Aerobiologia **16:** 271–274, 2000.

LATEX: A peculiar biological component in airborne particles?

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Received 13 October 1999; accepted in final form 30 March 2000

Key words: airborne particles, Latex, $PM_{2.5}$, PM_{10}, tires

Abstract

In a study in the USA, latex allergens have been identified in airborne particles. Natural rubber (latex) is a product from the plant *Hevea brasiliensis* and is largely used in the tire industry. In the vicinity of roads, latex can become airborne due to wear-off processes of tires. Sensitisation to latex has been increasing in the last decade; an important pathway for the sensitisation is mediated by the airways. It is not known, if this concerns mainly laboratory personnel or if this is also an environmental problem.

This study investigated the content of latex in airborne particles in the vicinity of a road with moderate traffic, in comparison to a control site. Latex was determined in a competitive ELISA based on polyclonal IgE antibodies. During spring and summer, collected airborne dust was analysed for the content of protein and latex. Latex concentrations in PM_{10} in the city were higher than at the control site. At both sites, latex levels were significantly lower in $PM_{2.5}$ than in PM_{10}.

Introduction

An increasing prevalence rate of sensitised persons against latex has been observed over the last decade (Baur, 1995). Dermal contact with latex is important for the induction of a *contact urticaria*, but inhalation (e.g. latex powder from gloves) is also an important pathway for the induction of hypersensitivity in the upper airways (Baur, 1995).

Particles of biological origin (pollen, spores) are important for the induction of allergic symptoms, and allergens have been observed in fine (<2.5 μm) and coarse (> 2.5μm) particles (Spieksma et al., 1995; Schäppi et al., 1996). In these studies, the focus was primarily on pollen and fungal allergens, and latex did not attract much attention. The most important contact to airborne latex occurs indoors in hospitals and in medical care centres (Baur, 1995). However, in a study from California, latex particles were identified in ambient air particles and in road dust near a freeway (Miguel et al., 1996). Latex from the plant *Hevea Brasiliens* is widely used in the tire production; overall about 50% from the global natural rubber latex production is used in the tire industry (Williams et al., 1995). Latex particles can become airborne by wear-off processes of tires during driving, stopping, and accelerating of vehicles.

The **purpose** of this study was to:

- establish a competition ELISA against latex
- investigate, if latex allergens can be identified in airborne particles <2.5 μm ($PM_{2.5}$) and <10 μm (PM_{10})
- investigate, if a site exposed to moderate traffic has a higher latex content than a suburban control site

Methods

PM_{10} and $PM_{2.5}$ measurements were performed during two periods in Zürich (Stampfenbachstrasse, moderate traffic; 2 meters from road; 50–80 cm above ground) and at a suburban control site (Kilchberg, balcony of an apartment, more than 60m away from road with moderate traffic) with no direct exposure to traffic. (Periods for both study sites: April 18th–May 29th, and June 26th–July 31st, 1998). The sampling time in the first period was 48 hours, in the second period 7 days. Particles were collected on teflon filters; the airflow for PM_{10} was 4 litres min^{-1} (Harvard low-volume impactor) and 15 litres min^{-1} for $PM_{2.5}$ (EPA-WINS). Before and after exposure, the filters were conditioned in a chamber (22 °C, 52% relative humidity) for 24 hours prior to the gravimetrical analysis. After this analysis, filters and extracts were stored at −80 °C.

After each series, exposed filters were submitted to an extraction in 1.5 mL physiological buffer (PBS-buffer: 137 mM NaCl, 2.7 mM KCl, 10 mM Na_2HPO_4, 1.8 mM KH_2PO_4, pH 7.4, 0.02% NaN_3) for 20 minutes in an ultrasonic bath. After centrifugation, the supernatant was used for immunological analysis. A competition ELISA has been developed for the quantitative determination of latex allergens. IgE-positve serum from a voluntary subject was used. In a skin prick test, the subject had positive reactions against latex, banana, ficus and mites but negative reactions against fungi and pollen. The RAST-classes for latex was 4, for ficus and banana 2. The following procedure was used for the competition ELISA: coating with antigens (Latex standard; Stallergènes, SA, Antony Cedex, France 1:7 dilution in PBS); blocking (with 0.1% BSA in PBS-Tween (1%)); adding serum (containing IgE against latex in PBS-Tween (1%); serum dilution 1:3) and particle extracts (from field samples). A secondary enzyme-linked antibody (anti-human IgE, Pharmingen, Clone G7-26) with alkaline phosphatase was used to determined the remaining IgE, attached to the coating agent. After adding the substrate (Diethanolamine, NPP, Fluka 73724), the absorbance was measured at 405 nm in a photometer. Standard curves were established using dilutions of the antigen standard (latex standard). The washing procedures between these steps took place with a PBS-Tween buffer (0.05%).

Statistical analysis. A statistical analysis was carried out in order to test the differences between PM_{10}, $PM_{2.5}$ and between the two sites. The analysis was based on a pairwise Wilcoxon-test performed in SYSTAT (Version 7.0.1.) in Windows 95.

Results

Competition ELISA

Figure 1 shows the standard curve for the latex standard, and a comparison with extracts from *tires* and *rubber gloves* (both containing latex): for both, water extracts from tires and water extracts from rubber gloves, a competitive inhibition after adding aliquots of the extracts could be observed (three concentrations for each). These signals were not identical to those of the latex standard as the latter is uniquely composed of latex whereas the other extracts contain other proteins. All results were standardised according to their protein content and will be presented in protein units (assuming that the latex standard consists 100% of latex proteins).

