AN ELECTRONIC INDICATOR FOR INSTANT QUALITY ASSESSMENT OF HONEY

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Abstract

Honey consumers are always faced with problem of ascertaining the quality of honey during purchase. Traditional methods of testing honey to know its quality are not reliable, and therefore, portable equipment for instant testing is required. This paper demonstrates (he possibility of determining quality of honey instantly with electronic device. The device was designed and constructed such that its input responds to electrical conductivity of honey, which is one of its properties whose value indicates the quality. Usually a good honey sample has electrical conductivity in the range of about 9u.Scm~ and 55uScm~ . The device was preset to respond with green light emitting diode (LED) if the electrical conductivity of honey falls within this range. A red LED indicates that the honey is adulterated. Quality of twenty samples of honey with known electrical conductivity was examined. The device responded with green LED for the samples with electrical conductivity within preset range, while for others it responded with red LED. The device is portable (pocket size), affordable, easy to operate and reproducible.

Introduction

Honey is used as food and as medicine, making it an essential commodity in most countries. It consists mainly of glucose, fructose, water, some minerals and traces of other type of sugars (White & Landis, 1980). It is usually diluted with sucrose (table sugar) and water by sellers to increase quantity. The adulterated honey is not potent and tasty as the pure honey and is very difficult-to identify. Several crude methods are employed to determine the quality of honey. For instance it is believed that a pure honey will not be soaked up by sand. Some also believed that a match stick dipped into pure honey can still ignite when scratched. All these methods are not reliable. To know the grade of honey requires some chemical analysis, but if not for research purpose it is not cost effective to take a bottle of honey to laboratory for quality assessment. While the cost of a chemical analysis may be more expensive than the price of a gallon of honey, it is also certain that most honey consumers will not have access to the laboratory. It therefore becomes imperative that portable electronic device for instant indication of quality of honey be constructed. The device can be made (o detect one of the properties of honey that has been well described, such as its moisture content. The results of chemical analysis of honey have shown that the average moisture content of honey is 17 percent, and may range between 13 percent and 25 percent. According to US standards for grades of extracted honey, honey may not contain more than 18.6 percent moisture to qualify for U.S. grade-A. Moisture content higher than 20 percent places a honey in U.S. grade-D, classified as substandard (White & Landis, 1980). Since moisture content of honey has been used to classify honey, and it is common knowledge that water is a conductor of electricity, it follows that moisture content of honey will be an important factor in determining the electrical conductivity of the honey. Adebiyi, Akpan, Obiajunwa, & Olaniyi, (2004) have shown that electrical conductivity of pure honey in southern part of Nigeria varies between about 9.42 jiScnT[1] and 55fiScm~', depending mainly on the water content. The water content of a diluted honey is higher and therefore the adulterated honey has a higher electrical conductivity. A device that can respond to variations in electrical conductivity of a liquid should therefore be suitable for assessing the quality of honey.

Procedure

The circuit required is one that can measure the value of electrical resistance of a liquid between two terminals at its input, and indicate "true" if the resistance falls within a specified range or "false" if it is not. This was designed, combining two potential dividers with two sets of voltage comparators. The distance between the two terminals and the length of the electrodes at input of the circuit were fixed to prevent fluctuation of electrical resistance. The voltage comparators were made of integrated circuit, 1C 741. A detailed description of voltage comparators can be found in Collins (1987), and Theraja (2005). Feedback resistors were used to stabilize the input. The value of the feedback resistors determines the bandwidth (range of resistance of liquid to be accepted as "true") of the circuit, while the resistors of potential divider controls the sensitivity of the device. The potential divider and voltage comparators were connected to a series of transistors so that the whole arrangement form a NAND and an AND logic gates. Green and red Light Emitting Diode (LED) connected to the output of the logic gates serve as true and false indicator respectively. At the input, one of the potential dividers is maintained at a constant voltage (about 4.5 volt). The voltage of the second potential divider is determined by a variable resistor and the electrical resistance of the liquid between the terminal electrodes. Depending on the values of the resistances, its voltage can be higher or lower than that of the first potential divider. One of the comparators responds to higher voltage, while the second responds to lower one with a positive output. The electrical resistance between two electrodes, each of surface area A and distance / apart in honey of conductivity a is given by:

$$R = 1/\sigma A \qquad (1)$$

There will be a resistance of approximately IMH between two electrodes, each 5mm long, 1mm diameter, and 1cm apart in a sample of pure honey. With a 1MQ resistor across the input terminals, the variable resistor was adjusted until green LED light was on (at the same moment the red LED went off). At this preset value of resistance, the input voltages of the two potential dividers are the same. The resistance of the feedback resistors on each of 1C-741 were varied until the range of response to electrical conductivities was within PjiScnT[1] and 55uScm~'. The circuit diagram is shown in figure 1. Twenty samples of honey were then obtained from various locations reputed for sale of high quality honey in Kaduna state. The electrical conductivity of each of them was measured with a calibrated conductivity meter, and (hey were tested with this new device. The result is presented in Table 1.

