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Evaluation of Maturity and Ripening Quality Analysis of Banana

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Abstract:

Food quality is an attribute of food that indicates its acceptability to consumers. Checking the nutritional value plays an important role in the food quality analysis. Fruits provide nutrients that are vital for the human body. They are rich in vitamins, potassium and are low in fat, sodium and calories. Consumption of these fruits help in keeping the human body healthy. However, these nutrients are dependent on how the fruits are ripened. Fruits are artificially ripened using chemicals and the most popular ones are ethephon and calcium carbide. These artificially ripened fruits have lesser nutritional values and also cause dizziness, memory loss, seizures, sleepiness. In this paper we propose a novel approach for detecting the quality of the fruit with the help of a handy device that uses the principle of Near-infrared spectroscopy.
Keywords: *Near-Infrared Spectroscopy, Calcium Carbide.*

I. Introduction

The World Health Organization in 2017 has stated that there are about 3.9 million deaths worldwide due to the paucity in fruits and vegetable consumption. It has been estimated that one-third of cancer cases and half of cardiovascular disease are related to diet. Consumption of fruits reduces the risk of life-threatening diseases, types of cancers. The World Health Organization suggests the consumption of 400 grams of fruits per person every day. Fruits contain micro-nutrients such as vitamins, minerals and dietary fiber. But these micro-nutrients vanish if the ripening of these fruits is done in the incorrect way [1].

Ripening is a process that makes the fruit more palatable and nutritious. Nutrients are lost in the process of artificially ripening the fruits to ripen them faster than normal for more fruit production and so that the fruit appears fresher and lasts longer. Chemicals like calcium carbide, acetylene and ethylene promotes the ripening of the fruits and gives it a better-looking color [2]. These artificially ripened fruit's chromatic color, size, texture attract the consumers to purchase and consume them. Little do the consumers know that process behind the fruit's ripening can cause severe health problems.

A customer uses all his senses i.e. sight, smell, taste, touch, and even hearing while purchasing a fruit. Checking each fruit's color and texture to determine if it is artificially ripened is practically not possible every time. Techniques using image processing were used to detect the artificially ripened fruits [3] or the smart utensils method [4] or Quartz Crystal Microbalance sensor which is based on furaneol imprinted polymer [5] have been developed on how to identify the artificially ripened fruit.

In this paper we design and develop a handy device that can be used for the determination of fruits that have been ripened by adulteration. This determination is done by using Near Infrared (NIR) Spectroscopy. The Near-Infrared region of the electromagnetic spectrum is used by the Near-

May – June 2020
ISSN: 0193-4120 Page No. 2175 - 2180

Infrared Spectroscopy, and it is also a non-destructive method. It has a wavelength of 780-2500nm [6]. The near-infrared spectrum is present between the infrared and visible regions. The absorptions in the NIR region are created from fundamental vibrations by overtones and combinations [7]. NIR Spectroscopy helps in determining the chemical and physical properties in a short span of time. A spectrometer helps in analyzing the wavelength of the electromagnetic radiations which have interacted with the food item. From this, the chemical composition and other necessary information can be extracted. Using this method of determining the chemical composition such as fats, vitamins, energy one can find out the amount of adulteration in the food items, and thus conclude its fitness for consumption [8]. One fruit sample has been taken and ripened artificially using calcium carbide and another fruit sample is taken and ripened naturally. In this case, a difference in the chemical composition between both the samples. On exposing the fruit sample to Near-infrared light of the spectrometer, the fruit sample absorbs some or all of the light depending on the wavelengths used and then reflects the remaining back to the spectrometer. The spectrometer then measures the reflected light and displays the data on a display device for all the wavelengths used. The data is then analyzed and the final conclusion drawn from the data analysis on a display device (cellphone) with the help of an application. This determination of adulteration is done using AS7263 NIR and a processor.

