

Identification of allergenic proteins in condoms by immunoenzymatic methods

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Background: A large increase of allergy to latex proteins has been observed lately probably as a result of a great use of latex-containing goods. At present these untoward reactions have led to consideration of this problem as a health and occupational hazard. It is therefore, necessary to identify the allergens contained in latex-manufactured products and to develop effective diagnostic tools to detect sensitized individuals.

Objective: The objective of this study is to identify antigenic and allergenic components in latex condoms by using chemical, immunochemical, and immunoenzymatic methods.

Methods: The protein content of extracts obtained from several brands of condoms was determined and characterized by using a modified Lowry method, a quantitative ELISA assay and SDS-PAGE. The allergenic behavior of these proteins was studied by IgE immunoblotting, EAST and ELISA techniques, using sera from subjects allergic to latex products, particularly to latex condoms.

Results: Wide variations in the protein content (38 to 740 $\mu\text{g/g}$ product) and composition were observed. The SDS-PAGE protein profiles showed components ranging from 7 to 94 kD of relative molecular weights; most of them were also detected in natural rubber latex. The most prominent bands were revealed in the 14 and 30 kD zones. A strong band of 69 kD in the SDS-PAGE profiles would correspond to a neoantigen, since it was not observed in natural latex. The immunoblotting analysis employing sera from 5 patients allergic to latex condoms showed the presence of 4 components with IgE binding capacity (14, 30, 69, and 94 kD). The EAST and ELISA methods showed the presence of allergens in all the condom brands studied.

Conclusions: The presence of allergenic proteins in several condom brands was demonstrated by different immunoenzymatic methods.

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INTRODUCTION

Latex-manufactured products are widely used by the general population. This becomes a health and occupational hazard and a risk to latex protein-sensitized subjects. After repeated exposure to these

products, by contact or inhalation, allergic individuals may suffer from cutaneous, respiratory, or systemic reactions.^{1,2}

The most common clinical manifestations are nonatopic irritant dermatitis and allergic contact dermatitis, elicited by chemicals added to natural rubber during manufacturing process.^{3–5} According to the American Academy of Allergy and Immunology, four groups of people are at higher risk with regard to latex allergens: health care workers,^{6,7} latex industry workers,⁸ children with spina bifida, and subjects with positive risk factors (multiple surgeries, reactions to latex containing products, hand eczema, atopy, etc).^{9–11}

Individuals not considered to be at risk should also be taken into account,

because of the increasing exposure to latex products. Prevalence rates of latex allergy lower than 1% have been reported to be present in this group.¹²

Rubber particles made of polyisoprene are coated with phospholipids, lipids, and proteins. As a result of the different manufacturing processes undergone by the natural rubber latex, many of these proteins remain unaltered while others are modified, by either disappearing or creating new reactive epitopes^{13–15}; therefore, not all latex-made products are similarly allergenic. Furthermore, we could observe that some products did not release significant amounts of proteins, suggesting that the manufacturing processes decrease the content of proteins.

The increased incidence of latex allergy in the last few years results from the greater use of gloves and condoms to prevent the spreading of the HIV virus.^{4,16,17} As a result, rubber latex allergy has become an increasingly common health and occupational hazard.

In the population not shown to be at risk, exposure to latex-made products (condoms, pacifiers, adhesive bandages, household gloves, toys, balloons, etc.) is also frequent, since these products contain allergens from natural rubber latex. Since it is difficult to eliminate all latex-made products from the environment, efforts should be directed both to identify sensitized individuals, and to detect the presence of latex proteins in manufactured products. The development of adequate methods to determine allergen content in latex-made products becomes necessary to diminish the risk of sensitization. Different types of gloves (household, surgical, and examination gloves) have been characterized as latex protein sources^{18–20}; while information regarding the allergenic protein content in other widely

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used medical and nonmedical products is scarce.

Characterization of latex products, including defined allergens, is important to develop in vitro tests to detect specific IgE to latex proteins in human serum. The aim of this study is to identify antigenic and allergenic components in condoms by chemical, immunochemical and immunoenzymatic methods, employing sera from subjects allergic to latex-containing products, especially latex-condoms.

