Physicochemical quality and sensory analysis of Moroccan honeys

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Abstract—This research shows the correlation between physicochemical quality and sensory analysis of some varieties of Moroccan honeys. We have selected and prepared 6 samples of Moroccan honey variety of different medicinal plants rosemary, eucalyptus, jujube, thyme, polyfloral and spurge physicochemical properties and sensory analysis were evaluated, for total phenolic content by the modified Folin-Ciocalteu method, in addition the color intensity were analysed. The results revealed that dark honey polyfloral had the highest levels of phenolic compounds (474.23 mg EAG /100 g) for (sample 5) the lowest value in bright honey rosemary (28.6 mg EAG / 100g) for (sample 1). Although Polyfloral honey has highest flavonoid values (11.69 mg EQ / 100 g of honey), followed by spurge honey (7.96 mg EQ / 100g of honey). The lowest value has obtained in rosemary honey (0.11 mg EQ / 100g of honey). This study shows that physicochemical quality is on concordance with sensory analysis.

Keywords— Color intensity, flavonoid, honey, medicinal plant, phenolic compounds, physicochemical quality, Sensory analysis.

1 INTRODUCTION

HONEY production in Morocco plays an important socio-economic role as a means of combating poverty and a source of supply for the domestic market. Because of its biological and bio geographical diversity. Morocco has a significant beekeeping potential conferring a great originality that makes it one of the most interesting regions in honey production [1].

The annual honey production is between 2500 and 3500 tons. The Department of Agriculture is making significant efforts to modernize the sector and help beekeepers, and estimates that production could reach 16 000 tons 2020 [2]. The Government program called Green Morocco Plan (GMP) actively supports Moroccan beekeeping. The Moroccan cultures reserve an important or even sacred place for bees and the benefits of honey [3].

In Morocco, three of bees predominate: two black "*Apis mellifica intermissa*" and "*Apis mellifica major*" "[4, 5]" and a golden yellow "*Apis mellifica sahariensis*" "[6, 7]".

Ecologically, the bee is decisive and even vital in the pollination of plant species, which ensures biological diversity and the sustainability of plant species [8]. In addition, the production has characterized by a few honeys with unique biological, palynological, and physicochemical properties, which qualify it to be used, such as a natural food sugar and a preventive factor or even a health remedy [9]. The manufacturers have therefore sought to qualify the performance of the product compared to a referent whose characteristics they know [10].

Sensory evaluation allows us to identify and quantify certain (fermentation, impurities, odors and flavors). It also plays an important role in product definition and related controls.

In particular, sensory evaluation is important for controling the conformity of unifloral honeys, as it may reveal the presence of botanical components not determined by other analytical systems, but never to modify the typical sensory characteristics, sometimes to such an extent that honey can't be marketed as unifloral [11].

The aim of this work is to evaluate physicochemical analysis of honey and their consumer appreciation by sensory analysis.

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2 MATERIALS AND METHODS

2.1 Physicochemical characterization of honeys

2.1.1 Honey samples

The study was carried out on 6 Moroccan honey samples from different floral origins. The honeys selected are: Rosemary (1), eucalyptus (2), jujube (3), thyme (4), poyfloral (5) and spurge (6).

2.1.2 pH

The pH was measured in a 10% honey solution using a pH meter (Codex Alimentarius, 2001) [12].

2.1.3 Refractive index

This value was measured at a temperature of 20 ° C by a refractometer [13].

2.1.4 Water content

The moisture content of honey is a quality criterion that determines honey's ability to resist fermentation and deterioration during storage. This content is determined by the CHATAWAY tables which give the direct correspondence between refractive index and water content[14].

2.1.5 Total sugar

This measurement was made on the scale that indicates the dry matter content or "Brix Degree" which is in concordance with the refractive index [15].

2.1.6 Intensity of color ABS450

The color of the honey is an important element used in the identification of the floral origin. Honey samples were diluted to 50% with water (45 - 50 °C). The solution obtained was filtred through a filter paper to ensure a total absence of coarse particles in the honey solutions. Absorbance was measured using a spectrophotometer (Rayleigh UV 9200) at 450 and 720 nm and the difference in absorbance is expressed in (mAU);
The intensity of the color was calculated by the following formula [16]:

$$ABS_{450}\ (mAU) = (Abs_{720} - Abs_{450}) \times 100$$

2.1.7 Total Phenolic Compounds

The determination of total polyphenols is evaluated according to the Folin-Ciocalteu colorimetric method according to the protocol of [17]. The honey solutions were prepared at a concentration of 0.05 g / ml, and 0.5 ml of the stock solution was mixed with 0.5 ml of Folin-Ciocalteu reagent. After 5 min, 2 ml of sodium carbonate (Na_2CO_3) at 20% was added. After incubation in the dark for 60 min, the absorbance was measured at 760 nm against a blank (distilled water). The phenolic compound content of each sample is expressed in mg equivalents of gallic acid per 100 g of honey. (mg EAG / 100 g) with reference to the calibration curve made with gallic acid(0_ 100mg/ml).

