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EXPERIMENTAL INVESTIGATION OF SOUND ABSORPTION OF SOME LOOSE UNCOOKED GRANULAR PASTAS, STARCHY FOODS AND CEREALS

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This work deals with the experimental study of the normal incidence absorption properties of several granular pastas, starchy foods and cereals as function of frequency in the range 50-1600 Hz. The influence of the size and the shape on the sound absorption was studied. The influence of these parameters on the resonance frequencies was also analysed.
Keywords: Sound absorption, cereals, pastas, impedance tube

1. Introduction

The sound absorption coefficient is an acoustic quantity that allows to define the ratio of incident energy and the absorbed one. Natural absorbing materials are used in many acoustical applications (reduction of noise level, the improvement of the communication between the speaker and audiences, etc.).In this goal, several studies have been made on natural porous granular materials such as perlite or Cork. [1, 2, 3, 4 and 5]. In to use this kind of materials in theater halls instead of fibrous materials or absorbent foams, the granular materials can be used under a suitable fabric or behind a perforated panel made of wood or plaster.

In this work we studied the acoustic absorption behavior of eight kinds of granular food products with deferent forms (Pipe Rigate, Pipette Rigate, Pipe Doppia Rigatura, Vermicelli, Rice, Beans, Lentils and Cowpea). The main purpose of this work is to measure the sound absorption coefficient of these materials as a function of grain size and the thickness of the samples, using the acoustic impedance tube.

2. Samples preparation

For all material the mean characteristic dimensions L and D or e and density were calculated by averaging five measurements for each quantity “Table. 1” and “Fig. 1”.

Table 1: The different grain sizes and their corresponding densities.

Material	The mean value of Grain Sizes (mm)		L/D or L/e	Density (Kg/m^3)
Pipe Rigate	L=13.37	D=3.86	3.46	592.67
Pipette Rigate	L=17.1	D=6.51	2.63	450.32
Pipe Doppia Rigatura	L=20.13	D=11.41	1.76	393.51
Rice	L=3.01	e=1.01	2.98	876.24
Lentils	e=2.17	D=4.1	1.89	881.5
Beans	L=11.88	D=7.22	1.65	797.5
Vermicelli	L=21.18	D=0.8	26.48	336.12
Cowpea	L=15.6	e=7.6	2.05	888.53

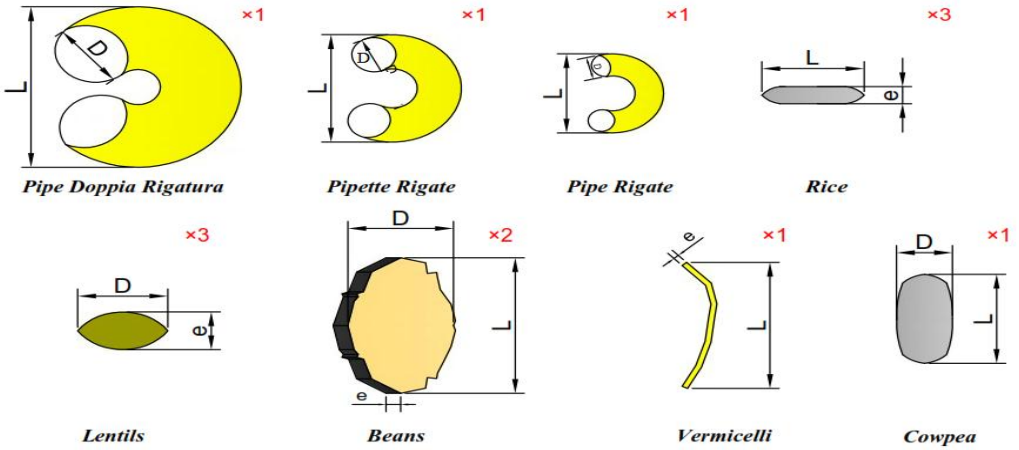

Figure 1:Different grain size of materials.

Eight kinds of materials were considered “Fig. 2”. For each kind a set of five loose cylindrical samples of 0.10 m in diameter has been tested. The thicknesses considered are 0.02 m, 0.04 m, 0.06 m, 0.08 m and 0.1 m. In total 40 samples were tested.

