

## WORK-RELATED SKIN SYMPTOMS AND TYPE I ALLERGY AMONG EASTERN-POLISH FARMERS GROWING HOPS AND OTHER CROPS

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**Abstract:** 73 eastern-Polish farmers growing hops and other crops were examined. They were questioned by a dermatologist and subsequently skin prick-tested with allergens of hops, grain dust, straw dust, hay dust, storage mites, and antigens of microorganisms typical for farm environment. Results: 14 farmers (19.2%) complained of work-related skin symptoms, caused most often by hops (11%), followed by grain (5.6%), hay (5.5%) and straw (4.1%). Five farmers (6.8%) complained of hand dermatitis, four (5.5%) of airborne dermatitis, and eight (11.0%) of pruritus. In two farmers, two skin diseases co-existed. The skin symptoms were mostly mild, however, one case of severe invalidating airborne dermatitis to hops was found. On skin prick tests, 14 farmers (19.2%) showed positive skin reaction to at least one allergen; 5.5% of farmers reacted to grain dust, 5.5% to straw dust, 11% to hay dust, and 8.2% to hops. Tests with storage mites showed positive reactions to *Acarus siro* in 9.6%, *Lepidoglyphus destructor* in 17.8%, and to *Tyrophagus putrescentiae* in 13.7%. Tests with microbial allergens elicited positive reactions to *Pantoea agglomerans* in 4.1%, *Saccharopolyspora rectivirgula* in 4.1%, *Aspergillus fumigatus* in 4.1% and to *Streptomyces albus* in 1.4% of farmers. Although results of skin prick tests in general did not correlate well with the work-related skin symptoms, in three of 14 farmers with skin symptoms the tests results played a crucial role in identifying the cause of their work-related skin disease.

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### INTRODUCTION

During work, farmers are continuously exposed to plant material capable of inducing skin disease [22]. Despite the fact that type I allergy occurs in farmers less frequently than in urban population [16], there are many cases of work-related IgE-dependent skin diseases, which have been well documented in the case of animal allergens [13, 14, 15]. Previously, we have studied occupational skin diseases related to the production of thyme [23]. This study aimed at assessing the frequency of work-related skin diseases and type I allergy to allergens of hops, grain, straw and hay, as well as to storage mites and microorganisms.

### MATERIAL AND METHODS

**Study group.** In the present study, farmers from 18 randomly selected farms in a rural community in Lublin region (eastern Poland) were enrolled on a voluntary basis. Altogether, 73 farmers and their relatives involved in work on farms were examined: 42 males and 31 females, aged 16–84 (median 46) years, with duration of exposure ranging from 2–73 (median 31) years. They were all employed full- or part-time on family farms with 6.5–18 ha arable land with hop and grain plantations.

**Study design.** The study was carried out in August and September 2000. The farmers were asked about any

recurring skin problems related to work, especially when exposed to plant material and dust. Those who declared having such problems, were questioned in detail about localisation, appearance and course of the skin changes. After completing the questionnaire, all farmers underwent skin prick testing with allergens typical for their workplace: grain dust (Biomed, Kraków), straw dust (Biomed, Kraków), hay dust (Biomed, Kraków and Allergopharma, Reinbek), storage mites *Acarus siro*, *Lepidoglyphus destructor*, and *Tyrophagus putrescentiae* (Allergopharma, Reinbek), antigens of microorganisms typical for this work environment *Pantoea agglomerans* syn. *Erwinia herbicola*, *Saccharopolyspora rectivirgula* syn. *Micropolyspora faeni*, *Aspergillus fumigatus*, and *Streptomyces albus* and hop extract (prepared as described below). The skin prick test (SPT) was carried out on the anterior forearm surface using standardised lancets (Allergopharma, Reinbek). The test site was observed after 20 minutes and the size of wheal reaction was recorded. Wheals of 3 mm or more in diameter were regarded as positive test result.

