ORIGINAL PAPER

DIELECTRIC STUDY OF PURE AND INSECTICIDE TREATED RICE SEEDS (*ORYZA SATIVA L.*)

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Abstract. *The present paper discusses the dielectric properties of insecticide treated and untreated rice seeds. The study revels that the dielectric constant and dielectric loss the both, treated and untreated rice seeds show similar behaviour except the noticeable change in dielectric constant and dielectric loss values of insecticide treated rice seeds. The effect of moisture on these properties has also been studied and it has been found that the moisture content largely affects these properties. For dielectric measurement impedance gain phase analyser HP 4194 A was used and for maintaining the temperature of these samples constant, a micro controller based temperature controller, Julabo F 25 was used.*

Keywords: *Dielectric constant, dielectric loss, moisture content, insecticide.*

1. INTRODUCTION

Dielectric properties of food and agriculture products have attracted attention of scientific community a lot. These properties are of paramount importance, when these products are subjected to microwave or radio frequency (RF) heating or high frequency radiation. Dielectric study of these products is essential in the designing of electrical equipments for online monitoring of their quality analysis.

There are various factors which affect the dielectric properties of seeds and grains like moisture content, bulk density, temperature, frequency of the applied alternating electric field, ionic nature, structure, constituents of food materials and concentration etc. [1]. Temperature and frequency affect the dielectric properties of these materials largely. Composition of food materials also affects its dielectric properties tremendously. Carbohydrate, protein, salt content and moisture are the other important components of food material. Water in food materials is found in either free or bound form. Free water affects dielectric constant more than bound water in the microwave frequency range. Carbohydrates affect the dielectric properties by forming hydrogen bonds with water but they do not show dipolar polarization at microwave frequencies. Impact of free water on dielectric properties becomes significant for carbohydrate solutions. Fats and lipids show very minute effect, they only show effect on dielectric properties due to dilution of water. Protein de-nutrition affects the dielectric properties of food materials, however, proteins are not much affected at microwave frequencies.

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The knowledge of dielectric properties of grains and seeds are important because of their application in the moisture measurement and moisture content measurement is important for the preservation and protection of such materials from insects and pathogens [1-2]. The preservation and protection can be achieved by heating them in such a way that the heat energy destroys only insects etc. without harming the host material [3]. The dielectric properties of seeds are also helpful in studying the viable test [4]. Dielectric studies of many seeds have been reported by various researchers [6-12].

2. MATERIALS AND METHODS

2.1. MATERIALS

The rice seeds used in present investigation were purchased from a local market of Lucknow, UP, India. Before the experiments, the seeds were cleaned manually to remove foreign matter. The moisture content in rice seeds was determined on wet basis. The various moisture contents were adjusted by adding distilled water and conditioning of the samples at 22ºC. The rice seeds were subjected to frequent agitation to aid uniform moisture. These were stored in sealed jars at 22ºC and permitted to reach at room temperature in sealed jars before opening for measurements. The samples were kept in this condition for about 24 hours before the measurements were taken.

2.2. METHODS

The capacitances (C_M) and dissipation factor (D_M) measurements have been made with the help of impedance/gain phase analyzer (model No. HP-4194A, frequency range 100Hz to 40 MHz) using a coaxial cylindrical capacitor. The sample holder has been silver plated to reduce dissipation losses. It was calibrated using standard liquids (Benzene and Methanol) and error in measurement for dielectric constant (ε') was found to be 1% and for dielectric loss (ε'') was 1.5%. The formulae for the measurement of dielectric constant and dielectric loss have already been published elsewhere by many researchers [1, 4-12].

3. RESULTS AND DISCUSSION

Fig. 1 is representing the variation of dielectric constant with frequency at different percentage of moisture content at constant temperature 25°C. The figure 1 represents the decrease in dielectric constant with increase in frequency which exhibits the dielectric dispersion in the material. High values of dielectric constant at low frequency region (5kHz and 10 kHz) and high moisture content could be attributed to high mobility of dipoles arising from the water molecules and also due to electrode polarization [1].

