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Comparative Study of Agricultural Products at Various Temperature Using Reflectometric Technique.

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ABSTRACT:

In this paper, main view to analysis of agriculture products with different temperature and comparison between physical properties such as dielectric constant ($\in'_p$), dielectric loss ($\in''_p$), relaxation time (τ_p), conductivity (σ_p), in pulverized form, *Pennisetum glaucum*, *Sorghum bicolar*, *Manihot esculenta*, *Lathyrus sativa*, has been studied at different temperature i.e. 20^{O}C, 30^{O}C, 40^{O}C and 50^{O}C. Dielectric parameters are the temperature dependent parameters. It is assumed that the finest crushed particles of smallest seed size (i.e. micron) under a pressure, behaves as a solid bulk. The experimental values have been verified by using co-relation formulas of Landan-Lifshitz-Looyenga and Bottcher. The result shows that the experimental values are very close to the values calculated from the Landau et al. and Bottacher formulae.

Keywords: Dielectric constant, Dielectric loss, Conductivity, Relaxation time, Agricultural products.

INTRODUCTION:

The behavior of dielectric substance is changed by the application of external electric field. The important concept in dielectric theory is that of an electric dipole moment which is measure of electrostatic effect of a pair of opposite charges separated by a finite distance. By using the Clausius-Mossotti equation, which leads to complex number for relative permittivity. By convention, we generally write the complex dieectric constant as -

$\in_r = \in'_r - j \in_r''$ …..(1)

where,

$\in_r'$ is the real part and $\in''_r$ is the imaginary part.

The dielectric parameters are generally dependent an frequency, temperature, density and other factors such as material structure and composition[1,14,15]. In this paper influence of temperature and density and dielectric parameters and thermodynamic parameters are reported. For the development of the field such as dielectric heating effect in germination and early growth of agri-products, improvements in nutritional quality, stored grain insect control, drying of grains, sterilization of grains etc. It is important to know the actual process of molecular level. To get some information in this direction we have undertaken the study of some agricultural products. These samples have been procured from Marathwada Agricultural University, Parbhani.

EXPERIMENTAL DETAILS:

For the determination of dielectric and thermodynamic parameters of agricultural products four samples were prepared by using sieves of different sizes. All the samples transferred into the glass bottles and labeled according to their grain size. To determine the relative packing factor (δ) densities for each powder sample is measured. Measurement of dielectric parameters ($\in'$) and ($\in''$) for these powder samples of different packing fractions were carried out using reflectometer technique at 9.85 GHz. [5,8,13,15,17] microwave frequency and at temperature (20^{O}C to 50^{O}C). But in this study we have noted the values of dielectric parameters for smallest grain size i.e. 62.5 micron particle size which can be considered as solid bulk at a 98 N force.

For the accurate measurements of wavelength in dielectric (λ_d), sample is introduced in the dielectric cell in steps. Applying constant force on the sample, each time the corresponding output power is measured by using crystal pick in the directional coupler. The relationship between reflected power and the sample height is approximately given by a sampled sinusoidal curve. The distance between two adjacent minima of the curve gives half the dielectric wavelength (λ_d).

Determination of molecular parameters:

The dielectric constant ($\in'$) and loss factor ($\in''$) for the agricultural products in powder at microwave frequency are determined by using relations[5,13,14,15].

$$\varepsilon'_p = \left(\frac{\lambda_0}{\lambda_c}\right)^2 + \left(\frac{\lambda_0}{\lambda_d}\right)^2 \qquad \ldots\ldots (2)$$

$$\varepsilon''_p = \frac{2}{\pi}\left(\frac{\lambda_0}{\lambda_c}\right)^2 \frac{\lambda_g}{\lambda_d}\left(\frac{d\rho\ mean}{dn}\right)^2 \qquad \ldots(3)$$

Where, λ_o = is free space wavelength,

λ_d = is wavelength in dielectric

λ_c = is cutoff wavelength of the wave guide

λ_g= is guide wavelength

The conductivity (σ_p) and relaxation time (τ_p) are obtained by using following relations[1, 6,11,18].

$$\sigma_p = \omega \in_0 \in'' \quad \ldots\ldots\ldots (4)$$

$$\tau p = \in'' / \omega \in' \quad \ldots\ldots\ldots (5)$$

Using relation (1) and (2) values of dielectric constant $\in'_p$ and dielectric loss $\in''_p$ different temperatures are obtained. The values of conductivity (σ_p) and relaxation time (τp) are obtained using the above relations (3) and (4). The values of $\in'_s$ and $\in''_s$ for bulk materials can be co-related for powder by using the relations given by Bottcher and Landau-Lifshtz-Looyenga[4,10,11,12,18].

