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Dielectric measurement of *Pulverized Coriander* (*Coriandrum sativum* Linn.) at microwave frequency.

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Abstract

The moisture content, conductivity, nutritional quality, dielectric heating effect on germination and growth of agricultural products, are the important with respect to quality maintenance. To understand the actual process at molecular level the investigation on dipolar behavior of coriander *(Coriandrum Sativum* Linn.) in the form of powder, at microwave frequency 9.85 GHz are carried out for different grain sizes and at different temperatures. The effect of packing density on dielectric parameters, relaxation time, and conductivity of coriander are reported.Experimental results of different relative packing fraction (δr) are further used to obtain transformation to 100% solid bulk, using correlation equations of Landau-Lifshitz-Looyenga and Bottcher. It is found that, there was fair agreement between experimental values and theoretical values. The result shows cohesion in the particles of Coriander powder under investigation.

Keywords: Coriander, Dielectric constant, Dielectric loss, Microwave technique.

INTRODUCTION

In recent years, to obtain the information on biophysical properties of seeds, fruits and other agricultural products, the study of dielectric behaviour from microwave absorption is used. The dielectric properties of agric- products describe interaction with microwave energy and depend on the frequency of electromagnetic field as well as on bulk particle properties of materials such as moisture content, density, temperature, packing fraction, relaxation time and chemical composition [1, 2, 3 and 4].

Coriander is cultivated in partially all the states and constitutes an important subsidiary crop in the black cotton soils of Maharashtra. Particularly all the parts of the plant, that is tender stem, the leaves, flowers and the fruits have a pleasant aromatic fragrance. The coriander leaves also constitute one of the richest sources of vitamin C (250mg/100g) and vitamin A. Its use as a condiment in curries, and particularly as fresh leaves for garnishing of curries and other dishes, and chutney as an appetizer, should be encouraged. Coriander seeds are considered to be carminative, diuretic, tonic, stomachic, antibilious, refrigerant and aphrodisiac. The seeds are chewed to correct foul breath [5].

MATERIALS AND METHODS

Using microwave reflectometric technique the dielectric constant ($\in'$), dielectric loss (ε''), relaxation time (τ_p), Conductivity (σ_p), and loss tangent (Tanδ), of Coriander are determined. Three samples of various particle sizes were prepared by using sieves of three different sizes and transferred into the glass bottles and sealed to avoid moisture intake while taking reading [5 and 6].

Relative packing fraction, the density (ρ) for each powder samples was measured. The moisture percentage of powder sample was measured using thermo-gravimetric method [7].

To determine wavelengths (λ_d) in dielectric, coriander sample powder introduced in the sample holding dielectric cell in steps and applying constant force on the sample, the corresponding reflection coefficient was measured by using crystal pick up in the directional coupler. The relationship between reflected power and the sample column position is approximately given by damped curve. The distance between two adjacent minima gives half the dielectric wavelength (λ_d). For accurate measurements of the dielectric wavelength λ_d, the dielectric cell was fabricated and designed by Kalamse et al.[8 and 9] is used.

The dielectric constant (ε'), and dielectric loss (ε''), for Tapioca powder at microwave frequencies were determined by the formulae.

$$\in' = \left(\frac{\lambda_0}{\lambda_c}\right)^2 + \left(\frac{\lambda_0}{\lambda_c}\right)^2 \quad \text{............ (1)}$$

$$\in'' = 2\left(\frac{\lambda_0}{\lambda_d}\right)^2 . \left(\frac{\alpha_d}{\beta_d}\right) \quad \text{................ (2)}$$

Where,

α_d – the attenuation introduced by the unit length of material.
β_d – the phase shift introduced by unit length of the material.
$\beta_d = 2\pi/\lambda_d$

$$\sigma_p = \omega \in_0 \in'' \quad \text{------------- (3)}$$

$$\text{And, } \tau_p = \frac{\in''}{\omega \in'} \quad \text{------------- (4)}$$

Where,

ω -is the angular frequency of measurement 9.85 GHz.
$\in_0$ - is the permittivity of vacuum.