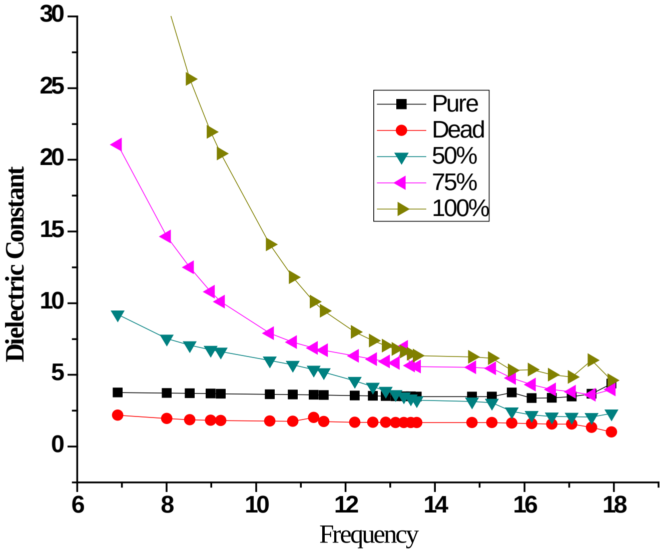

Figure 1. Variation of dielectric constant with frequency at different moisture content including pure and dead seed.

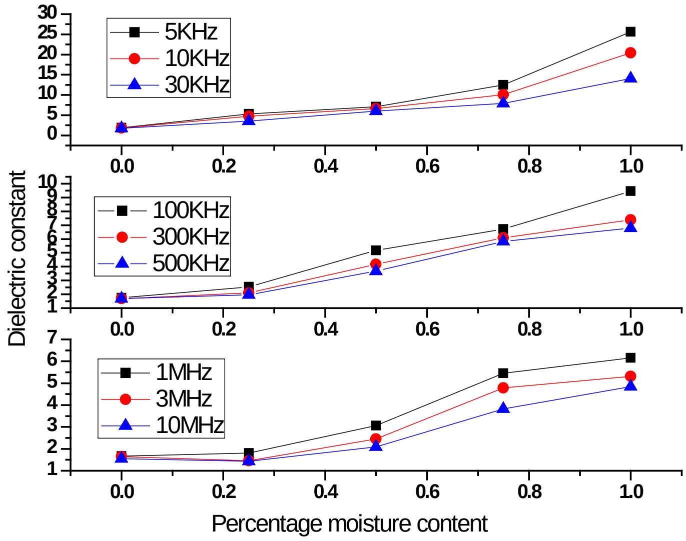

Figure 2. Variation of dielectric constant with percentage moisture content at different frequencies and temperature.

In Fig. 2 dielectric constant increases with increase in moisture level at a given temperature and different frequencies. The rate of increase of dielectric constant with the moisture content is high at low frequencies particularly at 5 kHz and 10 kHz. This is obvious from the fact that at high moisture level more water dipoles contribute to the polarization, because of high water mobility, the water dipoles easily follow the applied field variations. At low moisture contents, particularly below 10% dielectric constant of the complex permittivity are small. The reason behind it is strong bound water state (monolayer) where distance between the water molecule and cell wall is very small and attraction force is very large. Therefore, the dielectric constant are small with the increase of moisture level increases beyond 10% increase for the samples dielectric constant of the complex permittivity accelerates and this trend could be attributed to change of bound water state from first(monolayer) to second (multilayer) type. Sharp increase is noticed for all the frequencies for the high moisture content, particularly when moisture content is 10% and frequency 10 kHz. This behaviour could be attributed to the transition of bound water state second (multilayer) to third (osmotic tension) type or free-state water [1, 7, 10].

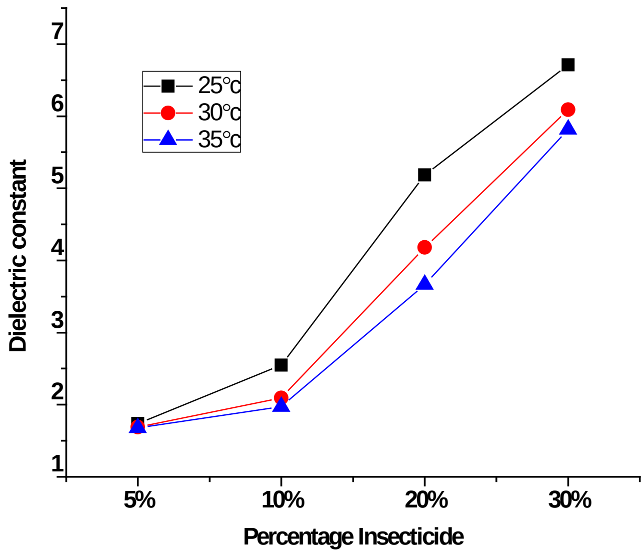

Figure 3. Variation of dielectric constant with variation of insecticide at three different temperatures.