RESULTS AND DISCUSSION:

Values of dielectric constant ($\in'$), dielectric loss ($\in''$), relaxation time (τ) and conductivity (σ) of agricultural products, for different temperatures are presented in Table 1. An examination of Table - 1 indicates that, there is a decrease in $\in'$, $\in''$, relaxation time and conductivity values with the increase of temperature. Such behavior is expected because according to Debye, when polar molecules are very large then under the influence of electromagnetic field of high frequency, the rotary motion of polar molecular of system is not sufficiently rapid to attain equilibrium with the field. The decrease in relaxation time with increased values of temperature due to increase in effective length of dipole. Again, increase in temperature causes an increase in energy loss due to large number of collisions and there by decrease the relaxation time. Graphical representation of ∈', ∈", relaxation time and conductivity for different temperature (20^{O}C to 50^{O}C) are shown in figure 1 to 4.

In the present study, it is observed that there is a fair agreement between experimental values and theoretical values. Another result indicates that the values of Dielectric constant, Dielectric loss of four selected samples are near about same, values observed by experimental methods of relaxation time are decreases with increase in temperature. The values of conductivity of Pearl Millet, Jowar, Tapioca are higher than lathyrus sativa. Hence, it may be predicted that the samples in powder form shows large cohesion in its particles and may serve as a continuous medium.

Table -1

Values of ϵ'_p, ϵ''_p, τ_p and σ_p with co-relation of Bottchers (ϵ'_s and ϵ''_s) and Londau *et al.* (ϵ'_s and ϵ''_s) at different temperatures.

Temp. (^{O}C)	ϵ'_p	ϵ''_p	τ_p (p.s.)	σ_p (10^{-2})	ϵ'_{s1} Bottchers	ϵ'_{s1} Londau	ϵ''_{s2} Bottchers	ϵ''_{s2} Londau
	(Pennisetum glaucum)							
20	3.248	0.569	2.83	31.13	3.248	3.170	0.569	0.541
35	3.161	0.540	2.72	29.51	3.161	3.090	0.539	0.535
50	3.125	0.462	2.39	25.30	3.125	3.070	0.462	0.569
	(Sorghum bicolor)							
20	3.354	0.645	3.11	35.30	3.354	3.260	0.645	0.645
35	3.338	0.555	2.70	30.41	3.339	3.270	0.555	0.556
50	3.164	0.441	2.25	24.15	3.164	3.120	0.441	0.442
	(Manihot esculenta)							
20	2.908	0.598	3.32	32.72	2.908	2.820	0.598	0.598
35	2.874	0.514	2.89	28.12	2.874	2.810	0.514	0.514
50	2.860	0.468	2.65	25.62	2.860	2.810	0.468	0.468
	(Lathyrus sativus)							
20	3.16	0.284	1.45	15.6	3.14	3.160	0.284	0.284
30	2.97	0.254	1.39	13.9	2.950	2.970	0.254	0.254
40	2.79	0.227	1.310	12.4	2.780	2.790	0.227	0.227
50	2.70	0.213	1.280	11.7	2.690	2.70	0.213	0.213

1. *Pennisetum glaucum*

Fig. 1.1 Temperature V/s dielectric constant (∈')

