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Comparative Dielectric Behaviour of Black Pepper and White Pepper

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ABSTRACT

The present paper discusses the comparative dielectric constant and dielectric loss of black pepper and white pepper within frequency range 10 kHz and 10 MHz and temperature between 300C to 510C. Impedance gain/phase analyser (HP 4194 A) was used to measure the dielectric constant and the dielectric loss and Julabo (temperature controller, F-25, Germany) was used for keeping the temperature of black pepper and white pepper seeds constant. It has been found that dielectric constant and loss is decreasing with the increase in frequency while the same are increasing with increase in temperature and moisture content.

Key words: Black pepper, white pepper, dielectric constant, dielectric loss, moisture content

INTRODUCTION

Black Pepper (Piper nigrum L), the King of Spices, is the most important and most widely used spice in the world. It belongs to the family of piperaceae and grows in the South Western region of India (Kerala, parts of Karnataka, Tamil Nadu and Goa). Apart from India other major producers of the black pepper and the white pepper are; Vietnam, Sri Lanka, Malaysia, Indonesia and few other countries. White pepper (Piper nigrum) is also a popular variety of pepper, also known as pepper corn; it also belongs to the family of Piperaceae. Both black pepper and white pepper are produced from the same barriers through different processes. For black pepper barriers are harvested when they are greenish yellow, then they are dried in sun, on the other hand for white pepper barriers are harvested when they are red or reddish orange. These ripe barriers are kept in water for some days, thus their skin becomes soft, which can be removed easily. They are also dried in sun. Black pepper has greater percentage of share in spice market than other spices [1]. Black Pepper is used in traditional medicinal systems like ayurveda, Siddha and Unani [2, 3]. It is used in curing asthma, cough, heart diseases, night blindness, urinary disorders and many pains. Black pepper as drug in the Indian and Chinese systems of medicine is well documented [4, 5]. Per 100g of black pepper contains, water 9.5-12.0g, protein 10.9-12.7g, starch 25.8-44-8g, fiber 9.7-17.2g, ash 3.4-6.0g, piperrine $C_{17}H_{19}O_3N$ 4.9-7.7%, essential oils mainly monoterpene and sesquiterpene 1.0-1.8% on the other hand per 100g of white pepper contains water 9.5-13.7g, protein 10.7-12.4g, starch 53.9-60.4g, fiber 3.5-4.5g, ash 1.0-2.8g, piperrine $C_{17}H_{19}O_3N$ 5.5-5.9%, essential oils mainly monoterpene and sesquiterpene 0.5-0.9% [6].

Literature survey reveals that Prashant B. Shyamkumar et al. reported antidiarrhoeal effect of black pepper [7-9], Murlidhar Meghwal et al. [10] reported DSC and thermal diffusivity of black pepper and its volatile oils. Amar Singh et al. [11] showed that piperine (an alkaloid), a component of black pepper is a good bioenhancer. In recent reviews Murlidhar et al. [12-13] showed that black pepper has carminative, anti cancer, cholesterol lowering, anti pyretic and immune enhancer properties while Shabnam Ashouri et al. reported insecticidal activities of black pepper [14]. The applications of dielectric spectroscopy in agrophysics are recently documented in a review by Skierucha et al. [15].

Most of the researchers have focused their studies on the medicinal properties of the black pepper seeds, but no studies have yet been done to explore the physical properties of black pepper and white pepper, so it is worthwhile to study comparative dielectric properties of black pepper and white pepper.

MATERIALS AND METHODS

The black pepper and white pepper seeds were purchased from a local market. Before the experiments, the seeds were cleaned manually to remove foreign matter. The moisture contents in black pepper and white pepper seeds were determined on wet basis. The moisture contents were adjusted by adding distilled water and conditioning of the samples at 20ºC. The samples were subjected to frequent agitation to aid uniform distribution of moisture. These were stored in sealed jars at 20ºC and permitted to reach at room temperature (30ºC) in sealed jars before opening for measurements. The samples were kept in this condition for about 28 hours before the measurements were taken.