The AS7263 is of size 2.5x2.5 cm^2. This spectrometer has six-channel near IR interference where each one of these six channels has a characteristic filter called the Gaussian filter. There is a 50 nm gap between each channel in the NIR Spectrum. The sensor also has a 16-bit Analog to Digital converter which mixes the current from every channel's photo-diode. There is a micro-controller integrated on the chip and has quite a low consumption of power. Each wavelength has a 20 nm of full-width half-max detection. The spectral device also has a supply voltage of 2.7V to 3.6V and an I2C interface.

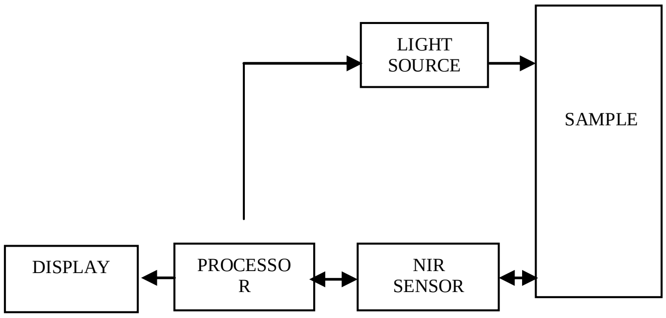


Fig. 1: Block diagram of the process

From Fig 1 it is observed that a light source is present in the NIR Spectrometer. The light source is triggered by the input pulse given by the processor. The light rays then fall onto the sample and some of the light rays are absorbed by the sample while the rest is reflected back. The reflected light rays then fall onto the NIR Sensor where the digital signals are converted into analog signals. These signals are then transferred back to the processor where the data is collected and analyzed. The output of the analyzed data is transferred to the display device (cellphone) via Bluetooth module.

II. METHODOLOGY

The fruit samples (banana) used in the study were from a farm. Calcium carbide used for artificially ripening fruits was arranged from a local chemical shop. This was added to some of the fruit samples while the remaining samples were left to ripe naturally.

Before ripening the fruit samples, a thermal image was taken of the raw sample using a Thermal Imaging Camera. This camera is a device which captures an image of the object by using infrared radiation emitted from the object. All the samples were kept at a constant distance of 31cm from the Thermal Imaging Camera. Also, a constant temperature was maintained while capturing the image. The captured image represents the temperature of the object. The temperature was found to be 29.1ºC and 28.3ºC for the raw fruit samples.

To artificially ripen the fruit samples an empty container was taken and 10 grams of calcium carbide wrapped in a piece of paper was placed at the bottom of the container. Before placing the fruit samples in the container, the calcium carbide present was moistened a little by adding few drops of water on it. Acetylene gas was produced immediately and in order to prevent the gas from escaping into the atmosphere, the container was made airtight. The

May – June 2020
ISSN: 0193-4120 Page No. 2175 - 2180

fruit samples were left in the container for 24 hours and were out post that and ripened at room temperature.

The temperatures of both the naturally and artificially ripened fruit samples were noted again using the Thermal Imaging Camera. The temperature of the naturally ripened sample was found to be 24.7ºC and the artificially ripened sample was 26.5ºC.

The artificially ripened fruit was then analyzed and compared along with the naturally ripened fruit. This analysis was done using AS7263 Near Infrared spectrometer. Using this spectrometer, the amount of reflectance from the fruit sample was obtained for six different wavelengths. The analysis of data was done by recording the values obtained by the spectrometer every day for four days for the wavelengths 810 nm and 860 nm. The amount of reflectance from the fruit sample was determined for six different wavelengths. Since the amount of absorption for the naturally ripened and the artificially ripened fruit varies depending on its chemical composition, the reflectance also varies. The part reflected back to the spectrometer for both the samples were measured and compared. Absorbance was calculated using the formula $A=\log(1/R)$

III. EXPERIMENTAL RESULTS AND DISCUSSIONS

It was noticed that the fruit samples which was naturally ripened had higher values of reflection as compared to the artificially ripened fruit samples. Absorbance was calculated from the reflectance values that were obtained from the experiment performed using the NIR spectrometer. The data of the bananas was recorded every day for four days for the wavelengths i.e. 810 nm and 860 nm. There was a decrease in reflectance as each day passed. The naturally ripened banana sample had reflectance values higher than the artificially ripened bananas for every wavelength. The graphs below show the difference in values between the naturally ripened bananas and the artificially ripened bananas and also show the decrease in reflectance values as days pass for two wavelengths i.e. 810 nm and 860 nm.

