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A novel use of a commercial liquid dielectric fixture in investigating temperature dependence of grain permittivity

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ABSTRACT Research on temperature dependence of permittivity (ϵ) of bulk grains at radio and microwave frequencies is very limited. There is also a need of an accurate but simple dielectric measurement device for the particulate materials. This work exploited a commercial device especially built for dielectric measurement of small volume of liquid for the first time to measure the ϵ of larger bulk wheat samples at temperatures between 15°C and 75°C. The integrity of the device with increased volume was tested by measuring the ϵ of regular and increased volume for low loss to lossy media. The percentage difference varied from 3.4% to 7.3% for the dielectric constant (ϵ'), and from 0% to 5.4% for the dielectric loss factor (ϵ''), which were well within the measurement uncertainty of the device ($\leq 25\%$). The ϵ' of the wheat increased almost linearly with temperature, and varied between 3.82 and 5.95, and the ϵ'' increased non-linearly with temperature with values between 0.07 and 0.93. Regression models predicted ϵ' and ϵ'' of the wheat with RMSE of 0.14 and 0.03, and R² values of 0.97 and 0.99 respectively.

Keywords: Permittivity, temperature dependency, dielectric constant, dielectric loss factor