MATERIALS AND METHODS

Protein Extracts

Two latex sources were used to prepare the protein extracts:

(1) *Natural latex.* Protein extract from ammoniated latex was obtained in the presence of 1% sodium dodecylsulphate (SDS) as previously described.²¹

Total water-extractable proteins were determined by the modified Lowry method, according to the recommendations of the American Society for Testing and Materials. Prior to the Lowry method, interfering chemicals added during manufacture of natural latex, were separated by precipitation of proteins.^{22,23} Ovalbumin was used as a standard. Each sample was tested in triplicate using four 2-fold serial dilutions in 0.1 M NaOH to ensure that the absorbance measurement of the diluted specimen fell within the limits of the calibration curve. Optical density was read at 750 nm.

(2) *Condoms.* The protein extracts were prepared by cutting condoms into small pieces, soaking them in phosphate buffered saline (PBS) with 1% of SDS (1:5 wt:vol extraction ratio) overnight at room temperature with continuous shaking. Each extract was centrifuged and filtered through a 0.22- μ membrane and further dialyzed overnight using a 2-kD molecular weight cutoff membrane (SPECTRA/POR MWCO 2000) against Tris buffered saline and finally concentrated by lyophilisation. Extracts were stored at -20°C until used. The amount of total water-extractable protein was

determined by the modified Lowry method.^{22,23}

Nine different condom brands were tested: Trojan (Extra strength-USA) Ramses (Extra-USA), Gold Circle (USA), Amor (Germany), McCondom (England), Life Styles (Vibra-Ribbed-USA), Tulipan (Argentina), Prime (Argentina), and Syltex (Argentina).

Anti-Latex Polyclonal Antiserum

New Zealand White rabbits were hyperimmunized by intradermal administration with 100 μg of SDS-natural latex extract in PBS with Freund complete adjuvant. Animals were inoculated every 3 weeks with the same immunogen prepared in Freund incomplete adjuvant. Specific antibody titers were determined by an indirect ELISA after each boost.

Rabbit serum samples taken before immunization did not show any specific latex antibodies as studied by indirect ELISA.

Sequential Competitive ELISA

Polystyrene microtiter plates (NUNC, Maxisorp, Denmark) were coated with 1 μg /well of natural latex protein extract, incubating for 12 hours at 4°C . After washing with 9 g/L NaCl containing 0.05% (vol/vol) Tween 20, 200 μL /well of blocking buffer containing 5% horse serum in PBS pH 7.4 was added and incubated for 2 hours at 37°C . Wells were then washed three times with NaCl-Tween 20.

Inhibition experiments were carried out by pre-incubating equal volumes of antigen, standard or condom extract, and rabbit anti-latex polyclonal antiserum (both diluted in blocking buffer) for 1 hour at 37°C . Antiserum dilution was previously determined (1:110,000) from the titration curve.

A volume of 100 μL of each of the above mentioned pre-incubated samples was transferred to the coated wells for competition with antigen in solid phase and incubated for 1 hour at 37°C . After washing with NaCl-Tween 20, 100 μL /well of goat anti-rabbit IgG horseradish peroxidase conjugate (BIO RAD) diluted 1:3000 in blocking buffer was added and incubated for 1

hour at 37°C . Color was developed by adding a solution containing o-phenylenediamine and 30% H_2O_2 in 0.1 M citrate-phosphate buffer pH 5.0. The reaction was stopped by the addition of 40 μL /well of 4 N sulfuric acid. The reaction product was quantified by reading the optical density at 490 nm.

The standard curve was obtained by preincubating natural latex samples of known protein concentration (0.5 ng/mL to 1 mg/mL) with the antiserum.

To establish the validity of our natural rubber latex standard curve we prepared a pool of extracts from the nine different condom brands and compared the results obtained with both antigen preparations.

To obtain the protein concentration of condom extracts, the natural rubber latex standard curve was employed, interpolating the results obtained from condom samples in the ng/100 μL to μg /100 μL range. Within this interval of antigen concentration, both dose-response curves are parallel (data not shown).

A non-linear relation between optical density and antigen concentration was observed. Logit function²⁴ was used to make the data fitting a straight line. Several serial dilutions of each condom sample were used to interpolate the transformed data in the ng/100 μL to μg /100 μL interval of antigen concentration, where errors are minimal.