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RESULTS AND DISCUSSION

The dielectric properties of Coriander depend on the packing fraction, temperature, relaxation, time, conductivity and moisture content, density of sample powder.

Correction of Dielectric parameter and temperature, packing fraction

The dielectric constant (ε'), dielectric loss (ε"), relaxation time (τ_p), loss tangent (Tanδ), bulk density (ρ) of coriander with packing fraction, temperature are listed in the table 1.

The dielectric constant, dielectric loss, relaxation time, loss tangent, bulk density, values increases with the increase in packing fraction of Coriander sample powder.

This result shows, higher values of relative packing fraction the inter particle hindrances offered to the dipolar motion of molecules in an electromagnetic field at microwave frequencies is high for compact medium, such results were made by other researcher [10, 11 and 12].

Correlation between dielectric parameters, relaxation time, moisture content, temperature, density

The values of dielectric constant, dielectric loss, relaxation time, conductivity and bulk density decreases with the decreases in moisture content of sample powder. With the increase in the temperature in 20º, 35º and 50ºc step the values of dielectric constant, dielectric loss, relaxation time, bulk density, conductivity decreases but these values increases with the increase in packing fraction. Such behavior suggests that, the adhesion the molecule decreases due to increase in hindrances to the process of polarization and rotatory motion of the molecules. This results decrease in the dielectric parameters.

The bound water filled in the gaps of heterogeneous mixture molecules, which enhances the dielectric parameter. The same result is true for the particles of smaller in size polar molecules are sufficiently rapid to attain the equilibrium with field than larger, hence that there is decrease in relaxation time [7].

Correlation between relaxation time, conductivity, temperature and packing fraction

The values of relaxation time, conductivity increases with the increase in packing fraction. With the increase in temperature of coriander sample powder in steps 20º, 35º and 50ºC the values of relaxation time, loss tangent, and conductivity decreases.

The result shows that, the decrease in relaxation time with increase in temperature is due to increase in the effective dipole length of dipoles of molecules in the sample powder, the decrease in relaxation time is also energy loss of dipoles due to increase in number of collisions. The dielectric loss is proportional to A C conductivity. Hence, there is decrease in conductivity due to increase in temperature.

Fitting dielectric parameter in Landau-Lifshitz-Looyenga and Bottcher formulae

In the table - 2 list of measured and computed values of dielectric parameters for bulk from powder of coriander at different temperatures and packing fraction. The result obtained at packing fraction δ_r = 1.

The specimen having minimum particle size of sample powder is finest about 70 micrometers. We assume it as solid bulk for δ_r = 1 getting correlation between powder and solid bulk. The result reported at are those measured on the finest crushed powder sample packed very closely in a sample holding dielectric cell, at force to obtain minimum voids between the particles. Other results for δr < 1 were obtained for different solid bulk. The correlation formulae of Landau and Bottcher (1960) [14 and 15].

The values obtained for bulk, dielectric permittivity and dielectric loss, are closer to the measured values of dielectric permittivity and dielectric loss at packing fraction δ_r =1.

This supports the assumptions of Landau and Bottcher [15] of choosing the finest crushed closely packed powder sample as a bulk. Matching of calculated and measured values of dielectric permittivity and loss values shows that the accuracy of measurement of dielectric wavelength λ_d, slight disparity in measurement gives inaccurate λ_d.

