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Electrical behaviour of some of the vegetables, fruits and food grains

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ABSTRACT

The electrical behaviour of some of the vegetables, fruits and food grains have been studied using the method of two probe resistance measurement at various levels of frequencies. The aim of the present study was to investigate the behaviour of its capacitance as a function of frequency. Electrical capacitance was found to decrease exponentially with increasing frequency, but the dielectric constant was a function of the moisture content thereby increasing its ability to store energy.

Key words: Dielectric constant, dielectric loss, conductivity, frequency.

INTRODUCTION

Agricultural products are highly perishable with short storage time. However, demand for agricultural products will never desist as long as human population growth continues to increase. This is a problem and hence there is an opportunity to increase the added value of the products. Achieving these objectives requires continuous assessment including in terms of technology in horticulture and in the field of basic science. Properties of these products are mostly affected by external factors such as weather, pests and post-harvest handling errors. Internal factors such as changes in chemical composition, metabolism, fibre conditions, moisture content, acidity etc. Also affect the quality of the agricultural produce. Measurements of the properties of agricultural products generally employ destructive methods.

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The measurements of all parameters were done when the vegetables, fruits and food grains were still in fresh condition. Electrical parameters are measured using LCR meter. The samples were placed between two plate conductive electrodes as dielectric material. The conductive plates were of copper. The parameter values of electricity were measured within a frequency of 50 Hz to 1 kHz. Each sample was measured for several times and the average was calculated for tomato, sweet potato, apricot, wheat powder and rice powder.

1 Material permittivity ε:

The permittivity of tested samples was measured using

$$\varepsilon = C\, d / A$$

Where:

C: is the capacitance of the food material in farad.

d: is the distance between the two electrodes of the capacitance in m.

A: is the surface area of the electrode in m^2.

2 Relative permittivity ε':

The dielectric constant or relative permittivity of the food material was determined using the relation

$$\varepsilon' = \varepsilon / 8.85 \times 10^{-12}$$

3 Dielectric loss factor ε'':

The dielectric loss factor was determined according to ASAE (1994) as follows:

$$\varepsilon'' = \sigma / (55.36(2450)10^{-12}$$

Where: σ: is the electrical conductivity of the food material

RESULTS AND DISCUSSION

The experimental result for the electrical conductance of sweet potato as a function of signal frequency is as shown in Fig.1. Electrical conductance value for sweet potato at low frequency is very small. Sweet potato shows resistive properties, so it is an insulator or a poor conductor. Thus, the ions and electrons in the skin and flesh are bound and are relatively stable. The low conductance indicates that ions are strongly bound to the constituent substances of sweet potato. Electrical conductance values express the ability of charge movement in the material and depend on the number of ions or free electrons in the material. Electrons of conductive material easily follow changes in the external alternating current. Thus, increasing of electrical conductance would easily occur if the frequency is increased, which is not easily possible in the resistive material. So, increasing the frequency only, slightly changes the conductance value of the resistive material.

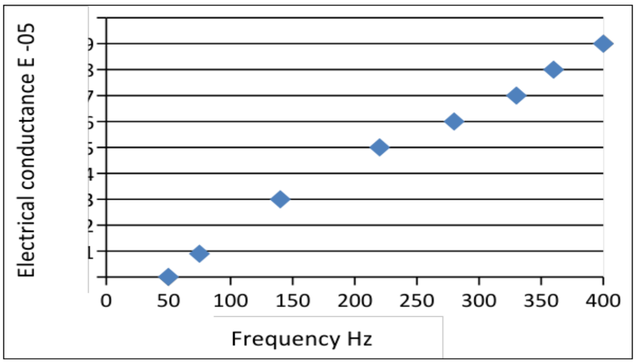

Fig1: Electrical conductance (10^{-5}) against Frequency of sweet potato

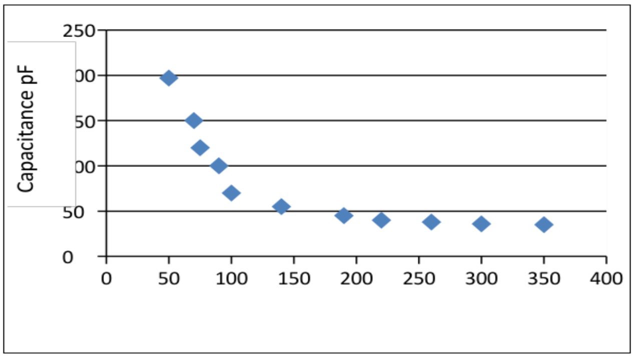

Fig 2: A graph of capacitance in pF against frequency for sweet potato.

