Original Research Article

Detection of the Electrical Conductivity and Acidity for Some Types of Honey

ABSTRACT

Honey is a natural food is produced from the nectar of flowers by bees, contains a lot of sugars, vitamins, minerals and nucleic acids. Honey is an important nutrient for the human body and health, where modern science proved that honey natural antibiotic and tonic for the human body. This study will determine the physicochemical properties such as electrical conductivity, pH and free acidity for different types of honey on the market in Saudi Arabia. Four types of honey were selected randomly sidr, buckwheat, clover and cotton. Electrical conductivity was found to be 0.68082±0.000572, 0.433637±0.001507, 0.21731±0.000572 and 0.19925±0.001137 mS/cm for sidr, buckwheat, clover and cotton, respectively. On the other hand, the pH measurements were found to be 5.6±0.03464, 4.73±0.01, 4.51±0.01 and 4.49±0.01527 for sidr, buckwheat, clover and cotton, respectively. Finally, the free acidity was determined by volumetric titration and was found to be 11.9737±0.02385, 14.6402±0.57618, 10.6931±0.58479 and 8.667±1.17898 meq/kg. However, the potentiometric titration method gives 9.8625±0.29931, 10.92833±2.577608, 9.8554±0.39422 and 6.212967±0.637388 meq/kg for sidr, buckwheat, clover and cotton, respectively. The conductivity and acidity were compared with the limited range in the codex Alimentarius and were found to be in the range.

Keywords: Honey; Acidity, pH; Electrical conductivity.

1-INTRODUCTION

Honey is one of the oldest and best loved sweetening agents for foods over the centuries, it has still retained a “natural” image [1], mainly composed of sugars and other constituents such as enzymes, amino acids, organic acids, carotenoids, vitamins, minerals, and aromatic substances. It is rich in flavonoids and phenolic acids that exhibit a wide range of biological effects and act as natural antioxidants [2]. Honey is a natural product produced by honey bees from various secretions of plants.

There are two major types of honey, categorized on the basis of secretions of plants used for their synthesis: (i) blossom honey made from the nectar of flowers, and (ii) honeydew honey made from secretions of all living parts of plants other than flower or excretions of sucker insects [3]. Honey is a viscous, aromatic, sweet food that is consumed and enjoyed by people around the world. For this reason, it requires certain standards and norms that guarantee its identity and quality so that consumers may safely consume honey, and the same shall have free circulation in the internal market and access to the external market [4]. The most common forms of honey tampering are the addition of cheap sweeteners (such as cane sugar or refined beet sugar, corn syrup, high fructose or maltose syrup) and honeybees fed with sucrose [5]. Moreover, honey is a food that undergoes many changes in its composition during storage [6].

Electrical conductivity (EC) is a good criterion of the botanical origin of honey and often used in routine honey quality control and purity. Honey contains organic acids and mineral salts, compounds which are called "ionizable" that is when in solution, they have the property to conduct electric current. The electrical conductivity of honey is defined as that of a 20% (w/v) weight in solution at 20^0C±0.5, where the 20% refers to anhydrous honey and express in mill Siemens per centimeter (mS.cm^{-1}). The EC value depends on the ash and acid content in honey: the higher their content, the higher the resulting conductivity. According to the codex Alimentarius, the EC not more than 0.8 mS/cm) [7,8].

The acidity in honey is caused by the organic acid usually existing in all honeys (tartaric, citric, oxalic, acetic, etc.) either from nectar or bees' secretions. The acidity of honey can be measured by titration against sodium hydroxide equivalents or direct measurement of pH. The commercial high-quality honey should have the free acidity up to 50mili equivalents/Kg. Honey's free acid is provided by all free acids as a whole and can vary widely. Many authors reported that free acid increases with time, as well as during fermentation, because honey sugars and alcohols transform into acids by honey yeasts. According to the codex Alimentarius, the acidity of honey ranges from a pH of about 3.4 to about 6.1 [9,10].