2.1. 8 Flavonoids

The total flavonoid content was determined using the aluminium trichloride method. 0.3 mL of 5 % $NaNO_2$ was mixed with an aliquot (1ml) of extract solution and after 5min, 0.3ml of 10% $ALCL_3$ was added. Once 6min were elapsed, 2ml of 1M NaOH was added and the total volume was made up to 10ml with distillate water. The total flavonoid content was determined using a standard curve with quercetin (0 - 100 mg/L) as the standard. Total flavonoid content is expressed as mg of quercetin equivalents (CE) / g of extract. Linearity range of the calibration curve was 10 to 100 µg/mL (r = 0.97) [18].

3 SENSORY ANALYSIS OF HONEYS

The method is based on the evaluation of the olfactory-taste characteristics of honey by appraisers and experts in the field of beekeeping. It is carried out according to the general methodology defined in ISO 8589 (1988) "[19, 20]".

4 RESULTS AND DISCUSSION

4.1 Physicochemical parameters

4.1.1 pH

The pH of a honey is related to the amount of ionized acid they contain (release of H^+ ions) and its composition in mineral elements. The pH values of the honey samples range from 4.29 to 4.63. Therefore, all honeys analyzed are considered acidic and ae in compliance with the standards of the Codex Alimentarius (2001). According to IBRAHIM, honey is naturally acidic regardless of its geographical origin and this may be due to the presence of organic acids that contribute to its flavor and stability against microbial deterioration [21]. pH is important during the extraction process as it affects texture, stability and shelf life. It is low enough to slow down or prevent the growth of many species of bacteria [22].Therefore; none of our samples studied exceeded the allowable limit, which can be considered as an index of freshness.

TABLE1: PH OF HONEYS STUDIED

Honey	Mean	
Rosemary	**4.4**	**±0.025**
Eucalyptus	**4.63**	**±0.1**
Thyme	**4.5**	**±0.02**
Jujube	**4.4**	**±0.06**
Polyfloral	**4.3**	**±0.01**
Spurge	**4.29**	**±0.01**

4.1.2 Water content

Water samples content is between 16 and 18.6%. The rosemary honey has the lowest humidity while the highest value was obtained for polyfloral honey and Euphorbia. These values are well below the maximum limit recommended by Codex Alimentarius (2001) which is 20% maximum. Samples Rosemary, jujube and thym are the honeys with the lowest water content, is 16%. These samples are preserved regardless of the storage temperature and the number of yeast that they contain, according to Gonnet [23] below 17% water, fermentation never occurs.
The water content is therefore a highly important element because it allows the estimation of the degree of maturity of the honeys and can provide information on the stability against fermentation and crystallization during storage; it therefore

conditions the preservation of the product [24]. In addition, the variation in water content is due to different environmental conditions such as: climate, floral origin, season of harvest of honey samples, water content of nectars, treatment techniques and conditions storage "[25, 14]". It is concluded that our samples can be stored without risk of altering their physicochemical properties.

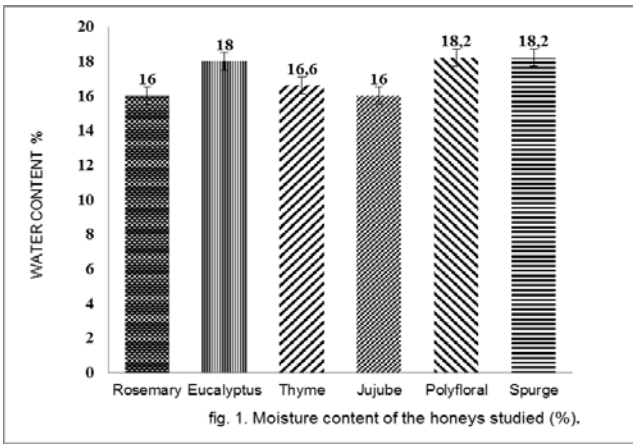

fig. 1. Moisture content of the honeys studied (%).

4.1.3 Total Sugars content

Honey is especially made up of carbohydrates that are expressed by the degree of Brix [15]. The average values of sugar analysis are ranged between 79.8 and 82.5%. Samples H1 and H4 have the highest carbohydrate content, unlike H5 samples. It is noted that composition sugar depends on the botanical origin of the plants from which the honeydew and / or nectar was harvested, the environment, climate and storage conditions [25].

