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Measurement of the acoustic phase velocity of trade butter by means of the ultrasonic transmission technique

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ABSTRACT

There are different methods and ways to measure the internal properties of materials; this depends on the type of material and the grade precisión and resolution that is deisred. In the case of food, there are different instruments to determine its quality, focussing on the main factors such as colour, textura, smell, flavour, pH, and microbial charge. In this work, a study is presented to determine the acoustic phase velocity of trade butter from the LALA® and Gloria® brands. The GAMPT acoustic tomography echoscope stage with 2MHz acoustic sensors was used to measure the thickness-dependent acoustic phase velocity [m/s] with a quasi-regular ambient temperatura of 16°C. The method applied was the transmisión technique with normal incidence. Measurements were performend in triplicate. The bulk density and acoustic impedance of the butter simples, as well as the rheological properties, were determineed by indirect methods. The results show that the acoustic pase velocity of butter LALA®, GLORIA® with salt, and GLORIA® without salt were, APV_{LALA} ≈ 1055.54m/s, $APV_{GLORIAws}$ ≈ 1224.46m/s y $VAF_{GLORIAns}$ ≈1169.44m/s, respectively. The bulk densities of the butters were ρ_{LALA} ≈ 0.908gr/cm^3, $\rho_{GLORIAws}$ ≈ ≈ 0.771gr/cm^3 y $\rho_{GLORIAns}$ 0.825gr/cm^3 a 15°C, respectively. Transmittance was evaluated as a function of frequency, where the effect of attenuation was observed and described as the thickness of the simples increased. However, the acoustic impedance was similar between the different type of butter simples, and this is because the acoustic phase velocity was different, but the producto times the bulk density was compensated for, this is, GLORIA® butter with salt presented a higher acoustic phase velocity but lower denisty; on the contraty, LALA® butter has the lowest acoustic phase velocity, but the bulk density was higher.

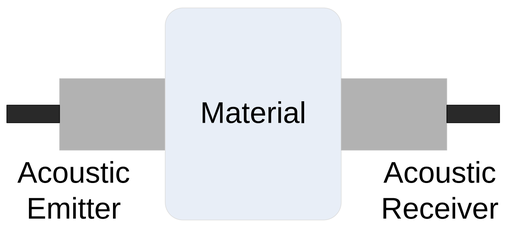
INTRODUCTION



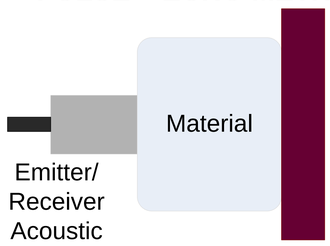
LOW INTENSITY ULTRASOUND

Name	Range, (Hz)
Infrasound	IS < 16
Audible Sound	16 ≤ AS ≤ 17.8
Ultrasound	17.8 < US < 1 G
Hypersound	HS ≥ 1 G

