

Occupational allergic rhinitis from guar gum

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*(Received in original form 15 June 1987 and in revised form 27 October 1987;
accepted for publication 13 November 1987)*

Summary

Three cases of allergic rhinitis from a vegetable gum, guar gum, have been detected. Two subjects were exposed to fine guar gum powder (Emco Gum 563, Meyhall Chemical AG, Switzerland), an insulator in rubber cables, when opening cables in a power cable laboratory. After 1–2 years' exposure the patients developed rhinitis. Scratch-chamber tests, nasal provocation tests, nasal eosinophilia and a RAST test proved their allergy. A third subject developed allergic rhinitis from another guar gum product (Meyproid 5306, Meyhall Chemical AG) after 2 years' exposure in a paper factory. A positive skin test and nasal provocation test confirmed the diagnosis. A fourth case of possible allergy to guar gum after exposure to Meyproid 5306 in a paper factory is also presented. No final diagnosis was reached in this case (in 1974). The present subjects, only one of whom was atopic, developed allergy within 2 years, although their exposure to guar gum was not especially heavy. Therefore, when handling guar, adequate ventilation facilities should be provided and protective clothing, including a respiratory mask, should be worn.

Introduction

Natural gums are high polymer carbohydrate products that are insoluble in alcohol and other organic solvents, but generally soluble or dispersible in water [1]. They occur as exudates from various trees and shrubs in tropical areas [1]. Their aqueous solutions possess suspending and stabilizing properties, and they are chiefly used as protective colloids and emulsifying agents in food products and pharmaceuticals, and as sizing for textiles [1].

The galactomannans are relative newcomers to the ranks of gelling and thickening substances. Three vegetable gums are of practical industrial importance as sources of galactomannans: locust bean gum, tara gum and guar gum [2]. Three or four species of guar plants (*Cyamopsis psoraloides*, syn. *Cyamopsis tetragonoloba*) are found in

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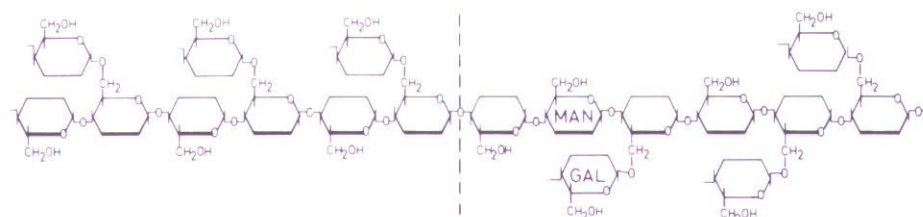


Fig. 1. Unit structure of guarin. Left: regular distribution of galactose (GAL) units; right: irregular distribution of galactose units. MAN = mannose.

tropical and sub-tropical regions of Africa, Arabia, India, Pakistan, U.S.A. (Texas, Arizona) and North Australia, where they occur as annual, bush-like plants [2,3]. The endosperm of the kernel forms the source of the commercial forms of guar gum. The isolated polysaccharide of guar gum is called guaran or guarin (Fig. 1) [4]. Guar gum is used in paper manufacture, foods, cosmetics, pharmaceuticals, interior coating of firehose nozzles, fracturing aid in oil wells, textiles, printing, polishing, atomic metal processing, and as a thickener and emulsifier [1].

The use of guar gum is increasing, since new applications have been discovered: (i) encapsulation of sensitive vitamins to improve storage stability; (ii) formulation of delayed action tablets; (iii) possible influence on the cholesterol level in blood serum; and (iv) for diabetics, influencing time-related postprandial glucose absorption. In Finland, guar gum has been used as a peroral medication for diabetes and hypercholesterolaemia since 1982 (Guarem®, Orion Diagnostics, Kuopio, Finland).

Vegetable gums are capable of inducing both type I and type IV allergy [4,5]. No allergic reactions to oral guar gum containing preparations have been reported (Orion Diagnostics, personal communication). Dermatitis of the hands, face and exposed skin surfaces has been observed in farmers who cultivate guar plants [3,6]. Recently, Leznoff *et al.* [7] reported the first case of type I allergy to guar gum. The patient developed cough, rhinitis and conjunctivitis. Here we present three cases of occupational allergic rhinitis from guar gum. We also present an earlier case that might have been guar gum allergy, although a definite diagnosis was not made.

