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ORIGINAL RESEARCH PAPER

SENSORY AND PHYSICOCHEMICAL EVALUATION OF SOME VARIETIES OF ROMANIAN ARTISANAL MEAD

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Abstract: Mead is a honey-based alcoholic beverage with 8 - 18 % alcohol content. Also named honey wine, mead is not so well known among Romanian consumers, even if it is considered among the oldest fermented beverages in the world. It is traditionally produced at home and/or in small meaderies, but still it is difficult to find it commercially. Different varieties of mead can be distinguished based on honey types, honey/water ratio, addition of spices and/or fruits, and the method of preparation, etc.
The present study was carried out in order to explore the Romanian consumers' acceptability regarding the artisanal meads obtained using different types of honey from local producers (linden, multifloral, raspberry, wild forest, and acacia). It is well-known that the type of honey plays a significant role in the sensorial evaluation of mead. For this purpose, six samples of mead were prepared in the laboratory. The sensory characteristics, such as aspect, flavor, color, and taste were analyzed. The results revealed that the sample obtained from acacia honey using elderflower as additional ingredient is better accepted by the Romanian consumers than other types of mead.

Keywords: *acceptability, fermentation, honey, mead, physicochemical parameters, sensory evaluation*

INTRODUCTION

In the recent years, Romania has increased its honey production, becoming one the European Union's major producer. A report from Food and Agriculture Organization Corporate Statistical database (FAOSTAT) shows that Romania productions as high as 25,000 tonnes have been obtained in certain years (Figure 1) [1, 2].

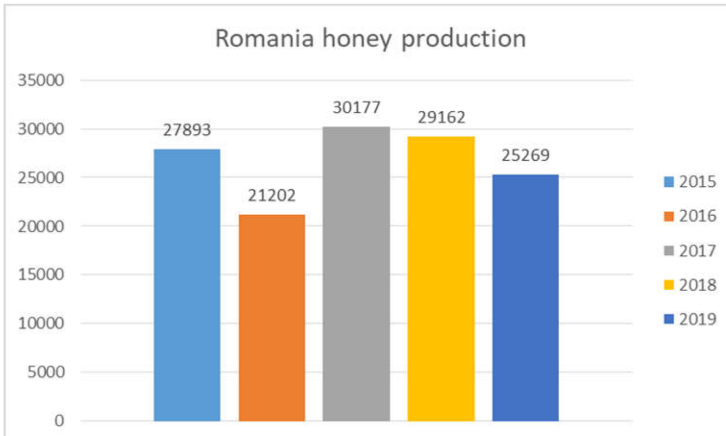

***Figure 1.** Romania honey production [in tonnes] [2]*

In this context, the Romanian honey producers can focus on different possibilities of honey valorization. Being itself a complex product that can be considered a functional food for its antioxidant and antimicrobial activities [3], honey represents an important source for obtaining remarkable functional foods or beverages.
One of these alternatives for honey valorization could be the production of mead which is an ancient alcoholic beverage obtained by the fermentation of diluted honey.
Also known as honey wine or hydromel, mead is considered a heath tonic due to the presence of its natural and high-quality compounds and can be served as an excellent aperitif or dessert wine.
Currently, this fermented drink was reintroduced worldwide and it is given increased attention especially in USA [4]. Also in Europe, the consumption of mead has gained popularity, several producers continued its fabrication mainly in Western Europe. Among the Eastern European countries, Poland stands out as the largest producer in the world [5]. Even if it is considered among the oldest fermented beverages in the world, this honey-based alcoholic beverage is not so well known among Romanian consumers. Mead (in Romanian "*mied*" or "*hidromel*") is traditionally produced at home by beekeeper and it is sometimes difficult to find it commercially [6].
In Romania, only a few scientific studies on mead production have been reported so far [7, 8].
As a permanent interest of our research team to valorize natural products and certain by-products, honey has been used in our previous study to prepare an innovative product based on honey and grape pomace [9].
Taking into account all these considerations, for the present study, one of the approaches for the honey valorization was to obtain artisanal meads according to an

accessible recipe and using different types of honey from local producers, knowing that the type of honey plays a significant role in the sensorial profile of hydromel.
The main objective of this investigation was to evaluate the acceptability of Romanian consumers regarding the experimental meads obtained using different types of honey.