The Aim of the work of this study is to determine physicochemical parameters such as electrical conductivity and acidity. This study is expected to determine the quality of different types of honey in Saudi Arabia and to classify honey on the color variation which is one way of indicating quality. Hence, it benefited the producer and consumer in providing awareness how easily the quality of honey can be governed by testing the color.

2. MATERIALS AND METHODS

2.1 Instrumentation and chemicals

Apparatuses and instrumentation used for this study are thermometer, conductometry, pH meter, volumetric flasks, beakers, stirrer, graduated cylinder. Reagents and chemicals used for preparation of samples are deionized water, Analytical Reagent grade Potassium chloride (KCl) dried at 105℃, Analytical Reagent grade NaOH, and phenolphthalein indicator.

2.2 Substance

Honey was purchased commercially from Saudi market manufacturers without preservatives or additional material. The types and colors of honey were collected in Table 1.

Table 1. Types and colors of Honey.

Types	Color
Sidr	Dark brown
Buckwheat	Black brown
Clover	Light brown

Cotton	Light brown

2.3 Preparation of solutions

2.3.1 0.1 M NaOH solution:

2 g of NaOH was weighed and dissolved in little amount of deionized water and transferred to 500 mL volumetric flask and shacked well. The exact concentration of NaOH was determined by titration against standard potassium hydrogen phthalate [11,12].

2.3.2 0.1 M KCl solution:

0.7455 g of KCl was weighed and dissolved in little amount of deionized water and transferred to a 50 mL volumetric flask and shacked well [11,12].

2.3.3 Phenolphthalein indicator (Acid/Base indicator):

0.5 g of Phenolphthalein was weighed and dissolved in 50 mL of 95% ethanol solution [11,12].

2.4 Instruments and working procedures:

2.4.1 Potentiometric measurements

The Potentiometric measurement was measured by pH/mV & Temperature meter (AD1000).

2.4.2 Electrical conductivity measurements

The electrical conductivity was measured at 20 ºC by conductivity meter (serial No. 03868) and expressed in mS/cm.

2.4.2.1 Calibration of conductivity meter

20 ml of 0.1 M KCl solution was putted in a constant temperature water bath at (20^0C) and wait to reach thermal equilibrium.The conductivity of 0.1 M KCl was measured by using conductometer. A set of 3 repetitions was performed.

2.4.2.2 Conductivity measurements for different samples of honey

20 g of each honey sample was weighed and dissolved in little amount of water and completed to 100 mL water and shake it well until all honey dissolved. The electrical conductivity for different solutions was measured by conductivity meter . For each sample, a set of 3 repetitions was performed [7,9].

2.4.4 Determination of pH

10 g of each honey sample was weighed and dissolved in 75 mL of CO_2-free water and shaked well until all honey dissolved. The pH was measured for different solutions at 20 °C. For each sample, a set of 3 repetitions was performed [7,9].

2.4.5 Volumetric titration

10 g of each honey samples was weighed and dissolved in 75 mL of CO_2-free water and shacked well until all honey was dissolved. 2 drops of phenolphthalein was added to conical flask and make titration with 0.1 M NaOH until end point was reached [13].

2.4.6 Potentiometric titration

10 g for each honey sample was dissolved in100 ml deionized water. Further, the mixture was poured into an beaker and add 2 drops of phenolphthalein and titrated with 0.1M NaOH using pH meter until pH= 8.5 [14].

3. RESULTS AND DISCUSSION

3.1 Conductivity

Conductivity is the indication of ionizable acids and compounds in aqueous solution. The conductivity measurements were collected from analysis of 20 mL of different honey samples solution at 20Cº±0.5. It was found to be 0.68082±0.000572, 0.433637±0.001507, 0.21731±0.000572 and 0.19925±0.001137mS/cm for sidr, buckwheat, clover and cotton respectively, Table 2. The conductivity for sidr was found to be greater than other types due to it higher of mineral content .

