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Research Paper

Determination of Sugar Adulteration in Honey Using Conductivity Meter and pH Meter

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Abstract
Natural honey is one of the highly required natural products because of its unique, highly nutritive and medicinal properties. These properties are attributed to the different substances that are encapsulated within a bee. Honey and its bye products are economy booster for marketers and farmers in the honey business. Due to its economic importance, adulteration of honey often takes place by altering the physicochemical, rheology and taste of honey, resulting in reduction of its nutritive, medicinal value and other quality factors. Several methods had been used in determining adulteration in honey, these methods includes attenuated total reflectance-fourier transform infrared spectroscopy(ATR-FTIS) and multivariate methods(MM), near infrared spectroscopy(NIR), nuclear magnetic resonance(NMR), and open ended coaxial probe (OECP). In this work, sugar syrup at different proportions were used to adulterate pure honey, the adulterated honey was then investigated using conductivity and pH meter method to understand the level of the adulteration of the honey. Findings from the measurement showed that conductivity of samples ranges from 0.10 - 44.9 µS/m. The conductivity of pure honey was greater than all adulterated proportions. The acidity of the honey was found to decrease with increase in adulterant proportion from 3.25-2.96. Furthermore, the resistivity of the samples increases with increases in adulterant. Based on the results obtained, it is concluded that the electrical conductivity of the honey decreases as percentage of adulterant increases.

Keywords*: Honey Syrup, Sugar Syrup, Conductivity Meter, pH Meter, Adulteration*

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I. Introduction

Natural honey is one of the highly required natural products because of its unique, highly nutritive and medicinal properties. Honey is unique sweet natural product that can be used in human nutrition without any further processing. Active components in plants depend on various factors and climatic conditions in different geographical locations (Vidaković *et al.,* 2017). Several methods had been used in researches to understand adulterations of honey. Some of the methods used are Attenuated Total Reflectance (ATF), Fourier Transform Infrared Spectroscopy (FTIR) and Multivariate methods (Rios-Corripio *et al.,* 2012; Riswahyuli *et al.,* 2020). Yakubu *et al.* (2019) used open ended coaxial probe to study honey adulterated with sugar syrup at different proportions. Other methods also currently in use are Near Infrared Spectroscopy Techniques (NIR), Potentiometric tongue, Electronic nose, Nuclear Magnetic Resonance (NMR), Polymerase Chain Reaction (PCR) etc. (Anna *et al.,* 2020).

Honey adulteration is a complex aberration, which has a significant economic impact, it can occur by the addition of different materials. Adulteration/addition of foreign substances to honey such as; molasses, starch solution, glucose, sucrose, water and inverted sugar, were reported (Yakubu *et al.,* 2019; Bogdanov, 2010). Physiochemical characteristic of Egyptian honey studied and results showed that the total soluble solid varied from 81.5 to 83.0%, pH value was 4.0 (Ibrahim *et al.,* 1978 & Roushdi *et al.,* 1979). Al-Khalifa and Al–Arify (1999), determined that the total soluble solids values was 82.20 – 84.33%, and pH value 3.70-6.06.

II. Conductivity, Acidity of Adulterated Honey

The conductivity is very often used in routine honey quality control. This property of honey is considered as effective standard for assessment of botanical origin and purity of honey. Among other things, honey contains components such as organic acids and minerals, which in an aqueous solution have the ability to

dissociate into the ions or to conduct an electric power. The bright colour of honey usually points to a lower conductivity than dark colour of honey (Kropf *et al.,* 2008). The electrical conductivity of honey is defined as that of a 20% weight in volume solution in water at 20° C, where the 20% refers to honey dry matter (International Honey Commission, 2009). The measurement of electrical conductivity points indirectly to the ashes content of honey (Accorti *et al.,* 1987). The ashes of honey give an indication of environmental pollution and hence also an indication of geographical origin. The electrical conductivity of the honey is related to the concentration of mineral salts, organic acid and proteins and proved to be useful for discriminating honeys of different floral origins (Acquarone *et al.,* 2007). Other factors, such as floral source, amount of organic acids and proteins, and storage time can also influence the electric conductivity of honey (Karabagias *et al.,* 2014). High electric conductivity values do not necessarily correspond to higher amounts of ash in the honey (Escuredo *et al.,* 2014). Exact classification of honey must be carried out not only by measuring the conductivity but also in relation to optical rotation and microscopic analysis (Přidal & Vorlová, 2002).