Table 1. Values of dielectric constant (ϵ'^{p}), dielectric loss (ϵ''^{p}), loss tangent (tanδ), relaxation time (τ_p), conductivity (σ_p) and moisture percentage of Coriander powder at different temperatures and packing fraction (δ_r)

Temp ˚C	Packing Fraction (δ_r)	$\in'_p$	$\in''_p$	tanδ	τ_p (p.s.)	σ_p (10^{-2})	Moisture (%)
20˚C	0.9249	2.913	0.324	0.111	1.795	17.73	0.751
	0.9671	3.027	0.426	0.141	2.279	23.32	0.575
	1.00	3.150	0.544	0.173	2.797	29.77	0.242
35˚C	0.9249	2.757	0.266	0.096	1.552	14.56	0.636
	0.9671	2.916	0.302	0.104	1.681	16.53	0.511
	1.00	3.001	0.364	0.121	1.956	19.92	0.445
50˚C	0.9249	2.731	0.221	0.081	1.309	12.09	0.757
	0.9671	2.878	0.278	0.097	1.568	15.22	0.623
	1.00	2.969	0.283	0.098	1.552	15.50	0.463

Table 2. Measured and calculated values of dielectric constant (ϵ'^{S}) and dielectric loss (ϵ''^{p}) for bulk from powder at different temperatures and packing fraction (δ_r)

Temp ˚C	Relative Packing Fraction (δr)	$\in'_s$ For solid bulk			$\in''_s$ For solid bulk		
		Measured	Calculated From Bottcher's formula	Calculated From Landu, *et al* formula	Measured	Calculated From Bottcher's formula	Calculated From Landu, *et al* formula
20˚C	0.9249	3.150	3.116	3.072	0.544	0.366	0.362

	0.9671 1.00		3.117 3.150	3.080 3.158		0.449 0.544	0.447 0.544
35˚C	0.9249 0.9671 1.00	3.001	2.942 2.987 3.001	2.921 2.976 2.990	0.364	0.301 0.318 0.364	0.297 0.316 0.364
50˚C	0.9249 0.9671 1.00	2.969	2.913 2.960 2.969	2.900 2.940 2.950	0.283	0.249 0.293 0.283	0.246 0.292 0.283

