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Near-Infrared Spectroscopy for Detection of Macro-Nutrient in the Food Content

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ABSTRACT:NIR region was first discovered in 1800. Karl Norris developed the NIR region in the early 1950s. It was put into practice by Phil Williams in the 1970s. This method was first used in the cereal industry. Spectroscopic method is based on the electromagnetic radiation being absorbed at particular wavelength range between 750-2500nm. In olden days, the food content where fully-filled with the essential nutrients. After a decade transition, due to excessive usage of chemical compounds the nutrients contents are reduced. For instance, we do not indulge to know the nutrients content present in the edible food. Our product, shows the macro-nutrients present in the food with accuracy. It helps us to visualise the chemical content in food without conducting any experiment. The advantage of using NIR spectroscopy method is that, for processing samples are not required, hence the analysis is done quickly without any tedious process.

KEYWORDS: NIR region, range 750-2500nm, macro-nutrients.

I.INTRODUCTION

The electromagnetic radiation are absorbed at the wavelength range 750-2500nm, in the food particles are comprised of broad bands which are due to the overlapping of absorptions. This is mainly due to overtones and their combinational vibration modes including various chemical bonds namely CH, OH and NH shown in the figure 1.

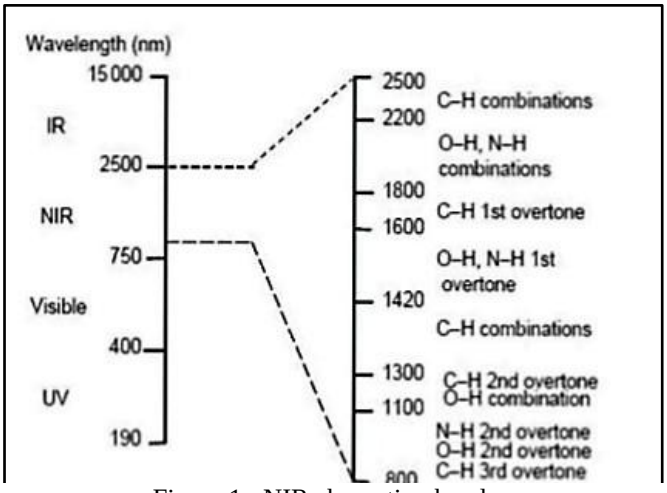

Figure 1: NIR absorption band

The concentration of macro-nutrients such as protein, vitamin, mineral, fat and carbohydrates are estimated. There exist a series of overtone and combination band for vibration. Hence, the order of magnitude will be less intense with the preceding one. Figure 2 shows the overtone and fundamental vibration occurring in the molecules.

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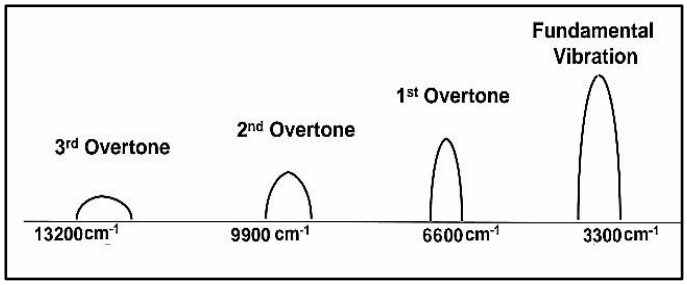

Figure 2: Overtone and fundamental vibration

As a result, different intensity containing the same chemical information are obtained by proceeding the process step-wise. Multivariate mathematics is applied for the calibration process when it comes to diffuse transmittance and reflectance.

Simple harmonic motion exists when the chemical bonds in the molecules are vibrated to first approximation. The resultant motion of the molecules in an atom is considered as independent vibration with respect to their centre of mass. A parabolic relation is defined between potential energy and interatomic distance. The strength of the bond is denoted by k and the frequency of vibration is defined as the function between the two atoms of mass m1 and m2.

The frequency spectrum of various rays along with the near-infrared rays and their corresponding wavelengths are shown in the figure3.

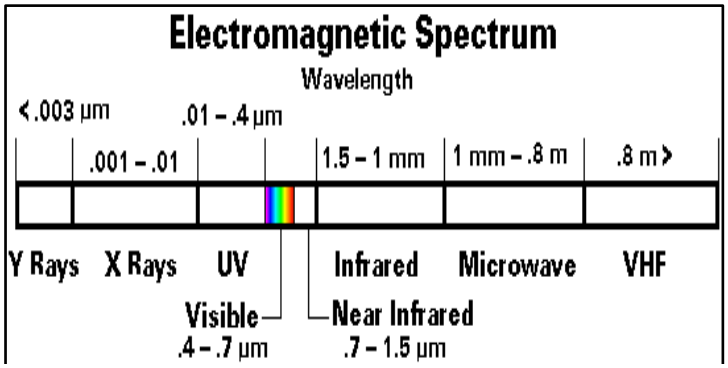

Figure 3: Frequency spectrum of NIR region

II.LITERATURE SURVEY

By conducting the survey, we were able to identify the rarely applied techniques related to the determination of the various chemical content in the food sample. The present available methods for the determination of the chemical contents are chromatography, lab testing using various method and NIR spectroscopy method.

The test are conducted in the laboratory with various chemical reagents in order to find the presence of particular macro-nutrient present in the given food sample. The methods followed are listed below:

TEST	CHEMICAL REAGENT	MACRO-NUTRIENT
Biuret test	NaOH, Hydrated Cu(II) sulphate, Potassium sodium tartrate	Protein
Benedict's test	Hydrated Copper sulphate, potassium hydroxide solution, potassium sodium tartrate	Carbohydrates
Ethanol test	ethanol	Fat

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Iodine test	iodine	starch

INFERENCE:

1. By conducting Biuret test, the presence of protein is indicated by purple colour.
2. By conducting Benedict's test, the presence of carbohydrate is indicated by blue colour.
3. By conducting Ethanol test, the presence of fat is indicated by cloudy white emulsion.
4. By conducting Iodine test, the presence of starch is indicated by blue-black colour.

