

Organic tracers in PM_{2.5} emitted from the combustion of pellets and agro-fuels in a stove

C.A. Alves, E.D. Vicente, S. Rocha and A.M. Vicente

Department of Environment, Centre for Environmental and Marine Studies, University of Aveiro, 3810-193 Aveiro, Portugal

Keywords: Pellet stove, PM_{2.5}, resin acids, methoxyphenols, anhydrosugars.

Presenting author email: estelaavicente@ua.pt

The consumption of pellets and alternative biofuels, such as some agricultural residues, has experienced a tremendous growth in Mediterranean countries, which has changed the panorama of biomass burning emissions. To apply source apportionment models, specific chemical signatures for smoke aerosols are necessary. In this study, filter samples of fine particles (PM_{2.5}) from the combustion of 4 different types of pellets and 3 agro-fuels (shell of pine nuts, olive pit and almond shell) in a pellet stove were collected. The PM_{2.5} samples were extracted with dichloromethane/methanol and the dried extracts were silylated before injection into the gas chromatograph-mass spectrometer. The analysis included monosaccharide anhydrides, resin acids, methoxyphenols and sterols.

On average, the anhydrosugar particle mass fractions for the 7 biofuels were 30 to 70 times lower than the values reported for manually fired systems (Fig. 1). The highest levoglucosan emissions were observed for olive pit. Levoglucosan to mannosan ratios (Fig. 2) ranged from values around 2 for pellets and shell of pine nuts to much higher quotients, similar to those reported for hardwood combustion (Fine *et al.*, 2004; Gonçalves *et al.*, 2010). Irrespective of biofuel, vanillin and vanilic acid were always present in the smoke samples. Coniferyl alcohol was only detected in samples from the combustion of olive pit and pellets with the highest softwood content. Sinapyl alcohol was exclusively emitted by olive pit. Dehydroabietic and isopimaric acids were represented in emissions whether from all type of pellets or from shell of pine nuts, whilst abietic acid was only quantifiable in PM_{2.5} from the combustion of pellets made of coniferous wood. Sitosterol was solely detected in smoke particles from shell of pine nuts and olive pit.

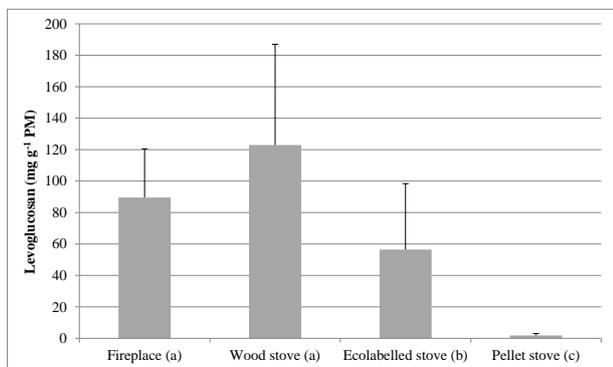


Figure 1. Levoglucosan mass fractions in particles emitted by different residential combustion appliances: (a) PM_{2.5} (Gonçalves *et al.*, 2011), (b) PM₁₀ (Gonçalves *et al.*, 2010), (c) PM_{2.5} (present study).

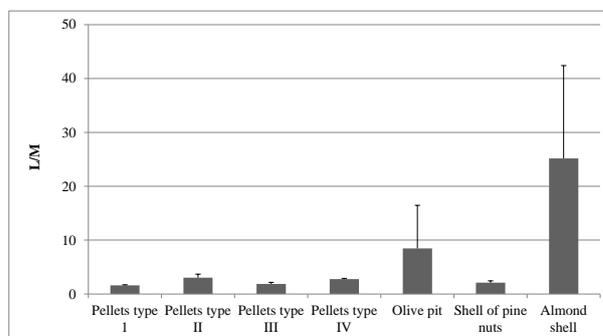


Figure 2. Levoglucosan to mannosan ratios.

Although quantitative information for these polar compounds has been previously reported for wood-fired residential combustion systems, as far as we know, this is the first time that the presence of most of these components is described in smoke particles from pellets and agro-fuels. It has been observed that emissions of individual compounds depend not only on the biofuel, but also on the combustion temperature and significant differences exist, especially between pellets and agro-fuels. Thus, no single compound can be proposed as universal biomass burning tracer. The differences between the fine particle organic compound emissions from pellets and agro-fuels should be accounted for in chemical mass balance models that use these constituents as tracers. Nevertheless, one can calculate a weighted composite residential combustion source profile based on the usage patterns of pellet stoves in a given region and then use the composite profile for the mass balance calculations.

This work was financially supported by AIRUSE - Testing and development of air quality mitigation measures in Southern Europe, LIFE 11 ENV/ES/000584. Ana Vicente acknowledges the postdoc grant SFRH/BPD/88988/2012 from the Portuguese Science Foundation (FCT).

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