Preface

The measurement of dielectric properties of several agriculture, environmental, and food processes is need for the society. Microwave measurements and dielectric properties of materials are finding increasing applications, as new electro-technology is adapted for the use in the agriculture and food processing industries. The interest in dielectric properties of materials has historically been associated with the design of electrical equipment, where various dielectrics are used for insulating conductor and other components of electrical equipment. The measurement of dielectric properties is not an end onto itself. Rather, these properties are intermediary vehicle for understanding, explaining, and empirically rating certain physical-chemical properties of materials.

Dielectric properties of agricultural products are important mainly for their usefulness in rapid sensing of moisture content by electrical measurements that use the high correlation between the dielectric properties of hygroscopic materials and their moisture content. They are also important in RF and microwave dielectric heating applications that may be useful in heating, drying or processing of these products. Knowledge about the variation of the dielectric constant and loss factor with variables such as frequency, moisture, and temperature and product density is important in selecting the best conditions and techniques for either measurement or power applications. Further study should be helpful in discovering new applications and improving techniques for such important properties and other quality characteristics.

With the exception of some extremely low-loss materials, i.e. materials that absorb essentially no energy from RF and microwave fields, the dielectric properties of
such most materials vary considerably with the frequency of the applied electric fields. An important phenomenon contributing to the frequency dependence of the dielectric properties is the polarization arising from the orientation with the imposed electric field of molecules which have permanent dipole moments. The mathematical formulation developed by Debye to describe this process for polar materials.

The influence of a dielectric depends on the amount of mass interacting with the electromagnetic fields, the mass per unit volume, or density, will have an effect on the dielectric properties. This is especially notable with particulate dielectrics such as pulverized or granular materials. Dielectric mixture equations can be used to estimate the dielectric properties of a solid material from the properties of an air-particle mixture made up of air and the pulverized particles of the solid. To use such equations, one needs to know the dielectric properties (permittivity, loss and loss tangent) of the pulverized sample and its bulk density (air-particle mixture density) and the specific gravity or density of the solid material.

The moisture content of cereal grain is an essential factor affecting the physical and chemical properties related to storage, processing, and quality control. Several methods are proposed to measure moisture content. Resistance type and RF capacitance type moisture meters are commonly used. Moisture meters using the resistance method have the advantage of low cost, but grain samples are crushed and wasted. RF capacitance type moisture meters measure the capacitance of the sample between two electrodes, thus sensing the dielectric constant of the grain. This method can be used with a wide range of moisture contents and it is nondestructive, but is subject to measurement errors caused by changes in bulk density.
Chapter I give the introductory information and describe the objective of the present work. Our increasing interest is to study the dielectric properties of different seeds at microwave frequency i.e. at X-band setup. The dielectric permittivity, dielectric loss, and loss tangent of seed samples has been measured at two different frequencies and at room temperature. These properties are important mainly for their usefulness in rapid sensing of moisture content by electrical measurements that use the high correlation between the dielectric properties of hygroscopic materials and their moisture content. They are also important in the dielectric heating of these materials, because the dielectric properties dictate, to a large extent, the behavior of the materials when subjected to RF or microwave fields for purposes of heating or drying.

The knowledge about the variation of the dielectric permittivity and loss factor with variables such as frequency, moisture, and temperature and product density is important in selecting the best conditions and techniques for either measurement or power applications. Further study should be helpful in discovering new applications and improving techniques for such important properties and other quality characteristics.

Chapter II describes the dielectric theory and experimental aspects of the experimental setup consisting of microwave X band. This chapter also consists of experimental methods like, wave guide theory, resonance, non resonance, Von-Hipple or shorted waveguide method and two-point methods, experimental theories, the basics equations for low and high loss dielectric materials and the actual experimental setup of microwave X-band. It also consists of theory of important components used in the experimental setup. The information regarding Agilent Technology make microwave power/frequency meter, which is used for the measurement of power, frequency and for
tuning purpose. One mechanical instrument designed for pressing the samples for density measurement is also given in this chapter.

Chapter III consists of frequency dependent dielectric properties of different seed samples. Measurements have been carried out for two different frequencies and at room temperature. The seed samples were Wheat, Oily, Seeds of Pulses, Vegetables and Jowars. The two point method is used to know the approximate value of these seed samples and these values are then putted in least square fit program of Sobhanadri. The experimental observations of these seed samples shows that the dielectric properties are frequency dependent and decreases with increasing frequency.

Chapter IV gives moisture dependent dielectric properties of seeds. The measurement of the moisture has been carried out for different moisture content for two different frequencies and at room temperature on the same microwave X-band. The results show that the dielectric permittivity is sensitive to water content and increases with increasing water content.

Chapter V consists of the density dependent dielectric properties of seed samples. Applying pressure changes the density of the sample and the dielectric properties have been measured for three different densities and for two different frequencies. The results show that as density increases the dielectric properties are decreases.

Chapter VI consists of temperature dependent dielectric properties of seed samples. The temperature of the sample is changed by putting the sample in specially prepared sample holder in water heater and the measurements have been carried out from room temperature to 60 °C at microwave frequency. The results show that the dielectric properties are temperature dependant and decreases with increasing temperature.
Chapter VII consists of dielectric parameter study of hybrid (mixed) seed samples for two different frequencies and at room temperature on the same microwave bench setup.

Chapter VIII gives the conclusion of the present work.