

Tomato contact dermatitis

Evy Paulsen¹, Lars P. Christensen² and Klaus E. Andersen¹

¹Department of Dermatology and Allergy Centre, Odense University Hospital, University of Southern Denmark, DK-5000 Odense C, Denmark and ²Institute of Chemical Engineering, Biotechnology and Environmental Technology, University of Southern Denmark, DK-5230 Odense M, Denmark

doi:10.1111/j.1600-0536.2012.02138.x

Summary

The tomato plant (*Solanum lycopersicum*) is an important crop worldwide. Whereas immediate-type reactions to tomato fruits are well known, contact dermatitis caused by tomatoes or tomato plants is rarely reported.

The aims of this study were to present new data on contact sensitization to tomato plants and review the literature on contact dermatitis caused by both plants and fruits.

An ether extract of tomato plants made as the original oleoresin plant extracts, was used in aimed patch testing, and between 2005 and 2011, 8 of 93 patients (9%) tested positive to the oleoresin extracts. This prevalence is in accordance with the older literature that reports tomato plants as occasional sensitizers. The same applies to tomato fruits, which, in addition, may cause protein contact dermatitis. The allergens of the plant are unknown, but both heat-stable and heat-labile constituents seem to be involved. The fruit contains fragrance compounds that are also present in *Myroxylon pereirae* (balsam of Peru), possibly accounting for cross-reactivity. The proteins in pulp and peel may contribute to protein contact dermatitis. Until more is known about the allergens, the diagnosis of contact dermatitis caused by tomato plants and fruit may be established with the use of ether extracts and fresh fruits, respectively.

Key words: allergic contact dermatitis; fragrance mix I; literature review; *Lycopersicon esculentum*; *Myroxylon pereirae*; patch test; protein contact dermatitis; Solanaceae; *Solanum lycopersicum*; tomato fruit; tomato plant.

The tomato plant [*Solanum lycopersicum* L. (synonyms *Lycopersicon esculentum* Mill. and *Lycopersicon lycopersicum* (L.) H. Karst] belongs to the nightshade family (Solanaceae). It is native to the western coastal areas of South America, from Ecuador to the northern part of Chile. The plant was imported to Europe in about AD 1540, and has become one of the most important crops worldwide, with hundreds of varieties.

Immediate-type reactions to tomatoes is well known, especially in atopics, with prevalences of clinical symptoms ranging between 2.3% and 40% in patients with food allergy, and a prevalence of 6.5% in a Mediterranean

population attending allergy clinics (1, 2). Contact dermatitis caused by tomatoes or tomato plants, on the other hand, is uncommonly reported (3). An ether-based tomato oleoresin in alcohol made of plant material has previously been marketed by Hollister-StierTM (Spokane, WA, USA), but this was discontinued years ago, and the present lack of commercial patch test material may contribute to the paucity of case reports.

The aims of this article are to present some new data on contact sensitization to tomato plants, and review the literature on contact dermatitis caused by tomato fruits and tomato plants.

Materials and Methods

Preparation of tomato plant extract

Tomato plants of the cultivar 'Ida Red' were grown in a greenhouse, at Aarhus University, Research Centre

Correspondence: Evy Paulsen, Department of Dermatology and Allergy Centre, Odense University Hospital, Sdr. Boulevard 29, DK-5000 Odense C, Denmark. Tel: +45 6541 2705; Fax: +45 6612 3819. E-mail: evy.paulsen@ouh.regionsyddanmark.dk

Accepted for publication 29 May 2012

Aarslev, Aarslev, Denmark, until the first ripe fruits appeared on the plants. The tomato plant extract was prepared according to the method of Addo et al. (4), with a few modifications. First, the fruits were carefully cut off the plants with a pair of scissors. Then, the fresh aerial parts of the plants, without fruits, were cut into larger pieces and steeped in ether in sealed glass containers for 24 hr, at room temperature. Approximately 2.5 l of ether [diethyl ether American Chemical Society (ACS) reagent, $\geq 98\%$, containing $\sim 2\%$ ethanol and ~ 10 ppm butylated hydroxytoluene (BHT) as inhibitor; Sigma-Aldrich Chemie GmbH, Steinheim, Germany] was used per 1 kg of fresh plant material. The extracts were filtered and dried with anhydrous sodium sulfate (Na_2SO_4 , ACS reagent, $\geq 99\%$, anhydrous, powder; Sigma-Aldrich Chemie GmbH). The dried extracts were filtered and combined, and evaporated at 30°C *in vacuo* with a rotary evaporator. The resulting resinous extract was dissolved in 96% ethanol corresponding to a tomato plant ether extract in 10% ethanol (tomato oleoresin 1:10 wt/vol ethanol), stored in a refrigerator (5°C) until use, and then used as is for patch testing.