Correlation between the frequencies and the conductance does not occur linearly but exponentially. Electrical conductance values of sweet potato increased slightly when the frequency is increased. The most significant improvement occurs when frequencies is above 100 Hz. Increased frequency of the signal will increase the rate of movement of electric charge, so the ions move in sweet potato more effectively. Capacitance describes the ability of capacitors to store energy in the form of electrical charge. The presence of a dielectric material in capacitors causes an increase in the capacitance value. The dependence of dielectric parameters have been examined by plotting curves of capacitance Vs frequency as shown in Fig2.Electrical permittivity is a dielectric property used to explain interactions of

foods with electric fields. It determines the interaction of electromagnetic waves with matter and defines the charge density under an electric field. In solids, liquid, and gases the permittivity depends on two values viz.
1. The dielectric constant, related to the capacitance of a substance and its ability to store electrical energy and
2. The dielectric loss factor, related to energy losses when the food is subjected to an alternating electrical field (i.e., dielectric relaxation and ionic conduction).

In foods, permittivity can be related to chemical composition, physical structure, frequency, and temperature, with moisture content being the dominant factor. Dielectric properties are primarily determined by their chemical composition (presence of mobile ions and permanent dipole moments associated with water and other molecules) and, to a much lesser extent, by their physical structure. The influence of water content largely depends on the manner in which they are bound or restricted in movement by other food components. Free water has a high dielectric activity, while bound water has low activity. Power dissipation is directly related to the dielectric loss factor and depends on the specific heat of the food, density of the material, and changes in moisture content (for example: Vaporization, soaking). Permittivity also depends on the frequency of the applied alternating electric field. Frequency contributes to the polarization of molecules such as water. In general, dielectric constant increases with temperature, whereas loss factor may either increase or decrease depending on the operating frequency. Both the dielectric constant and loss factor decrease significantly. Same results were observed for tomato though water content is more. We observed that capacitance value is more for apricot than wheat powder and rice powder. The moisture content of the food increases the loss factor (for tomato, sweet potato) and determines the dissipation of the energy out of the material or into the material. High values of capacitance at low frequency (50 Hz) could be attributed to high mobility of dipole due to free water state and electrode polarization. Frequency changes will affect the condition of the ions in the material. Ionic loss is inversely proportional to frequency and become critical as we go to the lower frequency. Dissipation of dipolar energy at higher frequencies is less dominant and ionic loss become almost absent. Decrease in the capacitance is not linear when the frequency increased. So it can be said, increasing the frequency of the signal cannot be linearly followed by changes in the internal dipole moment of sweet potato. The frequency of the signal source is a description of the speed of change in the direction of an external electric field. Changes in the external electric field will be followed by changes in the internal electric field of the sweet potato. Increased frequency will increase the speed of dipole changes. Thus, the frequency of the electrical signal will have consequences on the time for polarization. The value of high frequency gives a short time for polarization.

Conflicts of interest: The authors stated that no conflicts of interest.

REFERENCES

1. Incropera, F.P. & Dewitt, D.P. (2002), Fundamentals of heat and mass transfer, 5th ed., John Wiley & Sons, New York.
2. Mohsenin, N.N. (1980), Thermal properties of foods and agricultural materials, Gordon & Breach, New York.
3. Coskuner, Y.; Karababa, E. (2007), Some physical properties of flaxseed (Linum usitatissimum L.), Journal of Food Engineering, 78, 1067–1073.
4. Marzouk M. Bekhit and Saad A. Khalil, "Electrical Properties of Moist Limestone Samples In The Frequency Range 1Hz-10 Hz From Abu Rawash Area", Australian Journal of Basic and Applied Sciences, Vol. 1, No. 4, 2007, pp. 741-750.
5. Zeleny L. (1954): Methods for grain moisture measurements, Agricultural engineering, 35(4)252- 256.
6. Wittkopf J. J. and Macdonald M. D. (1949): Dielectric properties of Douglas fir at high frequencies, Bull. No. 28 Eng. Exp. Sta., Oregon State System of Higher Education, Oregon State Coll., Corvalis, Ore., p. 23.
7. Venkatesh M. S., Raghavan G. S. V. (2005): An overview of dielectric properties measuring techniques, Canadian Biosystem Engineering (47), p.7.15-7.29.
8. Sembery P., Géczi G. and Váczy G. (2001), Measurement Methods of Dielectric Properties of Mustard Seeds at Microwave Frequency Hungarian Agricultural Research, HU ISSN 1216- 4526, Vol. 10, No.3, p.16-18
9. ASAE.1994.Standared, Engineering Practice data, ISBN-929355-50. Lib. of Congress, by Am. Soci. of Ag. Eng, 459-466.
10. Theraja B.L.1993, A text book electrical technology, Pub. division of Nirja Constr. & Dev. Co. (p) Ltd. Ram Nagar, New Delhi-100055,118- 160.

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