Subjects and methods

Patients

Patients suspected of having an occupational disease are sent to our clinic. In cases of allergy the necessary clinical examinations and tests are performed by the appropriate specialists, as described below. Here, clinical and test data of three patients sensitized to guar gum are presented. An earlier patient who probably was allergic to guar gum is described in the Discussion section.

Skin-prick tests and scratch-chamber tests

Skin sensitivity to twenty common allergens, including epithelia, pollens and dust mite (patients 1 and 2, ALK, Copenhagen, Denmark; patient 3, Dome, Division of Miles Laboratories Ltd, U.K.), was tested with the skin technique of Aas and Belin [8]. Substances brought in by the patient were tested with the scratch-chamber method. A 10-mm long scratch was made with a sterile disposable needle (Neolus No. 1, Terumo Corporation, Japan) in the epidermis of the back. The chamber (Finn Chamber,

Epikon, Finland; diameter 8 mm) was fixed on the scratch with Scanpor tape (Norgeplaster, Norway). Vertically the chambers were 4 cm apart and horizontally 2 cm apart. The base solution of prick-test substances (Soluprick® ALK, Denmark) and histamine 10 mg/ml served as controls. The reactions (weal/flare) were recorded after 30 min of occlusion. Guar gum was tested using the commercial guar gum products the patients had been exposed to. According to the manufacturer (Meyhall Chemical AG, Switzerland), the product Emco Gum 563 is pure guar gum without preservatives, while Meyproid 5306 is a guar gum-based product containing certain additives that the manufacturer was not willing to declare. Patients 1 and 2 were also scratch-chamber tested with other commercial guar gum products (powders and their aqueous solutions without preservatives from Unipektin AG, CH-8264 Eschenz, Switzerland): Vidocrem F®, containing heat-treated guar gum, Vidogum FS 21®, a mixture of guar gum and locust bean gum, and Vidogel NR 20®, a mixture of galactomannans and other hydrocolloids. The peroral product (dose granules) for diabetes and hypercholesterolaemia, Guaram® (Remeda, Orion Diagnostics, Kuopio, Finland) and a weight control glucomannan–psyllium compound (Glupec®, Airin Co., Ltd, Japan, containing 85% glucomannan, 12.5% psyllium from *Plantago ovata* and 2% pectin) were also used as test substances. The above substances were tested 'undiluted' (in a small drop of water) and also using a 1% aqueous solution. Gum arabic was tested as a 10% aqueous solution.

Specific IgE (RAST) tests

IgE specific to guar gum. Ten grams of guar gum powder (Emco Gum 563) or gum arabic powder (Sigma G-9752) were dissolved in 100 ml of 0.01 M phosphate buffered (pH 7.4) saline (0.15 M NaCl). The powder solutions were left to mix overnight at room temperature and then centrifuged. The proteins of the supernatants were coupled with cyanogen bromide-activated paper discs, using the method of Ceska *et al.* [9]. One hundred microlitres of supernatant per disc was used. The other reagents for the radioallergosorbent test (RAST) were obtained from the Phadezym RAST kits (Pharmacia, Sweden). The results in PRU/ml (Phadebas RAST Unit) were based on the RAST reference serum of Pharmacia.

RAST inhibition experiments were carried out essentially as described by Yman *et al.* [10]. In order to measure the inhibitory capacity of the guar gum or gum arabic solution, serial dilutions (5, 10 and 20 µl) of the solutions in phosphate buffered saline were allowed to react with the patient's serum (20 µl of allergen dilution + 50 µl of serum) overnight at +4°C. These mixtures were then used for RAST determination. Twenty microlitres of PBS in 50 µl of serum were used to obtain the uninhibited results. The degree of reduction of serum RAST values after absorption is expressed as per cent inhibition.

Other RAST tests. These were performed using the commercial substances of Pharmacia (Sweden).

