

Facile specific detection of acetaldehyde in air samples using electrochemical enzyme biosensors

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Aldehydes are relevant markers in the assessment of human health, for the quality of food and of environmental air. Acetaldehyde is the major aldehyde in wine contributing to wine aroma but also influencing wine stability and its color, since it forms adducts with sulphur dioxide and serves as bridge between phenolic compounds leading to larger compounds with different chromatic characteristics. The group of Mitsubayashi developed “biosniffer” sensors based on fluorescence or electrochemical detection and membranes impregnated with dehydrogenase enzymes for the assessment of several compounds including acetaldehyde in gas phase [1-3]. Inspired by the advantages and simplicity of these methods, we developed simple electrochemical tests for the detection of acetaldehyde in aerosols and vapor samples. The chronoamperometric detection is sensitive and requires low-cost equipment. For a specific detection of aldehydes, we employed the two recombinant dehydrogenase enzymes from the Antarctic *Flavobacterium* PL002 strain, ALDS2 and F-ALDH characterized by different Michaelis-Menten constants and substrate specificity profiles [3]. These enzymes catalyze the conversion of aldehydes to the respective carboxylic acids with the simultaneous reduction of the enzymatic cofactor nicotinamide adenine dinucleotide. The electrochemical detection of NADH is achieved either via direct oxidation at +0.5 V vs Ag/AgCl on carbon nanotube electrodes or via mediated oxidation at +0.1 V using Meldola Blue-modified carbon electrodes. Several approaches were compared: placing the enzymes together with the enzymatic cofactor NAD⁺ in solution on the electrodes, using a single-use, pre-impregnated membrane or modifying the electrodes with an ink containing the enzymes immobilized on magnetic nanoparticles. The experimental setup was examined as well: we tested aerosol samples obtained by spray-ing known amounts of aldehyde solution in plastic tubes. In another approach we took advantage of the vapor pressure to sample aldehyde vapor from the headspace of tubes containing known amounts of aldehyde solution. A custom-made pump-based gas delivery system was used to bring the vapor samples in test tubes containing the electrodes modified with enzymes. The characteristics of each system are discussed for the development of an optimized application for the detection of acetaldehyde in wines.

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