Evaluation of agricultural residual biomasses as aggregates in ceramic materials

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Introduction

The reuse of waste materials from numerous industries, by incorporating them into the construction industry as part of cements, asphalts, ceramics, etc., has increased in recent decades. The objective of this process is the recovery of waste and the production of environmentally friendly materials.

In the present study, the focus has been placed on agricultural biomass residues such as corncobs, sunflower husks, olive stones, peanut shells, pistachio shells, barley and pine sawdust, in order to determine whether their general characteristics make them suitable for incorporation in clay mixtures as pore former in the production of ceramics.

Experimental

The biomasses were analyzed from the point of view of their chemical compositions and morphological structures, using diverse techniques: SEM, EDS, DTA-TGA, LOI, heat capacities and densities.

Results and Discussion

Figure 1 shows SEM images of some of the different biomass analyzed. A wide variety of structures and morphologies can be observed.

The weight loss of most of the studied biomass was 93-98%. Therefore, a very small percentage of the material (ashes) will remain within the matrix of the ceramic brick after sintering.

The densities of the analyzed biomass samples are shown in Table 1. These densities result in the aggregate conditions, lower than that of the clay material, which is 0.74 g / cm^{-3}.

From the DTA-TGA tests of the biomass it is possible to determine the range of temperatures in which the material will be combusted inside the bricks and the amount of residual material that will be definitively incorporated into it after sintering. In all the studied biomasses, the temperature ranges determined were between 230°C and 600°C. As an example, the behavior of corncobs is presented in Figure 2.

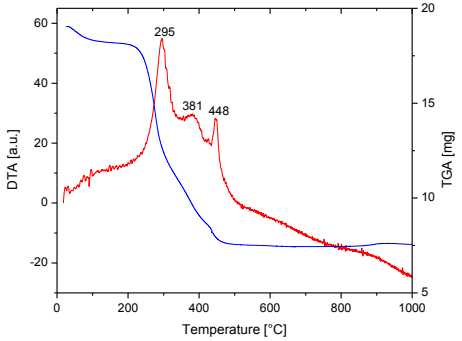

Figure 2. DTA-TGA of corncobs

Table 1. Properties of the studied biomasses

Biomass	Heat Capacity [kcal/kg]	Density [g/cm^{-3}]
Peanut shells	4414	0.12
Pine sawdust	4430	0.10
Barley	4422	0.22
Sunflower husks	4183	0.16
Corncobs	4768	0.10
Pistachio shells	4542	0.44
Olive stones	4960	0.36

The calorific powers determined for the biomass studied (Table 1) were lower than those corresponding to traditional solid and liquid fuels, which have values higher than 7500 kcal/kg.

Conclusion

The studied biomasses showed characteristics and behaviors that make their valorization as pore formers in clay ceramic pieces feasible. They can be easily ground to obtain the appropriate particle sizes. They have a wide range of combustion which prevents cracks in the ceramic product. The percentage of material finally incorporated into the ceramic is very low. Their densities are much lower than those of clay, so the proportions to be used must be low, at most 20%, so despite having significant heat capacities, they should not change the ceramic process conditions.

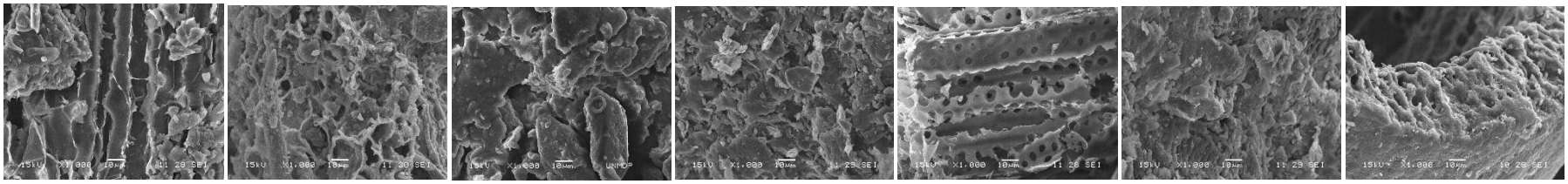

Figure 1. SEM images of biomasses