colonies with sugar solution during the active honey harvesting season. In this regard, the observed high average electrical conductivity value in samples of honeydew honey from 2009 (1241 μS/cm), compared to the same type of honey from 2010 (1041 μS/cm) and 2011 (1061 μS/cm) indicates a smaller amount of nectar in mildew for the samples from vintage 2009.

The data presented in Figure 2 show that diastase activity in fresh honey (vintage 2011) varies from 15,73 to 21,99 units by Gote. With one–year storage the established average values of diastase activity range from 18,64 to 26,6 units and with two-year storage – from 20,87 to 27,89 units by Gote. All reported values are within the tolerances specified by BDS 3050/80. The defined differences of diastatic number of honey samples analyzed are not essential, regardless of duration of storage. Taking into account that the indicator diastase activity is used for judging overheating of honey, it can be said that the recorded maximum storage temperature of honey samples (34,7°C) does not affect the given indicator. We believe that the reason for this is the better resistance of diastase to high temperatures. According to Shkenderov and Ivanov (1983)

Table 1. Values of some physico-chemical parameters of bee honey

Villages	Harvest, year	Types of honey	Water content, %	Specific optical rotation $[\acute{a}]^{20}_{D}$	Active acidity (pH)
M.Tarnovo	2009	honeydew honey	14.6	-2.25	4.25
Vetren	2009	multifloral honey	16.2	-12.5	4.32
Badeshte	2009	multifloral honey	15.4	-20.0	3.91
M.Tarnovo	2010	honeydew honey	18.6	-7.5	4.07
Vetren	2010	multifloral honey	16.2	-12.25	4.55
Badeshte	2010	multifloral honey	17.3	-17.25	3.68
M.Tarnovo	2011	honeydew honey	15.6	-8.0	4.47
Vetren	2011	multifloral honey	17.5	-18.5	4.17
Badeshte	2011	multifloral honey	18.5	-22.25	3.81

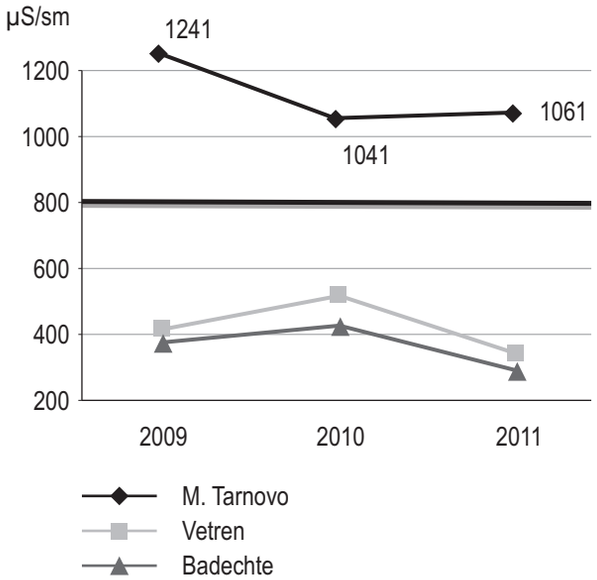

Figure 1. Electrical conductivity (µS/cm) in different places for harvesting of bee honey

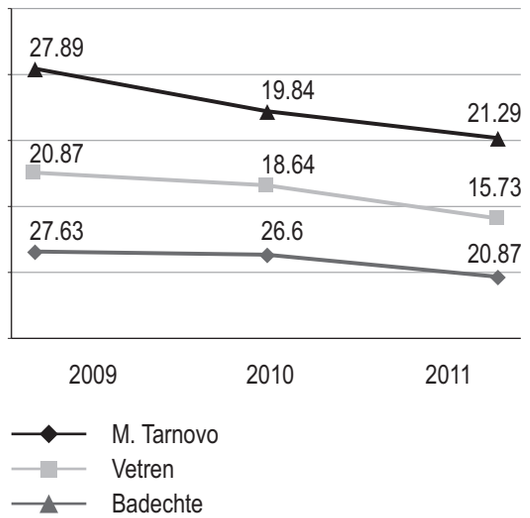

Figure 2. Diastase activity (units by Gote) in different places for harvesting of bee honey

degradation of enzymes in honey starts at 50 – 60°C. The diastase activity values obtained in the study do not differ significantly from the results of other authors for different types of honey (Ivanov and Mitev, 1972; Ivanov, 1973; Ivanov, 1978; Shkenderov and Ivanov, 1983; Ivanov, 1986; Persano et al., 1990; Persano et al., 1995; Dinkov and Russev, 2000; Ivanov, 2000).

The total acidity of samples freshly harvested honey (2011) ranged from 15,5 to 18,7 meg/kg for multifloral honey and 40,7 meq/kg for honeydew honey (Figure 3). After one year of storage average total acidity values have been determined in the range 14,1 – 27,7 for multifloral honey and 43 meq/kg for honeydew honey, and after two years 17 – 22,6 meq/kg and 42,2 meq/kg, respectively. For the honey samples from the village of Badeshte for the three years of the study higher values are observed. We believe that the reason for the reported differences to multifloral bee honey from the village of Vetren is most probably the different pasture in both regions. The total acidity values of honey samples obtained from analysis do not deviate from the tolerances specified in BDS 3050/80, Regulation 48 of 2003 and the results of Shkenderov and Ivanov (1983) for different types of Bulgarian bee honey. The results established give reason to assume that one-and two-year storage of bee honey at ambient conditions (7,8 – 34,7°C) does not affect the total acidity parameter. The minor changes in total acidity of bee honey after storage obtained in the present study confirm the results of other authors (Ivanov, 1978; Shkenderov and Ivanov, 1983).