The chromatography method which is used in the analytical chemistry for the separating and analysing the chemical compounds that are vapourised without decomposition. The individual chemical content in the food sample are obtained.

Tell spec's Enterprise Food Scanner Technology uses NIR spectroscopy method. For illumination purpose they had used two integrated tungsten halogen lamp with reflective properties. The spectral wavelength ranges from 900nm to 1700nm. It uses 1mm InGaAs (uncooled) detector. The various colours are used to indicate the chemical content like black, white, green, red, turquoise blue.

Through this paper, we propose an improved method for detecting macro-nutrient in the food using NIR spectroscopy method. The photodiode is used to provide the required illumination and from the overtone and absorbed spectral band, the accurate values are obtained. The comparison is made with the standard values. The outcome is displayed using a digital display.

III. COMPONENTS

A. BATTERY:

The battery is used to supply the required power to operate the device. Hence, the light is produced from the source with the consumption of required supply.

B. PHOTODIODE:

The photodiode is used to convert the light into electrical signal. The current is generated when photons are absorbed in the photodiode. Photodiodes contain optical filters and built-in-lens. The required amount of illumination is produced with the help of diode.

C. IMAGE SENSOR:

Image sensor is used to detect and convey the information that constitutes an image. It does so by converting the variable attenuation of light waves into signals, small bursts of current that convey the information. The wave can be light or other electromagnetic radiation.

D. OPTICAL SENSOR:

An optical sensor converts light rays into an electronic signals. The purpose of an optical sensor is to measure a physical quantity of light and depending on the type of sensor, then translates it into a form that is readable by an integrated measurable device. Optical sensors are used for contactless detection, counting or positioning of parts.

E. RECEPTOR:

The receptor denotes the various types of macro-nutrients namely, carbohydrates, fats, minerals, vitamin, etc.

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F. PCB:

The entire setup is fabricated in the PCB board. It mechanically supports and electrically connects the electrical and electronic components. Components are usually soldered onto the PCB to electrically connect and mechanically fasten.

IV. WORKING

In spectroscopy method, the process involves shining a near-infrared light onto the surface of a given food material. As a result, the molecules tend to vibrate and bounce back light in their own unique way with a particular range of wavelength. This reflected light is then collected and passed through a spectrometer that separates the light out into all the different wavelength it contains and their corresponding overtone and combination bands are identified. By analysing the unique optical signature of the scanned material and then compared with the standard approximate value of some functional group shown in the figure4, figure5 and figure6.

BOND VIBRATION	WAVELENGTH(nm)
CH stretch first overtone	1711
CH second overtone	1190
CH bend second overtone	2305
CH combination	1629
CH stretch/C=O stretch combination/Sym CH deformation	2225
CH stretch/CH_2 deformation	2311
CH stretch/C-C and C-O-C stretch	2500
CH stretch/C-C stretch combination	2434

Figure 4: chemical bond CH wavelength

BOND VIBRTION	WAVELENGTH(nm)
OH first overtone	1410
OH stretch first overtone	1597
OH bend second overtone	1940
OH combination	1930
OH stretch/OH bond combination	1960
OH stretch/HOH deformation combination	1990
OH stretch/CO stretch second overtone combination	1820
OH bond/CO stretch combination	2270

Figure 5: Chemical bond OH wavelength

BOND VIBRATION	WAVELENGTH(nm)
NH stretch first overtone	1508
NH stretch/NH bend combination	1990
NH in plane bend	2050
Sym NH stretch/C=O stretch combination	2060
NH bend second overtone/NH bend/NH stretch combination	2120
NH deformation overtone	2070

Figure 6: Chemical bond NH wavelength

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V. INFERENCE

Using spectroscopy method, the chemical makeup of food can be found out easily. Hence, the obtained wavelength is compared with the standard wavelength and the output is displayed in the digital display.

WAVELENGTH(nm)	BOND VIBRATION	COMPONENT
1570	N-H stretch 1st overtone	Protein
2300	C-H bend second overtone	Protein

Figure 7: Macro-nutrient protein with observed wavelength

VI.CONCLUSION

From the above mentioned macro-nutrient detector, the health status of the individual person can be improved wisely. Through this paper it can be noticed that the physics and the analog devices are embedded. Further, this technology can be shrinked and they connected along with the phone for the daily usage.

REFERENCES

[1]. NIR spectroscopy to agricultural products. In D. A. Burns, & E. W. Ciruczak (Eds.), *Handbook of near infrared-analysis* (pp.383-431). New York: Marcel Dekker.
[2]. Almendingen, K., Meltzer, H. M., Pedersen, J. I., Nilsen, B. N., & Ellekjaer, M. (2000). Near infrared spectroscopy – a potentially useful method for rapid determination of fat and protein content in homogenized diets, *European Journal of Clinical Nutrition*, 54, 20-23.
[3]. Baker, D. (1985). The determination of fiber, starch, and total carbohydrate in snack foods by near-infrared reflectance spectroscopy. *Cereal Foods World*, 30, 389-392.
[4]. Murray, I., & Williams, P. C. (1987). Chemical principles of near-infrared technology. In P. Williams & K. Noris (Eds.), *Near-infrared technology in the agricultural and food industries* (pp. 17-34). St. Paul, MN: American Association of Cereal Chemists.