UV-Spectroscopy for Original Honey and Comparing with Some Types of Honey in Iraqi Market to Investigate the Cheat in Them

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Abstract. Honey is a medication material and its very expensive, so some people try to cheat honey by adding sugar solution to it. In this work, a method was done to investigate the ratio of cheat or sugar solution in honey. UV-spectroscopy was done for original honey. UV-spectroscopy for several mixtures containing different ratios for honey and sugar solution was done to make normalization curve. Different types of honey were collected from Iraqi market and UV-spectroscopy was done for these types. For every graph done for these honey types collected from Iraqi market, maximum absorbance point was taken and applied on the normalization curve. After application on the normalization curve, the ratios of honey and sugar solution were found for every type of honey collected.

Keywords: honey, UV-spectroscopy, absorbance, sugar solution.

1. Introduction

Honey is viscous and benefit liquid produced by bees and other insects [1]. Bees and other insects, that produce honey, form honey from flowers nectar. Honey molecules are stored in wax templates that are called honeycomb [2]. Monosaccharides fructose and glucose are the reason of sweetness of honey [3]. Microorganisms or bacteria do not survive in honey so real honey does not damage at all [4]. 15 ml of honey has 46 calories [5]. Safety of honey is very good [6] but it should be taken carefully if it is used with drugs prescription or excessive dosage [7].

1.1. Formation of honey

Bees produce honey by collecting flowers nectar transforming it to sugar. Sugar supports metabolism of muscle cells during foraging or to be used as food at long-term period [8]. During collecting food, bees consumed part of nectar collected for metabolic activity of flight muscles, and the biggest part of nectar is used for regurgitation, digestion, and honey [9]. In winter or cold days, adult bees consume stored honey as food [10].

There are three types of bees:
1. Female queen.
2. Variable number of male drones whose job are fertilizing queen.
3. 20000 – 40000 female workers [11].
Bee collects floral nectar, which is rich with sugar, and stores it in its crop (an organ lies beside its stomach). Crop and stomach can store 40 mg of nectar sucked whilst weight of empty bee is approximately 80 mg. Bee stomach needs thousands of flowers to be filled and more than one hour of time [12].

1.2. Components of honey:

Honey consists of the following components that vary according to plants available in pasture, weather, and soil, as in the table {1}.

| Components of honey [13] | Percentage ratio |
|--------------------------|------------------|
| Fructose                 | 38               |
| Glucose                  | 31               |
| Maltose                  | 7                |
| Sucrose                  | 17               |
| Higher sugars            | 1.5              |
| Ash                      | 0.2              |
| Other undetermined materials | 3.3             |

1.3. Nutrition contents of honey:

Honey has nutritional components as in the table {2} [5].

| Nutritional component | Quantity |
|-----------------------|----------|
| Energy                | 1,272 kj = 304 kcal |
| Carbohydrates         | 82.4 g    |
| Sugars                | 82.12 g   |
| Dietary fiber         | 0.2 g     |
| Fat                   | 0 g       |
| Protein               | 0.3 g     |
| vitamins              |          |
| Riboflavin (B₂)       | 0.038 mg  |
| Niacin (B₃)           | 0.121 mg  |
| Pantothenic (B₅)      | 0.068 mg  |
| B₆                    | 0.024 mg  |
| Vitamin c             | 0.5 mg    |
| minerals              |          |
| Calcium               | 6 mg      |
| Iron                  | 0.46 mg   |
| Magnesium             | 2 mg      |
| Phosphorus            | 4 mg      |
| Potassium             | 52 mg     |
| Sodium                | 4 mg      |
| Zinc                  | 0.22      |
| Water                 | 17.1 g    |

1.4. Honey toxicity

If bees suck nectar of flowers rhododendrons, mountain laurels, and azaleas, their honey will be toxic because the honey produced contains grayanotoxins [16].
1.5. Most important yeasts available in honey

Honey has the yeasts below, as in the table [3] [13]:

| Type of yeast | Job                          |
|--------------|------------------------------|
| Emelise      | Transform dextreen to gel    |
| Phosphatase  | Produce phosphates           |
| Inphertese   | Analyze dual sugar to Monique sugar |
| Catalase     | Analyze oxides               |
| Peroxidase   | Has large focus power        |
| Lay ease     |                              |

1.6. Most important amino acids honey has

Honey consists of the amino acids: phenyl alanine acid, albroline acid, atrazine acid, altheronine acid, Alana nine acid, aflotame acid, alsarene acid, alizolosine acid, histidine acide, alfaline acid, alocieen acid, alarjaneen acid, alphocien acid, spartie acid, alcisteen acid, almethonyn acid, alarmatine acid [13].