Table 2. The conductivity for different honey samples.

Sample	Conductivity (mS/cm)	Condition
Sidr	0.68082±0.000572	20Cº and 20%
Buckwheat	0.433637±0.001507	20Cº and 20%
Clover	0.21731±0.000572	20Cº and 20%
Cotton	0.19925±0.001137	20Cº and 20%

3.2 Acidity from pH

The pH measurements for different honey samples were found to be 5.6±0.03464, 4.73±0.01, 4.51±0.01 and 4.49±0.01527, for sidr, buckwheat, clover and cotton, respectively, Table 2.

3.3 Free Acidity

3.3.1 Volumetric titration

The acidity of honey determined by titration against 0.1M of NaOH for different honey samples expressed as milli-equivalents of sodium hydroxide according to the following relation:

$$\text{Acidity (meq/kg)} = \frac{1000 \times \text{V(NaOH)} \times \text{M(NaOH)}}{\text{m of honey samples (g)}}$$

It was found to be 11.97373±0.02385, 14.65687±0.576187, 10.69317±0.584798 and 8.667±1.178988 meq/kg, for sidr, buckwheat, clover and cotton, respectively as shown in Table2 .

3.3.2 Potentiometric titration

The volume of titrant added at the equivalence point of a titration can be accurately determined by plotting the first and second derivatives of the titration curve. A first derivative is a plot for the rate of change of the ΔpH/Δv, vs. V_1 of titrant, as shown in Figs. (1-4). However, the second derivative is a plot of the rate of change of the first derivative $\Delta(\Delta pH/\Delta v)/\Delta V_1$, vs. V_2 of titrant, Figs. (5- 8). The equivalence point is the milliliters of titrant at the peak of the first derivative and the milliliters of titrant at the point where the line crosses zero for the second derivative.

The acidity for different types of honey (sidr, buckwheat, clover and cotton) was found to be 9.862553±0.299313, 10.92833±2.577608, 9.85544±0.39422 and 6.212967±0.637388 meq/kg, respectively, Table 3.

Table 3. The pH and acidity for different honey types by volumetric and potentiometric titration.

Types	Volumetric Titration (meq/kg)	Potentiometric Titration (meq/kg)	pH
Sidr	11.9737±0.02385	9.8625±0.29931	5.6±0.03464
Buckwheat	14.6402±0.57618	10.92833±2.577608	4.73±0.01
Clover	10.6931±0.58479	9.8554±0.39422	4.51±0.01
Cotton	8.667±1.17898	6.212967±0.637388	4.49±0.01527

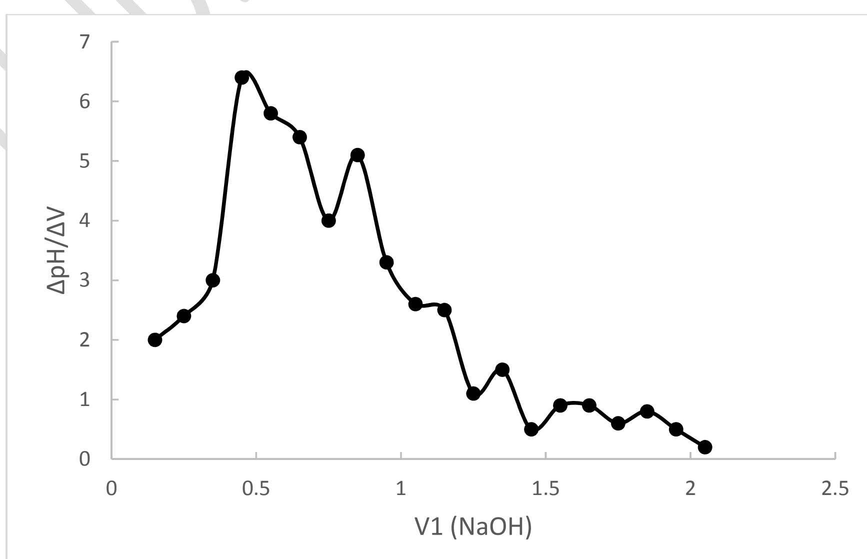

Fig. 1. First derivative for sidr honey.