MATERIALS AND METHODS

Generally, the three basic ingredients for mead preparation are: honey, water, and yeast. In traditional/artisanal mead, small amounts of spices, fruits (*e.g.* mead named *melomel*), vegetables, and flowers (*e.g.* mead with rose petals named *rhodomel*) [10], can be used as flavor ingredients.

Ingredients for mead preparation

Honey

For the present study were used five different varieties of honey: linden honey, multifloral honey, raspberry honey, wild forest honey and acacia honey, from local producers (Figure 2).

Linden honey	Multifloral honey	Raspberry honey	Wild forest honey	Acacia honey

Figure 2. *Varieties of honey used for the present study*

Before use, the quality of honey was verified, its sensorial properties and some physicochemical parameters were analyzed according to the methods described in the literature [11 – 15].

Yeast and water

The yeast used to initiate fermentation is usually strains of *Saccharomyces cerevisiae*, similar to that used in beer or wine production. For our study, commercially available dried yeast was used.
Dry yeast was rehydrated at a ratio of 100 mL of water per 1.8 grams of yeast for 15 minutes.
The natural mineral water used was AQUA Carpatica Natural Still Spring Water with the following parameters: nitrate free; Na - not detected; Mg - 17.0 mg·L^{-1}; Ca - 52.0 mg·L^{-1}; *p*H = 8.2 [16].

Elderflowers

One sample was prepared using bio elderflowers as additional ingredient.

The flowers were authenticated by our colleagues from the Biology Department of "Vasile Alecsandri" University of Bacău. Before use, the elderflowers was washed in running water and dried in natural convection mode.

Mead preparation

The production of mead involves several steps:

- Dilution of honey with water represents the first step in the must preparation. Honey can be diluted in different proportions [17, 18], and for the present study, honey was diluted with water at a ratio of weight 1 : 4 [19].

The dilution was performed with hot water at 65 °C to replace the pasteurization process. Usually, the must is sterilized, boiling being the most frequently method described in the literature. For preserving the aromatic integrity of ingredients and to avoid the formation of hydroxymethylfurfural, some mead producers use the "no-boil" method, maintaining strict sanitation standards, with careful attention to the fermentation process [4, 20, 21].

- After cooling at 30 °C, the *p*H of diluted honey was adjusted to *p*H = 5, by acidulation with lemon juice.
- The must was inoculated with 3 % volume yeast suspension.
- The fermentation was executed statically for 16 days at room temperature (20 - 22 °C) (Figure 3).
- The young mead was then removed from rough yeast sediment.
- The six samples of artisanal mead stocked in the 500 mL capacity bottles were stored in refrigerator for 8 - 12 weeks for maturation at 4 °C.

Figure 3. *Mead samples fermentation*

An identification code for each sample was assigned (HM from HydroMel) as presented in Table 1.

Physicochemical analyses

All physicochemical analyses for honey and mead samples were carried out according to procedures presented in literature [11 – 15] or to Association of Official Analytical Chemistry (AOAC) methods [22].

Moisture content was determined using refractometric method. Refractive index of the honey was measured at 20 °C with an Abbe refractometer (Kruss Optotronik D 22297, Germany) [14].

Table 1. *Mead samples identification codes*

Samples code	Type of honey for mead samples preparation	Additional ingredient
HM 1	Linden	-
HM 2	Multifloral	-
HM 3	Raspberry	-
HM 4	Wild forest	-
HM 5	Acacia	-
HM 6	Acacia	Elderflowers

The density was measured by pycnometer and it is expressed in $g{\cdot}mL^{-1}$.
*p*H, conductivity and total dissolved solids (TDS) was determined using Thermo Scientific™ Orion™ Versa Star Pro™ *p*H/Conductivity Multiparameter Benchtop Meter (Thermo Fisher Scientific, USA).
The free acidity of honey (expressed in milliequivalents/kg honey) [14] and total acidity for mead (expressed in $g{\cdot}mL^{-1}$ tartaric acid) [4, 5, 19] were calculated by acid-base titration with 0.1 M NaOH using phenolphthalein.
Alcohol strength was evaluated by distillation and density measurement of distillate; the results are presented as volumetric percentage of ethanol in beverage.
All the reagents used were of analytical grade and were purchased from Sigma-Aldrich.
All the analyses were done in duplicate.

Conditions for sensory evaluation of mead

The samples prepared in the present study were organoleptically analyzed by a multisensory approach using the scoring method with a 20 points scale system. The 20-point score sheet evaluates different aspects of mead. The panelists accorded points for each descriptor by filling out an evaluation form (Table 2).
Mead samples (20 mL) were served to the panelists, under white lighting, at room temperature. Panelists were required to wait 30 seconds between samples and instructed to cleanse their mouth with water between each sample.