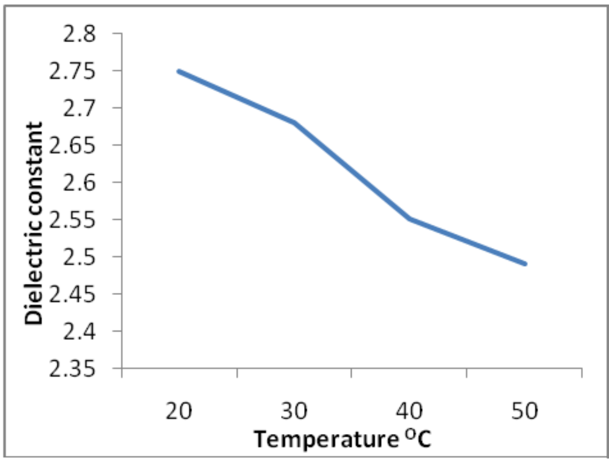


Fig.1.2. Temperature V/s Dielectric loss (∈")

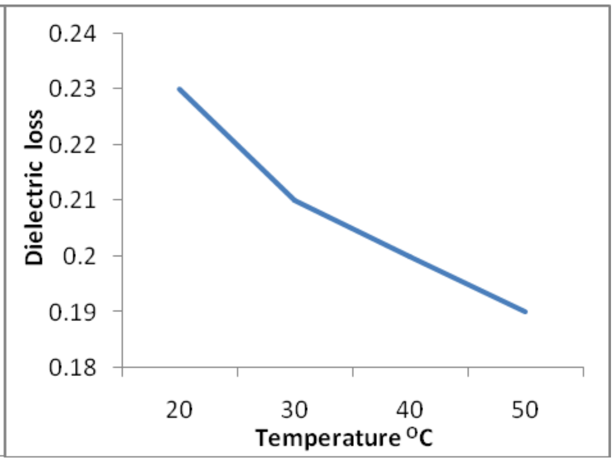


Fig. 1.3 Temperature V/s relaxation time (τ)

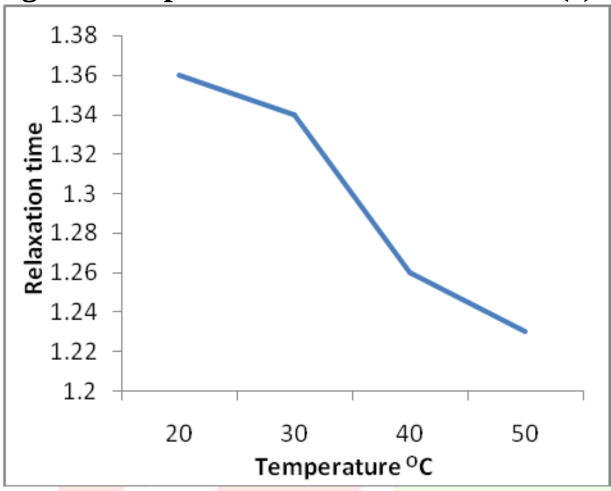
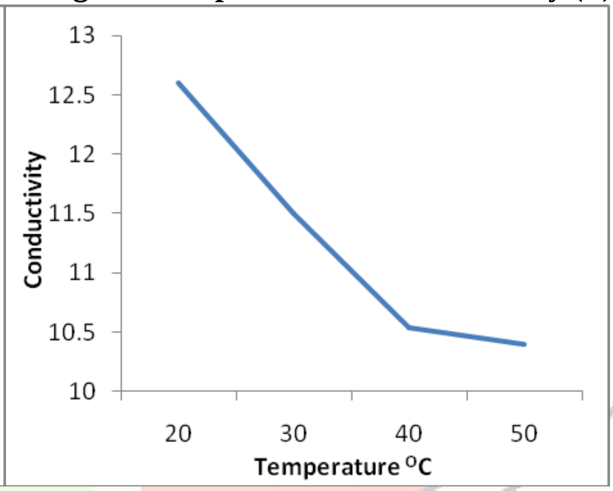


Fig.1.4. Temperature V/s conductivity (σ)



2. *(Sorghum bicolor)*

Fig. 2.1 Temperature V/s dielectric constant (∈')