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 gold plated to reduce dissipation losses. It was calibrated by 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 our group [16-22].

RESULTS AND DISCUSSION

Fig.1 shows the variation of dielectric constant with natural log of frequency at different percentage of moisture contents at constant temperature 300C for both the black pepper and white pepper. From Fig. 1 it is clear that, as frequency increases the dielectric constant of both the black and white pepper decreases and it is also clear that, the dielectric constant of black pepper is greater than that of white pepper at all moisture contents. The high values of dielectric constant may be because of high starch content in white pepper. The more starch molecules bind more water molecules and reduce the free water content of the system. This has already been explained by some researcher [23].

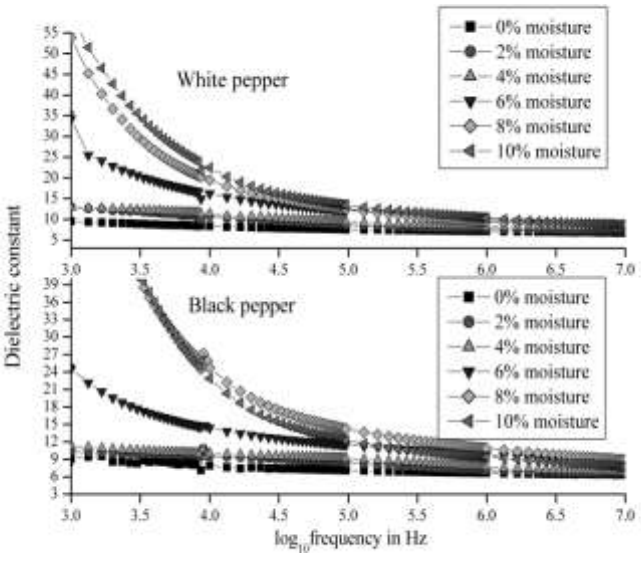

Fig. 1 Variation of dielectric constant with frequency for black pepper and white pepper at indicated moisture contents at 30^0C

Fig. 2 shows the variation of dielectric constant with percentage moisture contents at constant temperature 300C for both the black pepper and white pepper. From Fig. 2 it is clear that, as percentage moisture content increases the dielectric constant of both the black pepper and white pepper increases and it can also be seen that, the dielectric constant of black pepper is greater than that of white pepper. This is because the water content in white pepper is slightly higher than black pepper [23]. From the Fig. it can also be stated that 6% moisture content is the critical moisture content beyond which dielectric constant increases.

Fig. 3 shows the variation of dielectric constant with temperature at constant frequency 50 kHz for both the black pepper and white pepper. From Fig. 3 it is clear that, as temperature increases the dielectric constant of both the black pepper and white pepper increases and it is also clear that, the dielectric constant of black pepper is higher than that of white pepper. As temperature increases the denaturization of protein may take place which increases charge asymmetry and large polarization. Thus, dielectric constant increases and in case of black pepper protein content is more than in white pepper so black pepper has higher dielectric constant than white pepper at higher temperature. Here the effect of protein denaturization has higher impact on dielectric constant than starch at higher temperatures [23].

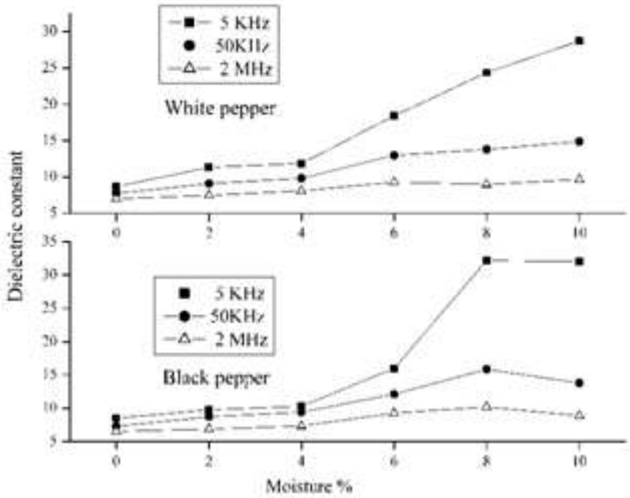

Fig. 2 Variation of dielectric constant with moisture for black pepper and white pepper at indicated frequencies at 30^{0}C