The acidity of honey is caused by organic acids (tartaric, citric, oxalic, acetic, etc.), nectar or bees secretions (Yadata, 2014). The acidity of honey may be determined by titration with sodium hydroxide (free acidity) or directly measuring the pH value. The natural acidity of honey can be increased by the storage and maturation of honey, as well as during the fermentation of honey. Honey that is adulterated with sugar syrup has very low acidity (<1), while honey that is adulterated with invert sugar has a pronounced high acidity (Yadata, 2014). The acidity value related to the balance of organic acids naturally present in honey varies according to the floral source and the bee species (Sousa *et al.,* 2016).In accordance with the regulation concerning the quality of honey in the Republic of Serbia (Official Gazette, 2015), minimum electrical conductivity in honeydew put in the market is fixed to 0.8 mS/cm. For other types of honey, the maximum permitted value of electrical conductivity is 0.8 mS/cm.

The honey color is one of its most changing features. Color is also one of the major quality degradation parameter during storage of honey and is dependent on moisture content along with storage temperature of honey (Bulut & Kilic, 2009). The color investigation reveals that, the adulterated honey is brighter in color while the pure honey is more reddish (Naila *et al.,* 2018). Ambaw and Teklehaimanot (2018), reported the color of adulterated honey adulterated with common adulterant like sugar, ripened banana, wheat flower, potato, maize flower, pollen, empty combs, melted candy, molasses and hot water in the sample from Arsi zone is yellow, yellow brown, and brown based on the physical observation. Honey color may be influenced by the phenolic compounds, pollen and minerals (Lazaridou *et al.,* 2004).

Kingsta *et al.* (2018), found that higher adulterant added to pure honey, results in rapid increase of output voltage and decrease in refractive index. Ribeiro *et al.* (2014), found the moisture content of pure honey (17.65%) increased gradually as the percentage of the adulterant was raised, at the 50% adulteration level the moisture content of 20.2% was close to the allowed limit for natural honeys (20%), which represents the critical moisture level for the keeping quality of honey (Codex, 2001; EU, 2002).

Oroian *et al.* (2018), evaluated honey samples adulterated by fructose and hydrolyzed inulin syrup. There was an increase in water activity as the proportion of the adulteration agent increased which suggested that water activity is increasing together with the proportion of the adulteration agent.

Hydroxymethylfurfural (HMF), ash, free acidity, diastase activity, sucrose and electrical conductivity have an important role in detecting and classifying types and concentrations of potential adulterants in honey (Amiry *et al.,* 2017).

Pure honey normally contains relatively small amount of acid which is important for the honey taste. Thus, honey is mildly acidic and pH value lesser than 7.The average pH value for most honey is 3.9. The typical range of pH value of honey varies between 3.4 and 6.1 (Bogdanov, 2010c).The impure or adulterated honey might have low pH level that which do not demonstrate pure honey criterion. Gebremariam and Brhane (2014), pH value increases whereas free acidity decreases up on addition of commercial sugar.

Ribeiro *et al.* (2014), stated that increase in the percentage of the adulterant resulted in significantly increased of pH values for the honey adulterated by corn syrup. Similarly Rehman *et al.* (2008), suggested the pH of adulterated honey samples was higher than that of pure samples in honey samples analyzed. Oroian *et al.* (2018), reported that the adulteration of honey with fructose increased the pH values of the samples, while the adulteration of honey with hydrolyzed inulin syrup decreased the pH values of the samples. Several authors suggested that the pH of the adulterated honey decreases when the adulterant level increases (Naila *et al.,* 2018).