Nasal provocation test

Nasal provocation tests were performed as follows: a small piece of cotton wool (diameter 1–2 mm) was impregnated with a small amount of the test material, together with physiological saline. The cotton wool was applied to the anterior opening of the inferior nasal meatus for 1 hr. The simultaneous use of another piece of cotton wool with physiological saline alone served as a control. The nose was observed by

inspection at 15-min intervals for 1 hr. The test was interpreted as positive if at least two of the following signs were clearly present: (i) itching, (ii) swelling of the mucosa, (iii) watery discharge or (iv) sneezing, and if another provocation test with lactose and saline was negative.

Spirometry with bronchodilation test and histamine provocation

The spirometers were recorded with a water-sealed spirometer (Kifa, Sweden). Rimiterol hydrobromide 0.2 mg, three puffs, was used in the bronchodilation test. An increase of at least 15% and 150 ml in FEV₁ was regarded as significant. Bronchial hyperreactivity was assessed with a histamine challenge test modified from the one described by Laitinen [see 11].

Patch tests

Epicutaneous tests were performed using the Finn-Chamber method as previously described [2]. Patients 1 and 2 were patch tested with the following patch test allergen series [see 12]: standard series, plastics and glues, rubbers and (meth)acrylates. Furthermore, Emco gum (undiluted and 10% in water), other vegetable gum products (the same substances and concentrations as in the scratch-chamber tests, i.e. 100% and 1%) and other substances from the working place brought in by the patient were tested. Patient 3 was not patch tested.

Results

The data and test results of three patients who developed allergic rhinitis when exposed to guar gum are summarized in Table 1. In 1986 we saw two patients (1 and 2, Table 1) from the same power cable laboratory who suffered from rhinitis on working days. The rhinitis started 2–3 hr after commencing work. Nocturnal or asthmatic symptoms were not present. The rhinitis disappeared during weekends and holidays. The patients were exposed to several chemicals, but they suspected that Emco gum, i.e. pure guar gum, caused their symptoms. After power cable experiments they had to open the cables and were then exposed to the fine guar gum powder, which was used as insulation in the rubber cables. Scratch-chamber tests, a nasal provocation test, nasal eosinophilia and a RAST test proved their allergy. Twenty controls (ten patients with atopic rhinitis and ten non-atopics, not exposed to guar gum) were negative with Emco gum in scratch-chamber tests. In the RAST inhibition test an 88–97% inhibition was obtained with 20 µl of guar gum (Fig. 2). Gum arabic-positive serum was not inhibited with guar gum. Gum arabic did not inhibit the patients' sera. Ten control sera (five from patients with atopic rhinitis and five from non-atopics, not exposed to guar gum) were negative. Nasal provocation tests with a placebo (lactose) were negative. The other chemicals that were used in the factory and to which the patients were exposed were negative. No other persons were exposed to guar gum powder in the laboratory.

Scratch-chamber tests with other commercial compounds containing guar gum were also positive (Table 2). A glucomannan-psyllium compound and gum arabic produced negative skin tests. Patient 1 was atopic and also showed positive prick-test reactions and RAST tests to pollens. He had a weak reaction to *Plantago ovata*, a psyllium compound (Table 1). Patient 2 was not atopic and had no atopy in his family.

When guar gum was identified as the causative agent, it was replaced and the rhinitis of the patients stopped. The patients are now free of work-related symptoms.

Patients 1 and 2 had suffered from moderate dermatitis. All patch tests including

Table 1. Characteristics of three patients with allergic occupational rhinitis from guar gum