Figure 2:Different loose granular materials.

3. Methodology and results.

3.1 Methodology

The acoustic absorption coefficient of the deferent materials is tested by the acoustic impedance tube of circular section with 100 mm in diameter and 1.20 m in length arranged vertically. The samples were tested in bulk without compaction. The sound absorption coefficients were measured in the range [50Hz-1600Hz].All measurements were performed in the “University Center for Acoustic and Thermal Research of the Higher School of Technology in Sale-Morocco”, at an ambient temperature and relative humidity of about 16°C and 50% respectively.

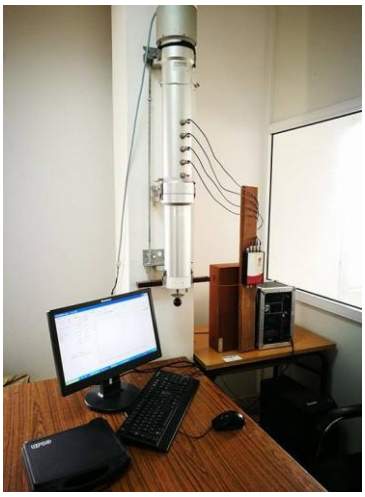

Figure 3: Acoustic impedance tube.

3.2 Results and discussion

3.2.1 Loose Pipe Rigate and Rice.

In a first step, we measured the sound absorption coefficient of four kinds of granular pastas.Five thickness was tested in the acoustic impedance tube varies between 20mm and 100mm.A set of five loose cylindrical samples of 0.10 m in diameter has been used.

The “Fig. 4” shows the influence of the thickness on the sound absorption behavior of the pipe rigate.When the thickness of the samples increases the sound absorption behavior in the low frequencies also increases. The increase in thickness is accompanied by a shift of the resonance frequency towards the low frequencies. The maximum value of the absorption coefficient is 0.79 about 545Hz.

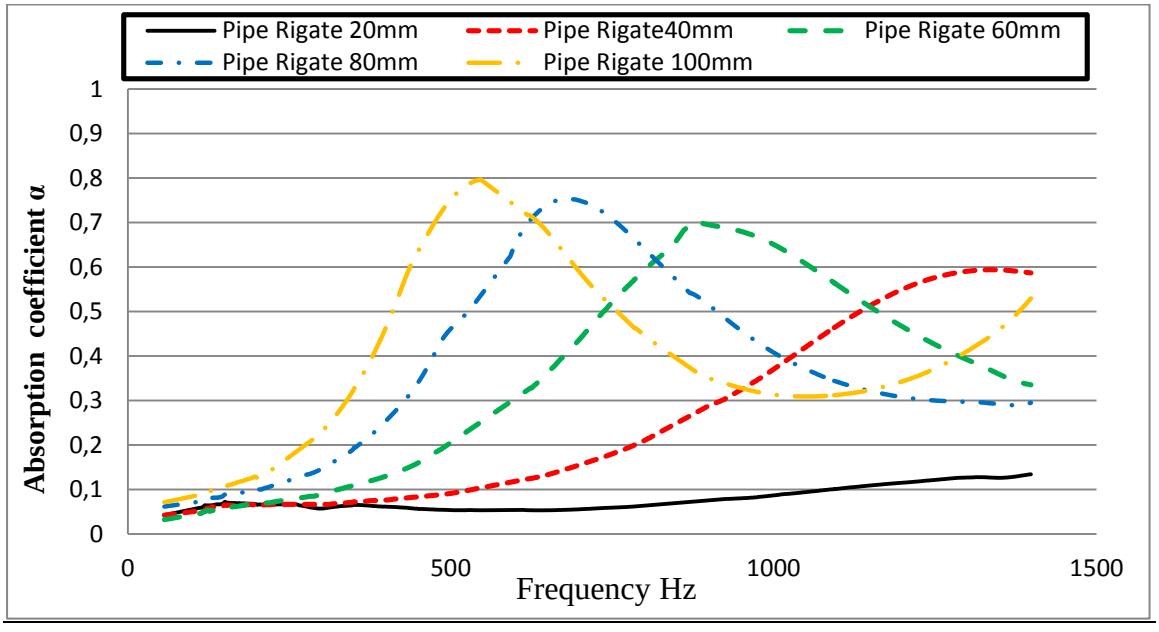

Figure 4:Experimental absorption coefficient spectra for different Thickness of Pipe Rigate.