The electrical conductivity of the honey is closely related to the concentration of mineral salts, organic acids and proteins. It is a parameter that shows great variability according to the floral origin and is considered one of the best parameters for differentiating between honeys with different floral origins (Terrab *et al.,* 2004). Pure honey is characterized by a conductance near zero. It was reported that if honey is adulterated with water or saturated sugar solutions, it will display greater conductance than pure honey (Rehman *et al.,* 2008).The comparative study of pure and adulterated honey samples indicated that; mean values for electrical conductivity for pure sample was 0.28 mS/cm which was found to decrease to 0.17 mS/cm for mixture of honey and sugar (1:1 w/w). This indicate adulteration cause reduction of electrical conductivity in honey. The concentration of

mineral salts, organic acids and proteins is lower in commercial sugars than natural honey (Gebremariam & Brhane, 2014). Oroian *et al.* (2018), evaluated the samples adulterated by fructose have lower electrical conductivity than the original ones because fructose decreases conductivity, while the samples adulterated by hydrolyzed inulin syrup have higher electrical conductivity than the original ones because of the acidic nature of the syrup.

The adulteration in honey affects both its viscometric and dynamic rheological behavior .As honey is primarily composed of sugars such as fructose and glucose, the change in composition profile by adulteration effectuates its viscosity and thus, rheology. Many researchers have studied rheology of honey to determine the botanical origin, temperature effect, etc. The use of rheological parameters in combination with other parameter is a promising method. Adulteration causes the degradation of honey and crossover frequency can be considered as one of the parameter to know the percentage of adulteration in honey (Kamboj & Mishra, 2015).

Honey is a viscous liquid that is non-elastic in nature and possesses liquid-like behavior. The resistance to deformation of the adulterated honey is low compared to the natural honey. Thus total resistance to deformation could be a good indicator for adulterant detection in the honey. Yilmaz *et al.* (2014), reported that adulterants in honey has lower viscosity when accharose and fructose syrup were added to natural honey, viscosity decreased and the decrease was enhanced as the concentration of the adulterants increased. They also mentioned shear stress of the adulterated honey decreases as the adulterant content increases which results in the decrease of viscosity of the honey.

III. Effect on Nutritional Property

Adulteration of the honey causes reduction its nutritive value and medicinal value. Lawal *et al.* (2009),postulated that majority of honey sold in the market is caramelized sucrose which do not have any nutritional value, hence consumers or buyers have lost nutritional value from honey.Different authors reported adulteration cause reduction in protein content from honey.Adulterated, overheated or longtime stored honeys show a reduction or absence of protein content (Almeida-Muradian *et al.,* 2013). Nisbet *et al.* (2018), demonstrated that the protein content of honey is a factor that can be reliably used for the detection of adulterated honey with <30% added sugar. All honey contains about 50–300 mg/kg of amino acids, with the most abundant amino acid being proline, which represents 50–85% of the amino acid total. Especially, certain ratios between concentrations of proline (minimum value of 180 mg/kg) could be used to separate natural and adulterated honey (Da Silva *et al.,* 2016; Cotte *et al.,* 2003). Of all the materials reviewed in the course of this study, confirmed all the methods used are expensive and needs expertise to operate on them. For this reason, this work is set out to use a simple and easy method to study the adulteration of honey with sugar syrup using conductivity meter and pH meter.

IV. Materials and Methods

Instrumentation and apparatuses used for the study are plastic bottles, conductivity meter, pH meter, volumetric flasks, beakers, stirrer, gas cylinder and hot plate.

Sampling and Sample Collection

The pure category of honey samples and commercial sugar were obtained from Dakingari town, located in Suru Local Government Area of Kebbi State, Nigeria. The collected samples were preserved in five (5) different containers and kept at room temperature.

Sample Preparation and Analysis

Five different proportions of the samples were prepared as shown in Figure 1. For brevity, the samples prepared are labelled as shown in Table 1.

