Toxicological effects of the particulate emissions from diesel engines and wood combustion are affected by used technology

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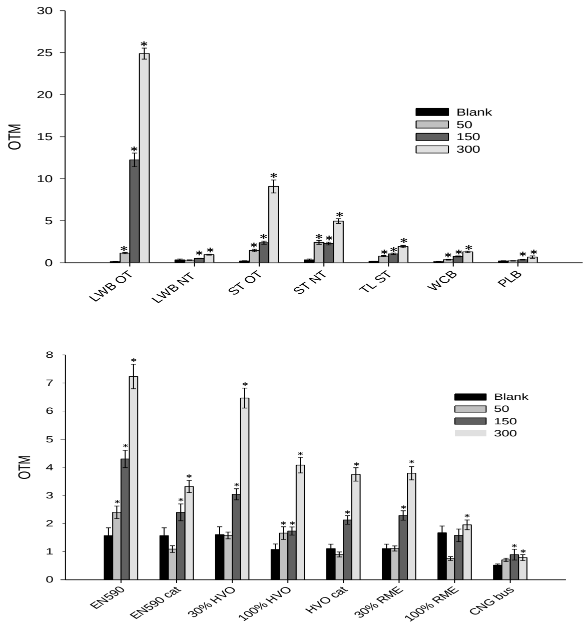
Keywords: Health effects of aerosols, Biofuels, Particulate matter, Toxicology

Particulate air pollution is one of the major public health concerns worldwide. Emissions from traffic and energy production are among the most important sources of these harmful particles. Especially residential wood combustion has increased in the same time as other emissions e.g. from traffic have been decreasing. The combustion emissions are associated with a large variety of adverse health effects, including both cardiac and respiratory symptoms. Recently IARC declared diesel engine emission to be carcinogenic to human but the biomass combustion emissions do not have the same status yet. This decision concerning diesel engine emissions is based mostly on the data from very old technologies. However, the engines have gone through significant improvements during recent years but the development of small scale combustion has been much slower.

We have investigated several modern and old technology heating appliances as well as different diesel engine types for the physicochemical and toxicological properties of the emitted particulate matter (PM). The studies included three types of diesel engines, Euro 2 small industrial engine, a large Euro IV truck engine and CNG powered bus. The conventional diesel fuel (EN590), rapeseed methyl ester (RME) and hydrotreated vegetable oil (HVO) was used as fuels in the two former and the catalyst aftertreatment was applied. Biomass furnaces were old and modern technology logwood boilers, old and new technology stoves and wood chip and pellet burning boilers. Particulate samples (Dp<1µm) for both toxicological and chemical characterization were collected from the diluted emissions. RAW 264.7 macrophage cell line was exposed to the particulate samples for 24h. Inflammatory parameters, TNFα and chemokine MIP-2 were analyzed. Cytotoxicity was analyzed with MTT assay and flow cytometric methods (PI exclusion and cell cycle analysis). Genotoxicity was determined with comet assay and intracellular oxidative species were detected in flow cytometric analyses of DCF oxidation. There were large differences in the magnitude of the toxicological responses. Old technology biomass combustion samples were up to 30 times more potent inducers of genotoxic responses than the modern technologies. The results from the engines were not as drastic but they revealed up to 8-fold differences in genotoxicity, respectively. The magnitude of the toxicological responses was generally slightly higher by the biomass combustion samples than the engine emission samples.



Genotoxicity assessed with comet assay after 24h exposure to PM_1 emission samples from different situations. Bars show blank and three doses (50, 150 and 300µg/ml) ± SEM. Upper figure presents the results from biomass combustion whereas the lower figure is for the engine emissions.

The old technologies had in most cases larger emissions than the technologically developed alternatives. This emphasizes the differences between the samples. The modern technologies can be considered less harmful than the old, but also the emissions from modern technologies can cause harmful effects. From the toxicological perspective the emissions from at least the old technology biomass combustion should not be considered as less harmful than the emissions from the engines.

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