1.7. Majority vitamins available in honey

Important majority vitamins exist in honey are: vitamin B1, vitamin B2, vitamin B3, vitamin B4, vitamin B5, vitamin B6, vitamin C, vitamin B8, vitamin B9, and carotene [13].

1.8. Physical properties

Physical and chemical properties of honey depends on temperature, type of flora that bee eat from, rate of special sugar contained in honey, and quantity of water. Honey is more saturated by specific sugar than usual sugar dissolved in water. At 25 °C, glucose precipitates down and transforms to granules resulting in “semisolid solution of precipitated glucose crystals in a solution of fructose and other ingredients”. At room temperature, density of honey becomes 1.38 – 1.45 kg/l [17].

1.9. Honey in Islam

Honey was mentioned in ALQURAAN ELKAREEM as in Annahl (the bees) surah in which ALLAH Sayed “your god inspired to bees to take on mountains, trees and from they trellis (make them) houses (68) and then eat from all fruit and walk in your god’s roads debased. A liquid which is different in colors gets out from their abdomens in which treatment to people; this is an evidence to people who think (69)”. As we see in these two verses, ALLAH (THE GOD) remembers that honey is a treatment for people. The prophet of THE GOD Muhammed (peace upon him and his family), the messenger of ALLAH, recommends us to use honey as a drug [18].

1.10. Optical properties of honey

Honey has a portion of water. Quantity of water could be easily measured by refractometer. The more the water content, the less the refractive index. Honey can also rotate polarized light. Fructose component rotates a negative rotation while glucose rotates in positive. The resultant polarization is a measure for them [19]. Honey colors vary from white to dark brown; that depends on sugar source of flora [20].

1.11. Medical uses

In medical treatment, honey was used in treatment of wounds after surgery and burns. It was assumed that honey is a good treatment for an ulcer and an ingrown toenail. It was found that honey is a good antibiotic material because it fights microorganisms and bacteria since it consists of methylglyoxal and hydrogen peroxide. It is good drug for cough in children rather than diphenhydramine and placebo drugs [21].
The UK medicines and healthcare products regulatory agency recommended not to give children under six years, that they have cough, except honey and warm water [22]. The world health organization suggests that honey is the best treatment for cough and sore throat even for children [23]. Up to date, no one found honey is a treatment for cancer, but they found it controls side effects of radiation therapy and chemotherapy of cancer [24] [25].

Though there is a lot of calories in honey, but these calories don’t transform in body to cholesterol and store in it because fructose is not a reason to weight gain [25] [27]. In folk medicine, it was used as a treatment for gastric diseases, ulcer, wounds, and burns in an ancient Greek, Egyptians, and Chinese medicine [28].

Many people tries to cheat honey, for gaining money, by adding sugar solution to it.

1.12. Aim of this work

Aim of this work is to investigate types of honey (available in Iraqi market) and measure ratio of sugar solution added to it to know how much proportion of cheat is in every type.

2. experimental work

In this work, we investigate proportion of cheat in honey by measuring percentage ratio (pr) of sugar solution in honey.

Pure Honey was used to make normalization curve. Mixtures in different ratios of (honey and sugar solution), as shown in table (4), were done to obtain a relationship or curve between the different ratios against UV absorption of them; this relation is called “normalization curve”. The volume of every mixture was 5ml; thereafter, every mixture was diluted with distilled water until its volume becomes 100ml to make absorbance curve goes down and be accepted.