Table 2. *Sensory evaluation form for mead studied samples*

Descriptor		Scoring limit [points]	Accorded score [points]	Overall impression and other observations
Visual	Aspect Color intensity	0-2 0-2		
Olfactory	Flavor	0-4		
Taste	Sweetness Acidity Acceptance	0-4 0-4 0-4		
Total points		**max. 20**		

RESULTS AND DISCUSSION

For best results in the mead production, it is extremely important the type of honey and the supplements used.
Therefore, the sensorial and physicochemical parameters for different types of honey used in the present study were measured. The results for these parameters shown in Tables 3 and 4 were in accordance with the literature and revealed the authenticity of all honey types used as raw material in this work having an appropriate quality corresponding to the standards.

Table 3. *Sensorial parameters of honey types used in the present study*

Sensorial parameter	Linden honey	Multifloral honey	Raspberry honey	Wild forest honey	Acacia honey
Color	light yellow	amber	amber	dark amber	extra light amber
Taste and flavor	sweet, strong distinctive flavor characteristic on linden flower	sweet, multifloral flavor	sweet, slight raspberry flavor	sweet, fruity flavor	sweet, characteristic flavor of acacia flower
Consistency	viscous, uniform, without crystallization	viscous, partially crystallized	viscous, partially crystallized	viscous, opaque	viscous, uniform, without crystallization
Purity	without impurities	without impurities	without impurities	without impurities	without impurities

Table 4. *Physicochemical parameters of honey types used in the present study*

Physicochemical parameter	Linden honey	Multifloral Honey	Raspberry honey	Wild forest honey	Acacia honey
Moisture [%]	15.5	16.5	15.2	15.70	17.8
Density [$g\cdot cm^{-1}$]	1.385	1.422	1.394	1.301	1.426
*p*H	4.40	3.55	4.12	3.80	4.05
Electrical conductivity [$mS\cdot cm^{-1}$]	0.545	0.359	0.436	0.208	0.105
Free acidity [meq / kg honey]	10.4	23.9	27.3	19.4	8.0

Before the sensorial analyses of mead samples obtained in the laboratory, some physicochemical parameters were determined such as: ethanol content, *p*H, total acidity as presented in Table 5.
The ethanol content ranges from 8.52 to 9.40 % vol. with small differences in fermented meads. Different results are reported in the literature [5, 18], ethanol content generally varies between 8 to 18 % vol., depending on the dilution coefficient of honey (initial °Brix), as well as the parameters of the alcoholic fermentation (time, temperature, type of yeast). The density ranged from 0.992 to 1.034 $g\cdot cm^{-1}$ and was within the values reported for mead [5, 18]. The decrease in density values compared to the initial densities is explained by the accumulation of ethanol and consumption of sugars during

alcoholic fermentation. This fact is also reflected by the decreasing value of dry matter content, the minimum value (5.6 %) was registered for the HM4 sample, the mead obtained from wild forest honey. The increase of total acidity in meads, when compared with the honey-must, indicates the production of acids by the yeast.

Table 5. *Physicochemical parameter of mead samples prepared in the present study*

Physicochemical parameter	HM 1	HM 2	HM 3	HM 4	HM 5	HM 6
Ethanol [% vol.]	8.56	8.52	8.57	9.18	9.35	9.40
Density [g·cm^{-1}]	1.022	1.031	1.034	0.992	1.031	1.020
*p*H	2.77	2.77	2.81	3.17	3.06	3.16
Dry matter [%]	10.2	11.3	12.1	5.6	12.0	10.8
Total acidity [g·L^{-1} tartaric acid]	6.37	6.93	7.35	6.56	4.20	3.60
Electrical conductivity [mS·cm^{-1}]	0.513	0.573	0.682	1.042	0.422	0.459
TDS [ppm]	255.5	278.8	332.3	510.8	211.4	222.5

According to the visual evaluation concerning aspect and color of mead samples, small differences were noticed, especially on aspect profile (Figure 4). The aspect and color of mead samples depends on honey types and ranges from light yellow, extra light amber, amber, and dark amber. The lowest aspect score was obtained by the HM4 sample obtained from wild forest honey, a possible explanation being the influence of viscosity and opacity of the wild forest honey used for preparation.