	Patient 1	Patient 2	Patient 3
Age (years)	27	49	42
Sex	Male	Male	Male
Causative agent	Emco gum	Emco gum	Meyproid 5306
Symptoms	Rhinitis, conjunctivitis	Rhinitis	Rhinitis, dyspnoea
Exposure time before symptoms	1 year	2 years	2 years
Scratch-chamber test with guar gum (see Table 2)	Positive	Positive	Positive
Positive prick test	Birch, mugwort	Negative	Dandelion, white oxeye
Nasal provocation test with guar gum	Positive	Positive	Positive
Nasal eosinophils (right/left)	-/+ +	+ + +/+ +	-/-
Total eosinophils in blood ($10^9/l$)	0.11	0.25	n.d.
Anamnestic atopy/family atopy	+/+	-/-	-/-
IgE	370 kU/ml	37 kU/ml	60 kU/ml
RAST tests	Guar gum	Guar gum	n.d.
(score in parentheses)	4.7 PRU/ml (3) Birch (3) Alder (2) Psyllium = <i>Plantago ovata</i> (1) Mugwort (0) Mite (0)	1.1 PRU/ml (2)	
Spirometry with bronchodilatation test and histamine provocation test	Normal	n.d.	Normal

n.d. = Not done.

PRU = Phadebas RAST units.

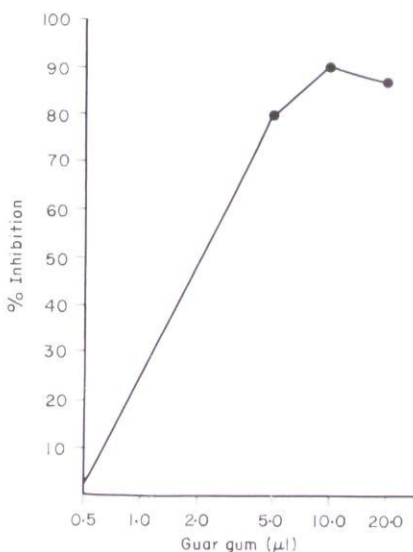
**Fig. 2.** Inhibitory capacity of guar gum solution. Gum arabic did not inhibit the patients' (case 1) serum.

Table 2. Scratch-chamber tests with vegetable gums (numbers show weal/flare in millimeters)

		Patient 1	Patient 2
<i>Scratch-chamber test with Emco gum</i>			
10% Emco gum (guar gum)		2/30 + p.s.	4/15
100% Emco gum (guar gum)*		2/30 + p.s.	4/20
Control		—	—
Histamine 10 mg/ml		2/30	5/20
<i>Scratch-chamber tests with other vegetable gums</i>			
Vidocrem®	Undiluted*	2/20	10/30 + p.s.
(heat-treated guar gum)	1%	8/25 + p.s.	5/30 + p.s.
Vidogum FS 21®	Undiluted*	7/30 + p.s.	3/20
(mixture of guar gum and locust bean gum)	1%	2/15	3/20
Vidogel NR 20®	Undiluted*	2/10	2/10
(mixture of galactomannans and hydrocolloids)	1%	2/20	—
Guarem®	Undiluted*	2/20	7/30 + p.s.
(pure guar gum)	1%	12/30 + p.s.	5/30 + p.s.
Glupec®	Undiluted*	—	—
(glucomannan–psyllium compound)	1% aqua	—	—
Gum arabic	10% aqua	—	—
Control		—	—
Histamine 10 mg/ml		3/25	7/30

* Mixed in a drop of water.

p.s. = Pseudopodia.

guar gum were negative in patient 1. His dermatitis was considered atopic. Patient 2 was patch-test positive to p-tert-butyl phenolformaldehyde resin. This explained his leather wrist-watch band allergy [2].

In 1976 we encountered a paper factory worker (patient 3, Table 1) who at the age of 42 in 1973 had developed allergic rhinitis from another guar gum dust product (Meyproid 5306, Meyhall Chemical AG, Switzerland). Our patient, because he was superintendent, had been less exposed to guar gum dust in that factory than the other seven workers, none of whom became sensitized. He had suffered from five to ten rhinitic attacks, lasting for some hours, before he also developed dyspnoea (in 1975) when exposed to Meyproid. He had no nocturnal symptoms. A positive scratch-chamber test (15 mm, histamine 5 mm) with pseudopodia, and a positive nasal provocation test, confirmed the diagnosis. Peak flow readings during work or bronchoprovocation tests with guar gum were not performed. This patient was not aware of earlier atopy or family atopy, but prick tests suggested allergy to compositae. The use of Meyproid was discontinued in the factory within a year, but the patient continued to have rhinitis from non-specific dusts. He did not develop asthma.