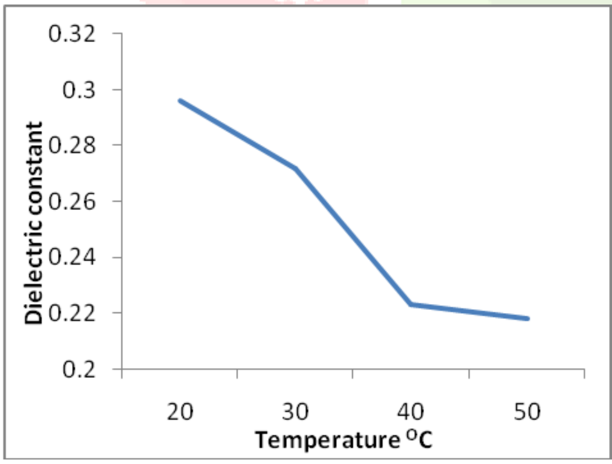


Fig.2.2. Temperature V/s Dielectric loss(∈")

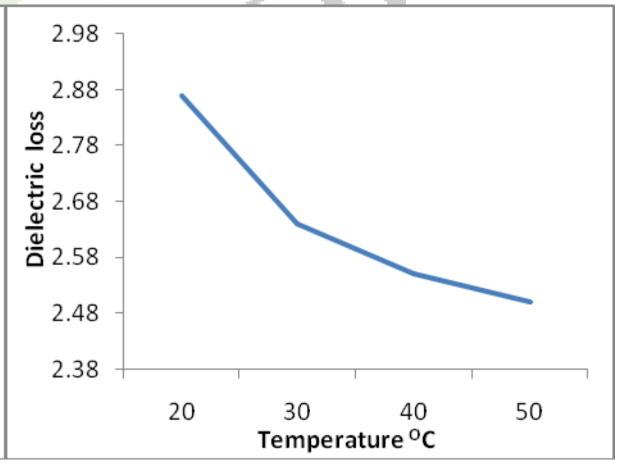


Fig. 2.3 Temperature V/s relaxation time (τ)

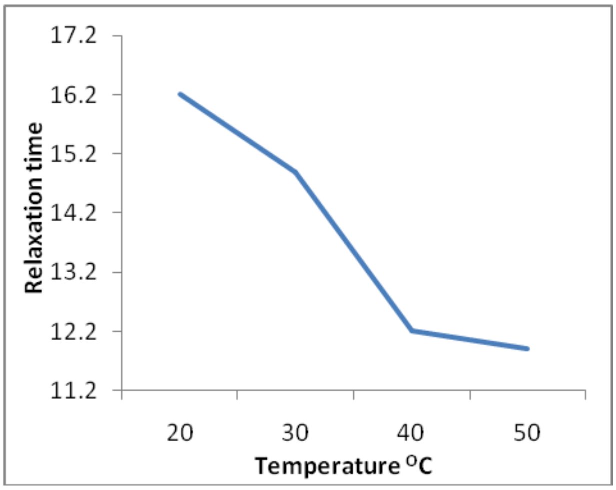
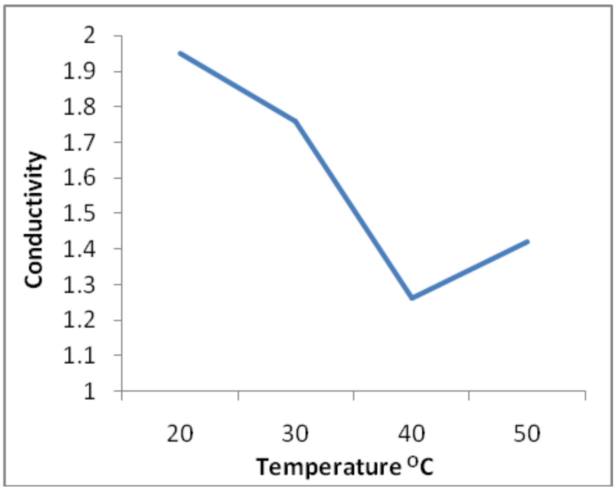


Fig.2.4. Temperature V/s conductivity (σ)



2. *Manihot esculenta*

Fig. 3.1 Temperature V/s dielectric constant (∈')