To reach the highest detectability of the assay, different conditions were tested: antiserum dilution, time and temperature of pre-incubation, coating-antigen concentration, time of the competition between immunocomplexes and coated antigen and time of the anti-rabbit conjugate incubation.

SDS-PAGE and Immunoblotting

Latex proteins were separated by sodium dodecylsulphate-polyacrylamide gel electrophoresis (SDS-PAGE) according to the method described by Laemmli.²⁵ A polyacrylamide gel of 15% with a discontinuous buffer system was used. Ten micrograms of protein from condom extracts were used per lane. To obtain clear and visible bands, protein extracts had to be con-

centrated by lyophilisation. Gels were fixed and proteins were stained with silver staining.

Immunoblotting of the separated latex proteins was performed as described.^{21,26} To assess the transfer efficiency, membranes were reversibly stained using 0.2% wt/vol. Ponceau S in 3% trichloroacetic acid. Thereafter, membranes were incubated for 1 hour at 37°C in blocking buffer (5% of horse serum in PBS pH 7.4) and cut into 5-mm strips for immunostaining. Sera from patients or control serum diluted 1:5 in blocking buffer were added to each strip and incubated for 12 hours at room temperature.

After washing (0.05% Tween-PBS), an amplifier system was used: strips were first incubated with biotinylated goat anti-human IgE (ϵ -chain specific) antibody (Vector, California, USA) diluted 1:2000 in blocking buffer (2 hours at 37°C), and then, with ExtrAvidin-alkaline phosphatase conjugated (1:5000, SIGMA) for 1 hour at 37°C. Strips were washed and color was developed with 5-bromo-4-chloro-3-indolylphosphate/nitro blue tetrazolium (5-BCIP/NBT, Sigma).

Patient Sera

Serum samples were obtained from subjects who attended the Allergy Service of the San Juan de Dios Hospital (La Plata, Argentina). Patients signed their informed consent previously. The protocol was approved by the Ethical Committee of the Hospital San Juan de Dios of La Plata.

A control group consisted of 40 sera from healthy subjects with normal total IgE levels, according to age in our population, with only occasional contact with latex products and no symptoms related to latex allergy. This group consisted of 14 females and 26 males; mean age: 25.3 years, ranging from 2 to 47 years.

A pooled serum was prepared with sera from 30 patients allergic to latex. They had a clinical history of latex allergy; the presence of specific IgE to natural latex proteins was determined by ELISA, EAST and immunoblotting methods developed in our laboratory.

All patients had positive skin prick test performed with the latex protein extract diluted 1:10,000 (50 ng/mL) in 9 g/L NaCl with 50% glycerol. A glycerol-solution of 9 g/L NaCl was used as negative control and histamine dihydrochloride (1 mg/mL), as positive control.

Nine sera from patients with clinical symptoms of allergy to condoms were used to characterize condom allergens. Allergy was documented by a clinical history of urticaria, itching, or pruritus after contact with latex condoms. Table 2 shows data from these patients including total IgE and specific IgE to NRL and condom proteins.

Detection of Specific IgE to Condom Proteins by ELISA

Indirect ELISA was developed by coating the wells of microtiter plates (NUNC, Maxisorp) with the protein condom extract showed in Figure 1, lane 6 (1 μ g/well). After blocking with PBS-containing 5% of horse serum (1 hour at 37°C), 100 μ L of serum samples (diluted 1:5 in blocking buffer) were added and incubated for 12 hours at 4°C. After washing to remove the unbound material, a monoclonal anti IgE antibodies-alkaline phosphatase conjugate (Southern Biotechnology Associates, Inc, Birmingham, AL USA) diluted 1:4000 in blocking buffer, was added. Color was developed with *p*-nitrophenyl phosphate disodium and OD was measured at 405 nm.

Optimal concentration of proteins for coating the ELISA plates was determined by using antigen concentrations from 0.001 to 0.3 mg/mL.

To establish the cutoff value of the assay, sera from the control group were assayed under the same conditions as those used for patient sera. The cutoff value was calculated as the mean optical density plus 3 standard deviations.