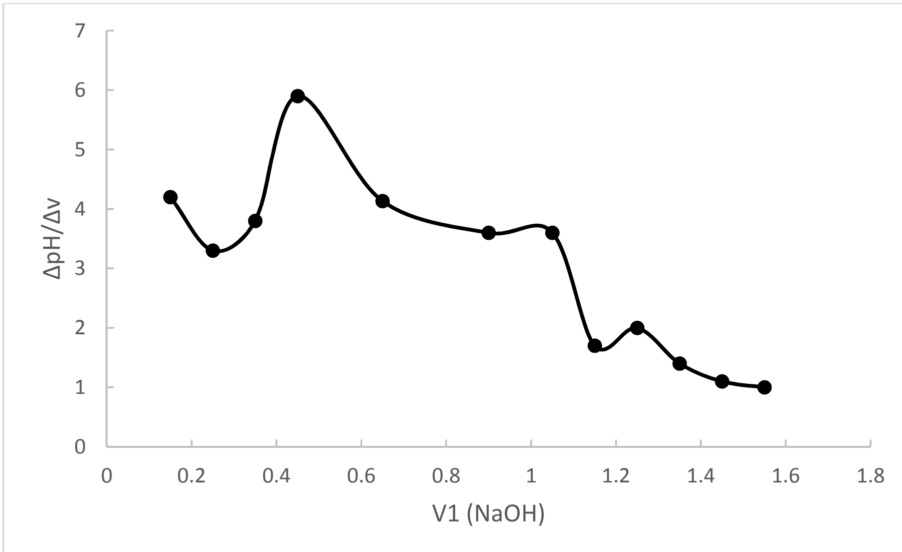

Fig. 2. First derivative for buckwheat honey.

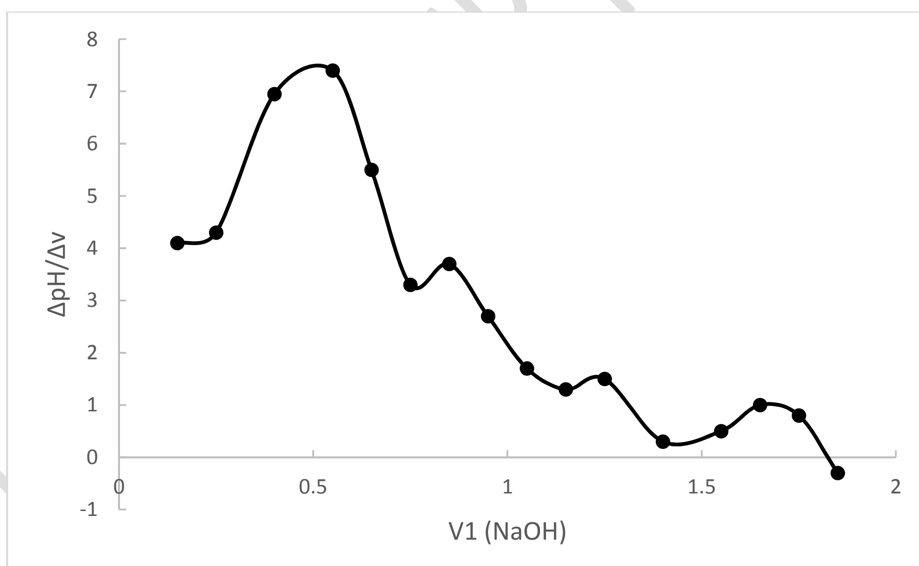

Fig. 3. First derivative for clover honey.