For leguminous we measured the sound absorption of four species (Rice, Beans, Lentils and Cowpea). As an example, the “Fig. 5” shows the effect of the thickness on the sound absorption for rice. As the thickness increases, the resonance peak shifts to the low frequencies: 1400Hz, 918Hz, 642Hz and 515Hz for thicknesses 40mm, 60mm, 80mm and 100mm respectively. The increase in thickness leads to an increase in sound absorption at low frequencies f <560Hz.

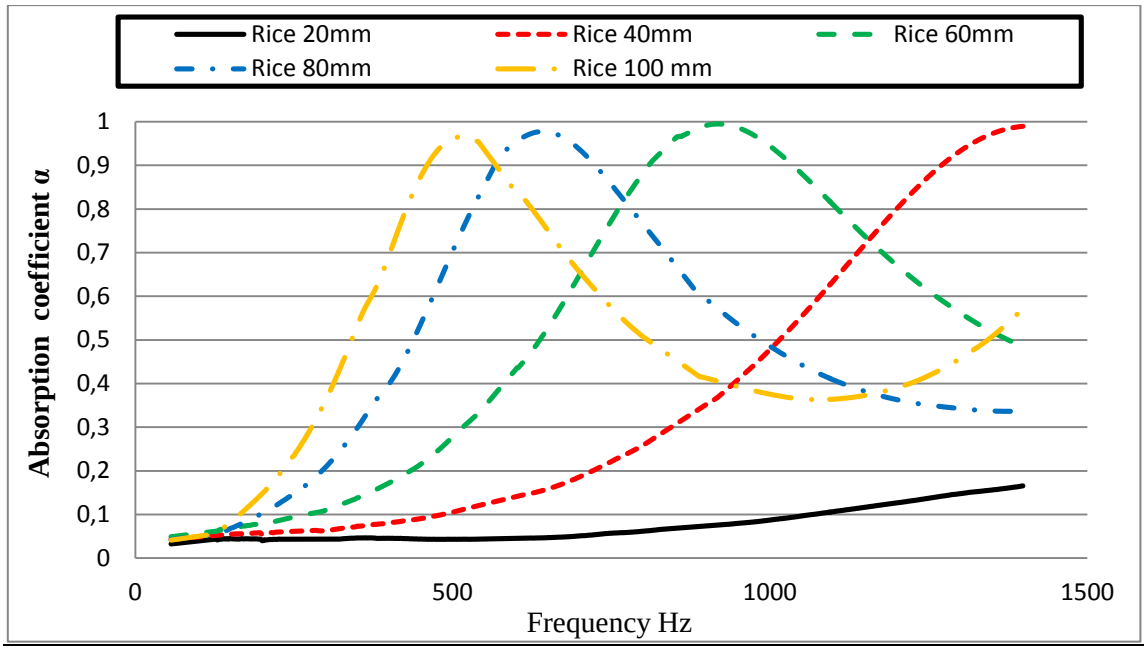

Figure 5:Experimental absorption coefficient spectra for different Thickness of Rice.

3.2.2 Comparison of different materials.

The "Fig. 6" shows the measured sound absorption coefficient for the eight species of materials. The thickness was fixed at 60 mm. It should be noticed that the rice, lentils and Beans are more absorbent than the pastas forms. The most absorbing material is the rice, the least absorbent material is vermicelli which can be considered as a fibrous material "Table. 2".