**Preparation of microbial antigens for skin tests.** The antigens were produced in our Department from the strains of *Pantoea agglomerans*, *Saccharopolyspora rectivirgula*, *Aspergillus fumigatus* and *Streptomyces albus*, according to the unified procedure described earlier [17, 21]. In all tests lyophilised saline extracts of bacterial or fungal cell mass were used. In the case of *P. agglomerans* the bacterial mass was harvested from nutrient agar cultures, while in the case of *S. rectivirgula*, *A. fumigatus* and *S. albus* the mass was harvested from sugar broth cultures. The mass was then homogenised and extracted in saline (0.85% NaCl) in the proportion 1:2 for 48 hrs at 4°C, with intermittent disruption of cells by 10-fold freezing and thawing. Afterwards, the supernatant was separated by centrifugation, dialysed against distilled water for 24 hrs, concentrated by evaporation to 0.1-0.15 of previous volume and lyophilised. Before the testing, the antigens were dissolved in phosphate buffered saline (PBS, Biomed, Kraków) at the concentration of 5 mg/ml, sterilised by filtering and checked for sterility and lack of toxicity.

**Preparation of hop extracts for skin tests.** Fresh cones and leaves of hops (*Humulus lupulus*) were cut into small pieces, and extracted parallelly with glycerol and saline (0.85% NaCl) in the proportion 1:2 (w/w) for 48 hrs at 4°C. Subsequently, the extracts were centrifuged for separation of clear supernatants, which were then sterilised by filtering, checked for sterility and lack of toxicity, and stored at 4°C until usage.

**Statistical analysis.** Percentage fractions were calculated for every variable and the positive (PPV) and negative (NPV) predictive values were calculated for skin prick tests with grain dust, straw dust, hay dust and hop

extract, taking the results of the dermatologist-assisted questionnaire as standard. The positive predictive value is the probability that a subject with positive test results is ill, and the negative predictive value – that a subject with negative test result is healthy [2].

## RESULTS

Among the 73 examined farmers, 14 (19.2%) reported skin problems when working on the farm. This group comprised eight females and six males, aged 24 – 74 (median 47.5) years with duration of working on farm 12 – 52 (median 34.5) years. Five farmers (6.8%) complained of hand dermatitis, four (5.5%) – of symptoms typical for airborne dermatitis, and eight (11.0%) – of pruritus without any visible skin rash. In two farmers, co-existence of 2 skin problems was found: dermatitis and pruritus without visible skin changes which were provoked each by different occupational activities. Detailed data regarding farmers with skin symptoms are presented in Table 1. On skin prick tests, 14 farmers (19.2%) showed positive skin reaction to at least one of the allergens tested. The frequency of the positive SPT to each tested allergen is summarised in Table 2.

**Skin problems related to work with hops.** 65 farmers did not report any skin problems when working with hops and eight (11%) complained of skin problems related to this activity: four complained of rashes on uncovered skin, the description of which was sufficient to diagnose airborne dermatitis (cases No. 28, 29, 37, and 64 in Table 1), two farmers reported hand dermatitis (Nos. 10 and 45), and a further two – pruritus without visible skin changes (Nos. 9 and 63). Positive skin reactions to four hop allergen preparations: cone extract in glycerol, cone extract in saline, leaf extract in glycerol, and leaf extract in saline were found in one, two, three and four farmers respectively. In all, six persons (8.2%) reacted to at least one hop extract. Among farmers complaining of skin problems related to hops, prick tests gave positive results in two, and negative in six. The tests were also positive in four persons who did not report any hop-related skin problems. The predictive values for SPT with hops (skin reaction to at least one of the preparations) were PPV = 0.33 and NPV = 0.91.