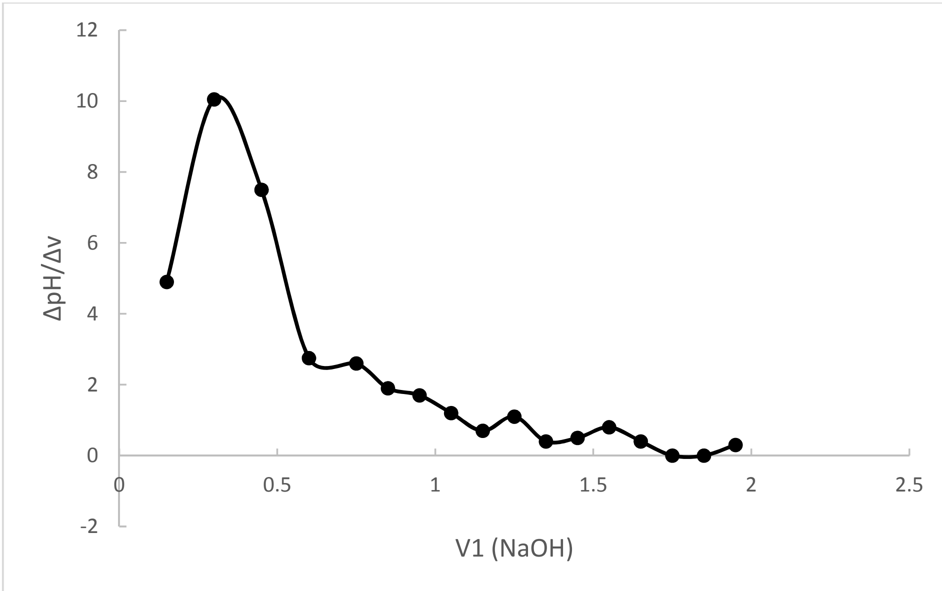

Fig. 4. First derivative for cotton honey.

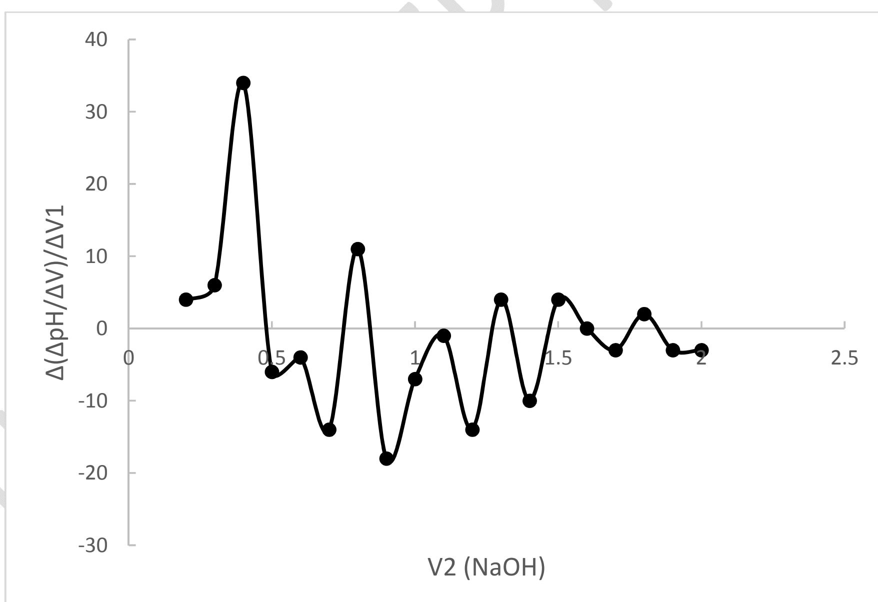

Fig. 5. Second derivative for sidr honey.