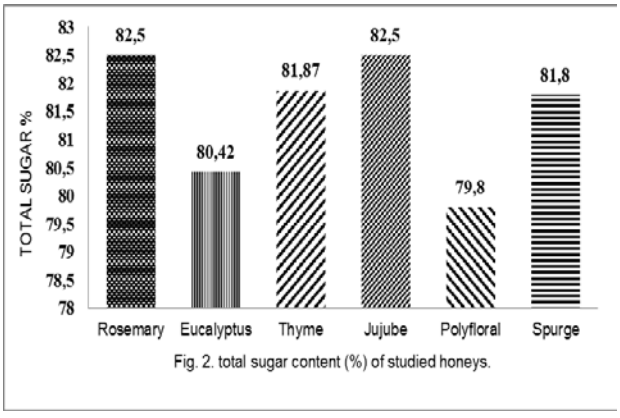

Fig. 2. total sugar content (%) of studied honeys.

4.1.4 Color Intensity of (ABS 450)

It has been reported that honey differences in the origin and composition are clearly reflected in their color intensities [26]. Therefore, honey color is an important parameter that can be used to identify its floral origin. Honeys color intensities (ABS_{450}) analyzed varies between 264 mAU and 431 mAU. Rosemary honey has the highest color intensity (431 mAU), and poly floral honey shows the lowest level (264 mAU). In comparison with honey from samples from other countries, the ABS450 values for Italian honey are between 25 and 3413 mAU [27], 70 to 495 mAU for Slovenian honeys [28].

Indeed, ABS_{450} is a reliable parameter to confirm the presence of pigments that have antioxidant activities such as carotenoids and certain flavonoids [29].

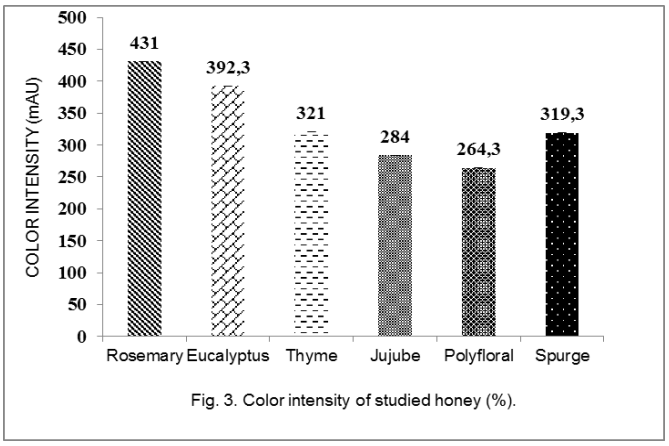

Fig. 3. Color intensity of studied honey (%).

4.1.5 Phenolic compounds content

It is noted that the determination of total polyphenols gives us an overall estimate of the content in different classes of phenolic compounds contained in the samples analyzed [30]. The figure shows that the polyphenol content in honeys vary considerably from 28.57 to 474.23 mg of EAG / 100g of honey. The lowest value in rosemary honey (28.6 mg EAG / 100g honey), while the highest concentration of polyphenols, 474.23 mg EAG / 100 g, is dosed in polyfloral honey (H5) ; which suggests that the latter has a better antioxidant potential.

These results are lower than those reported by Reibai [31] (697.22 mg EAG / 100g honey). While, [27] reported very low values (2-181 mg EAG / 100 g honey) when compared to our results. These differences can be attributed to the botanical origin, period of harvest and the hive environment [32]. Indeed, the botanical and geographical origin affects phenolic compounds concentration, distribution pollen and honey antioxidant activity [33]. In general, darker honeys contain higher phenolic amounts and have better antioxidant activity than lighter honeys [34].

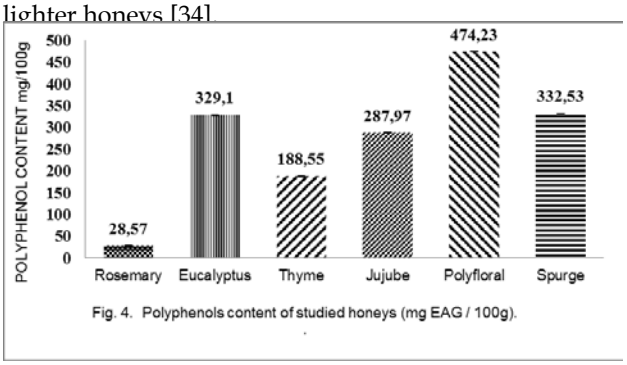

Fig. 4. Polyphenols content of studied honeys (mg EAG / 100g).