Table 1: Summary of Proportions Sugar Syrup Percentage

S/N	Adulteration (%)	Pure Honey (%)
A	0	100
B	25	75
C	50	50
D	25	75
E	100	0

Figure 1: Prepared Samples in Containers

Measurement of Parameters

The electrical conductivity of the prepared samples were measured using conductivity meter. The set up for the measurement is shown in Figure 2. The resistivity of the samples were also measured.

Figure 2: Electrical Conductivity Test

The pH meter values for the samples were also measured using the set up shown in Figure 3.

Figure 3: Set-up for Measurement of pH Values of Samples

V. Results and Discussion

Electrical conductivity was measured at room temperature using conductivity meter and pH values were determined using pH meter while resistivity of the samples were calculated and measured in Ω. The results obtained for the measurement of conductivity is shown in Figure 4.

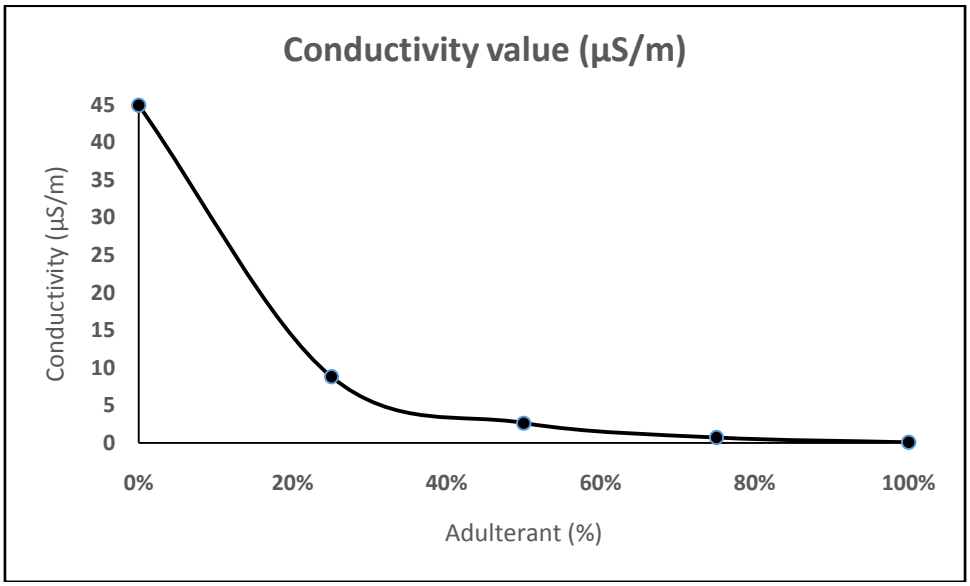

Figure 4: Conductivity of Samples Prepared

Careful observation of Figure 4 shows that the conductivity of the measured samples at room temperature ranges from 0.10 - 44.9 µS/m. The sample A has a conductivity of 44.9 µS/mwhile the sample E had a conductivity of 0.10 µS/m. The decreases in conductivity as adulterants increases is due to the decrease in concentration of mineral salts, organic acid and proteins as a result of the adulteration (Acquarone *et al.*, 2007).

