



Effects of “Natural” Water and “Added” Water on Prediction of Moisture Content and Bulk Density of Shelled Corn from Microwave Dielectric Properties

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ABSTRACT

Dielectric properties of samples of shelled corn of “natural” water content and those prepared by adding water were measured in free space at microwave frequencies and 23°C. Results of measurements of attenuation, phase shift and dielectric constant and loss factor at 9 GHz show no difference between the samples with “natural” water and those in which water was added artificially. Bulk densities and moisture contents predicted from calibration equations expressed in terms of dielectric properties of both natural and added water samples agreed closely, and standard errors were less than 1% for moisture content and relative error for bulk density was less than 5%.

KEY WORDS: Dielectric properties, natural water, added water, free space, bulk density, moisture content.

INTRODUCTION

It is well known that water content of grain and seed strongly influences their dielectric properties [Nelson, 1973a; Nelson, 1982; Nelson, 1973b]. Understanding water behavior at microwave frequencies is key to the success of dielectric-based heating and moisture sensing applications [Metaxas and Meredith, 1983; Nyfors and Vainikainen, 1989; Kraszewski, 1996]. For purposes of research, it is customary to artificially add water to grain and seed to investigate variations of their dielectric properties with frequency, temperature, moisture content and bulk density [Nelson, 1973a; Trabelsi and Nelson, 2003]. Also, moisture sensors are often calibrated with data obtained from measurements on grain and seed samples to which water was added.

The question is how well the dielectric properties obtained for grain and seed samples with “added” water compare to those obtained for grain and seed samples with “natural” water. And, consequently, how accurate moisture measurements on freshly harvested grain performed with sensors calibrated with grain samples with “added” water are. It is the objective of this paper to answer these basic, important questions.