Clinical study

Since 2005, the above-mentioned extract has been used for aimed patch testing in eczema patients suspected of having contact dermatitis caused by tomato. With a micropipette, 15 μl of the extract was placed on filter paper in an 8-mm Finn Chamber[®] (Epitest Ltd Oy, Tuusula, Finland) on Scanpor[®] (Actavis Norway AS, Vennessla, Norway), and applied to the back for 2 days, with readings on D3–4 and possibly D5–7, according to the criteria of the International Contact Dermatitis Research Group (5).

The patch test results were obtained from computerized data, and supplemented with information from case records and personal interviews with most of the patients who tested positive.

The older literature was searched by textbooks and the newer literature by databases such as MEDLINE/PubMed (<http://www.ncbi.nlm.nih.gov/pubmed/>), Bota Derma (<http://www.botaderma.com>) and Botanical Dermatology (<http://www.botanical-dermatology-database.info>). Both kinds of search were supplemented with selected studies from reference lists in articles.

Results

Between January 2005 and December 2011, 93 persons, including 10 consecutive controls, were patch tested with the tomato plant extract, and 8 (9%) tested positive (Table 1). The majority of the positive reactions were

Table 1. Distribution of reactions to a tomato plant ether extract in 10% ethanol in 93 patients tested from January 2005 to December 2011

Type of patch test reaction	Number of patients
Positive	8 (9%)
Follicular	4
Doubtful positive	26
Irritant	0
Negative	55

weak but relevant (Table 2), and, most often, concomitant sensitization to other allergens was present (Table 3). Altogether, 2 patients had one other contact allergy, 2 patients had two other contact allergies, and the remaining 4 patients had three or more other contact allergies. Four of the 8 patients testing positive had Compositae contact allergy, but this turned out to be a common feature in all patients tested: the pooled prevalence of Compositae sensitization in the groups with positive, follicular and doubtful positive reactions was 39%, and that in the group with negative reactions was 40%.

Three of the 10 controls had doubtful/follicular positive reactions to the tomato extract, and 1 had 1+ reactions on D3 and D7, and was included in the positives, as she seemed to be truly allergic.

As some fragrance compounds from *Myroxylon pereirae* resin and fragrance mix I (FM I) have been detected in tomatoes (6), the prevalence of sensitization to FM I and *M. pereirae* resin was recorded. Of 8 patients with positive reactions to tomato plant, 1 (13%) tested positive to FM I; of 4 patients with follicular reactions, 2 (50%) tested positive to FM I; of 26 patients with doubtful positive reactions, 1 (4%) tested positive to FM I; and of 55 patients with negative reactions, 8 (15%) tested positive to FM I. Whether or not follicular and doubtful positive reactions to tomato extract and FM I were considered to be weakly positive and included in the positives, or, conversely, included in the negatives, the conclusion was the same: there was no difference between the prevalence of fragrance allergy between individuals with positive and negative patch test results with tomato extract, respectively.

Concerning *M. pereirae* resin, no one tested positive among the tomato-sensitive patients, and, altogether, there was only one positive reaction in the group with follicular reactions, and two positive reactions and one doubtful positive (follicular) reaction in the group with tomato-negative reactions, meaning that there was no association between positive reactions to tomato extract and positive reactions to *M. pereirae*.

Table 2. Results of patch testing with a tomato plant ether extract in 10% ethanol and characteristics of the 8 patients who tested positive

Patient number	Sex/age (years) Occupation	Reading D 3–4	Reading D 6–7	Relevance	Contact with tomato plant	Perioral dermatitis caused by fruit	Other dermatitis caused by fruit	Prick test result
1	F/47 Teacher	+	No reading	Old	Yes	No	No	Negative
2	F/34 Housewife	+	+ (IR?)	Current	Yes	No	Hand eczema worse	NT
3	F/48 Student	+	+	Current	Yes	No	No	Negative
4	F/28 Housewife	+	? + Ulceration/ follicular reaction	Current/old	Yes	No	Itching of hand eczema	Positive for dog, cat, moulds
5	F/52 Nurse aide	+	+	Old	Yes	No	No	NT
6	F/64 Pensioner	++	+	Current/old	Yes	No	No	NT
7	F/43 Chef	+	? +	Old	Yes	No	Protein contact dermatitis suspected	Positive for birch, grass, dog, house dust mites, hazel nut, raw potato, raw tomato, raw iceberg lettuce
8	F/77 Pensioner	+	+	Old	Yes	No	No	Prick test food items negative

IR, irritant reaction; NT, not tested.