An indirect ELISA was performed by coupling the polystyrene wells with protein extracts obtained from eight different condom brands. Then, blocked strips were incubated with sera from control group, pool of positive sera and the five sera from the condom-allergic patients described in Table 2. IgE was detected as previously described.

Detection of Specific IgE to Condom Proteins by EAST

Determination of specific IgE in human sera was performed by using paper discs activated with CNBr. Condom protein extracts were coupled to CNBr-activated paper discs at 1 mg/mL of proteins in 0.1 M carbonate/bicarbonate buffer, pH 8.5 according to Ceska's method.²⁷ Each disc was incubated with 50 μ L of serum (diluted 1:5) for 12 hours at room temperature. After thorough washing, bound specific IgE was revealed with monoclonal anti-human IgE (ϵ -chain specific) alkaline phosphatase conjugate

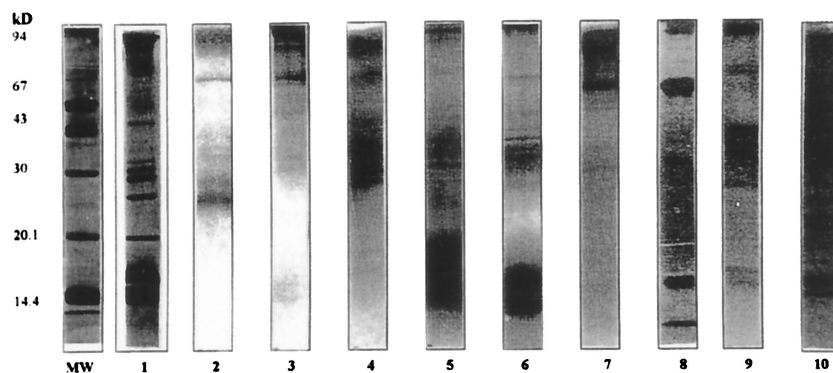


Figure 1. SDS-PAGE analysis of protein extracts from natural latex and condoms. Molecular weight (MW) markers: 1, extract from ammoniated latex; 2, Trojan; 3, Ramses; 4, Prime; 5, Gold Circle; 6, Tulipan; 7, Amor; 8, Siltex; 9, McCondom; and 10, Life Styles. All samples were stained with silver stain.

diluted 1:5000 (SIGMA) by incubating for 12 hours at room temperature. Color was developed by adding an enzyme substrate solution containing a chromogen (*p*-nitrophenyl phosphate, Sigma).

To optimize the coating of paper discs, different protein concentrations of the extract were tested. The concentration that produced no further increase of OD when analyzed with the pool of positive sera (1 mg/mL), was chosen for further tests. Background value was determined with sera from the non-atopic control group.

Assay specificity was controlled by using 15 serum samples with specific IgE to unrelated allergens and total IgE levels higher than 200 IU/mL. Furthermore, a serum with more than 20,000 IU/mL of total IgE was also tested.

To measure specific IgE in classes, a calibration curve was obtained by using a pool of anti-Dermatophagoides sp sera, as reported by Lundkvist.²⁸

RESULTS

Protein Composition of Condom Extracts

Table 1 shows the protein content of the condom extracts analyzed. When comparing the different condom brands we could observe that the industrial procedures used yielded a final product with a variable quantity of latex proteins (65 to 1406 μ g/unit).

The sequential competitive ELISA showed a good linear response within a wide range of protein concentration (0.8 ng/mL to 1 mg/mL) with a detection limit of 650 ng/mL, calculated with a *t* test (99% of confidence).

The total protein concentration of the condom extracts, as determined by the modified Lowry method, ranged from 56 to 824 μ g/g of product. In contrast, when an immunochemical method was employed, lower quantities (38 to 740 μ g/g) were found.

The natural ammoniated latex extract analyzed by SDS-PAGE as shown in Figure 1, lane 1, exhibited a protein profile with intense bands in the region of 14 and 17 kD, and other less intense

bands in the regions of 27 to 33, 40 to 70 kD and at the top of the gel.