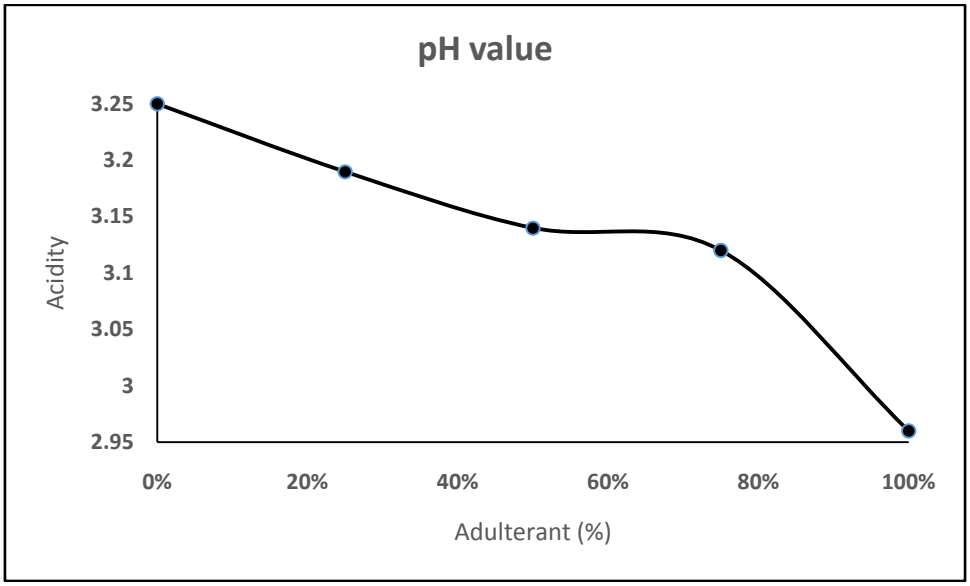

Figure 5: Acidity of Samples Prepared

Based on the values of pH shown in Figure 5, the samples were termed acidic. The pure honey had the highest acidity while the highest concentration of adulterant had the lowest acidity which agrees with works reported in (El-Bialee & Sorour, 2011; Desissa, 2014; Zivkov *et al.*, 2018). According to Ouchemoukh *et al.* (2006), they argued that the acidity of honey is due to presence of organic acids.

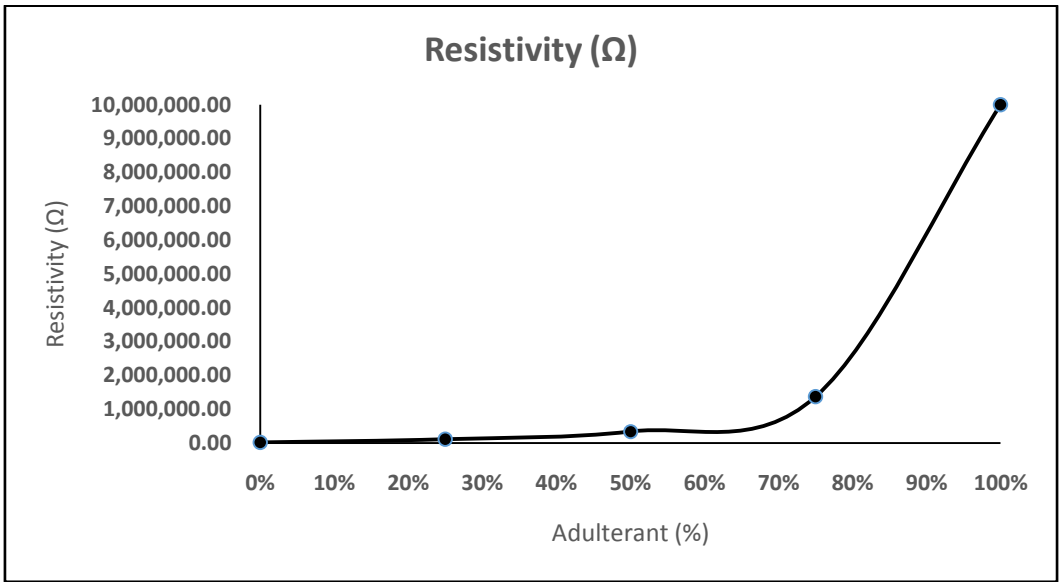

Figure 6: Resistivity of Prepared Samples

Observation on Figure 6 shows that sample with higher adulteration had higher resistivity. The result is not surprising since resistivity inversely related to conductivity. The inverse relationship between conductivity and resistivity is in agreement with works in (Zivkov *et al.*, 2018). The summary of all findings are shown in Table 2.

Table 2: Summary of Results

S/N	Adulteration (%)	Conductivity value (µS/m)	Resistivity Value (Ω)	pH value
A	0	44.9	2.22×10^4	3.25
B	25	8.82	1.13×10^5	3.19
C	50	2.66	3.46×10^5	3.14
D	75	0.73	1.37×10^6	3.12
E	100	0.10	1.0×10^7	2.96

VI. Conclusion

The present research revealed that, adulteration of honey will cause significant effect on its conductivity, resistivity and pH value. The alteration of these mentioned parameters will certainly affect the nutritional value of the honey which may eventually lead to adverse effect on human when consumed. For this singular reason, this research can be referred to as a guide to measuring honey using an easy and accurate method for testing the quality of honey. Based on the result obtained, it is concluded that pure honey has higher conductivity than adulterated ones.