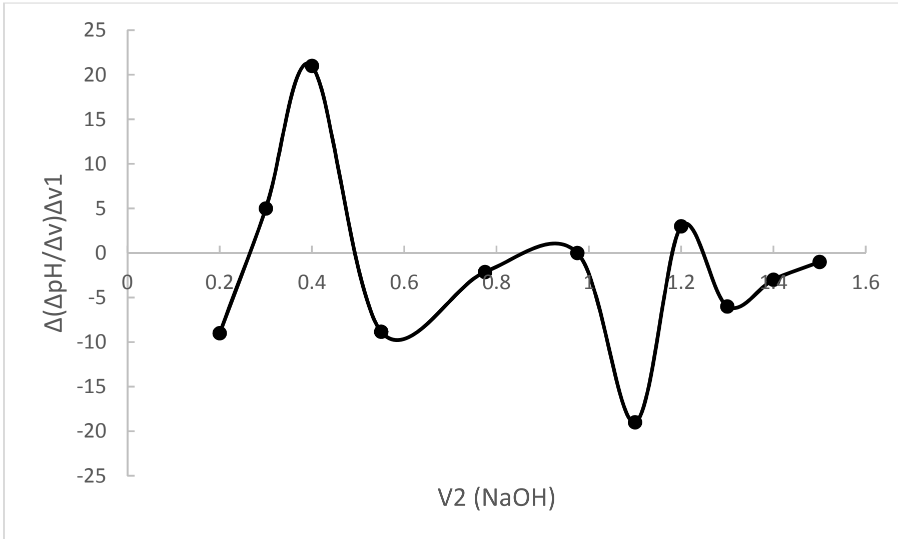

Fig. 6. Second derivative for buckwheat honey.

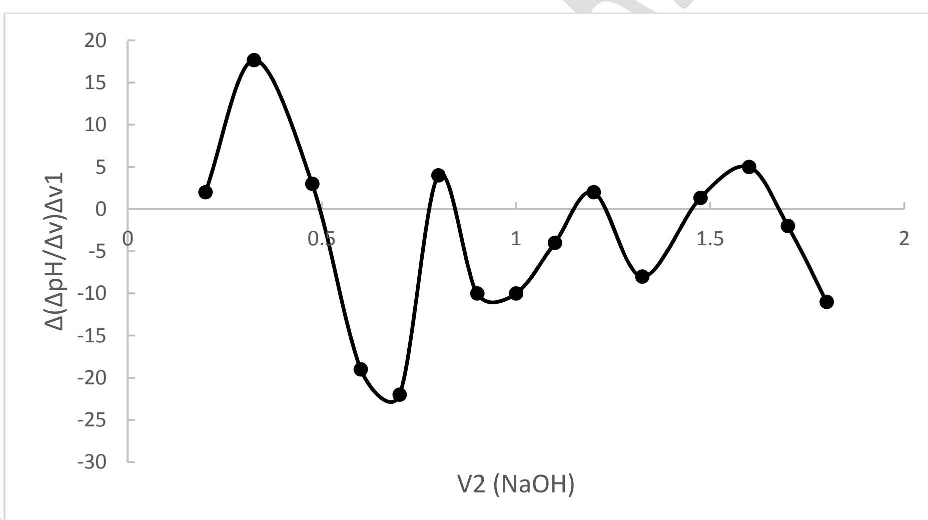

Fig. 7. Second derivative for clover honey.