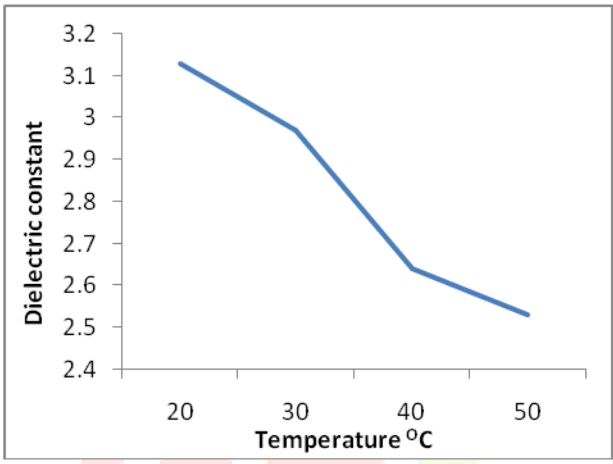


Fig.3.2. Temperature V/s Dielectric loss(∈")

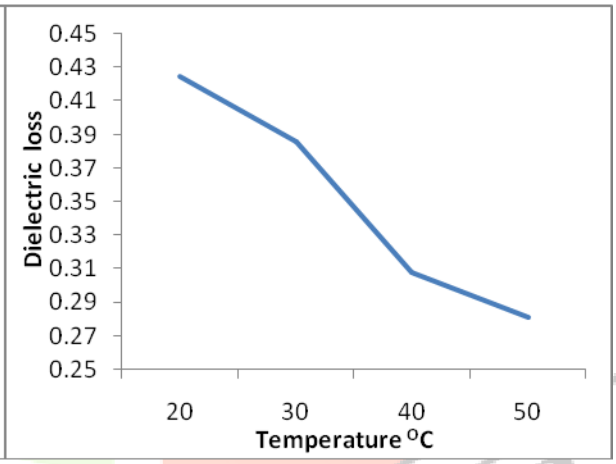


Fig. 3.3 Temperature V/s relaxation time (τ)

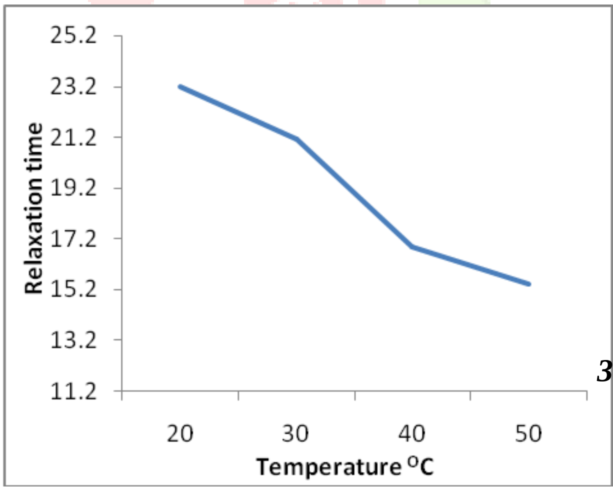
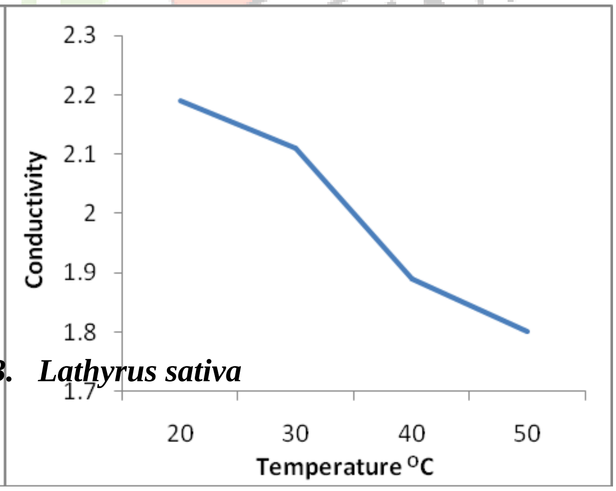
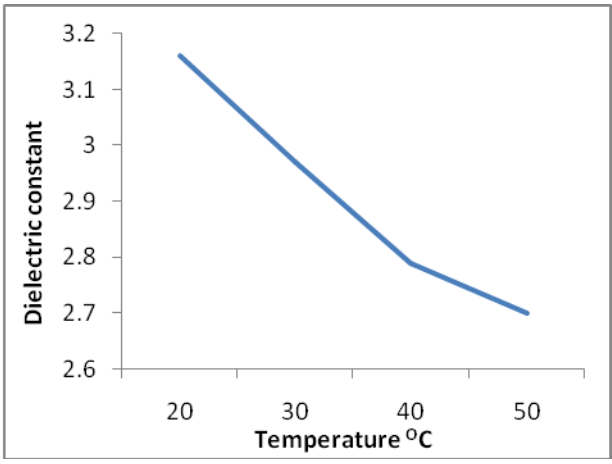