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4.1.6 Flavonoids content

Flavonoids are low molecular weight phenolic compounds responsible for the aroma and antioxidant potential of honey [35]. The flavonoid contents in studied honey samples, presented in fig, show that, polyfloral honey has highest flavonoid values (11.69 mg EQ / 100 g of honey), followed by spurge honey (7.96 mg EQ / 100g of honey). The lowest value was obtained in rosemary honey (0.11 mg EQ / 100g of honey).

These results are inferior to those reported by Rebiai [31] (29 mg EQ / 100g) for polyfloral honey. On the other hand, they are close to those obtained by Can [36] in Turkish honeys (0.64 to 8.10 mg EQ / 100 g), in Tunisian honeys (10 to 22 mg EQ / 100 g) [37] and for Brazilian honeys (3 to 10 mg EQ / 100 g) [38]. However, variation in honey flavonoid content is dependent on flower source, environmental and climatic conditions, and geographical area [39].

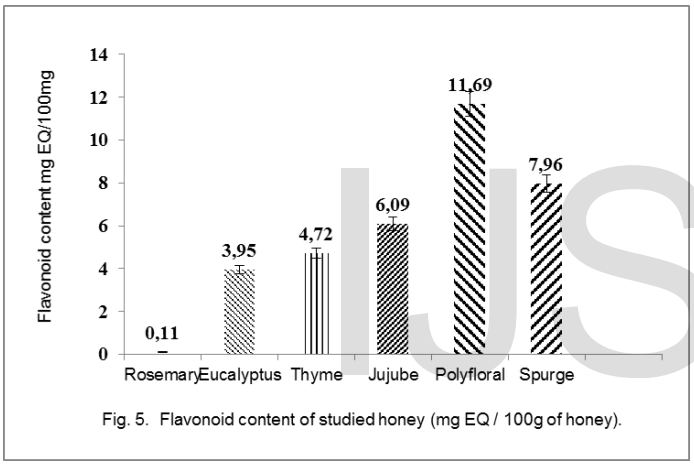

Fig. 5. Flavonoid content of studied honey (mg EQ / 100g of honey).

4.2 Honeys Sensory analysis

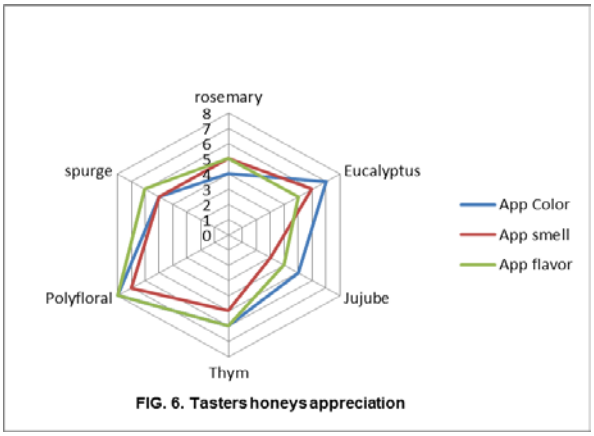

FIG. 6. Tasters honeys appreciation

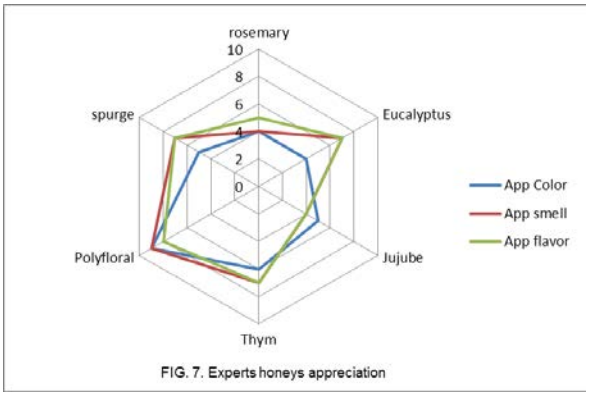

FIG. 7. Experts honeys appreciation

Honeys characterization allows us to identify the important characteristics of honeys studied in the context of sensory analysis. For this, a series of conventional tests have been made to arrive at a correct judgment.

The study allowed us to point out that polyfloral honey and Eucalyptus had a good satisfaction in terms of color, smell while honey due to its sweet flavor that allows it to have a gooey texture.

Following the results of the hedonic tests, we considered it useful to carry out organoleptic tests with the experts to confirm the judgment.

The results of expert assessments are consistent with those obtained from the tasters except that they validated the color of polyfloral honey instead of eucalyptus honey.

CONCLUSION

Physicochemical and sensory analysis show that honey type is an important factor, and may provide some insights of the consumer preferences based on the honey aromas. The total phenolic content and flavonoids varied greatly among different types of honey. Dark honeys show having a high content of phenolic compounds and flavonoids, whereas light honeys with low content in phenolic compounds and flavonoids. Finally the results confirm that physicochemical quality is on concordance with sensory analysis of honeys in Morocco.

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