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Honey Adulteration Detector

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***Abstract*—Adulteration of pure honey with synthetic honey has become much more prevalent in recent years. The consumer is often faced with worthless substitutes but sometimes also with a dangerous cocktail of chemical such as antibiotics, coloring etc. Being a substance of medicinal importance, adulteration can make it severely harmful to consume. So with the help of this paper we propose a solution which gives power to the consumer as well as the food industrialists to differentiate between healthy and adulterated honey. Our approach for the same is to develop an IoT-based device which comprises of a micro-controller, sensors and a Wi-Fi module to detect the change in properties of honey due to adulteration. The device declares the result on the basis of change in color, pH, density and electrical conductivity. The results of tests performed by the consumers would be stored in a database that can be accessed via a web app which can help to compare the quality of honey present in the market. The simplicity of the system can help food inspectors, medical institutes, food industries as well as the common people to prevent the side effects of the low quality honey**

***Index Terms*—Internet of Things, Honey Adulteration Detector, Food Adulteration,Quality of honey**

I. INTRODUCTION

Honey can be a wonderful alternative to your refined sugar which is just a source of empty calories. This lovely ingredient made by nature can not only sweeten your life but it is also abundant in minerals, nutrients and living enzymes.But it can be quite a challenge to find good, pure honey.According to the study,honey is the world's third most adulterated food.It is easy to cheat the common people with adulterated honey as commercial honey can often be mixed with glucose solution, high fructose corn syrup, sugar cane, corn syrup and other ingredients you may not even know about.

Chemical techniques have been developed for the detection of honey adulteration. But with this paper we put forward our approach to detect the adulteration in honey with the help of micro-controllers and sensors.

II. EFFECT OF ADULTERATION ON HONEY PROPERTIES

Effect on colour of honey:

Adulterants added in honey bring deviation in it's colour.Different adulterants produce different effects on colour of honey. When honey is adulterated with irid, the colour of the honey turned into yellow, adulterating honey with sugar by boiling honey and water by using heat changes the colour of honey to light white, adulterating honey with equal amount honey with sugar melting have red colour and it becomes solid ,adulterating white honey with sugar directly by adding have extra white colour ,adulterating honey with molasses using heat have black colour looks like coffee honey colour. Common adulterants like sugar, ripened banana, wheat flower, potato, maize flower, pollen, empty combs, melted candy, molasses and hot water in the sample can give yellow, yellow brown, and brown colour.

Effect on pH value of honey:

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. The impure or adulterated honey might have low pH level that which do not demonstrate pure honey criterion.

Effect on electrical conductivity of honey:

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. 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. The concentration of mineral salts, organic acids and proteins is lower in commercial sugars than natural honey.

Effect on density of honey:

Density values depend on water content, pure honey has a higher density compared with the other adulterated samples. Adulterating pure honey with different concentration of starch, molasses and distilled water causes density decreases with increasing concentration of starch added to honey, the

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same trend was observed for adulterated honey by the addition of glucose and distilled water but density values increases with increasing concentration of molasses added to honey. Density values depend on water content; pure honey has a higher density compared with the other adulterated samples except molasses.

III. TRADITIONAL AND HOUSEHOLD METHODS USED FOR DETECTION

Determination of Hydroxymethylfurfural (HMF) Level:
This method was used to determine the concentration of 5-(hydroxymethyl-) furan -2-carbaldehyde (HMF). The result of HMF level is usually expressed in milligrams per kilogram (mg/kg). 5.0g from each honey sample was weight accurately into a beaker to test the HMF level. 25.0 ml of distilled water was then added and mixed well until the 5.0g honey samples was completely diluted dissolved. The mixed solution was then transferred into a 50ml volumetric flask. 0.5ml of Carrez solution I was added into the volumetric flask and mixed well by vortex. The mixed solution was then added with Carrez solution II and mixed thoroughly by vortex. Then, distilled water was added into the volumetric flask up to the mark. A drop of ethanol might be needed to suppress the foam that form during mixing. This mixture was then filtered using a filter paper. The first 10ml of filtered solution was rejected while the remaining solution after filtration was collected. 1.0ml of the filtrated solution was pipetted into two separate test tubes with the volume of 1.0ml each. For sample solution, 1.0 ml of the distilled water was added to the test tube that contained honey solution. This solution was mixed well by vortex followed by the addition of 1.0ml of 0.2% sodium bisulphate and mixed well by vortex for reference.

Additions to test tube	Sample solution	Reference solution
Initial honey solution	1.0 ml	1.0ml
Water	1.0ml	-
0.2% sodium bisulphite solution	-	1.0ml

Table 2.2: Guide for preparation of dilution for sample solution and reference solution

Additions to test tube Sample solution Reference solution Initial honey solution 1.0 ml 1.0ml Water 1.0ml - 0.2% sodium bisulphite solution - 1.0ml 35 The absorbance of the sample solution against the reference solution at 284nm and 336nm were obtained within an hour by using 1cm quartz cell. If absorbance at 284nm was more than the value of 0.6, the sample had to be diluted with distilled water and for the reference with 0.2% bisulphite to obtain the sample absorbance that is low enough for accuracy of results. Each honey sample was prepared and tested for three times. Results were recorded as Mean + Standard Error Mean (S.E.M). Calculation of HMF level content in mg/kg.