VII. Recommendations

Based on the results obtained in this work, the following recommendations were made;

i. There is need for a government to provide a central laboratories at all major honey market.
ii. Strict national legislation passed on apiculture sector to avoid unnecessary mix of adulterant in honey.
iii. Training beekeepers and other stakeholders on how to handle the quality of honey, and identification of honey with adulterants.
iv. Other methods can be employed to compare the results obtained

Reference

[1]. Accorti, M., Piazza, M.G. and Oddo, L.P. (1987). Electric Conductivity and Ashes Content of Honey. Apiacta, 1.
[2]. Acquarone, C., Buera P. and Elizalde, B. (2007). Pattern of pH and Electric Conductivity upon Honey Dilution as a Complementary Tool for Discriminating Geographical Origin of Honeys. *Food chemistry*, 101, 695-703.
[3]. Al- khalifa, A.S. and Al -Arify, I.A. (1999). "Physicochemical Characteristics and Pollen Spectrum of some Saudi Honey, Food Chemistry, Vol. 67. Pp. 21-25.
[4]. Almeida, A.D., Eckersall, D., Bencurova, E., Dolinska, S., Mlynarcik, P., Vincova, M. and Bhide, M. (2013). Farm Animal Proteomics. Proceedings of the 4th Management Committee Meeting and 3rd Meeting of Working Groups 1, 2 & 3 of COST Action FA1002. Košice, Slovakia, Pp. 25-26 New York: Springer.
[5]. Ambaw, M. and Teklehaimanot, T. (2018). Study on the Quality Parameters and the knowledge of producers on Honey Adulteration in selected districts of Arsi Zone. *International Journal of Agriculture and Veterinary Sciences*, 4(1), 1–6. Retrieved from http://www.bioinfopublication.org/jouarchive.php?opt=&jouid=BPJ0000217
[6]. Amiry, S., Esmaiili, M., and Alizadeh, M. (2017). Classification of Adulterated Honeys by Multivariate Analysis. *Food Chemistry*, Pp. 224, 390–397. https://doi.org/10.1016/j.foodchem.2016.12.025
[7]. Anna, P.J., Maria H.B. and Katarzyna, S. (2020). Modern Methods for Assessing the Quality of Bee Honey and Botanical Origin Identification. Department of Bromatology, Medical University of Bialystok, Mickiewicza 2D St., 15-222 Białystok, Poland; *Foods*, 9, 1028; doi:10.3390/foods9081028. www.mdpi.com/journal/foods
[8]. Bogdanov. S., (2010). "Honey Control. Book of Honey". Chapter 9. Bee Product Science, www.beehexagon.net.
[9]. Bulut, L. and Kilic, M. (2009). Kinetics of Hydroxymethylfurfural Accumulation and Color Change in Honey during Storage in relation to Moisture Content. Journal Food Process. Pp. 33:22–32
[10]. Codex Alimentarius Commission Standards. (2001). Revised Codex Standard for honey, Codex STAN 12-1981, Rev (1987), Rev. 2 (2001). Council Directive 2001| 110| ES of 20 December 2001 relation to honey (Text). *Official Journal of the European Communities*.–2002.–L, v. 10, p. 47-52.
[11]. Cotte, J.F., Casabianca, H., Chardon, S., Lheritier, J. and Grenier-Loustalot, M.F. (2003). Application of Carbohydrate Analysis to Verify Honey Authenticity. Journal of Chromatography, 1021(1–2): 145-155
[12]. Da Silva, P.M., Gauche, C., Gonzaga, L.V., Costa, A.C. and Fett, R. (2016). Honey: chemical composition, stability and authenticity. *Food Chemistry* 196:309–323
[13]. Desissa, Y. (2014). Detection of the Electrical Conductivity and Acidity of Honey from Different Areas of Tepi *Food Science and Technology*, 2(5): 59-63. http://www.hrpub.org DOI: 10.13189/ fst.2014.020501
[14]. El-Bialee, N.M., & Sorour, M.A. (2011). Effect of Adulteration on Honey Properties. International *Journal of Applied Science and Technology* (Vol. 1). Retrieved from www.ijastnet.com
[15]. Escuredo, O., Dobre I., Fernández-González, M. and Seijo, M.C. (2014). Contribution of Botanical Origin and Sugar Composition of Honeys on the Crystallization Phenomenon. Food Chemistry, 149, 84-90.
[16]. European Union Directive (EU), (2002). European Union Directive 2001/110/EC of 20th, December 2001 relating to Honey," *Official Journal of the European Communities*. Brussels, Belgium, Pp. 47-52,
[17]. Gebremariam, T. and Brhane, G. (2014). Determination of Quality and Adulteration Effects of Honey from Adigrat and Its Surrounding Areas. *International Journal of Technology Enhancements and Emerging Engineering Researc*h, 2, 71.
[18]. Ibrahim, H., Soliman, N. and Wina, H. (1978). "Studies on the Properties of the Major Egyptian Honey Kinds and one Honey Ripening" Agricultural Research Review, Vol. 55, Pp.125-128.
[19]. International Honey Commission Methods (2009). Harmonised Methods of the International Honey Commission Methods, Swiss Bee Research Centre, FAM, Liebefeld, Switzeland.
[20]. Kamboj, U. and Mishra, S. (2015). Prediction of Adulteration in Honey Using Rheological Parameters Prediction of Adulteration in Honey Using Rheological Parameters. *International Journal of Food Properties*, 18(9), 2056–2063. https://doi.org/10.1080/10942912.2014.962656
[21]. Karabagias, I.K., Badeka, A.V., Kontakos, S., Karabournioti, S. and Kontominas, M.G. (2014). Botanical Discrimination of Greek Unifloral Honeys with Physic and Chemometric Analyses. *Food Chemistry*, 165, 181-190.
[22]. Kingsta, R.M., Shamilee, M. and Sarumathi, S. (2018). International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering Detection of Adulteration in Honey using Optical Sensor. *International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering*, 7. https://doi.org/10.15662/IJAREEIE.2018.0703032
[23]. Kropf U., Jamnik M., Bertoncelj J. and Golob T. (2008). Linear Regression Model of the Ash Mass Fraction and Electrical Conductivity for Slovenian Honey. *Food Technology and Biotechnology*, 46, 3, 335-340.
[24]. Lawal, A.K. and Adekalu, J.B. (2009). Physicochemical Studies on Adulteration of Honey in Nigeria. *Pakistan Journal of Biological Sciences*, 12 (15): 1080-1084.

