RICTA
8th Iberian Meeting on Aerosol Science and Technology
A Coruña · June 26th-28th 2024

LEVELS OF PM-BOUND ORGANIC COMPOUNDS FROM RESIDENTIAL COAL COMBUSTION

E.D. Vicente[1,2], A.I. Calvo[2], M. Evtyugina[1], A. Vicente[1], R. Fraile[2] and C. Alves[1]
[1]Country Department of Environment and Planning, CESAM, University of Aveiro, Aveiro, 3810-193, Portugal
[2] Department of Physics, University of León, León, 24071, Spain
Keywords: coal, PM-bound organics, residential combustion
Presenting author email: aicalg@unileon.es

According to estimates, household air pollution from solid fuel combustion was responsible for 3.2 million deaths in 2020, due to health-damaging pollutants such as particulate matter (WHO, 2022). The majority of deaths associated with indoor air pollution, caused by the use of solid fuels, affect children under the age of five (resulting in low birth weight, acute lower respiratory tract infections, anemia, and premature mortality) and women (leading to chronic obstructive pulmonary disease and cardiovascular disorders) (Ali et al., 2021). Among the variety of solid fuels available, coal continues to be widely used for heating and cooking all over the world (Kerimray et al., 2017). Although emissions from indoor coal burning are a major public health concern in developing areas, little is known about indoor air quality in households equipped with coal burning appliances in higher income countries. To fill this gap in knowledge the present study aimed to evaluate the impact of residential coal combustion on indoor particulate organic composition.

Indoor air quality was assessed in an empty rural house with a coal-burning stove. Four combustion experiments were performed, during which no other indoor activities occurred, ensuring unbiased data under real environmental conditions. Every day, the stove was ignited using wood chips and newspaper sheets, followed by the burning of six coal batches. Each experiment lasted approximately 6 hours and 40 minutes, with consistent refill intervals and coal amounts on different burn days. Additionally, two days of no burning were included for background measurements. The collection of PM_{10} samples was performed with high-volume samplers positioned centrally in the open kitchen/living area and outdoors, on the front porch. These samples underwent extraction using dichloromethane/methanol, with subsequent injection of the dried extracts into a gas chromatograph-mass spectrometer (GC-MS). For the analysis of anhydrosugars and acid compounds, the extracts were silylated before injection. The study targeted twenty PAH compounds, revealing higher average PAH concentrations indoors during coal burning (33.4 ± 20.9 ng m^{-3}) compared to outdoors (3.18 ng m^{-3}) and indoors without stove operation (4.07 ng m^{-3}). PAHs with higher molecular weights (more than four rings) constituted the largest portion (77-91%) of indoor PM_{10} samples.

The PM_{10} samples contained a diverse range of oxygenated organic compounds, including saccharides, phenolics, acids, alcohols, and glyceridic constituents. Levoglucosan showed significantly higher concentrations during coal burning days (averaging 8.4 times higher than background air). Several compounds like phenyl compounds, aromatic dicarboxylic acids, and fatty acids exhibited significantly lower concentrations or were absent in outdoor/background air but were prevalent during coal burning, suggesting emissions linked to coal combustion or stove materials. Even-numbered homologs dominated the series of n-alkanols and n-alkanoic acids, with high indoor concentrations during burning days compared to outdoors, indicating their association with coal combustion. Similarly, compounds such as dehydroabietic acid, glyceryl esters of long chain fatty acids, cholesterol, phthalimide, and oxidized Irgafos 168 were only present during combustion experiments. Some compounds' presence, like phthalimide and oxidized Irgafos 168, may suggest contamination from plastic packaging or coal interaction, warranting deeper research into their sources and impacts.

This work was partially supported by the Junta de Castilla y Leon co-financed with European FEDER funds (Grant LE025P20). It was also in part supported by the AEROHEALTH project (Ministry of Science and Innovation, co-financed with European FEDER funds, Grant PID2019-106164RBI00). Furthermore, it is part of the project TED2021-132292B-I00, funded by MCIN/AEI/10.13039/501100011033 and by the European Union "NextGenerationEU"/PRTR. The financial support to CESAM by FCT/MCTES (UIDP/50017/2020 + UIDB/50017/2020 + LA/P/0094/2020), through national funds, is also acknowledged. FCT is acknowledged for the research contract under Scientific Employment Stimulus to Estela D. Vicente (DOI: 10.54499/2022.00399.CEECIND/CP1720/CT0012).

Ali M.U., Yu Y., Yousaf B., Munir, M.A.M. Ullah S., Zheng C., Kuang X., Wong M.H. (2021) Health impacts of indoor air pollution from household solid fuel on children and women. J. Hazard. Mater. 416, 126127.

Kerimray A., Rojas-solórzano L., Amouei M., Hopke P.K., Gallachóir B.P.Ó. (2017) Coal use for residential heating: Patterns, health implications and lessons learned. Energy Sustain. Dev. 40, 19–30.

WHO, 2022. Fact Sheets: Household Air Pollution. https://www.who.int/news-room/fact-sheets/detail/household-air-pollution-and-health.