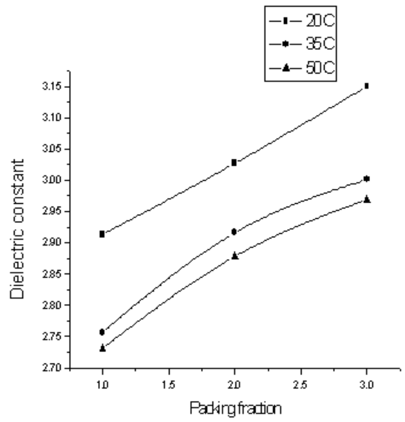

Fig.1 : Packing fraction Vs Dielectric constant

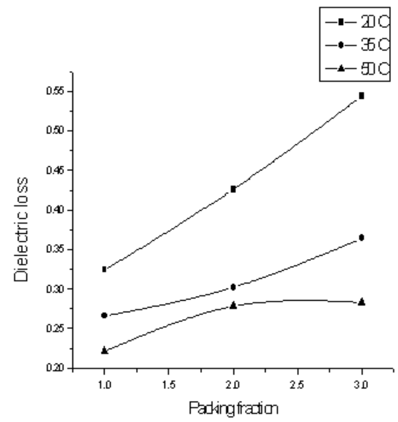

Fig.2 : Packing fraction Vs Dielectric loss

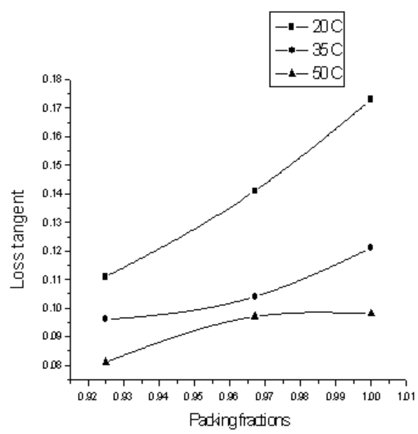

Fig. 3. Packing fraction Vs Loss tangent

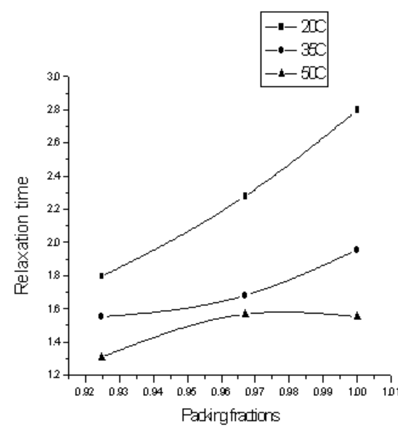

Fig 4. Packing fraction Vs Relaxation time

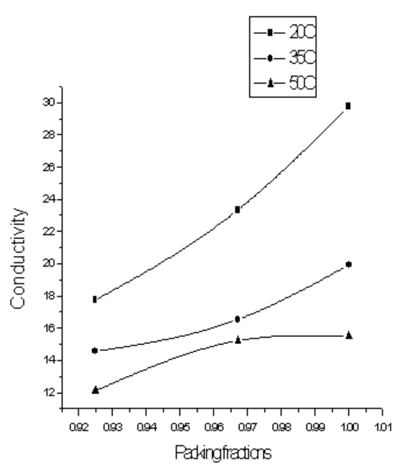

Fig 5. Packing fractions Vs Conductivity.