Table 4: the ratios of natural honey and sugar solution in the mixtures that were made to obtain normalization curve.

| Symbol | Meaning                                      |
|--------|----------------------------------------------|
| 0 pr   | Zero of honey + 100 % of sugar solution      |
| 20 pr  | 20 & of honey + 80 % of sugar solution       |
| 40 pr  | 40 % of honey + 60 % of sugar solution       |
| 60 pr  | 60 % of honey + 40 % of sugar solution       |
| 80 pr  | 80 % of honey + 20 % of sugar solution       |
| 100 pr | 100 % of honey + zero of sugar solution      |

A line that intermediates the normalization curve points was then drawn on the normalization curve; thereafter, mathematically equation was obtained between percentage ratios of (honey and sugar solution) and their absorbance.

After the normalization curve had been obtained, several types of honey were collected from Iraqi market, and UV examination was done for these types to obtain maximum absorbance point for every graph.

The Maximum absorbance points for the honey types, under test, were then applied on the normalization curve to get percentage ratios of original honey and sugar solution in every honey type; from this percentage ratio, it could be obtained the ratio of sugar solution in every kind of honey collected from Iraqi market which represents the ratio of the cheat.
3. Results

3.1 Obtaining the normalization curve

The normalization curve that was obtained in experimental work between UV absorption and percentage ratios of (honey and sugar solution) was drawn in Fig. (1).

![Normalization Curve](image1)

**Figure (1):** The normalization curve.

The Fig. (1) was then converted to Fig. (2) by exchanging the axes to find the percentage ratio of sugar solution and honey in honey types by applying maximum absorbance point of the samples upon the normalization curve.

![Normalization Curve Converted](image2)

**Figure (2):** The dotted (blue) line is the normalization curve after it was converted.

A line was drawn (the straight black line) on the normalization curve to find a mathematically equation that represent the normalization curve. The mathematically equation that was found is:

\[ y = 0.5016x^3 - 7.995x^2 - 6.7796x + 104.67 \]  

---------- (1)
Where (y) represents percentage ratio of (honey and sugar ratio), and (x) represents absorbance of it.

3.2 Application honey types from Iraqi market on the normalization curve

Honey types that were collected from Iraqi market are:
1. Sak honey (jet & berseem).
2. Alsad honey.
3. warak fodder honey (sidr).
4. Baba honey.

Every type of these honey types was lighted with water until its volume becomes 100 ml, and then UV spectroscopy was done for each type.

3.2.1. Sak honey (jet & berseem)

UV spectroscopy was done for sak honey (jet & berseem), and its chart is in Fig. (3). The maximum absorbance point of this chart is (0.8); that means, the maximum absorbance point of sak honey (jet & berseem) is (0.8).

When this absorbance point (0.8) is applied on the normalization curve, the resultant value of percentage ratio is almost 90, i.e., 90%; then, the percent ratio of natural honey in this type of honey is 90%, and ratio of sugar solution is 10%.

When this value is applied in the equation (1), the resultant value of percentage ratio is 94. That means the ratio of honey is 94% and sugar solution is 6%. Then this honey is good.

3.2.2. Alsad honey

Alsad honey spectroscopy is shown in Fig. (4). From this figure, the maximum absorbance point is (1.4). When this point is applied on the normalization curve in the Fig.(2), it can be gotten that the percentage ratio graphically is almost (80) and mathematically by applying eq.(1) is (83.88); that means, 83% is honey and 17% is sugar solution.

Consequently, this type of honey contains 83% honey and 17% sugar solution.
3.2.3. **Warak Fodder (sidr) honey**

Warak (sidr) honey spectroscopy is shown in Fig. (5). In this figure, the maximum absorbance point is 0.9 at 280 nm. When this point is applied on the normalization curve, Fig. (2), it is obtained graphically that the percentage ratio is almost 93 and mathematically from equation (1) is 92.45; consequently, the ratio of honey in this type of honey is 92.5% and sugar solution is almost 7.5%.

4.2.4

1.7
1.3
0.9
0.93
1
1.35
1.4
1.23
0.9
0.6
0.45

**Figure (4):** alsad honey spectroscopy.

**Figure (5):** warak (sidr) honey UV spectroscopy.

The maximum absorbance point is (0.8); then, it was applied on the normalization curve in the Fig. (2) to obtain the percentage ratio value. The percentage ratio value that was obtained graphically is almost (93) and mathematically by applying equation (1) is (94). Consequently, warak sidr honey has 94% honey and 6% sugar solution.