The Fig. 3 shows dielectric properties of seeds at different % of insecticide. It is clear that dielectric constant increases sharply at 10% moisture content at all temperatures. The magnitude and increase in dielectric constant value is highest when temperature of the seeds is 25^0C [1, 7-11].

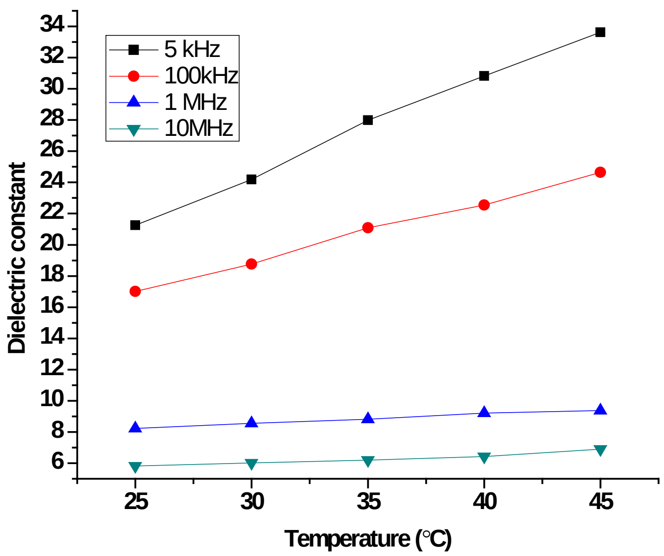

Figure 4. Variation of dielectric constant with temperature at four different frequencies.

Temperature is important factor on the dielectric properties of materials. The graph has been plotted between dielectric constant and temperature. At decreased 25°C and low frequency 5 KHz dielectric constant increases. But when we increases frequency 100 KHz dielectric properties decreases comparatively 5 KHz frequency. On 1MHz frequency dielectric properties shows very least variation in dielectric constant. And on 10 MHz frequency it tends to saturation condition and exhibit negligible increment [1, 4-9].

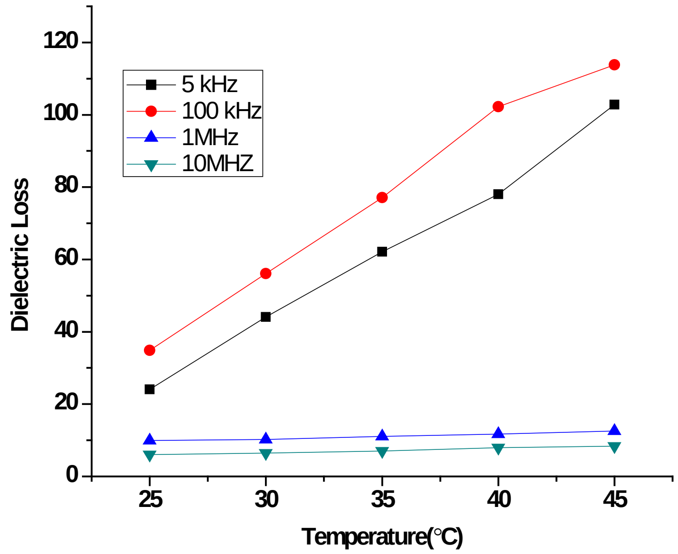

Figure 5. Variation of dielectric loss with temperature at four different frequencies.

The present graph is showing variation of dielectric loss verses temperature at indicated frequencies. At 5 kHz (low frequency) as temperature increases dielectric properties increases continuously. As we increase frequency to 100 kHz the increment is very much similar to 5 kHz. Further increases in frequency 1 MHz and 10 MHz dielectric loss does not show the similar trend and eventually attains saturation condition [4-12].

4. CONCLUSIONS

Following conclusions are drawn from the present observations:

- Dielectric constant of rice seeds decreases with increase in applied frequency.
- Dielectric constant of rice seeds increases with increase in moisture content of the rice seeds.
- Dielectric constant of insecticide treated seeds is more than untreated seeds.
- Dielectric constant increases with increase in temperature also.

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