Fig.3.4. Temperature V/s conductivity (σ)



3. *Lathyrus sativa*

Fig. 4.1 Temperature V/s dielectric constant (∈') **Fig.4.2. Temperature V/s Dielectric loss(∈")**



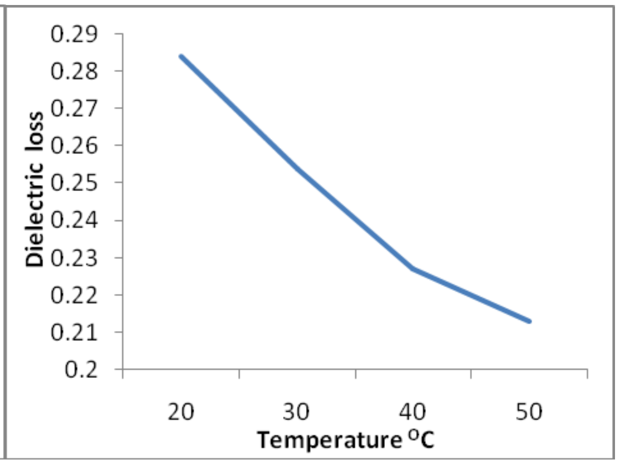
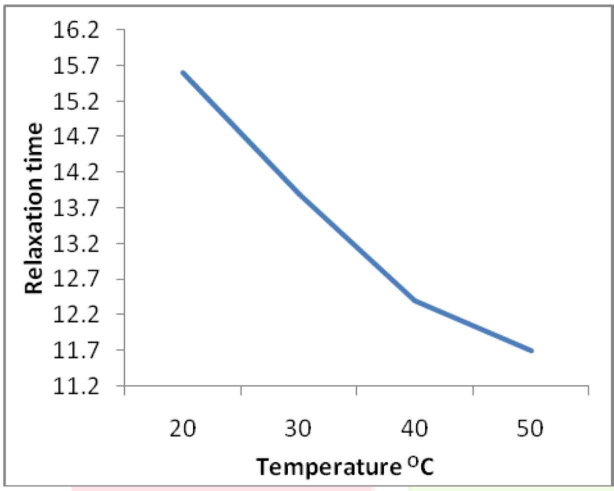
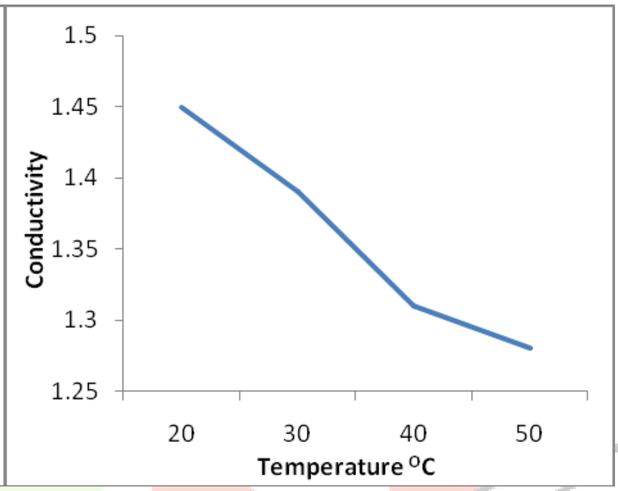


Fig. 4.3 Temperature V/s relaxation time (τ) **Fig.4.4. Temperature V/s conductivity (σ)**





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