Table 3. Distribution of other contact allergies in 8 patients with contact sensitization to tomato extract

Allergen	Number of positive reactions
Nickel sulfate	5
Compositae	4
Colophonium, cobalt chloride, potassium dichromate, budesonide, hydrocortisone 17-butyrate	2 of each
<i>l</i> -Carvone, fragrance mix I*, fragrance mix II†, <i>p</i> -tertiary-butylphenol formaldehyde resin, 2-bromo-2-nitropropane-1,3-diol, methylchloroisothiazolinone/ methylisothiazolinone, methyldibromo glutaronitrile/ phenoxyethanol, carba mix, cream 'as is'	1 of each

*Fragrance mix I consists of cinnamyl alcohol, cinnamal, eugenol, amyl cinnamal, hydroxycitronellal, geraniol, isoeugenol, and *Evernia prunastri* absolute.

†Fragrance mix II consists of citral, citronellol, farnesol, coumarin, hexyl cinnamal, and hydroxyisohexyl 3-cyclohexene carboxaldehyde.

Seven of the 8 patients were referred because of hand eczema; the last patient had had hand eczema, but her main complaint at referral was nummular eczema, and she knew that contact with tomato plants elicited eczema.

Discussion

Contact dermatitis caused by tomato plants has been reported occasionally in the older literature, most often

anecdotally without adequate patch test investigations. Some of the first cases were reported by Lain in 1918: the skin that had been in contact with the 'hairs' or bruised parts of the plant would begin to sting or itch, and this would be followed by the development of erythema, papules, and vesicles (7). Typically, the dorsum of the hands, the wrists and the forearms were involved, and the risk of dermatitis was highest when the plants were dewy (7). Lain did not consider the plant to be a frequent cause of 'dermatitis venenata', as he had seen fewer than 12 cases in two seasons, and although he was convinced of the aetiological importance of the tomato plants, he did not perform patch tests to prove this (7). Likewise, Hannah mentioned a patient who allegedly was 'very sensitive to contact with tomato leaves', but patch testing had not been performed at the time of writing (8). O'Donovan, and later on Shelmire and Sneed, simply quoted tomato as a cause of seasonal dermatitis or dermatoses in farmers (9–11).

The first prevalence study was conducted in Hungary and reported by Szego in 1965 (12). It comprised 350 unselected inpatients, coming from both rural and urban areas, who were patch tested with 5% infusions and decoctions of nine agricultural plants, including tomato, rice, sunflower, maize, and hops (12). Among farm workers, the tomato leave infusion and decoction elicited positive reactions most frequently, while the decoction ranked second in townspeople (12). Altogether, 8 subjects tested positive to the infusion and 11 to the decoction, corresponding to 5.4% of all persons tested, and making tomato plants the second in the overall ranking (12).

Only 1 patient tested positive to both preparations (12). Tomato plants were thus frequent sensitizers, especially in the rural population, in this study, which included well known allergenic plants such as sunflower and hops.

Later epidemiological studies have also focused on the risk to agricultural workers. McCurdy et al., in their questionnaire and clinical study of occupational dermatitis in 183 Californian table grape harvesters, used 43 tomato workers as controls (13). The grape harvest workers reported a rash occurring in the previous 12 months significantly more frequently than the tomato harvest workers (62% versus 21%), but, on clinical examination, eczema was found in only 10%, and the prevalence of (irritant and allergic) contact dermatitis was also considered to be low (2%) in both groups, even though patch testing was not performed (13). One of the reasons for the higher prevalence of reported rashes in grape harvesters than in tomato harvest workers may be heavier exposure to plant material in the former, as tomatoes are mechanically harvested (13).

In a subsequent cross-sectional study in the same area, comparing 238 grape workers with 166 citrus workers and 355 tomato workers, the conclusions were the same: grape workers were more likely to report rashes in the last 12 months than the two other groups of workers, and, on physical examination, grape workers had contact dermatitis (without patch testing) or lichenified hand dermatitis significantly more frequently than tomato workers, possibly because of crop-specific exposure and differences in the use of protective equipment (14). The self-reported prevalence of rashes in the past 12 months was lowest in tomato workers, at 6.2%, which was much lower than the 21% found in the previous study (13).