The HMF content (mg/kg)-

$$\frac{A_{284} - A_{336} \times 149.7 \times 5 \times D}{W}$$

Where, A_{284} = Absorbance at 284 nm.
A_{336} = Absorbance at 336 nm
D = Dilution factor
W = Weight of the sample.

Determination of Sugar Profile:
This method determined the sugar profile (glucose, fructose, sucrose and maltose) in the honey samples. In the preparation of sample for standard, 1.0mg of each standard sugar (fructose, glucose, maltose and sucrose) was weighed accurately into a 5ml screw-top The HMF content (mg/kg)-

$$\frac{A_{284} - A_{336} \times 149.7 \times 5 \times D}{W}$$

Where, A_{284} = Absorbance at 284 nm.
A_{336} = Absorbance at 336 nm
D = Dilution Factor
W = Weight of sample
1000 = Conversion g into mg.
10 = Conversion 5 into 50 ml.
1000 = Conversion g of honey into kg.

36 glass vial. For honey sample preparation, 5.0 mg of honey samples were weighed accurately into a 5ml screw-top glass vial. The samples prepared were then added with 0.45ml of pyridine. These vials were immersed into the waterbath at 70°C for at least 10 minutes. 0.5ml of Hexamethyldisilazane (HMDS) was added to each vial and mixed well. Then, 0.05ml of Triflouroacetic acid (TFA) was carefully added drop by drop into the mixture. The vial was shaken occasionally during the adding of TFA at room temperature. These clear solutions were allowed to stand for at least 15 to 30 minutes. Homogenous clear solution was obtained. If the solutions turn cloudy, new samples preparation were needed. The solutions were left for 24 hours at room temperature before injecting into the gas chromatography (GC-14A). 1.0µl of each sample solution was required for the injection into the capillary of gas chromatography column.

Determination of Water Content in Honey:
The hand held honey refractometer is specially designed to determine the percentage of water in honey. The method using this honey refractometer was determination of water

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content in honey was easy. The prism of the hand held refractometer was cleaned and dried before used. Following that, the prism of the refractomer was covered evenly with a honey sample evenly . The reading of the refractive index was recorded. Each sample was measured twice and the average value was taken. After used, the prism of the refractometer was cleaned carefully.

Determination of Hydrogen Peroxide:

This is the easiest test to perform and determines the existence of hydrogen peroxide in honey sample. A 30 % (w/v) concentration of honey was prepared by weighing 3g of honey and diluted in 10 ml of distilled water. The mixture was then incubated in a waterbath 38 at 37ºC for 30 minutes. The test strips from the test kit was dipped in the mixture and the color developed was read against the colour code to obtain the concentrations of the H2O2 formed. Each sample was tested three time for accuracy purpose and the results were recorded.

Determination of pH Level:

pH reading of the crude honey was very unstable and hard to determine. Therefore honey was diluted into 10 %solution (w/v). The pH meter was calibrated at pH 3.7 (4.0), 7.0 and 9.0 before used. 10 g of honey sample was dissolved in 75 ml of carbon dioxide-free distilled water. This solution was mixed by using magnetic stirrer. The pH electrodes were immersed into the solution. pH value of the honey solution was recorded in two decimal places.

Detection of Sugar Solution in honey:
(Household methods)

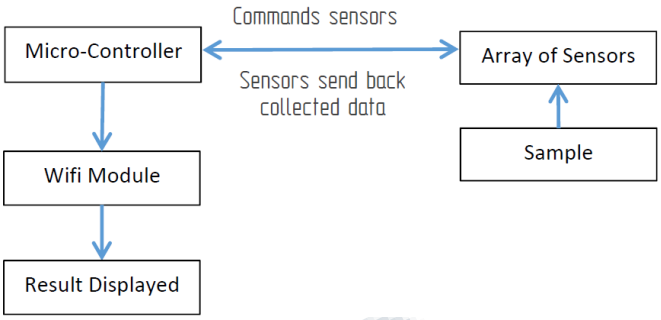
At home if the honey is added to a glass of water it sh should not disperse in the water. Also, if a cotton wick dipped in a pure honey will burn. If adulterated, the presence of water will not allow the honey to burn if it does; it will produce a cracking sound.

IV. PROPOSED SYSTEM

The honey adulteration detector system detects the presence of adulteration in sample. First, the sample is placed near the array of sensors which comprises of colour sensor, pH sensor, pressure sensor and DS18B20(Temperature Sensor IC).The sensors measure the above described particular properties.Colour and pH sensor measure the variations in sample property from pure honey property.The pressure sensor measure the density using the formula:

$$P=\rho gh$$

where, ρ is the density
g = gravitational constant
h is the depth of the beaker



Fig(1). Block Diagram of the System

Using the obtained value the deviation in property is calculated. Change in electrical conductivity is measured using the temperature sensor IC.These deviations in the properties tell us about the honey being pure or adulterated. Wifi module is connected to the micro-controller in order to send the data to the database which would be accessible via a web app.the result would be displayed on an LCD screen connected to the micro-controller as well as on the web app.

CONCLUSION

Food is an essential part of human life. Anything intrigued with it enters the food chain.May it be beneficial or harmful.Adulterant are the negative entities associated with our daily intake of food. This problem is more serious in developed and under developing countries. It is the need of the hour that we start differentiating between what's healthy and what's harmful.Honey being the third most adulterated substance in the world and one of the most common utility of any household needs to be unadulterated. The presented paper suggests a way to get rid of the harmful effects of the adulterated honey. With future research and developments these results can be more accurate and it is even possible to check the amount of adulteration.

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