[25]. Lazaridou, A., Biliaderis, C.G., Bacandritsos, N., Sabatini, A.G. (2004). "Composition, Thermal and Rheological Behaviour of Selected Greek Honeys", *Journal of Food Engineering*, 64, 9.

[26]. Naila, A., Flint, S.H., Sulaiman, A.Z., Ajit, A. and Weeds, Z. (2018). Classical and novel approaches to the analysis of honey and detection of adulterants. *Food Control*. https://doi.org/10.1016/j.foodcont.2018.02.027

[27]. Nisbet, C., Kazak, F., and Ardal, Y. (2018). Determination of Quality Criteria that Allow differentiation Between Honey Adulterated with Sugar and Pure Honey. Biological Trace Element Research.

[28]. Official Gazette RS (2015). Rulebook on quality of honey and other bee products, No. 101.

[29]. Oroian, M., Ropciuc, S. and Paduret, S. (2018). Honey Authentication using Rheological and Physicochemical Properties. *Journal of Food Science and Technology*, 55(12), 4711–4718. https://doi.org/10.1007/s13197-018-3415-4

[30]. Ouchemoukh, S., Louaileche, H. and Schweitzer, P. (2006). " Physicochemical Characteristics and Pollen Spectrum of some Algerian Honeys, *Food Control*, Vol. 18, Pp. 52–58.