The average values for hydroxymethylfurfural (HMF) content given in Figure 4 show the following:

- In freshly harvested honey (vintage 2011) range of variation is 3,28 – 4,38 mg/kg and the highest average value was reported for samples from the village of Vetren. The values determined in analysis are typical of natural non-heated honey – less than 10 mg/kg (Ivanov and Mitev, 1972; Shkenderov and Ivanov, 1983);
- In honey stored one year values vary between 8,6 and 62,23 mg/kg. The comparative analysis between the values obtained for freshly harvested honey (vintage 2011) and honey stored for one year (vintage 2010) shows little difference (from 3,28 to 8,6 mg/kg) for honeydew honey and significant differences for samples of polyflora honey – for the village of Vetren from 4,38 mg/kg to 16,1

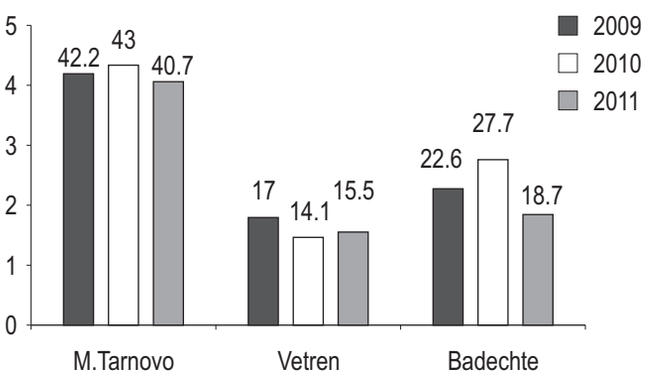

Figure 3. Values for total acidity (meq/kg) in different places for harvesting of bee honey

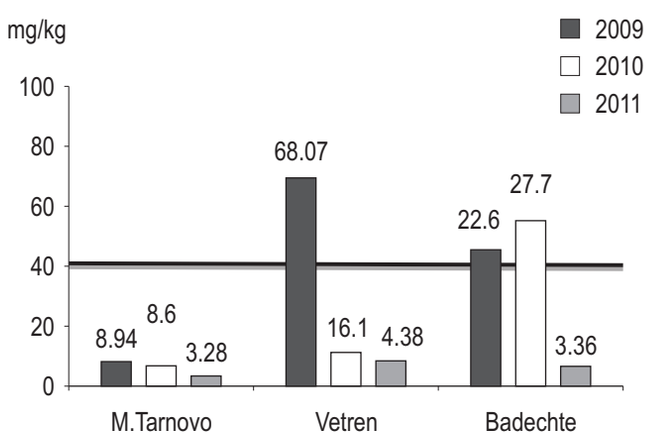

Figure 4. Values for HMF(mg/kg) in different places for harvesting of bee honey

mg/kg, respectively, for the village of Badeshte – from 3,36 mg/kg to 62,23 mg/kg, respectively. The reported average HMF content in honey samples from the village of Badeshte after one–year storage is higher than the requirements stated in Bulgarian and European standards (40 mg/kg);

• For honey stored two years (vintage 2009), HMF values range from 8,94 to 105,44 mg/kg. Comparing the results for samples of honey from vintage 2011 and 2009 shows that in honeydew honey the change is from 3,28 to 8,94 mg/kg, i.e. values are below 10 mg/kg and are responsible for natural honey. For samples of multifloral honey changes are significant with values varying from 4,38 mg/kg (2011) to 68,07 mg/kg (2009) for samples from the village of Vetren and for those from the village of Badeshte – from 3,36 mg/kg (2011) to 105,44 mg/kg (2009). The data show that with two-year storage of multifloral honey at temperatures from 7,8 to 34,7°C HMF values in some cases could be above the admissible in regulatory documents (BDS 3050/80, Regulation 48/2003, Bogdanov et al., 1997) are reached.

The survey results show clearly that the hydroxymethylfurfural content parameter in samples of multifloral honey is significantly affected by the conditions and duration of storage. The significant increase in the amount of HMF in the analyzed samples of honey from the village of Badeshte along with storage at temperatures above 30ºC could be related to errors in the technology of keeping the bee colonies (mainly the terms and conditions of supplementary feeding) and in the technology of harvesting the bee honey. The results obtained in the survey show that the amount of HMF in honeydew honey (honey samples from the town of Malko Tarnovo) is not substantially altered in one-and two-year storage at home, the values are preserved within the admissible range. The data in this study regarding the clearly defined dependence on the amount of HMF in honey on the temperature and duration of storage correlate with the communications by other Bulgarian authors (Shkenderov and Ivanov, 1983; Dinkov, 2005b) according to whom for 1–2 years HMF can reach up to 30 mg/kg and at higher temperatures it accumulates faster.

Conclusion

Storage of bee honey in small containers at ambient conditions (temperature 7,8 – 34,7°C) does not substantially alter the parameters water content, electrical conductivity, specific optical rotation, pH, total acidity and diastase activity. The values of the above parameters established in the study are within admissible limits, according to Bulgarian and international standards, regardless of the duration of storage – one and two years.

The hydroxymethylfurfural (HMF) content in multifloral honey samples is significantly affected by the conditions (temperature 7,8 – 34,7°C) and duration (one- to two-years) of storage. The amount of HMF in honeydew honey is not significantly altered in one- and two-year storage at home, and values are preserved within the limit range – less than 40 mg/kg.

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