Investigation of allergic and inflammatory effects by emissions of wood and wood products in a murine asthma model

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Wood products widely used in construction but also for flooring and furniture are softwoods like pine and engineered wood like oriented strand board (OSB). As a natural, biological material, wood and wood products emit specific volatile organic compounds (VOCs). In the current study, we have investigated possible allergic and inflammatory effects on the lung after exposure to pinewood or OSB. Using a murine asthma model, we have characterized the impact of wood-VOCs on the susceptibility and the severity of airway inflammation in allergen-sensitized and non-sensitized mice in comparison to unexposed control animals. Our data show that short-term exposure to pinewood (concentration range: 3 – 6.5 mg/m^3) had no inflammatory or asthma-enhancing effects on the airways. Similarly, long-term exposure over 12 weeks to pinewood (3 - 18 mg/m^3) did not promote allergic asthma and airway remodelling in antigen-sensitized mice. However, we observed a slightly impaired lung function in non-sensitized mice after sub-chronic exposure to pinewood at high concentrations. In contrast, short-term and long-term exposure to OSB (1.8 – 4.3 mg/m^3) had no adverse effects on the lung but reduced airway inflammation and antigen-specific IgE levels in antigen-sensitized mice. Taken together, our results demonstrate that VOC emissions by pinewood and OSB had no inflammatory or asthma promoting effects on healthy as well as on allergen-sensitized mice at environmentally relevant concentrations.

Additivity or Synergism: Are the chemosensory effects of VOC mixtures emitted from oriented strand board (OSB) more potent than those emitted from pine wood?

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Emissions from wood products can contribute significantly to the total amount of volatile organic compounds (VOCs) in indoor environments. However, the VOC emission profiles of wood and wood products can differ markedly due to processing differences and therefore, the possible health effects of such diverse mixtures might vary. In practice, the total VOC (tVOC) concept summarizing all measured VOC concentrations is used to avoid irritation or reduced well-being. However, the guidance level (RW II) of every single VOC has to be adhered to. These guidance levels are often derived from toxicological studies related to irritation/ inflammation of the respiratory tract but human (e.g. bicyclic terpenes) or animal experiments (e.g. aldehydes) are used. Thus, such effects are measured with different methods and under different conditions (e.g. histopathology or symptom reports). Using such diverse endpoints, the RW II of bicyclic terpenes and aldehydes are both set to 2 mg/m^3. Sensory irritation, a well-defined endpoint in toxicology is caused by the activation of chemoreceptors located on peripheral nerves innervating the respiratory tract. To study effects of two different VOC mixtures typically emitted from OSB panels and solid pine wood we used and established *in vitro* system of dissociated peripheral neurons and measured the potency of five representative VOCs (i.e. octenal, hexanal, limonene, 3-carene, and α-pinene) as well as the two mixtures. The potency of the VOCs of activation chemoreceptors like the transient receptor potential ankyrin 1 (TRPA1) channel were estimated from Ca^{2+}-imaging experiments. Here, effective concentrations (ECs) of the VOCs and the mixtures were measured that activated 25 percent of the neurons (EC_{25}). For the single VOCs these EC_{25} (confidence intervals) values were: octenal: 0.4 (0.1-1.7) mM, hexanal: 2.0 (0.1-4.1) mM, limonene: 4.9 (1.5-24.8) mM, 3-carene: 3.6 (0.7-27.9) mM, and α-pinene: 16.3 (10.8-27.2) mM. These values indicate that the aldehydes are more potent activators of chemoreceptors than the terpenes. Among this group α-pinene was least potent. Based on the relative portion of these five VOC in OSB and pine wood emissions (e.g. α-pinene: 55.4% in OSB and 78,6% in solid pine wood) EC_{25} values of 10.2 mM (OSB) and 14.6 (pine wood) were calculated by using a purely additive model. In contrast, the EC_{25} of the VOCs mixtures in the Ca^{2+}-imaging experiments revealed values of 4.9 mM (OSB) and 16.3 mM (pine wood) indicating some synergistic effects of the OSB mixture. Here, the proportion of the two aldehydes was 28% and their potency to activate chemoreceptors might act over additive. In conclusion, the results of this *in vitro* study using similar endpoints and exactly the same methods indicate synergistic effects of VOC mixtures with high aldehyde content. These results can be used to extrapolate comparable airborne concentrations of these VOC mixtures that could be tested in human exposure studies.