Latex content in airborne particles

Figure 2 shows latex concentrations at the urban (A+B) and the suburban sites (C+D). The highest latex concentrations were determined in PM_{10} at the urban site (A). At the suburban site, latex levels in PM_{10} were higher than in $PM_{2.5}$, but lower than at the city site. At both sites, the latex content was higher in PM_{10} than in $PM_{2.5}$. (The latex levels in $PM_{2.5}$ were at the detection limit.) This is an indication that latex particles occur in the coarse size.

Discussion and conclusions

Latex could be identified in airborne particles, especially in PM_{10}. Levels in $PM_{2.5}$ were much lower and close to the detection limit. This indicates that latex particles have a size of 2.5–10 μm, which corresponds to values given in literature (6 μm) (Williams et al., 1995). The city site near the traffic artery exhibited higher levels than the control site. At the latter, however, also positive latex concentrations were identified in PM_{10}.

Unfortunately, no standard ELISA-test is available which makes comparisons with values from other reference difficult. An air quality standard for indoor latex levels of 0.5 ng m^{-3} has been proposed in order to prevent sensitisation (Baur, 1995), a value which has been reached in our analyses. The latex levels in airborne particles from Miguel et al. (1996) were lower than ours (0.028 ng m^{-3}: annual mean, 0.3 ng m^{-3}: peaks); the difference might have occurred because of differences in the analytical procedures and

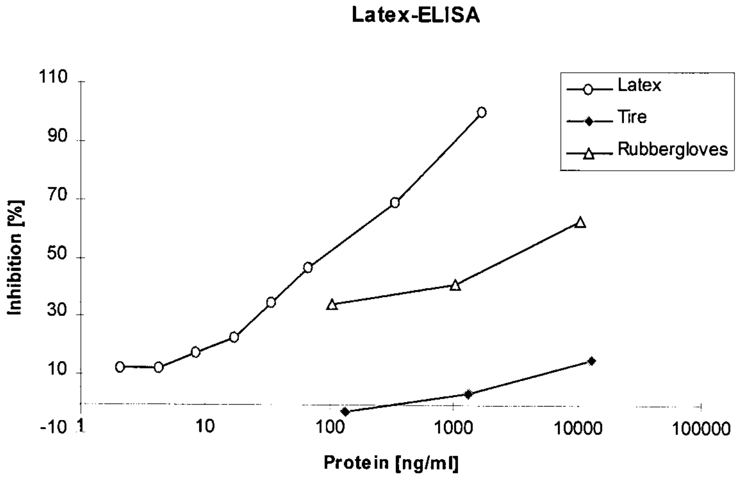

Figure 1. Competition ELISA and standard curve for latex-standard and extracts from rubber gloves and tires. Inhibition of the serum IgE binding to the coated latex standard by adding indicated aliquots (protein equivalents in ng/ml) of latex (Stallergènes), water extracts from a tire and rubber gloves.

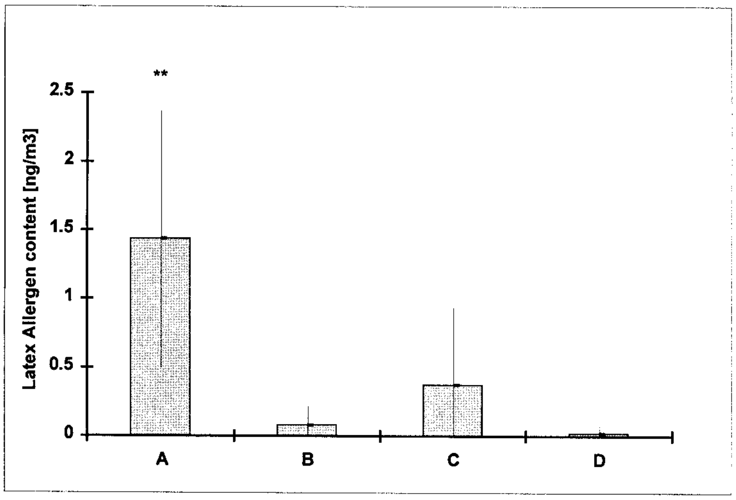

Figure 2. Latex content in airborne particles in ng m^{-3} (protein equivalents) A: Zürich (city) PM_{10}, B: Zürich (city) $PM_{2.5}$, C: Kilchberg (suburban) PM_{10}, D: Kilchberg (suburban) $PM_{2.5}$ (A differs significantly from B and C ** $p < 0.05$). Columns: average values; whiskers: ± standard deviation). (Number of observations: A = 11, B = 16, C = 5, D = 15)

the use of different standards. We conducted additional experiments based on particle collection on glass-fibre filters which indicated systematically lower latex levels than those obtained with teflon filters. This is an indication of a more efficient extraction from teflon filters compared with other filters. Although a cross-reactivity with some important allergen species (birch tree, grass) can be excluded, an interference of other species (e.g. profilin) cannot completely be ruled out. From our results, we have indications that latex is a peculiar component in airborne particles near roads. It would be interesting to determine the prevalence rate of latex positive sensitisation in these populations.

Acknowledgements

The authors kindly thank “Amt für Gesundheit und Umwelt der Stadt Zürich” for the support of the study and for providing us with air pollution data. Many thanks to Dr. A. Helbling, University Hospital Berne (Inselspital) for providing us with sera from patients.

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