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Gloves, condoms and bouncy balls

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Gloves can be dangerous. Yes, but so can rubber soles, condoms, swimming caps, various medical appliances and even toys. And the offender is latex. Latex is the milky fluid tapped from rubber trees, which – following a series of processes – produces the different types of rubber used by the commercial, medical, transportation and defence industries. To date, natural rubber is used in over 40'000 products. And it is nothing new. Ancient Mesoamerican societies were already harvesting latex in 1600 BC from the Panama rubber tree or *Castilla elastica*. Not only were they harvesting it but they also processed it in order to obtain a pliable bouncy rubber, by adding the sap extracted from a second plant – a species of morning glory vine or *Ipomoea alba* – which grows on *C.elastica*. With the rubber, they fashioned hollow rubber figurines, wide rubber bands and bouncy balls with which they are said to have played violent games. Liquid rubber was used for medicines and paint.

Tapping a rubber tree

Courtesy of www.rubbercal.com

Samples of latex were taken back to Europe by explorers in the 18th century. It is said that John Priestley (1733-1804) – an English chemist, best remembered for his discovery of oxygen[1] along with the Swedish chemist Carl Scheele (1742-1786) – noticed by chance that he could rub out black marks with it and coined the term 'rubber'.

There are more than 2'500 different species of rubber-producing plants, amongst them the dandelion, the milkweed and the sagebrush. The rubber tree used for commercial purposes today is the *Hevea brasiliensis* tree. Brazil was indeed the first country to provide the world with natural rubber in the 19th century. However, in 1876, *H.brasiliensis* seeds were exported to Kew Gardens in London at the request of the Victorian botanist Sir Joseph Hooker (1817-1911). Seedlings were then taken to Ceylon (Sri Lanka today) and later to Singapore. It was not long before estates of rubber plantations were created, in Malaysia by the British, and in Indonesia by the Dutch. Currently, 85% of the world's natural rubber grows on the Malaysian plantations.

Where is the danger? Latex is a mixture of rubber particles, proteins, lipids, carbohydrates, sugars and water. In the late 1970s, a growing number of latex-related allergies were reported mainly amongst health care workers, rubber industry workers, housekeeping personnel and in patients with spina bifida. The latter seem to be particularly predisposed to this type of allergy where latex sensitisation hovers between 29% and 72%! The sudden surge of latex allergy was caused by the demand for latex gloves as a precaution against the transmission of HIV and Hepatitis B. To match the demand, the standard of latex processing was slackened and 'dirty' latex was delivered, i.e. latex with a significant amount of protein.

[1] Priestley called the gas he discovered 'dephlogisticated air'. It was the French scientist Antoine Lavoisier (1743-1794) who named it oxygen.

The clinical manifestations of latex allergy include urticaria, rhinitis, conjunctivitis, bronchospasm and anaphylaxis. The culprits are various proteins, one of which is known as the small rubber particle protein (SRPP). SRPP is amajor latex allergen bound to the surface of small rubber particles. Rubber is a hydrocarbon polymer of 1,4 isoprene. Rubber particles have been compared to the oil bodies in plants. The size of rubber particles ranges from 5Å to 30'000Å and each rubber particle contains hundreds to thousands of rubber molecules. In mature trees, these rubber particles have a pear form. It is thought that the isoprenoid polymers are wrapped up into a mosaic of protein, membrane lipids and other components arranged in an intact monolayer membrane about 100Å thick.

SRPP, as well as the latex itself, is synthesized in specialised vessels – or lacticifers – located just under the phloem of the rubber tree. Besides its allergenic properties, SRPP may well be one of the proteins which plays an active role in rubber synthesis, i.e. isoprenoid polymerisation. Indeed, rubber synthesis takes place on the surface of rubber particles, where SRPP is found. How SRPP actually participates in rubber synthesis, no one really knows. It could function as a rubber transferase, by snatching hydrophilic substrates outside the rubber particle and adding them to the hydrophobic core of the rubber particle. SRPP does seem to catalyse the formation of long-chain length rubber, but it is not known whether it has a direct role in elongating the chain or whether it only participates in the initial synthesis of the isoprenoid molecules which are then added onto the rubber polymer.

The great mystery resides in the existence of this rubber solution in the first place. Why do plants make latex? There are a number of pathogen-related proteins in latex, so it is not unreasonable to believe that latex is an answer to plant wounding. The immediate concern, however, is to produce allergen-free latex. Ridding latex of all of its proteins would demand heavy and expensive treatments, which would probably alter the properties of the rubber anyway. Some scientists are now turning to a desert shrub, known as guayule or *Parthenium argentatum*, found in Mexico and Texas. The latex from this plant species has much less protein than its *Hevea* counterpart and seems to be hypoallergenic even when tested on *Hevea*-hypersensitive patients. Continued research should lead to genetically engineered guayule lines that would enhance rubber yield and extend the growing range.

Cross-references to Swiss-Prot

Small rubber particle protein, *Hevea brasiliensis* (Para rubber tree) : O82803

References

1. Oh S.K., Kang H., Shin D.H., Yang J., Chow K.-S., Yeang H.Y., Wagner B., Breiteneder H., Han K.-H.
   Isolation, characterization and functional analysis of a novel cDNA clone encoding a small rubber particle protein from *Hevea brasiliensis*
   J. Biol. Chem. 274:17132-17138(1999)
   PMID: 10358068

2. Hosler D., Burkett S.L., Tarkanian M.J.
   Prehistoric polymers: rubber processing in ancient Mesoamerica
   Science 284:1988-1991(1999)
   PMID: 10373117