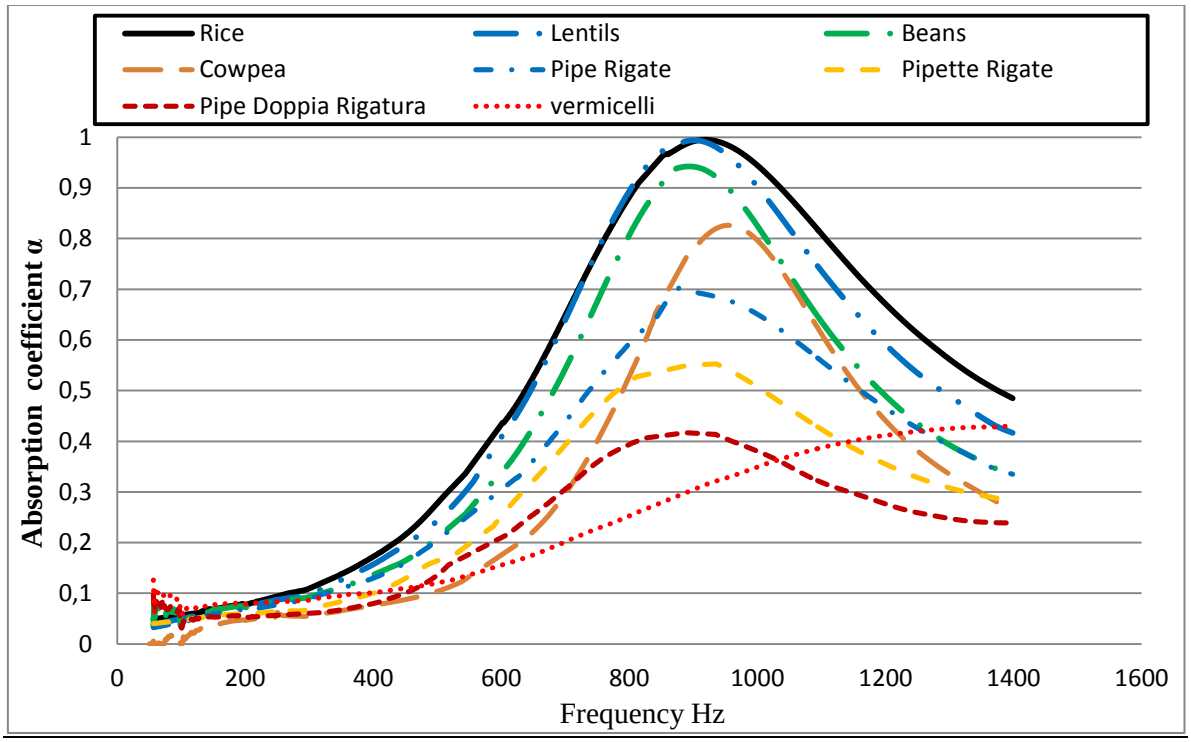

Figure 6:Comparison between the normal sound absorption coefficient spectra for loose Pipe Rigate, Pipette Rigate,Pipe Doppia Rigatura, vermicelli,Rice,Beans,Lentils and Cowpea. Thicknesses=60mm.

The “table. 2” shows the values of the sound absorption coefficients of the eight kinds of materials in the frequencies: 125Hz, 250Hz, 500Hz, 1000Hz and 1400Hz.

Table 2: The values of the sound absorption coefficients of the different loose granular materials.

Material	125Hz	250Hz	500Hz	1000Hz	1400Hz
Vermicelli	0,0704	0,0832	0,1205	***0,3491***	0,4308
Pipe Doppia Rigatura	0,0493	0,0833	0,1360	***0,3802***	0,2400
Pipette Rigate	0,0505	0,0704	0,1641	***0,5072***	0,2821
Pipe Rigate	0,0518	0,0708	0,1657	***0,6504***	0,3350
Cowpea	0,0268	0,0622	0,1041	***0,7959***	0,2677
Beans	0,0572	0,0625	0,2097	***0,8245***	0,3316
Lentils	0,0576	0,0873	0,2433	***0,9021***	0,4165
Rice	0,0578	0,0943	0,2778	***0,9441***	0,4848

3.2.3 L / D Ratio.

The L/D ratio has a great influence on sound absorption. The “Fig. 7” shows this effect for three kinds of materials (Pipe Rigate, Pipette Rigate and Pipe Doppia Rigatura), the frequencies concerned are 125Hz, 250Hz, 500Hz and 1000Hz.The results show that when the L/D ratio increases the absorption coefficient also increases, Except for the point L / D = 3.46 at the frequency 1000Hz, The sound absorption coefficient in this point is less than the point with L / D = 2.63, This may be because of the variation in physical parameters such as Porosity, Tortuosity and the air resistivity, due to the forms of these three materials.