In Fig. 2 and Fig 4 the graphs were plotted between Reflectance and Time period for the wavelength 810 nm and 860 nm respectively. It is observed from the graph that the line of the graph decreases with increase in time duration. The reflectance of the fruit samples was found to be the most on the first day i.e. when the banana just ripened and the reflectance was found to be the least when the banana was getting rotten. In Fig. 3 and Fig. 5 the graphs were plotted between absorbance and time period for the wavelength 810 nm and 860 nm respectively. It was observed from the graph that the line of the graph increases with the time duration.

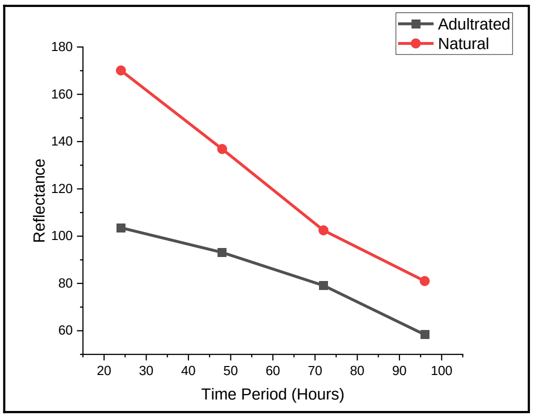


Fig. 2: Graph plotted between Reflectance and Time period for the wavelength 810 nm

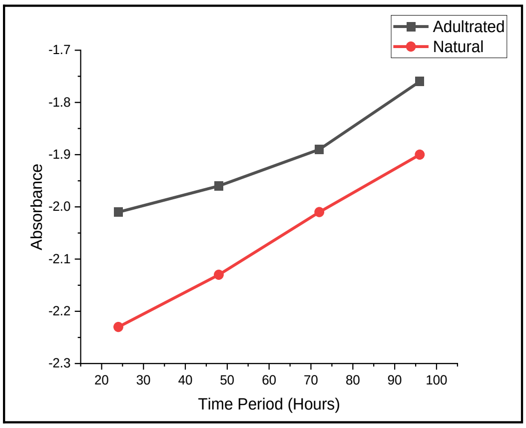


Fig. 3: Graph plotted between Absorbance and Time period for the wavelength 810nm

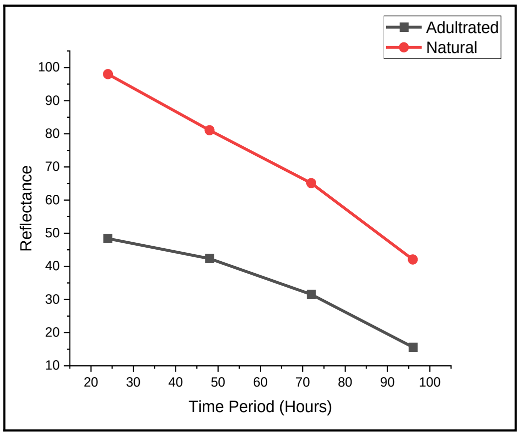


Fig. 4: Graph plotted between Reflectance and Time period for the wavelength 860nm