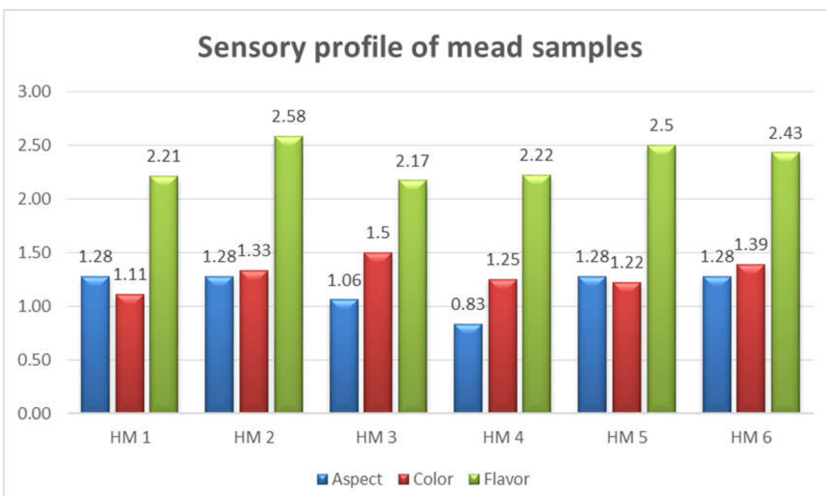

Figure 4. *Aspect, color and flavor profile of mead samples*

Concerning the flavor, it appears that the multifloral honey gave an aroma appreciated by panelists, the HM2 sample obtained the highest flavor score.
In addition to flavor, taste represents significant sensorial characteristic for mead, mainly depending on the type of honey used for fermentation. Figure 5 shows the taste profile and the average score of mead samples. The results revealed that the sample HM6 prepared using acacia honey using elderflower as additional ingredient presented the most appreciated taste (average score 9.22/12) and have obtained the highest average score (14.32/20). It can be observed that HM4 also obtained the lowest score

for taste, as well as for aspect, which makes it to present the lowest total average (12.47/20).

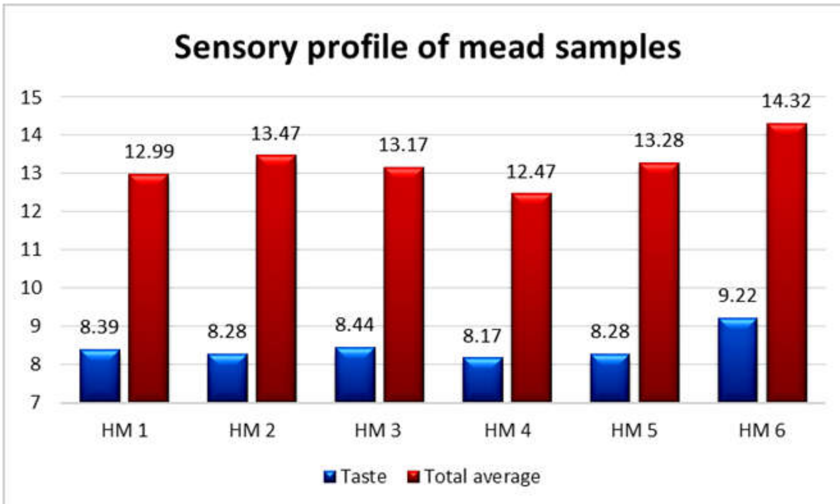

Figure 5. *Taste and average score profile of mead samples*

CONCLUSION

In the present study, six samples of mead were prepared in the laboratory using different types of honey. The sensory characteristics, such as aspect, flavor, color, and taste were analyzed.

Sensory analysis of the six samples showed that the sample obtained from acacia honey using elderflower as additional ingredient obtained the highest score for the taste and total average. A possible explanation of this result may be related to the fact that the taste of elderflower fermented beverage (named "*socata*") is better known by Romanian consumers than mead and is well appreciated by them.

However, it is important to note that each type of honey does not guarantee high sensory acceptance of the corresponding mead.

Mead exploration represents an area possessing great potential allowing the development of this beverage not so well known in Romania. Therefore, this study provides useful information for the hydromel Romanian producers.

Mead production can be a sustainable approach and a profitable alternative for the valorization of honey that cannot be marketed as such. Thus, upcoming research must be focused on improving the sensory quality and consumer's acceptability of mead [23 – 25].

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