In the present study, the patients had been exposed to tomato plants at some time, typically as amateur gardeners growing tomatoes. In fact, the high prevalence of Compositae sensitization in these patients is suggestive of a plant interest that may cause concomitant sensitization to a variety of plants from different families. The allergens of the tomato plants are unknown, but on the basis of his study, Szego quoted the suggestion of Rávnay that both heat-stable and heat-labile allergens may be present (12). Even though 5-methoxypsoralen has been detected in aerial plant parts, no cases of phototoxicity have been reported (15).

The high prevalence of follicular and doubtful positive reactions to the tomato extract probably represents a mixture of slight irritancy and weakly positive allergic reactions. Originally, the oleoresin extracts were intended for open application patch testing, but, in this study, they were used under occlusion: in patient number 2, the reading was possibly irritant on day 7, but both tomato

plants and the stalks of tomatoes used in cooking would elicit itching of her skin, and true contact allergy was thus likely. Furthermore, as the extract was used in aimed patch testing, some doubtful reactions are to be expected.

The older literature thus gives the impression of tomato plants as occasional sensitizers, and, apart from the Hungarian study with a prevalence of 5.4% in unselected patients, this is in accordance with more recent epidemiological studies and the prevalence of 9% in aimed patch testing in the present study. However, a possible source of error is the difference in patch test material: water-based preparations were used in the Hungarian study, whereas we used an ether-based extract, and this may result in a lower prevalence if the main allergens are water-soluble. Furthermore, none of our patients was monosensitized to tomato plants, suggesting that persons with pre-existing contact dermatitis or contact sensitization are more likely to be sensitized.

Three patients (numbers 2, 4, and 7; Table 2) reported contact symptoms from tomato fruits. According to Larramendi et al., who screened newly referred patients attending six Spanish allergy clinics with prick tests with peel and pulp tomato extracts, delayed cutaneous (and gastrointestinal) symptoms were more frequent in tomato prick test-negative subjects (2). Patient number 2 was not atopic, whereas numbers 4 and 7 had positive prick test results with standard inhalant allergens, including birch pollens and tomato. An association between contact dermatitis caused by tomato and atopy has been reported previously: Templeton quotes Rowe as reporting a case of hand eczema attributed both to contact with tomatoes and to ingestion of tomatoes in a female with a family history of atopy (16). In the discussion of the study of Sulzberger et al., tomato juice was reported as a cause of cheilitis (17). In accordance with the few reports in the older literature, Klauder and Kimming, in their survey of contact dermatitis caused by carrots in a food processing company, reported that they 'rarely observe' sensitization to tomato (18). In the 1970s, the first studies on contact dermatitis caused by tomato supported by positive patch test reactions appeared: Sinha et al. tested 53 patients with hand eczema resulting from contact with vegetables with fresh tomato juice, and 10 had a positive reaction, which was also found in 4 of 20 controls (19). Cronin, in her study on caterers with hand eczema, reported a positive patch test reaction to tomato peel in one subject, and, likewise, Kanerva et al. tested 2 females, who had occupational allergic contact dermatitis caused by spices, with tomato as is, which elicited a 2+ positive reaction in the patient with a personal and family history of atopy (20, 21). Incidentally, the patient also tested positive to lettuce as is (Compositae) (21). Poljacki et al. patch tested with

green tomatoes, and reported an association between positive patch test reactions to these and sensitization to *M. pereirae* resin (22).

The clinical features of contact dermatitis may be caused both by simple chemicals, acting as haptens, and proteins (23). Hjorth and Roed-Petersen, in their study on occupational dermatitis in food handlers, coined the term protein contact dermatitis for eczema without relevant positive patch test reactions, but with relevant positive results in immediate-type tests, such as scratch-patch tests (24).