3.3 **Baba honey**

Baba honey spectroscopy is illustrated in Fig. (6). In this figure, the maximum absorbance point is 0.9 at 280 nm. When this point is applied on the normalization curve, Fig. (2), it is obtained graphically that the percentage ratio is almost 93 and mathematically from equation (1) is 92.45; consequently, the ratio of honey in this type of honey is 92.5% and sugar solution is almost 7.5%.
4. conclusions:
From the four honey types above, it could be concluded that sak honey (jet and berseem) contains often 94% honey and 6% sugar solution, alsad honey contains often 83% honey and 17% sugar solution, warak fodder (sidr) honey contains often 94% honey and sugar solution 6%, and baba honey contains often 92% honey and 8% sugar solution.

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6. References:
[1]. Crane E. Honey from honeybees and other insects. Ethol Eco & Evol [internet].1990;3(sup1): 100–105. Available from https://www.tandfonline.com/doi/abs/10.1080/03949370.1991.10721919.
[2]. Crane E, Walker P, Day R. Directory of important world honey sources. International Bee Research Association [internet]. 1984 Available from https://en.wikipedia.org/wiki/Special:BookSources/086098141X.
[3]. National Honey Board. Carbohydrates and the Sweetness of Honey. Wayback machine [internet]. 2012 [2011 July 1]; available from https://en.wikipedia.org/wiki/Honey.
[4]. Geiling N. The Science Behind Honey’s Eternal Shelf Life. Smithsonian [internet].2017. available from: https://www.smithsonianmag.com/science-nature/the-science-behind-honeys-eternal-shelf-life-1218690/?no-ist.
[5]. Full Report (All Nutrients): 19296, Honey. USDA National Nutrient Database, Agricultural Research Service [internet]. 2015 Oct 15 [2015 Feb 28]. Available from https://ndb.nal.usda.gov/ndb/foods/show/6287?fg=&man=&facet=&count=&max=35&sort=&qlookup=honey&offset=&format=Full&new=&measureby=
[6]. Goldman RD. Honey for treatment of cough in children. Can Fam Physician (Systematic review) [internet].2105 Oct [2014 Dec]; 60 (12): 1107–1110.available from https://www.cfpp.ca/content/60/12/1107.long.
[7]. “Honey”. Mayo Clinic [internet]. 2015 Sep [2013 Nov]. available from http://bsj.uobaghdad.edu.iq/index.php/BSJ/GUIDELINE.
[8]. Suarez RK, Lighton JR, Joos B, Roberts SP, Harrison JF. Energy metabolism, enzymatic flux capacities, and metabolic flux rates in flying honeybees. Proc Natl Acad Sci U S A [internet].1996. 93 (22): 12616–20.Available from

Figure (6): baba honey UV spectroscopy.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3804110.1073/pnas.93.22.12616.

9. Binkley D. How bees make honey is complex process. The Columbus Dispatch, Columbus, Ohio [Internet]. 2014 Aug 31 [2015 Nov 17]. Available from https://en.wikipedia.org/wiki/Honey.

10. Honey and Bees, National honey board [Internet]. 2010 March 5 [2015 Nov 15]. Available from: https://web.archive.org/web/20121005070729/http://www.honey.com/honey-at-home/learn-about-honey-how-honey-is-made.

11. Whitmyre Va. The Plight of the Honeybees. University of California [Internet]. 2007 March 4 [2007 Ap 14]. Available from https://web.archive.org/web/20070304202354/http://groups.ucanr.org/mgnapa/Articles/Honeybees.htm.

12. Beekeeping: Everything You Need to Know to Start Your First Beehive by Joachim Petterson – Weldonowen [internet]. 2015 Page 57. Available from: https://en.wikipedia.org/wiki/Honey#cite_note-16.

13. hakim Al, Alshahroory AB. Bees honey [internet]. (book), p. 117.available from: https://en.wikipedia.org/wiki/Honey#cite_note-16.