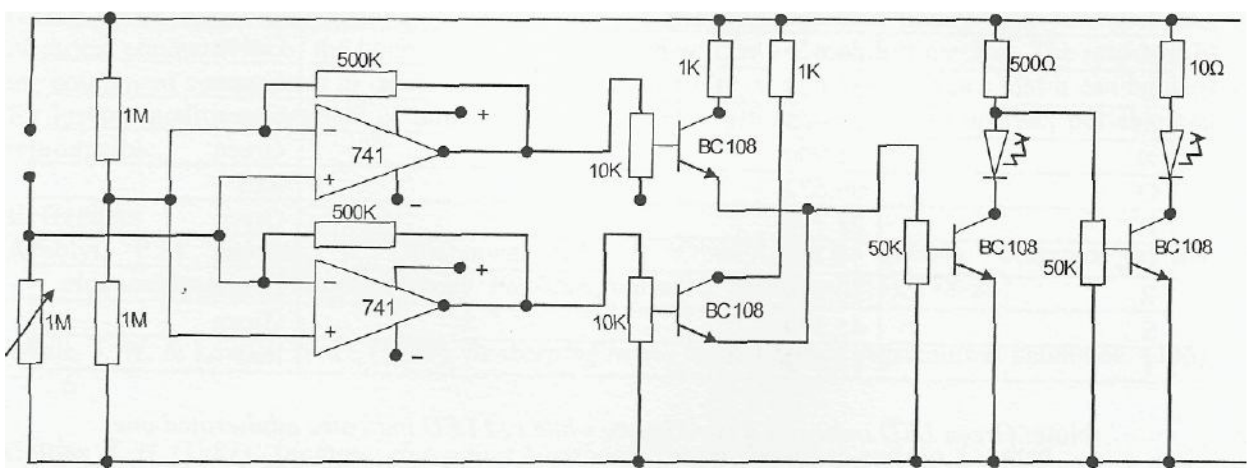

Figure 1. Circuit Diagram of Honey Quality Indicator

Result and Discussion

The results obtained for electrical conductivities and the corresponding response of the meter to each of the honey samples is as presented in Table 1. In the Table, honey samples are labelled with letters A-T. The electrical conductivity of each of them was presented- in micro-Siemens per centimetre. The corresponding LED indication on the meter was shown as green or red, representing true or false. Seventeen samples have electrical conductivity within the range of values preset for pure honey, between about 9u.Scm ' and 55u,Scm~[l] (Adebiyi, Akpan, Obiajunwa, & Olaniyi, 2,004). These were also indicated as pure honey with green LED on the constructed meter. Three of the samples that had value of conductivity outside the range of the preset values were indicated with red LED as adulterated. Sample T is suspected to have been mixed with some quantity of water that resulted in higher electrical conductivity. Sample 0 had a relatively lower electrical conductivity, outside the specified range. The sample is suspected to have been stored for a long period of time that granulation has occurred. Granulated honey is more susceptible to spoilage by fermentation caused by natural yeast found in all honeys (White & Landis, 1980).

Table 1. Response of the Equipment to Quality of Some Samples of Honey

Samples	Electrical Conductivity $uScm^{-1}$	LED indicator
A	53.932	Green
B	54.655	Green
C	50.596	Green
D	68.944	Red
E	22.796	Green
F	52.598	Green
G	23.519	Green
H	54.655	Green
I	41.700	Green
J	40.366	Green
K	54.822	Green
L	30.024	Green
M	29.468	Green
N	13.900	Green
O	06.672	Red
P	22.796	Green
Q	51.708	Green
R	30.914	Green
S	45.370	Green
T	84.672	Red

(Note: *Green LED indicates a pure honey while red LED indicates adulterated one)*

The correlation between the two determinations in the table shows that the device responded as expected, This showed that adequate sensitivity was obtained with the high resistors of order of mega-ohm used for potential divider at the input of voltage comparators. From equation 1, the surface area A of each electrode and the gap between them affect the value of electrical resistance at the input. The surface area is proportional to diameter and length of each of the electrodes. It is therefore necessary to have a fixed length and gap of the electrodes. The electrodes used here have diameter of 1mm, length of 5mm, and are separated by distance of 1cm, producing a resistance of about one mega-ohm in a sample of honey. Wider gap and shorter lengths of the electrodes will result in higher values of resistance, and hence requires higher values of resistors in the potential dividers at the input. The upper and lower limits of conductivity to which the device can respond is determined by the values of feedback resistors of the 1C 741. The range can be narrowed or expanded by adjusting the resistance values.

Though moisture content is not the only property that can be used to classify a pure honey, it turns to be an important factor because in diluting honey with table sugar, water is added, which leads to a higher electrical conductivity. Base on that, the device will always identify an adulterated honey since the electrical conductivity of such honey will always be higher. If a honey sample has lower moisture content than the set standard values, the device will equally indicate it as adulterated, with red LED, as was the case of sample 0 in the Table 1.

This simple device is reproducible. All the components used in the construction are available at affordable costs in local markets. They are of very small sizes, so the resulting equipment can comfortably be carried in a pocket for use anywhere. It operates on dry cell batteries so it is free from electric power failure. The electric current through the LEDs are of order of tens of milliampere, (Theraja & Theraja, 2005) and time spent during usage is usually between 2 to 5 seconds. So, power consumption is very low and the batteries can last for months. No special training is required to operate this device.

Conclusion

Since adulteration of honey involves addition of water, the electrical conductivity of adulterated honey used to be higher than normal. Electronic device was constructed to utilise this property in identifying pure honey. It consists of potential dividers and AND and NAND logic gates that were constructed with IC-741 and transistors. Based on range of electrical conductivity of honey reported in literatures, the device was preset to respond with either green or red light emitting diode(LED) when dipped into honey. It was used to test twenty samples of honey. The corresponding electrical conductivity of the honeys was also measured with an independent method. The response of the equipment corresponds to result of electrical conductivity, which demonstrates that it can be used for instant quality assessment of honey. The equipment is affordable, easy to operate, portable and reproducible,

References

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