

ALLERGENIC CHARACTERISTICS OF CHEMICAL COMPOUNDS MIGRATING FROM
POLYMER BUILDING MATERIALS

G. P. Trubitskaya, A. N. Bokov,
A. I. Polyak, and R. F. Komarova

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Methods of determining the allergenic activity of volatile substances given off into the atmosphere from polymer building materials (PBM) are developed. To detect sensitization in experiments on guinea pigs, in vitro allergic diagnostic methods are used (the passive hemagglutination test, specific leukocyte agglomeration test, intensification of leukocyte pyroninophilia test). It is shown that prolonged contact with PBM can give rise to atopic allergic reactions.

KEY WORDS: *polymer building materials; allergy.*

No fewer than 15,000 chemical substances, many of them with allergenic properties, are circulating at the present time in the air, soil, and water [1, 6].

With the study of the adverse action of complex groups of chemicals migrating from polymer materials into the body a new branch of hygiene came into existence in the 1960s [5, 9, 10, 12].

In the existing view the combined action of complex mixtures of chemicals of low activity is nonspecific; accordingly, until recently during the hygienic evaluation of polymer building materials (PBM) no account has been taken of their allergenic activity.

The object of this investigation was to develop adequate methods of approach and to choose the most informative tests and those most readily available to the practitioner for detecting the allergenic activity of PBM. Particular attention was paid to the study of polymer materials with no general toxic properties.

EXPERIMENTAL METHOD

The technique developed by Bokov [4] and originally intended for studying the general toxic action of PBM under simulated conditions was used.

The scheme of the apparatus used to develop techniques for studying the sensitizing action of PBM is shown in Fig. 1. The polymer materials were placed in generator chambers with a capacity of 1000 liters, in which the natural conditions of use of these materials in residential and public building were simulated. The materials were studied under two conditions simultaneously: supplying air to the animals from the generator chambers continuously all round the clock and interruptedly (exposure for 24 h followed by 24 h of rest). Air was supplied to the control animals from generator chambers not containing polymers.

Experiments were carried out on guinea pigs, which are the most sensitive species of animals to the sensitizing action of chemicals [7] and resemble man most closely in their allergic reactivity [3]. Blood was taken from the experimental animals intravitaly by cardiac puncture. The total protein, complement, lysozyme, and sialic acid were determined, the histaminopectic index (HPI) and serum protein profile were studied, and the differential leukocyte count of the blood obtained by the usual methods. Besides studying the indices of nonspecific immunity, the specific allergic diagnostic methods were used: the passive hemagglutination test (PHT) [2], the specific leukocyte agglomeration test (SLAT) [11], the intensification of leukocyte pyroninophilia test (ILPT) [13], drop tests with haptens, and the conjunctival test [8] in the writer's modification. For the conjunctival test concentrations

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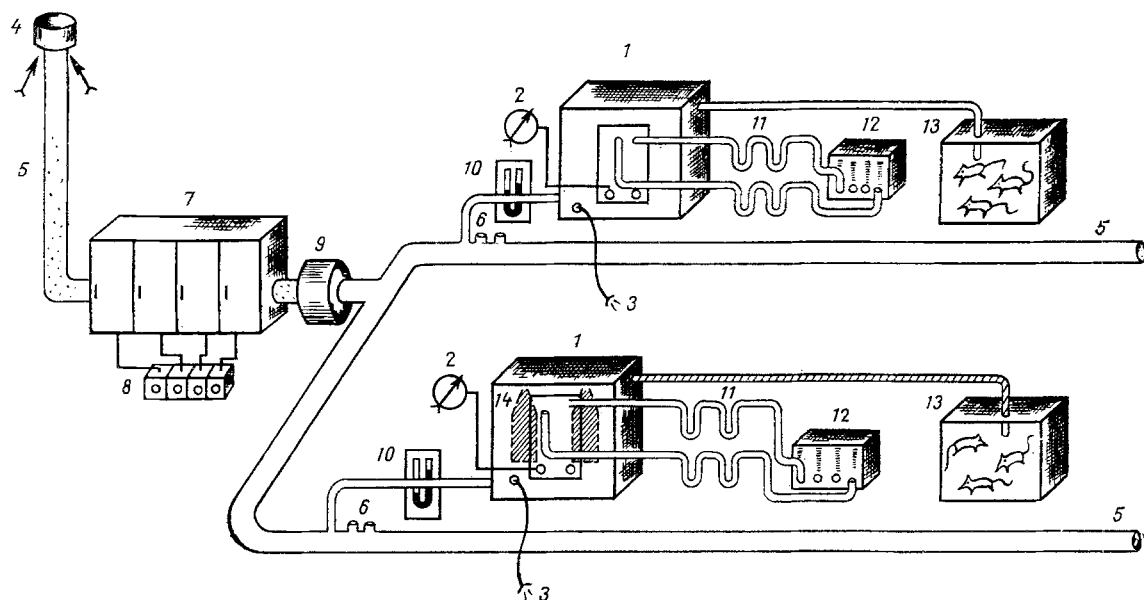


Fig. 1. Scheme of apparatus for studying allergenic action of polymer building materials under simulated conditions: 1) generator chamber; 2) temperature regulator; 3) terminal for connecting heating element to power supply; 4) external air intake; 5) air ducts; 6) branch pipes from air ducts; 7) fans supplying air to chambers; 8) magnetic starters; 9) chambers for purifying external air; 10) rheometers; 11) absorbers; 12) high-pressure fans for taking air samples; 13) chambers containing animals; 14) polymer material.

