Biological Durability and Oxidative Potential of Man-Made Vitreous Fibres as Compared to Crocidolite Asbestos Fibres

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Z. Naturforsch. **56 c,** 633–648 (2001); receiced January 22/February 12, 2001

Biodurability, Mineral Fibres, Oxidative Potential

In this study we investigated relationships between redox properties and biodurability of crocidolite asbestos fibres and three different man-made vitreous fibres (MMVF): traditional stone wool fibres (MMVF 21), glass fibres (MMVF 11) and refractory ceramic fibres (RCF). Each fibre type was incubated up to 22 weeks in four different incubation media: gamble solution (GS) pH 5.0 and pH 7.4, representing blood plasma without proteins, and surfactant-like solution (SLS) pH 5.0 and pH 7.4. During incubation time aliquots of incubation mixtures were removed and analysed in a biochemical model reaction, mimicking activated phagocytes. In addition, changes of fibre morphology and chemical composition were examined using SEM- and EDX-technology.

In the presence of crocidolite asbestos fibres and MMVF 21 the formation of $OH^{\cdot}$-radicals according to the Haber-Weiss sequence could be demonstrated, whereas MMVF 11 and RCF showed no reactivity. Crocidolite asbestos fibres exhibited a significant higher activity compared with the stone wool fibres at the onset of incubation. The oxidative capacities of these fibre types were shown to depend on both specific surface area and iron content. The oxidative potentials of crocidolite asbestos fibres as well as MMVF 21 were not constant during incubation over several weeks in each incubation medium. The reactivities showed sinoidal curves including reactivities much higher than those at the onset of incubation time. These irregular changes of oxidative capacity may be explained by changes of the redox state of fibre surface-complexed iron.

Furthermore our results showed clear differences between incubation of fibres in GS and SLS, respectively, indicating that phospholipids play an important part in fibre dissolution behaviour and oxidative reactivity.

In conclusion we suggest, that biodurability testing procedures should not exclusively concentrate on dissolution rates of fibres. They should include fibre characteristics concerning known pathogenic mechanisms to evaluate the real toxic potential of the fibre type looking at. Secondly we suggest, that phospholipids should be constituents of incubation liquids used for standardised fibre biodurability test procedures thus representing more realistic incubation conditions.