May – June 2020
ISSN: 0193-4120 Page No. 2175 - 2180

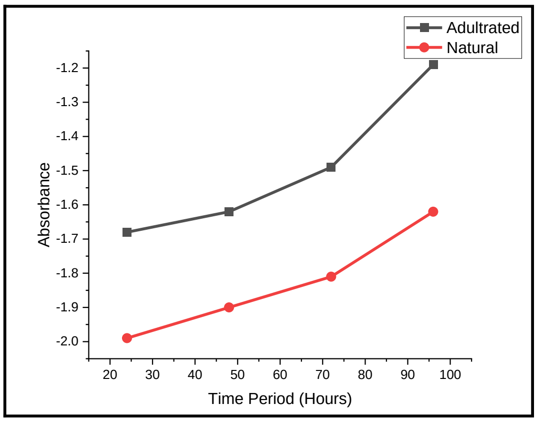
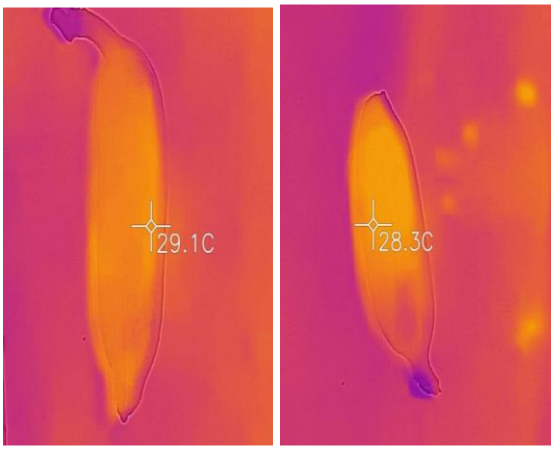
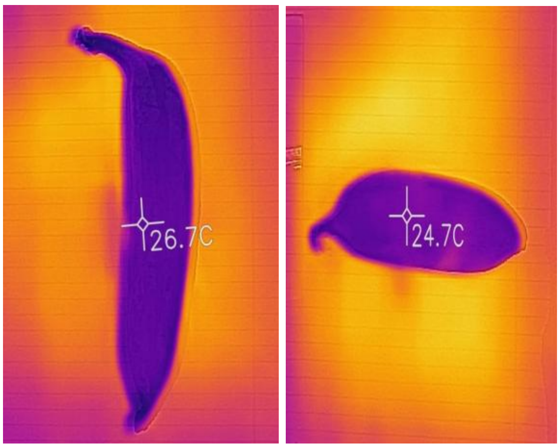


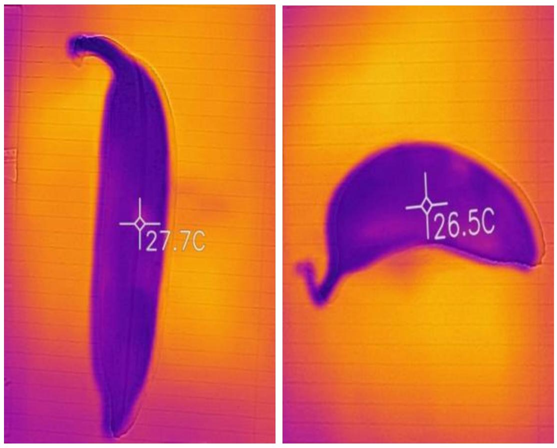
Fig. 5: Graph plotted between Absorbance and Time period for the wavelength 860nm



(a)



(b)



(c)

Fig.6: Temperature variation for banana samples where (a) is the raw banana (b) is naturally ripened banana and (c) is artificially ripened banana

The data obtained from the NIR Spectrometer was validated using a Thermal Imaging Camera. Fig. 3 shows the variation in temperature which was noted using a thermal imaging camera. From the figure it was understood that the initial temperature of the raw bananas was found to be higher than the ripened bananas. On comparing the temperature difference between the naturally ripened banana and the artificially ripened banana, it was noticed that the artificially ripened banana had temperatures higher than the naturally ripened banana.

IV. CONCLUSION

Near Infrared Spectroscopy is a non-destructive technique with which adulteration i.e. calcium carbide in fruit samples was determined. From this determination, the customer using the device will receive the message on a cellphone whether the fruit is suitable for consumption or not.

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