**Skin problems related to work with grain.** Two of 73 studied farmers denied exposure as they did not cultivate grain. Among the remaining 71 farmers, 67 had no skin problems when exposed to grain, and four (5.6%) reported skin problems: hand dermatitis in three cases (Nos. 9, 13 and 42 in Table 1) and pruritus in one case (No. 60). None of these persons had positive prick test results with grain dust. Positive SPT reactions to grain dust were found only in four symptom-free farmers. Thus, the predictive values for SPT with grain dust calculated from these data were: PPV = 0, and NPV = 0.94.

**Table 1.** Detailed description of farmers with skin problems provoked by activities associated with plant production.

No.	Gender, age	Years of farm work	Work-related skin complaints	Test results beyond the norm	Possible interpretation
4	M, 64	52	pruritus when exposed to hay dust starting after 5 min. work and lasting for days	none	irritation
9	F, 51	35	pruritus starting after 15 min. work with hops, resolving within 30 min. after cessation; hand dermatitis after 15 min. work with grain resolving within 30 min. after cessation; hand dermatitis after 15 min. work with straw resolving within 30 min. after cessation;	SPT: hops leaf (+), hay (+), <i>P. agglomerans</i> (+), <i>A. siro</i> (++), <i>L. destructor</i> (+++), <i>T. putrescentiae</i> (+++)	immediate allergy to storage mites, immediate allergy to hops
10	F, 43	25	hand dermatitis after several hours of work with hops, persisting for several days; hand dermatitis at almost every handwork – especially in wet conditions.	none	irritant contact dermatitis
13	F, 44	34	hand dermatitis after several hours of work with grain, persisting for several days; symptoms caused only by contact with grain	none	contact dermatitis*
28	F, 39	24	airborne dermatitis after 2 hrs. work with hops on field, parallel conjunctivitis, tearing, sneezing and cough; dermatitis resolving after 2–3 days; dry hops does not provoke any symptoms	none	contact dermatitis*
29	M, 74	45	airborne dermatitis after 30 min. work with hops, resolving within 30 min. after cessation	none	irritation
34	M, 38	20	pruritus within 30 min. of working with freshly cut hay, resolving within 1 hour after cessation	none	irritation
36	M, 67	41	pruritus within 1 hour of working with dried hay, resolving within 2 hrs. after cessation	SPT: hay (++), <i>L. destructor</i> (++), hop cone (+), hop leaf (+), <i>P. agglomerans</i> (+), <i>S. rectivirgula</i> (+), <i>A. fumigatus</i> (+)	pruritus caused by immediate allergy to hay dust and storage mite <i>L. destructor</i>
37	F, 56	46	airborne dermatitis within 30 min. of working with hops, itching, oedema, erythema, papular rash on the neck; skin changes resolve after 2 days	SPT: hop cone (++), hop leaf (+), <i>S. albus</i> (+), hay (+)	airborne dermatitis caused by immediate allergy to hops
42	F, 24	12	hand dermatitis after several hours working with grain, resolving within 1–2 days; pruritus after several minutes of exposure to straw dust	none	contact dermatitis*
45	M, 31	21	exfoliative hand dermatitis when working with hops, especially when handling bags for hop cones, starting 0.5–1 hr. after beginning the work and persisting approx. 2 days	SPT: <i>T. putrescentiae</i> (+), hay (+)	irritation
60	F, 48	36	pruritus appearing within 0.5 hr. when exposed to dust of grain, straw and hay, resolving within 1 hour after work cessation	none	irritation
63	M, 47	32	pruritus of face when working with hops, starting after 20 min. work and resolving within 20 min. after cessation	SPT: hay dust (+)	irritation
64	F, 51	39	airborne dermatitis after 20 min. working with hops, resolving within 4 hrs. after cessation	none	irritation

\* Based on tests that could be carried out during the field study, definitive distinction between allergic and irritant contact dermatitis was not possible