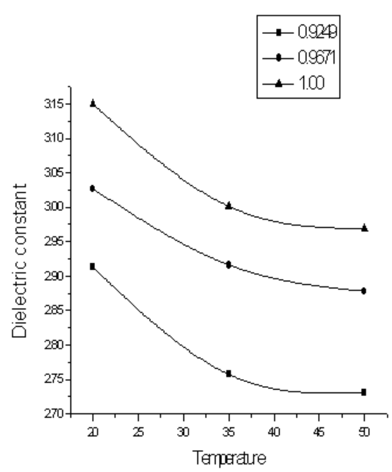

Fig 6. Temperature Vs Dielectric constant

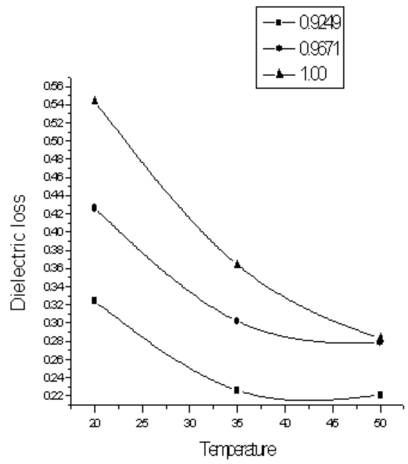

Fig 7. Temperature Vs Dielectric loss

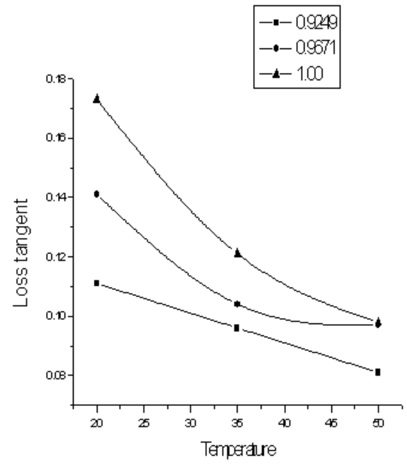

Fig 8. Temperature Vs Loss tangent

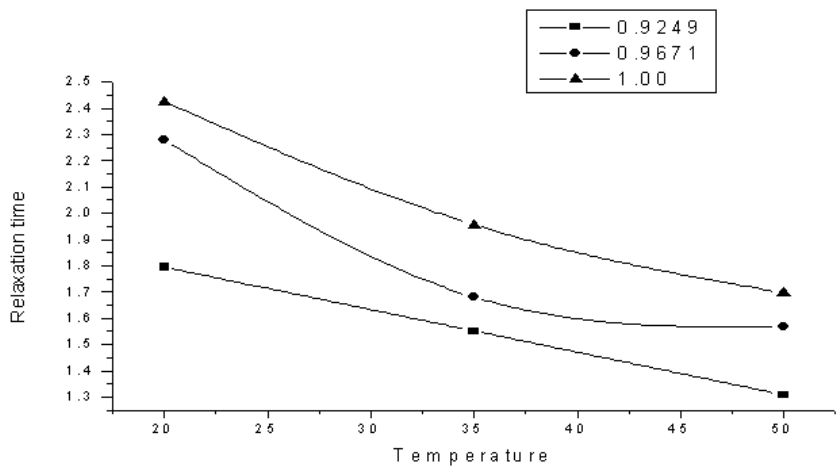

Fig 9. Temperature Vs Relaxation time

CONCLUSION

Moist material is usually an inhomogeneous mixture, contains bound water in the gaps of powder molecules, which increases the dielectric parameters. At present, from dielectric properties of moist material of different structures containing water in various levels of binding very little is known, for the further research the topic is open for investigation.

For packing fraction δr = 1 the medium is compact, the values of dielectric parameters are higher than less bound particles.

The correlation formulae for Landau-Lifshitz-Looyenga and Bottcher between powder and solid bulk give satisfactory results. There was fair agreement between the values obtained experimentally and theoretically of dielectric parameters. This shows large cohesion in the particles of coriander powder under investigation, serve as continuous medium.

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REFERENCES

[1] Bansal, A. K., Singh, P.J. and Sharma, K. S. 2001.Microwave dielectric measurements in different varieties of rapeseed mustard seed in powder form. *Indian Journal of Pure and Applied Physics.* 39:799-803.

[2] Kraszewski, A. and Nelson, S. O. 1993. Microwave permittivity of pecan nuts, *Journal of microwave power of Electromagnetic Energy.* 28(3): 165-175.

[3] Kraszewski, A. and Nelson, S. O. 1994. Determination of moisture content and bulk of shelled corn by measurement of microwave parameters. *Journal of Agricultural Engineering Research*. 58: 37-46.

[4] Nelson, S. O. 1992. Measurement and application of dielectric properties of agricultural products. *IEEE transaction on Instrumentation and measurement* 41 (1):116-122.

[5] Purthi, J S. Spices and Condiments. National Book trust, New Delhi, India.

[6] Sisodia, M. L. and Raghuvanshi, G. S. 1990, Basic microwave technique and Laboratory mannual, Willey Eastern Ltd.

[7] Reynold, S. G. 1970.The gravimetric method of soil moisture

determination ; A study of equipment and methodological problem. *Journal Hydrol*.11: 256-273.

[8] Gawali, P. G., Rekha pande, Kalamse, G.M. 2005.Dielectric behaviour of chickpea at microwave frequencies. *Indian Journal of Pulses research,* 18(2):192-195.

[9] Dictionary of Indian Raw materials 1976. Wealth of India, Govt. of India press, CSIR, New Delhi.

[10] Bhatnagar, D, Gandhi, J. M. and Yadhav, J. S. 1996. Estimate of dielectric behaviour of bulk materials using its powder. *Indian Journal of Physics.*70 A (4) :539- 542.

[11] Jagid R. A., Neeru, Bhatnagar, D., and Gandhi, J. M. 1996. Microwave probing to study particulate behaviour of basic powdered material. *Indian Journal of pure and Applied Physics*. 34 : 316-318.

[12] Yadhav, J. S. and Gandhi, J. M. 1992. Simple microwave technique for measuring the dielectric parameters of solids and their powders, *Indian Journal of Pure and Applied Physics*. 30:427.

[13] Dielectric phenomenon in Solids. 2004. Kwan Chi Kao, *Elsevier* Academic press, London.

[14] Bottcher, L.J. F. 1952. Theory of dielectric polarization. *Elsevier*, Amsterdam. Pp- 415.

[15] Landau, L. D. and Lifshitz, E. M. 1960. Electrodynamics of continuous media. Perjaman press, London. Pp- 46.