Condom protein profiles obtained by SDS-PAGE are showed in Figure 1 (lanes 2 to 10). As can be seen, the different brands showed different protein compositions, with components within a wide range of molecular weights (from 7 to 94 kD and higher). Bands are seen in the 7-kD zone (lane 8), 14 to 17 kD (lanes 5, 6, and 8–10), 30 to 33 kD (lanes 2–10), 40 kD (lanes 4, 6, 9, and 10), 69 kD (lanes 2–4, 6–9), and 90 kD (lanes 3, 7, 10). The most prominent bands observed in natural rubber latex (14 to 17, 27 to 33 kD-zones and at the top of the gel) were also detected in extracts from several condom brands (Fig 1).

In spite of the difficulty to detect polypeptide components of low molecular weight by this technique, a weak band of about 7 kD could be observed (lane 8). A 27-kD component, an important latex allergen in adult allergic patients, was also revealed in condom extracts (Fig 1, lanes 2 and 10). A component of 69 kD revealed in the SDS-PAGE of condom extracts was not seen in natural rubber latex extract.

Allergenic Composition of Condom Extracts

Allergenic properties of condom extracts were studied by analyzing the binding of serum IgE from atopic patients using the EAST, ELISA, and immunoblotting techniques.

Tables 2 and 3 show the results of specific IgE to condom proteins and natural latex proteins, as determined

by EAST and ELISA. Activated paper discs and polystyrene microplates were coated with the same condom extract as that employed in the immunoblotting experiments. Total IgE levels, as determined by ELISA, and skin prick test results are also included.

Five of the nine sera from patients with clinical signs of atopy to condoms showed the presence of specific IgE as determined by EAST, ELISA (Table 2), and immunoblotting (Fig 2, lanes 4–8). The other four sera had neither higher than normal total IgE levels nor condom-specific IgE. Results obtained employing the pool of latex-positive sera are included in Table 2.

The presence of allergenic components in eight out of the nine condom extracts analyzed was also investigated by ELISA (Table 3), employing the sera from patients 1 to 5 and the pool of positive sera. All condom extracts contained components that were bound by serum IgE.

In order to detect the presence of individual allergenic proteins, the condom extract shown in Figure 1 lane 6 was employed to perform the IgE immunoblottings. When the pool of positive sera was used to reveal the IgE reactivities, latex immunoblotting (lane 1) showed bands in the regions of 14 to 17, 27 to 39, 40 to 67 kD and at the top of the gel, while in the condom immunoblotting (lanes 2) reactivities, the regions of 14 and 30 kD were observed. In addition, condom IgE immunoblottings did not show any bands in sera from nonatopic patients (con-

Table 1. Protein content of condom extracts

Condom	ASTM Lowry Method*		Quantitative ELISA		
	mg/mL	μ g/g Product	mg/mL	μ g/g Product	μ g/unit
Trojan	0.246	736	0.201	601	1250
Ramses	0.043	56	0.029	38	65
Prime	0.301	622	0.196	405	557
Gold-Circle	0.121	363	0.090	270	475
Tulipan	0.386	729	0.310	586	820
Amor	0.047	141	0.036	108	172
Syltex	0.154	462	0.150	450	630
McCondom	0.165	479	0.138	401	581
Life Styles	0.295	824	0.265	740	1406

* ASTM: American Society for Testing and Materials.

Table 2. Data of Patients Atopic to Latex Condoms

Patient	Age (yr)	Sex	Latex Skin Prick Test	Total IgE (UI/mL)	Latex Specific IgE by		Condom Specific IgE by*		Clinical Signs†
					EAST (class)	ELISA (OD ₄₀₅)	EAST (class)	ELISA (OD ₄₀₅)	
1	19	Female	Positive	92	3	1.56	3	0.988	U, P‡
2	23	Female	Positive	78	2	0.855	2	0.822	O, P
3	23	Female	Positive	816	3	0.923	2	0.755	P
4	17	Female	Positive	117	3	0.610	3	0.551	V
5	45	Female	Positive	155	3	1.86	3	0.966	U, P
6	31	Male	Negative	25	0	0.199	0	0.226	P, E
7	38	Male	Negative	18	0	0.191	0	0.220	P
8	55	Female	Negative	34	0	0.115	0	0.210	O
9	41	Female	Negative	55	0	0.223	0	0.155	U, P
Positive pool				1150	3	2.152	3	1.210	
Negative serum				<60	0	0.279	0	0.305	

* Condom extract showed in figure 1 lane 6 was employed to coat the solid phases.