TABLE 1. Changes in Immunological Indices of Guinea Pigs Caused by Polymer Building Materials

Indices	Continuous exposure				Intermittent exposure			
	days of experiment							
	14	21	30	60	14	21	30	60
Total protein	0	0	-/0	0	0	+/-	+/-	0
Albumins	0	0	0	0	0	-/0	0	0
Globulins								
α	+/-	+/-	0	0	+/-	0	0	0
β	0/+	0	0	0	0	0	0	0
γ	0	0/-	-/0	+/-	0	0	0/-	0
Lysozyme	-/-	-/-	-/-	-/-	-/0	-/-	-/-	-/-
Complement	-/-	-/-	0	0	0/-	+/-	-/0	+/-
Alkaline phosphatase	0	0	-/0	0	0	0	0	0
Sialic acids	0	+/-	+/-	0	0	0	+/-	0
Eosinophils	0	0	0	0	0	0	0	0
Stab neutrophils	0/+	0	+/-	0	0	+/-	0	0
Platelets	0	0	+/-	0	0	0	0	0
Lymphocytes	0	0	0	0/+	0	-/0	0	0
Skin tests			Negative results					

Note. 0) variations of indices within normal physiological limits; -) decrease, +) increase in indices ($P \leq 0.05$). Numerator) experiments with grade 2/P nitrolinoleum; denominator) with grade 6/P nitrolinoleum.

of haptens not causing signs of conjunctivitis in intact animals were used: 0.01% cyclohexanone, 0.1% formaldehyde, 0.1% phthalic anhydride, 0.1% catapine, and 4% 1-aminoguanidine. The PHT, ILPT, and SLAT also were carried out with water-soluble haptens only, in concentrations 2 to 3 orders of magnitude below those used for the conjunctival test.

EXPERIMENTAL RESULTS

The conditions and the optimal times for studying the indices were established for four types of polymer materials: two samples of nitrolinoleum and two polymer fabrications.

TABLE 2. Changes in Sensitization Indices of Guinea Pigs Due to Contact with Foam Rubber Prepared by Different Formulas

Indices	Formula 1		Formula 2		Formula 3		Formula 4	
	day of exposure							
	14	30	14	30	14	30	14	30
Drop test								
Number of animals	5	5	5	5	5	5	Not studied	
Number giving positive reaction	0	0	0	0	0	0		
Conjunctival test								
Number of animals	Not studied		5	5	5	5	5	5
Number giving positive reaction			0	2	0	0	0	0
Mean number of points			0	0,8	0	0	0	0
PHT								
Number of animals	8	9	8	7	9	8	8	8
Number forming antibodies	6	4—5	0	3	0	0	0	0
Titer of antibodies (log ₂)	4,0—6,0	6,0—8,0	0	4,0—5,0	0	0	0	0
SLAT								
Number of animals	8	8	Not studied		9	8	8	8
Number giving positive reaction	2—7	1—2			0	0	0	0
ILPT								
Number of animals	8	8	8	8	8	8	8	8
Number giving positive reaction	8	8	8	8	8	8	0	0
Mean number of points	1,8—2,8	2,7—2,8	3,0	3,0	1,4	1,4	0	0

It will be clear from Table 1, which gives the results of two preliminary experiments, that substances given off by nitrolinoleum caused statistically significant changes in certain indices; the most marked changes, reaching a maximum by the 30th day of the experiment, were observed in experiments with substances migrating from mark 2/P nitrolinoleum. Exposure to the more complex group of substances given off by mark 6/P nitrolinoleum in higher concentrations led to changes in fewer of the indices and a decline in the immune responses of the animal toward the 30th day of poisoning. The greatest changes in immunobiological reactivity of the animal also were found to develop if exposure was continuous. In view of these results, in the subsequent experiments continuous exposure all round the clock for 30 days was used and tests were carried out on the 14th and 30th days of the experiments.

In accordance with this scheme 14 samples of various PBM were studied to determine their allergenic activity: 6 types of foam rubber, chipboards incorporating M-19-62 and SK-75 resins, Mytishchi and Sumgait polyvinyl chloride linoleums, etc., 9 of which were shown to have definite allergenic properties.

The results of four experiments (carried out jointly with chemical technologists) aimed at obtaining foam rubber without allergenic properties are given in Table 2. The results show that foam rubber prepared in accordance with the first type of formula had the greatest sensitizing action. Excluding catapine, which has a marked allergenic action, from the formula and, at the same time, increasing the content of one of the vulcanizing agents from 1 to 1.5% (the second variant) led to some reduction in the titer of humoral antibodies and cellular immunity, but allergization of the animals was still considerable. Reducing the content of the vulcanizing agents to its previous level (to 1%, without catapine, third variant) led to a marked decrease in cellular immunity and no humoral antibodies could be found. Only when the third variant of the formula was used in conjunction with a longer period of washing of the finished article (fourth variant) was a sample of foam rubber free from allergenic properties obtained.

The techniques as developed can thus be used to detect the sensitizing action of chemicals liberated into the atmosphere from PBM. Prolonged contact with these materials can lead to the development of atopic allergic reactions. The conjunctival test with haptens and the allergic diagnostic methods in vitro are informative with respect not only to detection, but also to evaluation of the intensity of sensitization. By appropriate modification of the formula and improvement of the technological process it is possible to obtain polymer materials free not only from general toxic, but also of allergizing action.

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