Likewise, Cronin, in the above-mentioned study on occupational hand dermatitis in 47 caterers, 30 of whom had a personal or family history of atopy, used a modified prick test in which the food items were taped to the skin for 15–20 min after the prick test procedure (20). Of the 9 subjects who had an immediate-type allergy to foods, 7 had a personal history of atopy and 1 a family history, and 3 had positive prick test reactions to tomato (20). As suggested by these data, there was a correlation between atopy and immediate-type, but not delayed-type, sensitization (20). A similar association was reported by Hannuksela and Lahti in their investigation on the usefulness of the 'scratch-chamber' test in detecting immediate-type allergy to fruits and vegetables (25): 16 of 148 birch pollen-allergic subjects had positive scratch-chamber test reactions to tomato, as compared with 4 of 104 who not allergic to birch pollens (25). The reactions were relevant in the majority of cases, with itching of the lips and slight perioral dermatitis after ingestion of tomatoes as the main complaints, and only 1 case of hand eczema resulting from contact with the fruit (25). A mixture of immediate and delayed symptoms caused by contact with uncooked tomatoes was also reported by Tavadia et al. in a female atopic restaurateur: handling the fruits worsened her fingertip dermatitis, and eating them caused oral tingling and facial erythema (26). The diagnosis was based on the demonstration of elevated levels of IgE specific for tomato, potato, and natural rubber latex, the last-mentioned probably resulting from cross-reactivity (26). The allergen may be the protein patatin, which is found in both potatoes and tomatoes, and which is 60% homologous with a latex protein allergen (26). Occupational protein contact dermatitis caused by tomato and other fruits was also diagnosed by elevated specific IgE levels in an atopic male kitchen assistant with hand eczema (27).

Positive prick test reactions, however, are not always indicative of sensitization. Larramendi et al. identified 113 tomato prick test-positive subjects by routine tomato prick tests in 1734 patients referred to allergy clinics in Spain (2). Only 18 of these 113 subjects reported

symptoms from tomatoes, and all of them were atopics with pollen allergy, mainly to *Artemisia* and *Platanus*, suggesting cross-reactivity (2).

Conversely, 9 subjects with negative prick test reactions to tomato reported immediate oral or cutaneous symptoms (2).

Patient number 7 (Table 2) was an atopic female, who was probably occupationally sensitized to lettuce, potato, and tomato, and protein contact dermatitis was suspected. Although she still works as a self-employed chef, her hand eczema has substantially improved, and it is thus possible that the positive prick test reaction to tomato was caused by irritancy or clinically non-relevant cross-reactivity to birch pollen.

Several studies have focused on ingestion of tomatoes as an aggravating factor in eczema patients. Veien et al. reported on the effects of a diet that excluded, among other things, tomatoes in 113 patients with mainly long-standing dermatitis not typical of atopic dermatitis, urticaria, or seborrheic dermatitis (28). The most common clinical features were recurrent vesicular hand eczema, anogenital dermatitis, 'fixed' type of eczema, and pruritic papules and excoriations of the trunk (28). Contact urticaria was described by 34 patients, most frequently caused by tomato (12 cases), whereas 4 patients reported flares of dermatitis after oral challenge with tomato (three times or more) (28). Despite the fact that patients with atopic dermatitis, according to the Hanifin and Rajka criteria, were excluded from the study, there was a statistically significant association between a history of personal and/or familial atopy and cutaneous reactivity (50% of 113 patients versus 25% of controls) (28).

Tomatoes are also included in the list of food items that may cause flares in individuals sensitized to *M. pereirae*. Salam and Fowler, in a retrospective study of 71 patients with positive patch test reactions to *M. pereirae* resin, balsam of Tolu, fragrance mix, cinnamal, or combinations of these, reported that almost half of the subjects who followed a *M. pereirae*-reduced diet (formerly called balsam of Peru diet) experienced improvement of their dermatitis (29). Tomatoes were the food items most commonly reported as causing flares of dermatitis in 30 patients (29).

Inspired by such clinical findings, Srivastava and Cohen set out to detect the presence of sensitizing compounds from *M. pereirae* in tomatoes by high-performance liquid chromatography and mass spectrometry (6). They detected both cinnamic alcohol (= cinnamyl alcohol), also present in FM I, and coniferyl alcohol, but cautiously concluded that clinical studies were necessary to establish these as the main allergens causing flares from tomatoes (6).

As only one of the tomato plant-sensitive subjects (patient number 2; Table 3) tested positive to FM I, and the prevalence of fragrance mix contact allergy was similar in subjects with and without sensitization to tomato plant extract, it seems unlikely that cinnamyl alcohol is a major sensitizer in tomato plants.