Discussion

Nasal provocation tests have been performed by the same otorhinolaryngologist (E.V.) at our clinic since 1972. About 300–400 provocation tests are performed each year. This gives high reproducibility and is of great importance in making a correct

diagnosis of occupational allergic rhinitis. Furthermore, in these cases it was possible to use laboratory tests to confirm the diagnosis of allergy. About thirty (twenty-seven in 1986) allergic occupational rhinitis cases, in addition to those with asthma and allergic rhinitis, are diagnosed in our institute each year; the allergy is mainly to flour dust.

The commercially available products of guar gum contain mainly galactomannans (85–94% of the dried substance) and also protein (3–7%), raw fibre (1–5%), ash (1–2%), fat (0.5–1%) and natural impurities (6–15%) [5]. The polysaccharide of guar gum has been called guaran and guarin. The molar ratio of galactose to mannose in guaran is about 1:2 (Fig. 1) [5]. Because proteins are usually responsible for type I allergy, it seems probable that the protein part acted as allergen, although the galactomannan moiety might be of importance in the IgE binding reaction of allergens [13]. We did not try to isolate or purify the allergen.

It is well known that non-standardized vegetable allergens show considerable differences in quality. In order to obtain more information about the allergenic nature of guar gum products we used different commercially available guar gum products for skin testing. Scratch-chamber tests revealed an allergic reaction to all substances containing guar gum in patients 1 and 2. Sometimes a stronger scratch-test response is noted with a more dilute substance, as was the case with patient 1 (Table 2). The depth of the scratch might influence the weal/flare response, but with guar gum the undiluted test substance forms a thick hydrocolloid and the allergen (protein molecules) might not be optimally apposed to the scratch, resulting in a weaker response.

Vegetable gum-induced allergic contact dermatitis has been reported from agar, gum arabic, karaya gum and gum tragacanth [2]. Because patients 1 and 2 had suffered from dermatitis, they were patch tested with the allergens to which they had been exposed, including guar gum. They did not show patch-test allergy to the vegetable gums tested, although on first testing, patient 1 showed patch-test irritation to guar gum (10% and 100% Emco gum). Retesting revealed the irritative nature of the first patch test. Preservatives in vegetable gums have also been reported to cause allergic contact dermatitis [14,15]. In our cases the manufacturer claimed that the Emco gum did not contain preservatives, and patch testing did not suggest sensitization to preservatives.

Earlier, guar gum was mainly used as a wet-end (beater) additive in paper making [4]. The paper industry also used guar gum for filler retention as a size press or calender stock additive. Guar gum was not used extensively in foods [4]. Our first patient suspected of having guar gum allergy was examined in 1974. She was a 26-year-old non-atopic female who took daily samples in a paper factory from wood pulp to which Meyproid 5306 had been added. The annual consumption of Meyproid 5306 in the factory was 11 050 kg. After 7 years of exposure the patient started to suffer from conjunctivitis and rhinitis on working days. She was symptom-free during weekends and vacations. A prick test with standard allergens was negative, but she was not tested with guar gum. The nasal provocation test was not conclusively positive: itching +, swelling –, watery discharge +/–?, sneezing –. She could not be re-examined, and a definite diagnosis of guar gum allergy could not be achieved. Retrospectively, we believe she might well have been allergic to guar gum. It is also possible that some earlier patients who developed rhinitis from paper dust might have been allergic to guar gum. Nowadays guar gum is not extensively used in the paper industry in Finland.

To summarize: it is evident that with increasing use of guar gum more cases of allergy will appear. The present patients developed allergy although their exposure was

not especially heavy. Therefore, when handling guar gum, adequate ventilation should be arranged and appropriate protective clothing, including a respiratory mask, should be worn.

Acknowledgments

The authors wish to express their gratitude to Meyhall Chemical AG (Switzerland), Orion Diagnostics (Finland) and Unipektin AG (Switzerland) for information on guar gum products.

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