# Variation of electrical impedance parameters during the soaking of dry crops

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## Introduction

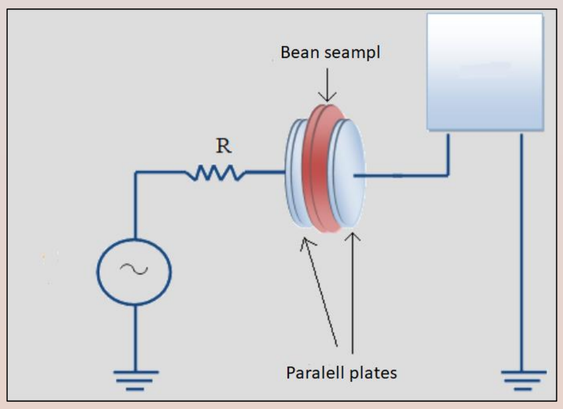
When processing nutritionally important dry pulses such as beans, soaking is one of the most important preparatory steps. As this process is relatively time-consuming, there are economic reasons to improve production practices. Soaking time varies from bean to bean, usually between 5 and 12 hours. However, this long soaking time can be reduced by ultrasound.

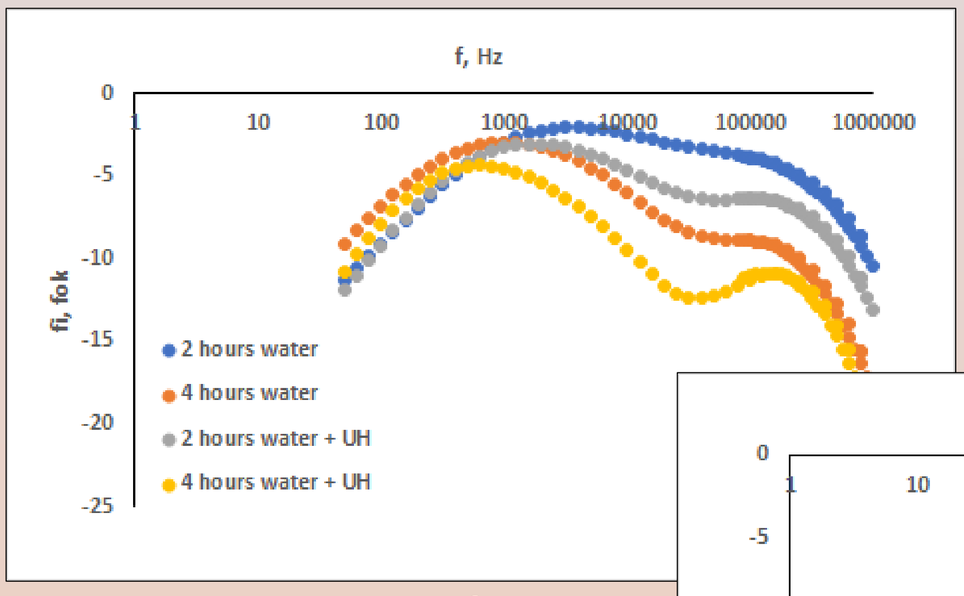
## Materials and methods

The experiments were performed on red kidney beans (Phaseolus vulgaris cv. Rampart). Prior to the actual sample preparation, beans were manually sorted into four groups according to their size (S - small ≤ 13 mm; M - medium = 13 - 15 mm; L – large = 15 - 17 mm; X - extra-large ≥ 17 mm).

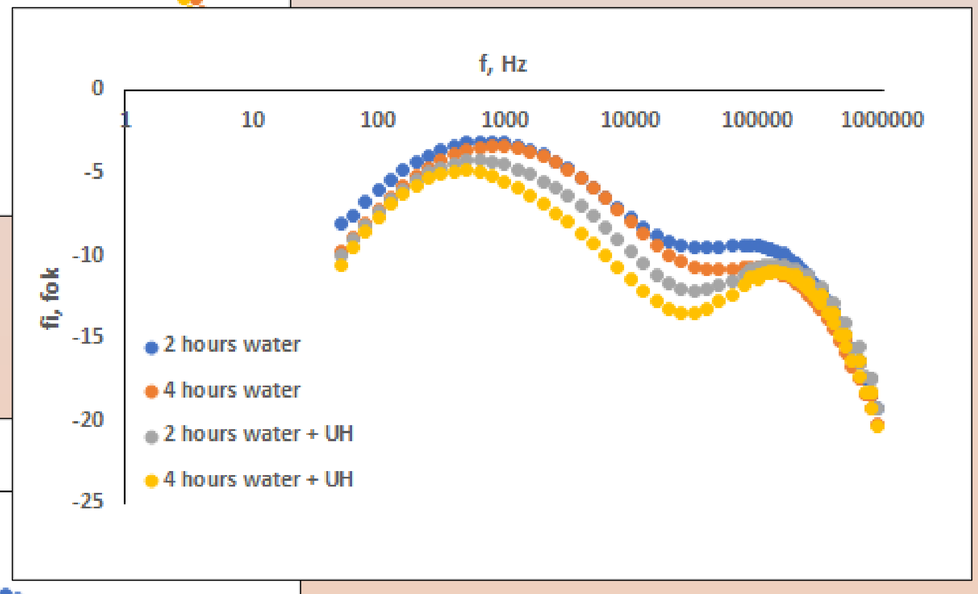
For the ultrasound treatments we used an ultrasonic bath (HBM Machines, The Netherlands). The treatments applied were performed at 40 kHz 300 W at 20 °C. During the measurements, 20 g of sample was weighed out into 200 ml glass containers and 100 g of distilled water was weighed into the containers. In order to ensure adequate sound conductivity, the ultrasonic equipment was filled with tap water in which the vessels containing the samples were placed. For the control group, 20 °C was also used.