TRANSMISSION METHOD



PULSE – ECHO METHOD



MATERIALS



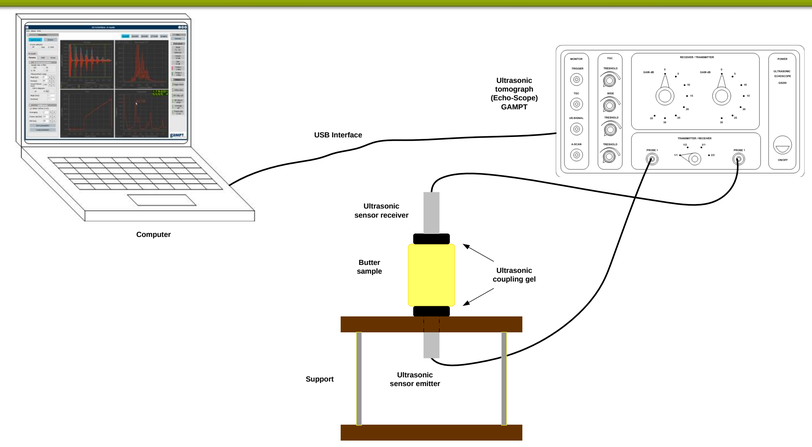
Experimental conditions

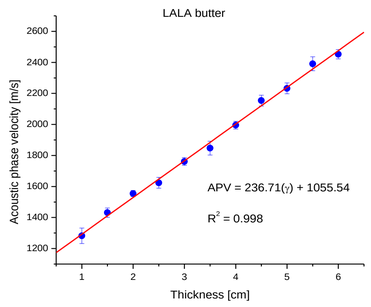
- ✓ 7 – 10 AM.
- ✓ Samples of butter, unsalted and with salt:LALA y GLORIA brands(thicknessr: 1, 2, 3, 4, 5 y 6cm).
- ✓ Sampling rate 100MHz.
- ✓ The excitation pulse was applied at normal incidence.

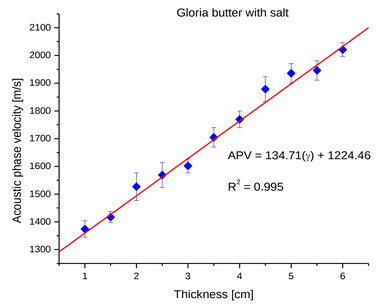
Thermodynamic conditions:

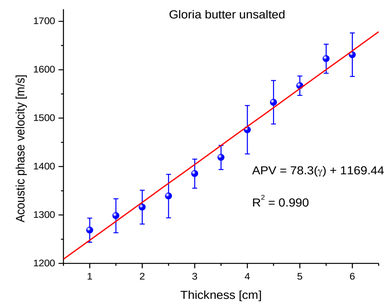
- ✓ Open system.
- ✓ Atmospheric pressure: 1023.10hPa
- ✓ Humidity: 37%
- ✓ Temperature in the laboratory: 16±1°C

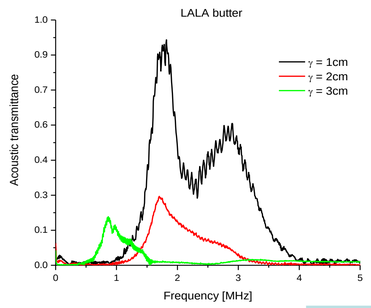
RESULTS

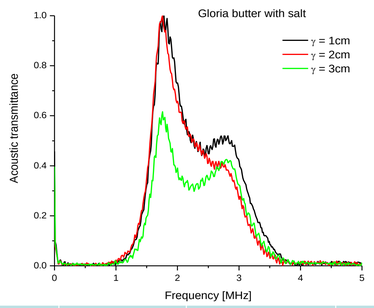


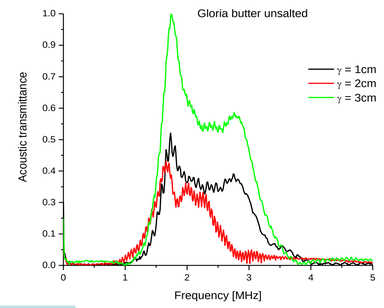












PARAMETERS	LALA	GLORIA, unsalted	GLORIA, with salt
Acoustic pase velocity, transmission method [m/s]	1055.54 ± 1.53	1169.44 ± 0.66	1224.46± 0.66
Bulk density, ρ [gr/cm³]	0.908 ± 0.05	0.825±0.05	0.771±0.05
Acoustic impedance, Z [MRayls]	0.958430	0.964788	0.944058
Elastic modulus, G´ [Pa]	0.958430	0.964788	0.944058
Viscoelasticity loss module, G´´ [Pa]	60700.90	60097.31	109060.50
Acoustic attenuation, α [dB/cm]	0.3577	0.2865	0.4692

ACKNOWLEDGEMENTS

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CONCLUSIONS

- ✓ The acoustic properties of the comercial butter types LALA and GLORIA, unsalted and with salt, were characterized.
- ✓ To date, the acoustic properties of the butter types studied have not been described in the literature.
- ✓ The use of acoustic pulses as excitation sources leads to a greater scattering of the intrinsic properties of the butter.
- ✓ It is posible to increase the sensitivity of the experiments if an adiabatic system is used.
- ✓ It is proposed to produce butter with cow and goat milk to characterize its acoustic and mechanical properties.