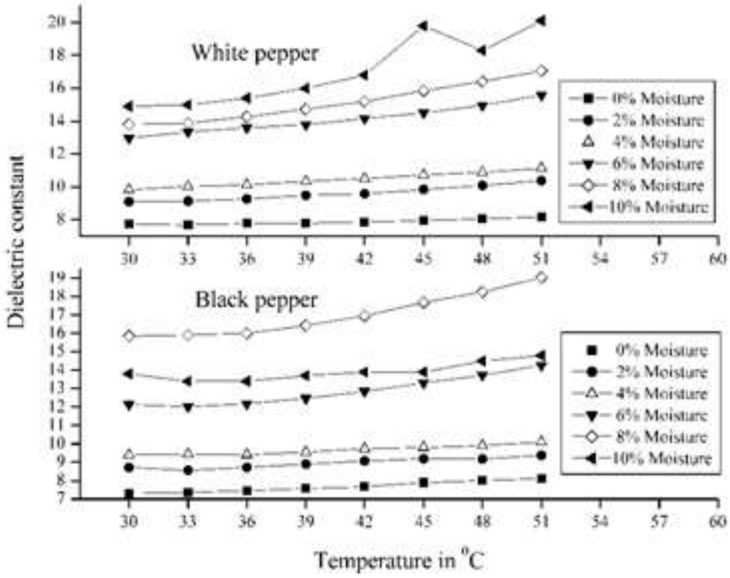

Fig. 3 Variation of dielectric constant with temperature for black pepper and white pepper at indicated frequency

Fig. 4 shows the variation of dielectric loss with natural log of frequency at different percentage moisture contents at indicated temperature 30^{0}C for both the black pepper and white pepper. From Fig. 4 it is clear that, as frequency increases the dielectric loss for both the black pepper and white pepper decreases and it is also clear that, the dielectric loss of black pepper is greater than that of white pepper. Here it can also be seen that the nature of variation of dielectric loss for both the samples is same but the dielectric loss in case of black pepper is much higher than that of white pepper, which may be because white pepper contains more essential oils than black pepper [6] and according to Ryynanen as lipid contents increase dielectric properties change [24].

Fig. 5 shows the variation of dielectric loss with percentage moisture content at indicated temperature 30^{0}C for both the black pepper and white pepper. From Fig. 5 it is clear that, as percentage moisture increases the dielectric loss for both the black pepper and white pepper increases and it is also clear that, the dielectric loss of black pepper is greater than that of white pepper. In both the cases the dielectric loss is increasing beyond 6% of moisture content which indicates that this is the region of critical moisture content, below which water is in bound state and above it is in Free State.

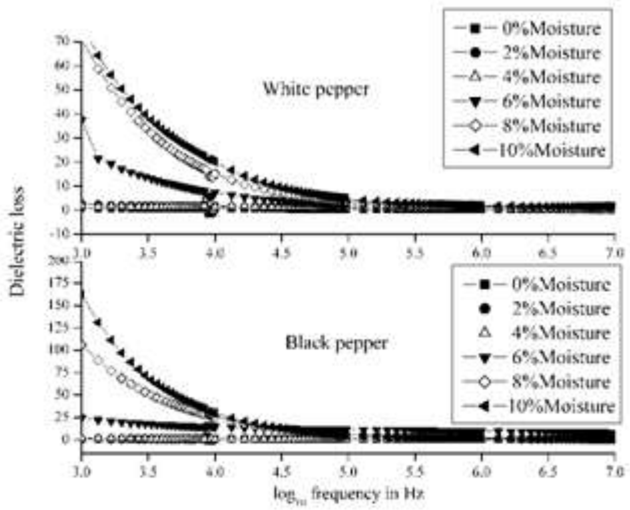

Fig. 4 Variation of dielectric loss with frequency for black pepper and white pepper at indicated moisture content at 30^{0}C.