In a recent article by Patel and Gawkrödger, 45 (10%) of 455 adult patients with eczema seen in a cutaneous allergy clinic reported food-related skin problems (30). The majority (82%) of these 45 patients had a personal history of atopy, including 22 with atopic dermatitis (30). Thirty patients reported food-related immediate-type reactions, such as perioral tingling, lip and facial swelling, and urticaria, most frequently caused by nuts and dairy products, followed by tomatoes (30). Twenty-four subjects had elevated IgE specific for clinically suspect food items. Altogether, 13 patients reported worsening of their eczema as an intermediate (occurring between 1 and 48 hr after ingestion) or delayed (occurring 48 hr after ingestion) reaction, but none of these reactions was related to tomatoes. The authors concluded that dermatologists should be more aware of the possibility of food-induced skin reactions (30).

As most of the reports on food allergy comprise a variety of food items, it is not always possible to obtain a proper description of the clinical features of tomato-sensitive subjects from these. It is clear, however, from the study on occupational hand dermatitis in caterers, that positive prick test reactions to foods were especially prevalent in persons with a personal or family history of atopy (20). Likewise, Templeton, in his case report on tomato, and Veien et al., in their study, reported an association between atopy and aggravation of eczema by ingestion of tomatoes and other food items (16, 28), and although Patel and Gawkrödger reported a low prevalence of self-reported food allergy in eczema patients in general, more than half of the persons affected had immunological

signs of type I allergy to foods (30). Conversely, in the original study on protein contact dermatitis in Danish sandwich makers and chefs, only 7 of 33 subjects had a personal and/or family history of atopy, and the prevalence of positive scratch-patch test reactions to food items was not higher in the atopic persons (24). The tomato fruit thus seems to be able to cause contact dermatitis by delayed hypersensitivity, protein contact dermatitis, and possibly immediate-type reactions. The last-mentioned is more prevalent in atopic individuals, partly because of cross-reactivity with pollens, and the dermatitis may be elicited by repeated cutaneous contact with or ingestion of tomatoes. By contrast, delayed hypersensitivity to tomato has been described in atopics (21), but was more prevalent in persons with negative prick test reactions to tomato in the study of Larramendi et al., and, likewise, positive patch test reactions to food in Cronin's study were more prevalent in non-atopics (2, 20).

In conclusion, contact dermatitis resulting from tomato may be caused both by the plant and by the fruit, unripe or ripe, but neither of them seems to be a frequent sensitizer. Concerning allergens, both heat-stable and heat-labile compounds may play a role in tomato plant allergy, whereas fragrance compounds such as cinnamyl alcohol and coniferyl alcohol, which are present in *M. pereirae* as well as in beefsteak, cherry tomatoes, and plum tomatoes, seem to be important in contact dermatitis caused by tomato fruit. The pulp and, especially, the peel of the tomato fruit contain several proteins that cause immediate-type reactions, and it is possible that some of these may also elicit protein contact dermatitis (31). The tomato plant and its fruits thus seem to cause contact dermatitis in different ways, and further studies are needed to characterize the allergens involved. Until then, ether extracts of the plant tested in alcohol and fresh fruit are suitable for diagnosing tomato allergy and dermatitis.

References

- 1 Hausen B M, Vieluf I K. *Allergiepflanzen/Pflanzenallergene. Handbuch und Atlas der allergieinduzierenden Wild- und Kulturpflanzen*, 2nd edition: Landsberg/München, Ecomed Verlagsgesellschaft mbH, 1997.
- 2 Larramendi C H, Ferrer A, Huertas A J et al. Sensitization to tomato peel and pulp extracts in the Mediterranean Coast of Spain: prevalence and co-sensitization with aeroallergens. *Clin Exp Allergy* 2008; **38**: 169–177.
- 3 Mitchell J C, Rook A. *Botanical Dermatology. Plants and Plant Products Injurious to the Skin*, Vancouver, Greengrass, 1979.
- 4 Addo H A, Sharma S C, Ferguson J, Johnson B E, Frain-Bell W. A study of compositae plant extract reactions in photosensitivity dermatitis. *Photodermatology* 1985; **2**: 68–79.
- 5 Lindberg M, Matura M. Patch testing. In: *Contact Dermatitis*, 5th edition, Duus Johansen J, Frosch P J, Lepoittevin J-P (eds): Berlin, Springer-Verlag, 2011: pp. 439–464.
- 6 Srivastava D, Cohen D E. Identification of the constituents of balsam of Peru in tomatoes. *Dermatitis* 2009; **20**: 99–105.
- 7 Lain E S. Dermatitis *Lycopersicum esculentum* (tomato plant). *J Am Med Assoc* 1918; **71**: 1114–1117.
- 8 Hannah L. Ragweed dermatitis. A new treatment with preliminary report of a case. *J Am Med Assoc* 1919; **72**: 853–854.
- 9 O'Donovan W J. Exogenic dermatitis. *Lancet* 1927; **1**: 1128–1129.
- 10 Sneyd P. Dermatoses on the farm. *Ind Med Surg* 1955; **24**: 117–118.