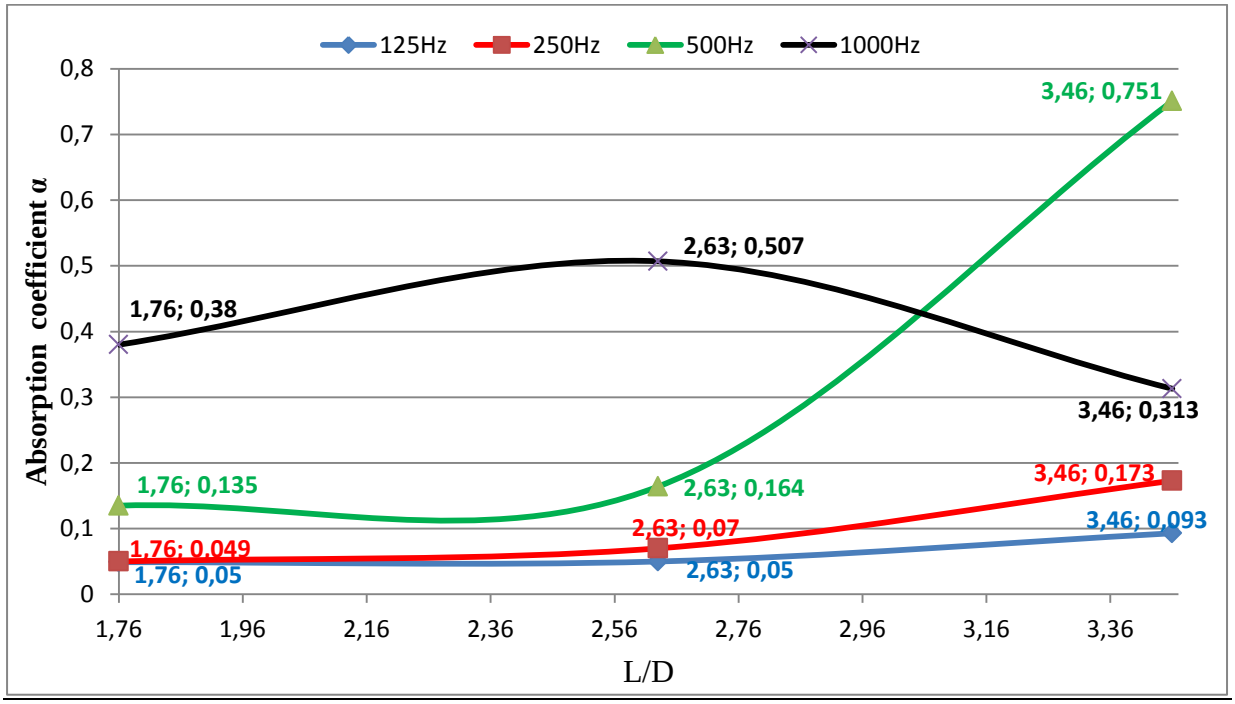

Figure 6:The influence of the L / D ratio on the sound absorption behavior.

4. Conclusion

In this work we measured the experimental sound absorption coefficient of eight kinds of granular material with several thicknesses (20mm, 40mm, 60mm, 80mm and 100mm) separated in two groups, The first group is the group of pastas contains four materials (Pipe Rigate, Pipette Rigate, Pipe Doppia Rigatura and vermicelli), The second group is the group of cereals contains four defer-

ent materials (Rice, Beans, Lentils, Cowpea). The results show that the acoustic absorption behaviors of the cereals are more perform than pastas. The most absorbent material among the eight granular materials is the rice, and the least absorbent is vermicelli. An L / D ratio was measured for three materials of the pastas group (Pipe Rigate, Pipette Rigate and Pipe Doppia Rigatura), the results show that the L / D ratio has a great influence on the sound absorption, When the ratio increases the absorption coefficients also increases.

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