† Localized clinical signs: U, urticaria; P, pruritus; O, edema; V, vulvovaginitis; and E, erythema.

‡ This patient also suffered a giant urticaria.

Table 3. Specific IgE to Eight Different Condom Extracts by ELISA

Condom Extracts	Serum Samples						
	Positive Pool	Negative Serum	Serum 1*	Serum 2*	Serum 3*	Serum 4*	Serum 5*
McCondom	0.501	0.250	0.290	0.368	0.301	0.396	0.401
Trojan	0.986	0.220	1.105	0.586	0.670	0.810	0.885
Gold-Circle	1.015	0.231	1.218	1.050	0.905	0.981	0.996
Life Styles	1.121	0.228	1.005	0.860	0.380	0.796	0.445
Amor	0.461	0.256	0.310	0.321	0.310	0.361	0.332
Tulipan	1.118	0.210	1.218	0.310	0.470	0.578	0.755
Ramses	0.998	0.251	1.118	0.778	0.320	0.445	0.556
Prime	0.969	0.268	1.008	0.396	0.530	0.421	0.441

* These sera belong to patients described in Table 2.

trol group) (Fig 2, lane 3). When sera from latex-allergic (lanes 9 to 11) or condom (lanes 4 to 8)-allergic patients were employed, bands in the regions of 14 (lanes 4–6, 8–11), 30 (lanes 5–7, 10), 69 (lane 7), and 94 kD (lane 7) could be observed.

DISCUSSION

Latex allergy is a hypersensitivity condition for which there is no treatment. Instead, exposure to latex containing products should be avoided.

We have developed a sensitive and specific immunochemical method to quantify the presence of natural latex proteins in rubber products. In addition, intact and processed proteins

from natural latex were identified in condom extracts by SDS-PAGE and immunochemical methods, using sera from allergic patients and a rabbit polyclonal antiserum.

In spite of the similarities among the manufacturing processes, final products may contain variable quantities of proteins. Briefly, the manufacturing processes consist of dipping the mold in natural latex containing different additives and chemicals according to the features of the final product, basically its thickness. The exact industrial process used by the different manufacturers is not known and it may lead to products with a variable amount of residual proteins. We have observed that

different brands of condoms show a wide variation in protein composition (Fig 1 and Table 1) as judged by the SDS-PAGE profiles and in protein quantities, as measured by different methods.

The competitive immunochemical assay employed in these experiments, showed a high detectability and a mostly linear response. Accordingly, samples with a low protein content could also be analyzed. In addition, as shown in Table 1, the protein content measured by ELISA was lower than that obtained with the modified Lowry method. Condom extracts may contain additives that influence the immunologic competition reaction between proteins in natural latex and proteins in different condom extracts. Not all the proteins present in the condom extracts are antigenic.

The presence of allergenic proteins in condoms was demonstrated by three immunochemical methods. A pool of sera containing specific IgE to natural latex proteins and nine sera from patients with clinical signs of allergy to condoms were employed as source of IgE. Four sera, however, did not show the presence of specific IgE to latex nor to condom proteins (Table 2), suggesting that reactions observed in these

patients were not caused by IgE-dependent mechanisms. This clinical picture might be caused by the presence of additives that may elicit type IV hypersensitivity reactions.³

We did not perform the immunoblotting method with all the condom extracts due to difficulties in obtaining clear bands. The extract shown in Figure 1 lane 6 was employed to demonstrate the binding of serum IgE to condom proteins. Our results suggest that some condoms could contain natural latex proteins that remain unaltered throughout the manufacturing processes (in the 14 and 30 kD-zones). It should be considered that a band could be formed by several different protein components with the same relative molecular weight. On the other hand, some other components from natural latex could be modified, and most of them disappear (Figs 1 and 2). In spite of the wide variation of the protein composition among different condom brands, allergenic patterns obtained by immunoblotting with patients' sera were easier to examine than those obtained when natural latex was employed as antigen. This might suggest that some components are lost, destroyed, or altered during the manufacture processes.