- 11 Shelmire B. Contact dermatitis from vegetation. Patch testing and treatment with plant oleoresins. *South Med J* 1940; **33**: 337–346.
- 12 Szego L. Sensibilisation durch landwirtschaftliche Pflanzen und Pflanzenschutzmitteln. *Acta Med Hung* 1965; **21**: 19–24.
- 13 McCurdy S A, Wiggins P, Schenker M B et al. Assessing dermatitis in epidemiologic studies: occupational skin disease among California grape and tomato harvesters. *Am J Ind Med* 1989; **16**: 147–157.
- 14 Gamsky T E, McCurdy S A, Wiggins P, Samuels S J, Berman B, Shenker M B. Epidemiology of dermatitis among California farm workers. *J Occup Med* 1992; **34**: 304–310.
- 15 Rzeznik Y-C, Scll Y. The BotaDerma database. 2007. Available at: <http://www.botaderma.com>
- 16 Templeton H J. Epidermal and dermal sensitization (coexisting in the same individual). *J Am Med Assoc* 1945; **127**: 908–911.
- 17 Sulzberger M B, Goodman J, Byrne L A, Mallozzi E D. Acquired specific hypersensitivity to simple chemicals. II. Cheilitis, with special reference to sensitivity to lipstick. *Arch Dermat Syph* 1938; **37**: 597–615.
- 18 Klauder J V, Kimming J M. Sensitization dermatitis to carrots. *AMA Arch Derm* 1956; **74**: 149–158.
- 19 Sinha S M, Pasricha J S, Sharma R C, Kandhari K C. Vegetables responsible for contact dermatitis of the hands. *Arch Dermatol* 1977; **113**: 776–779.
- 20 Cronin E. Dermatitis of the hands in caterers. *Contact Dermatitis* 1987; **17**: 265–269.
- 21 Kanerva L, Estlander T, Jolanki R. Occupational allergic contact dermatitis from spices. *Contact Dermatitis* 1996; **35**: 157–162.
- 22 Poljacki M, Paravina M, Jovanović M, Subotić M, Duran V. Contact allergic dermatitis caused by plants (in Croatian). *Med Pregl* 1993; **46**: 371–375.
- 23 Amaro C, Goossens A. Immunological occupational contact urticaria and contact dermatitis from proteins: a review. *Contact Dermatitis* 2008; **58**: 67–75.
- 24 Hjorth N, Roed-Petersen J. Occupational protein contact dermatitis in food handlers. *Contact Dermatitis* 1976; **2**: 28–42.
- 25 Hannuksela M, Lahti A. Immediate reactions to fruits and vegetables. *Contact Dermatitis* 1977; **3**: 79–84.
- 26 Tavadia S, Morton C A, Forsyth A. Latex, potato and tomato allergy in a restaurateur. *Contact Dermatitis* 2002; **47**: 109.
- 27 Gala Ortiz G, Condé-Salazar L, Guimaraens D, De La Hoz C, Cuevas Agustin M. Occupational protein contact dermatitis from fruits. *Contact Dermatitis* 2000; **43**: 43.
- 28 Veien N K, Hattel T, Justesen O, Norholm A. Dermatitis induced or aggravated by selected foodstuffs. *Acta Derm Venereol (Stockh)* 1987; **67**: 133–138.
- 29 Salam T N, Fowler J F. Balsam-related systemic contact dermatitis. *J Am Acad Dermatol* 2001; **45**: 377–381.
- 30 Patel T, Gawkrödger D J. Food allergy in patients with eczema: immediate symptoms are usual, with nuts and tomatoes the major allergens. *J Eur Acad Dermatol Venereol* 2011; **25**: 865–867.
- 31 López-Matas M A, Larramendi C H, Ferrer A et al. Identification and quantification of tomato allergens: in vitro characterization of six different varieties. *Ann Allergy Asthma Immunol* 2011; **106**: 230–238.