[31]. Přidal, A. and Vorlová, L. (2002). Honey and its Physical Parameters. Czech Journal of Animal Science, 47, 10, 439-444.

[32]. Rehman, S., Khan, Z.F., and Maqbool, T. (2008). Physical and Spectroscopic Characterization of Pakistani Honey. Cienciae Investigacion Agraria, 35(2), 199–204. https://doi.org/10.4067/S0718-16202008000200009

[33]. Ribeiro, R.D.O.R., Mársico, E.T., da Silva Carneiro, C., Monteiro, M.L.G., Júnior, C.C. and de Jesus, E.F.O. (2014). Detection of Honey Adulteration of High Fructose Corn Syrup by Low Field Nuclear Magnetic Resonance (LF 1H NMR). *Journal of Food Engineering*, 135, 39-43.

[34]. Rios-Corripio, M.A., Rojas-López, M. and Delgado-Macuil, R. (2012). Analysis of adulteration in honey with standard sugar solutions and syrups using attenuated total reflectance-Fourier transform infrared spectroscopy and multivariate methods, CyTA - *Journal of Food*, 10:2, 119-122, DOI: 10.1080/19476337.2011.596576

[35]. Riswahyuli, Y., Abdul Rohman, Francis.M.C.S., Setyabudi, and Raharjo, S. (2020). Indonesian wild honey authenticity analysis using attenuated total reflectance-fourier transform infrared (ATR-FTIR) spectroscopy combined with multivariate statistical techniques. *Hellyon 6 Journal.* e03662, 1-7.

[36]. Roushdi, M., Mohamed, A. and Kamelm, M., (1979). "Evaluation of some indices on granulation of Egyptian honey especially for El- Minia", *J. Agric. Res*. Tanta, Univ. 5 (1) 125-130.

[37]. Sousa, J.M.B., Soza, L.E., Marques, G., Benassi, M.T., Gullon, B. and Pintado, M.M. (2016). Sugar Profile, Physicochemical and Sensory Aspects of Monofloral Honeys Produced by different Stingless Bee Species in Brazilian Semi-arid Region. *Food Science and Technology*, 65, 645-651.

[38]. Terrab-Diez, M.J. and C. Andres. (2004). Physicochemical Parameters and Pollen Analysis of Moroccan Honeydew Honeys. *International Journal of Food Science and Technology*, 39:167-176.

[39]. Vidaković S., Babić J., Knežević S., Pelić M., Jakšić S., Kartalović B. and Živkov Baloš M. (2017). Label Analysis of Serbian Honey: what does (not) the label tell us? Archives of Veterinary Medicine, 10, 2, 53-62.

[40]. Yadata D. (2014). Detection of the Electrical Conductivity and Acidity of Honey from different Areas of tepi. *Food Science and Technology*, 2, 5, 59-63.

[41]. Yakubu, A., Zulkifil, A. and Muhammed, A. (2019). Determination of Adulteration of Honey Syrup Using Open Ended Coaxial Probe Sensor at Microwave Frequency. *Open Access Library Journal*, **6,** e5448. https://doi.org/10.4236/oalib.1105448

[42]. Yilmaz, M.T., Tatlisu, N.B., Toker, O.S., Karaman, S., Dertli, E., Sagdic, O., and Arici, M. (2014). Steady, Dynamic and Creep Rheological Analysis as a Novel Approach to Detect Honey Adulteration by Fructose and Saccharose Syrups: Correlations with HPLC-RID results. *Food Research International* (Ottawa, Ont.), 64, 634–646. https://doi.org/10.1016/j.foodres.2014.07.009

[43]. Živkov, M.B., Nenad, P., Suzana, V., Dragana, L.P., Miloš, P., Željko, M. and Sandra, J. (2018). Electrical Conductivity and Acidity of Honey. *Arhiv veterinarske medicine*, Vol. 11, No. 1, 91 – 101.