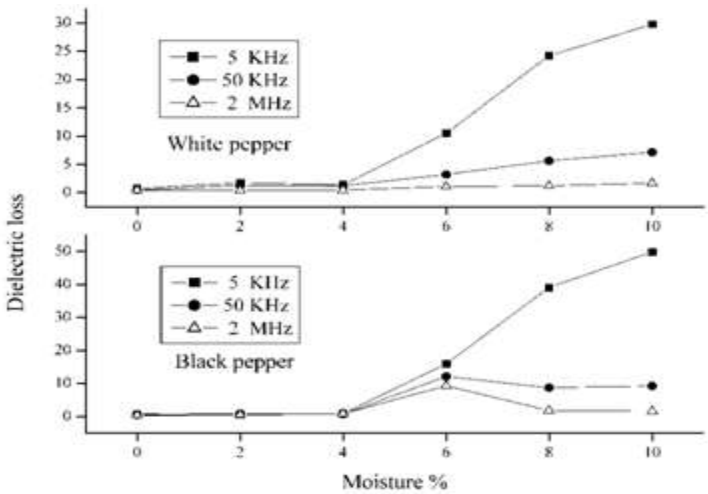

Fig. 5 Variation of dielectric loss with moisture content for black pepper and white pepper at indicated frequencies at 30^{0}C

Fig. 6 shows the variation of dielectric loss with temperature at constant frequency 50 kHz for both the black pepper and white pepper. From Fig. 6 it is clear that, as temperature increases the dielectric loss for both the black pepper and white pepper increases and it is also clear that, the dielectric loss of black pepper is greater than that of white pepper. We have already discussed that upto 6% water is in bound state and the dielectric properties increases with increase in temperature [25]. Beyond 6% of moisture content the free water content increases, and then combined effect of bound water and free water on dielectric properties is observed.

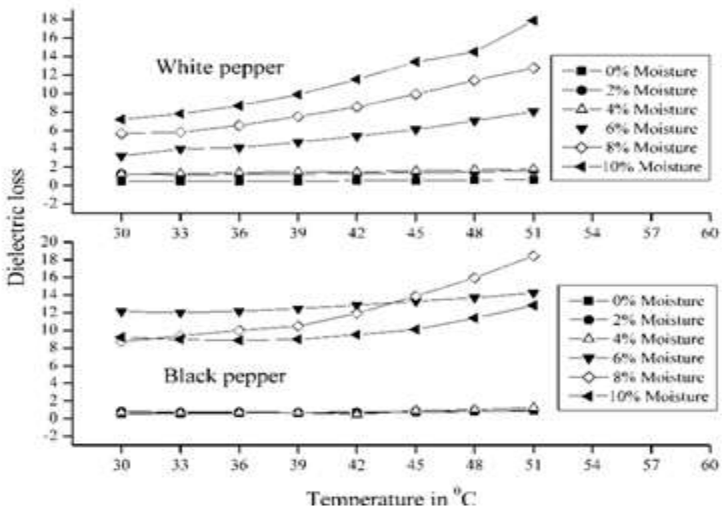

Fig. 6 Variation of dielectric loss with temperature for black pepper and white pepper at indicated moisture contents

CONCLUSION

From the above results it can be concluded that the constituents of the seeds strongly affect the dielectric constant and dielectric loss of the seeds. As in case the constituents of black pepper and white pepper are different so their dielectric constant and dielectric loss are different. Here it can also be concluded that the moisture and temperature also affect the dielectric properties of black pepper and white pepper, which is well established.

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