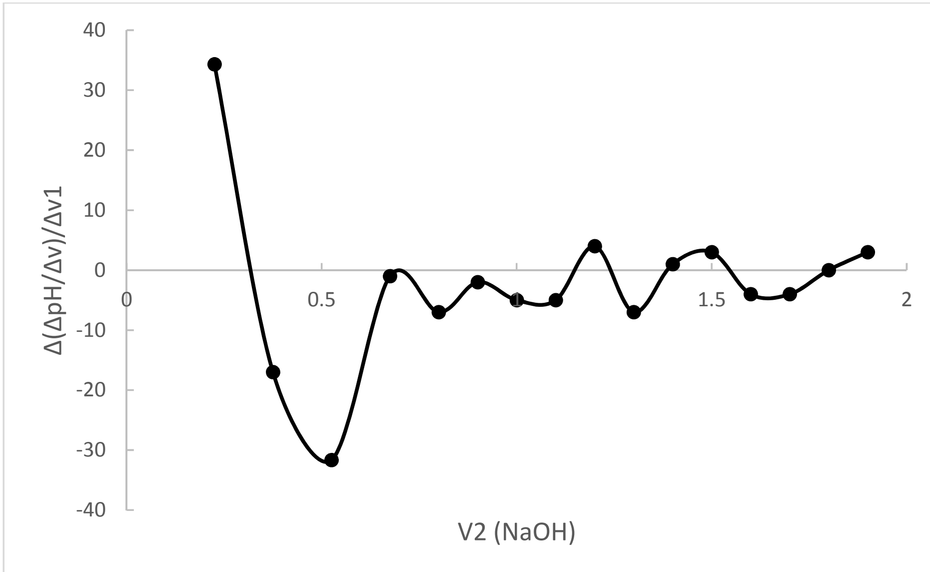

Fig. 8. Second derivative for cotton honey.

4-CONCLUSION

The conductivity of samples collected from different types of honey has been analyzed at 20 ºC ±0.5. According to the work, the conductivity of darker honey detected to be greater than the lighter honey. However, the acidity of honey samples has been determined and almost darker honey exhibited slightly high acidity. The conductivity and acidity were compared with the limited range in the codex Alimentarius and were found to be in the range. The analyzed honey samples proved to be of good quality and meet the standard values.

REFEERENCES `

1. Aparna AR, Rajalakshmi, D. Honey – its characteristics, sensory aspects and applications. Food rev int. 1999; *15*(4): 71-455.
2. Alqarni AS, Owayss, AA, Mahmoud AA. Mineral content and physical properties of local and imported honeys in Saudi Arabia. J. Saudi Chem. Soc. 2012; *18*(5): 618–625.
3. Escuredo O, Dobre I, Fernández-González M, Seijo, MC. Contribution of botanical origin and sugar composition of honeys on the crystallization phenomenon. Food Chem. 2014; *149*: 84–90.
4. Codex Alimentarius Committee on Sugars. Codex standard 12, revised Codex Standard for Honey. 2001; *11*: 1–7.
5. Puscas A, Hosu A, Cimpoiu C. Application of a newly developed and validated high-performance thin-layer chromatographic method to control honey adulteration. J Chromatogr A. 2013; *1272*: 132–135.
6. Moreira RFA, Maria, CAB, Pietroluong M, Trugo, L C .Chemical changes in the volatile fractions of Brazilian honeys during storage under tropical conditions. Food Chem. 2010;*121*(3): 697–704.

7. Desissa Y. Detection of the Electrical Conductivity and Acidity of Honey from Different Areas of Tepi. Food Sci. Technol. 2014; 2(5): 59-63.

8. Codex Alimentarius standard for honey, Ref.Nr.CL 1993/14SH- FAO and WHO, Rome; 1993

9. Cavia, MM, Muino MAF, Torre, SR, Huidobro, J F, Sancho, M T. Evolution of acidity of honeys from continental climates: Influence of induced granulation. *Food Chem*. 2007; *100*(4): 1728-1733.

10. Pridal1, l. Vorlova. Honey and its physical parameters Czech J. Anim. Sci., 2002; 47: 439–444.

11. Pourtallier Y, Taliercio . Honey control analyses Apiacta 1, France; 1972.

12. Stefan B. Harmonized methods of the international honey commission World network of honey science, Greece; 2001.

13. El-Haskoury, R, Kriaa, W, Lyoussi, B, Makni, M. *Ceratoniasiliqua* honeys from Morocco: Physicochemical properties, mineral contents, and antioxidant activities. *Food chem*. 2018; 26(1):67-73.

14. Wei, Z, Wang, J. Tracing floral and geographical origins of honeys by potentiometric and voltammetric electronic tongue. *Anal Bioanal Chem*. 2014; *108*, 112-122.