14. Majtan J. Honey: an immunomodulator in wound healing. Wound Repair Regen [internet]. 2014 Feb 24 [2014 Apr ]; 22 (2): 187–192. Available from: https://onlinelibrary.wiley.com/doi/abs/10.1111/wrr.12117.

15. O’Meara S, Al-Kurdi D, Ologun Y, Ovington LG, Martyn-St James M, Richardson R. Antibiotics and antiseptics for venous leg ulcers. Cochrane Database Syst Rev [internet]. 2014 Jan 10; 1(1). Available from: https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD003557.pub5/abstract.

16. Sievenpiper JL, Souza RJ, Mirrahimi A, Yu ME, Carleton AJ, Beyene J, Chiavaroli L, Di Buono M, Jenkins AL, Leiter LA, Wolever TM, Kendall CW, Jenkins DJ (2012). Effect of Fructose on Body Weight in Controlled Feeding Trials: A Systematic Review and Meta-analysis. Ann Intern Med. 2012; 156 (4): 291–304. doi:10.7326/0003-4819-156-4-201202210-0000.

17. Tomak P. Chemical and Functional Properties of Food Saccharides [Internet]. Tailor and Francis group; 2003 Oct 20. pp. 74–. Available from: https://www.taylorfrancis.com/books/9780429209604. doi:https://doi.org/10.1201/9780203495728.

18. Al-bukhari MI. Sahih Bukhari [internet]. vol. 7, book 71, number 584, 585, 588 and 603. Available from: http://www.iium.edu.my/deed/hadith/bukhari/071_sbt.html.

19. Bogdanov S. Physical Properties of Honey. In:editor Baghdanov S. Book of honey [internet]. Internet archive.2009 Sep [2018 Nov 15].chapter 4. Available from: https://web.archive.org/web/20090920094501/http://www.bee-hexagon.net.80/files/file/E/Honey/PhysicalPropertiesHoney.pdf.

20. Bees ‘producing M&M’s coloured honey [internet]. Telegraph.co.uk. 2019 Aug 23. Available from: https://www.telegraph.co.uk/news/newstopics/howaboutthat/9587260/Bees-producing-MandMs-coloured-honey.html.

21. Oduwole, Olabisi; Udoh, Ekong E.; Oyo-Ita, Angela; Meremikwu, Martin M. (2018). “Honey for acute cough in children”. The Cochrane Database of Systematic Reviews. 4: CD007094. doi:10.1002/14651858.CD007094.pub5. ISSN 1469-493X. PMID 29633783.

22. “Cough”. NHS Choices. 20 June 2013. Retrieved 18 June 2014.

23. “Cough and cold remedies for the treatment of acute respiratory infections in young children”. World Health Organization. Retrieved 15 October 2015.

24. “Honey”. Mayo Clinic. 1 November 2013. Retrieved 24 September 2015.
[25]. Bardy J, Slevin NJ, Mats KL, Molassiotis A (2008). "A systematic review of honey uses and its potential value within oncology care". J Clin Nurs. 17(19): 2604–23. doi:10.1111/j.1365-2702.2008.02304.x. PMID 18808626.

[26]. Bogdanov S, Jurendic T, Sieber R, Gallmann P (2008). "Honey for nutrition and health: A review". Journal of the American College of Nutrition. 27 (6): 677–89. doi:10.1080/07315724.2008.10719745. PMID 19155427.

[27]. Sievenpiper JL, de Souza RJ, Mirrahimi A, Yu ME, Carleton AJ, Beyene J, Chiavaroli L, Di Buono M, Jenkins AL, Wolever TM, Kendall CW, Jenkins DJ (2012). "Effect of Fructose on Body Weight in Controlled Feeding Trials: A Systematic Review and Meta-analysis". Ann Intern Med. 156 (4): 291–304. doi:10.7326/0003-4819-156-4-201202210-00007. PMID 22351714.

[28]. Pećanac M, Janjić Z, Komarcević A, Pajić M, Dobanovacki D, Misković SS (2013). "Burns treatment in ancient times". Med Pregl. 66 (5–6): 263–7. doi:10.1016/s0264-410x(02)00603-5. PMID 23888738.