As shown in Figure 2, condom extracts contain both 14 and 30 kD-protein fractions, which are also contained in natural rubber latex. The 14 kD-band would contain the Hev b 1-protein, the major allergen of latex (Fig 1), since the components included in this band were recognized by the IgE from eight out of the nine patient sera analyzed by immunoblotting.

The 23-kD fraction or Hev b 3, also described as a structural latex component, may not be present in the extract because of its tendency to fragment into small polypeptides.

A 69-kD component, seen in several condom extracts, was not observed in the natural rubber latex SDS-PAGE profile. This fraction could be a neo-antigen arising as a result of the vulcanization process, or a natural latex protein coupled to added chemicals

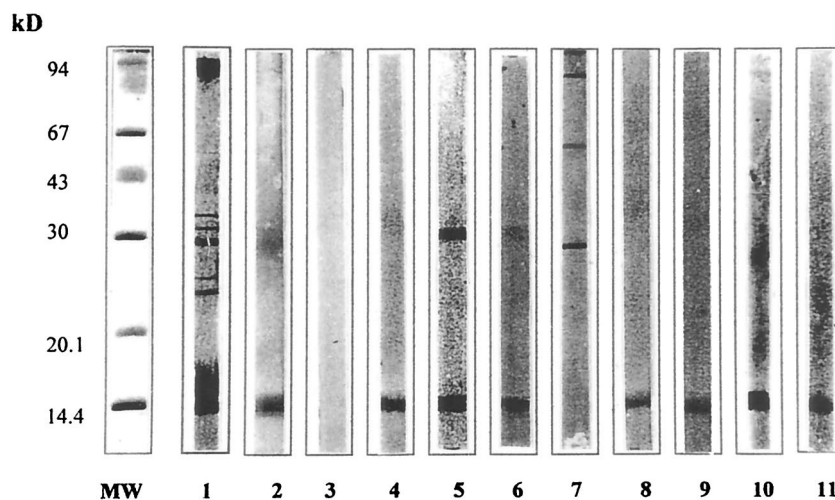


Figure 2. IgE reactivity analysis by immunoblotting. Molecular weight (MW) markers: lane 1, natural latex IgE immunoblotting revealed with the positive pool; lanes 2–11, condom IgE immunoblotting revealed with the positive pool (lane 2), with a negative serum from control group (lane 3); with sera from condom allergic patients (lanes 4–8), and with sera from latex allergic patients (lanes 9–11).

which would alter its relative molecular weight.

From our results it could be concluded that considerable differences in protein content can be found when different types of latex-made products are studied. High temperatures and some additives added to natural latex do not appear to alter some immunodominant epitopes, since they are bound by serum IgE. The washing procedures undergone by latex products are unable to remove some proteins attached to the rubber particles and strong detergents would be necessary to release them. It is known that the 14-kDa protein, Hev b 1, coats the large polyisoprene particles in natural latex providing them with structural integrity. We have previously observed that the addition of SDS detergent to the aqueous extraction buffer increased the elution of proteins attached to rubber particles.^{21,29} This component has been described as the major allergen of natural rubber latex.^{15,17}

The 30-kD component, which is an important latex allergen, was also observed in condoms (Fig 2), exhibiting a strong cross-reactivity with proteins widely present in several fruits (banana, passion fruit, peach, strawberry, and avocado).^{30–32}

Similar results have been found with gloves analyzed by SPT and immunologic assays.^{17,18,32} The total protein content of condoms is lower, however, than that measured in natural latex and gloves. When comparing the different latex-made products, the origin and type of natural latex employed by the industry should be considered, since many differences among products made by various manufacturers and even between products of different batches from a single brand, have been described.^{18,33,34} Glove manufacture processes may render new antigens from natural rubber latex [2.5, 11 and 26 kD].^{13,15} Nevertheless, other components may persist in the final product [4.7, 14, 16, 23, 29, 30, 33, 39 and 54 kD],^{15,20,29,31,35} including the 14 and 30-kD components that have been described as the most frequently detected allergen in gloves, with the strongest IgE reactivities.²⁰

In summary, we have demonstrated that different commercial condoms contain proteins that can act as allergens. Since the use of these products is very frequent in the general population, manufacturers should provide products with adequate labeling, as well as to improve the washing proce-

dures to eliminate the allergenic components.

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