The magnitude and phase angle of the impedance of the beans were measured in the frequency range of 30 Hz to 800 kHz with an HP4284A and in the frequency range of 75 kHz to 10 MHz with an HP4285A precision LCR meter at 1 V measurement voltage in an HP16451 B measuring system. To achieve good electrical contact, an electrical conductive gel was placed between the bean shell and the electrode.

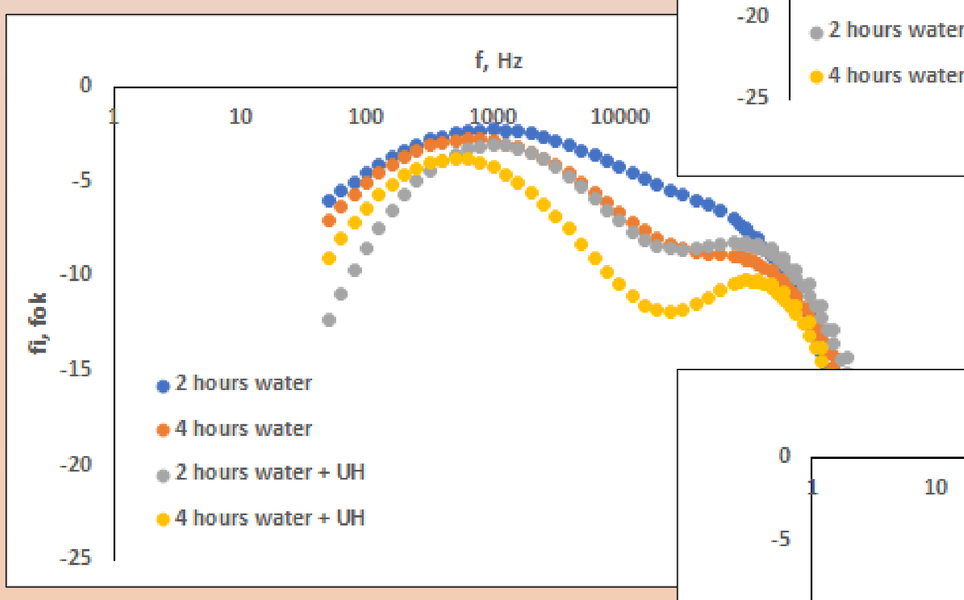


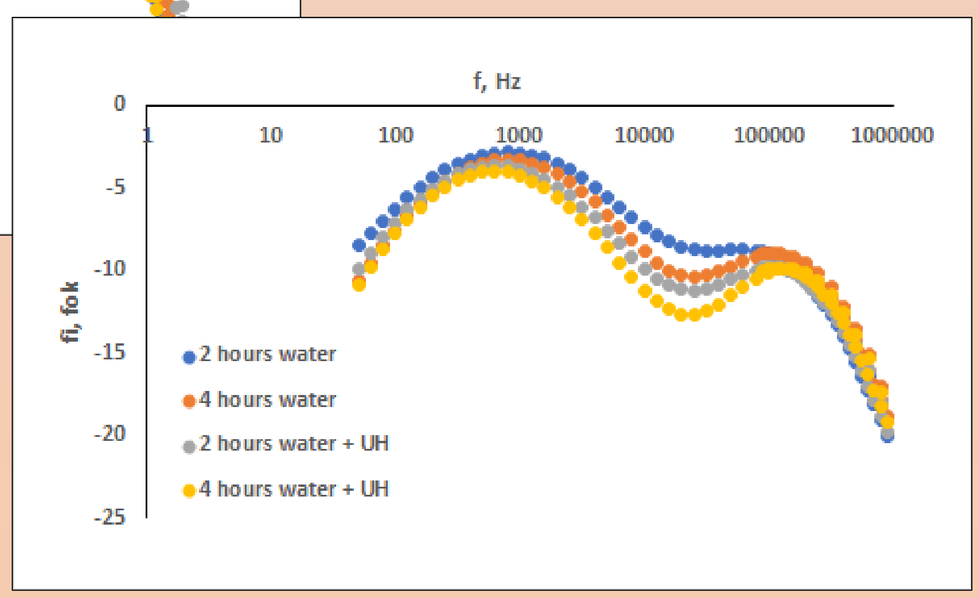

group of< 13 mm




group of 13-15 mm




group of 15-17 mm




group of > 17 mm

## Results

There is no correlation between the spectra of the different size classes. However, as the soaking time increased, the magnitude of the impedance decreased, which may indicate that the increased water content reduced the viscosity and thus increased the mobility of the charges, resulting in a decrease in resistance and impedance.

This reduction is also clearly visible in the ultrasonic treatments compared to the control samples.

The phase angle spectrum shifted towards lower frequencies, which in turn may be a result of the destructive effect of ultrasound. The effect of the treatments shifts the minimum point around 31000 Hz towards lower frequencies.

Further studies are needed to accurately describe the effects of each soaking process.

## Conclusion

The spectra obtained are homogeneous in shape. The longer the soaking time, the lower the impedance value and the more the ultrasound-induced structure damage was well detected. These suggest that it may be possible to qualify the structural condition of the soaked dry structures. But in addition, we can also obtain information on the state of soaking.