**Table 2.** Frequency of positive skin prick test reactions among 73 Polish farmers growing hops and other crops.

Allergens	Positive reactions	
	n	%
<b>Various crops</b>		
Grain dust	4	5.5%
Straw dust	4	5.5%
Hay dust (Allergopharma)	5	6.8%
Hay dust (Biomed)	7	9.6%
<b>Hops</b>		
Extract of leaves (saline)	4	5.5%
Extract of leaves (glycerol)	3	4.1%
Extract of cones (saline)	2	2.7%
Extract of cones (glycerol)	1	1.4%
<b>Mites</b>		
<i>Acarus siro</i>	7	9.6%
<i>Lepidoglyphus destructor</i>	13	17.8%
<i>Tyrophagus putrescentiae</i>	10	13.7%
<b>Microorganisms</b>		
<i>Pantoea agglomerans</i>	3	4.1%
<i>Saccharopolyspora rectivirgula</i>	3	4.1%
<i>Aspergillus fumigatus</i>	3	4.1%
<i>Streptomyces albus</i>	1	1.4%

**Skin problems related to work with straw.** 70 farmers did not report any skin problems when exposed to straw. Among the remaining three farmers (4,1%), one complained of hand dermatitis (No. 9 in Table 1), and two – of pruritus (Nos. 42 and 60). None of them had positive prick test results with straw dust. Positive reactions to straw dust allergens were elicited in four farmers, who denied any skin problems. The predictive values for SPT with straw dust were: PPV = 0, NPV = 0.96.

**Skin problems related to work with hay.** 69 farmers did not report any skin problems when exposed to hay dust and four (5.5%) complained of pruritus (cases No. 4, 34, 36, and 60). Two allergens of hay dust were used for testing. Allergen preparation from Allergopharma Company elicited skin reactions in five farmers (6.8%), including one farmer with hay-related pruritus and in four farmers with no symptoms. In the remaining three farmers complaining of pruritus, prick tests were negative. The predictive values for SPT with Allergopharma hay dust allergen were thus PPV = 0.2 and NPV = 0.96. The allergen from Biomed Company elicited skin reactions in seven farmers (9.6%) who did not report skin symptoms, and remained negative in all the cases with hay dust-related symptoms. The predictive values calculated from these data for SPT with the Biomed preparation were PPV

= 0.0 and NPV = 0.94. In all, eight farmers (11%) reacted to at least one hay allergen on SPT.

**Skin prick test with storage mites.** Nineteen (26.0%) of 73 farmers had positive SPT reaction to at least one storage mite allergen, among them seven (9.6%) to *Acarus siro*, 13 (17.8%) to *Lepidoglyphus destructor*, and 10 (13.7%) to *Tyrophagus putrescentiae* (Table 2).

**Skin prick test with microbial antigens.** Seven of 73 farmers (9.6%) had positive SPT reaction to at least one microbial allergen, among them three to *Pantoea agglomerans*, three to *Saccharopolyspora rectivirgula*, three to *Aspergillus fumigatus*, and one to *Streptomyces albus* (Table 2).

No relationship was found between the occurrence of work-related symptoms and positive SPT reactions to any of the allergens tested (Yates-corrected chi-square = 0.001, p = 0.95).

## DISCUSSION

Three types of work-related skin complaints were recorded during the study: hand dermatitis, airborne dermatitis (dermatitis of exposed skin areas, in which the causative role of sunlight can be excluded), and pruritus without visible skin changes. The number of farmers reporting work-related skin problems is considerably high – 21.9% of them reported skin symptoms, including 8.2% of airborne dermatitis and 6.8% of hand dermatitis. Although in the whole group no statistically relevant relationship was found between the occurrence of work-related symptoms and SPT, in three cases (farmers No. 9, 36 and 37) the skin test played a crucial role in identifying the cause of work-related skin symptoms.

From the activities questioned, working with hops seemed to cause most frequently skin problems. In our study group eight of 73 farmers (11%) complained of hop-related skin problem – mostly airborne dermatitis, followed by hand dermatitis and pruritus without skin changes. Most of the skin diseases were mild and allowed farmers to continue their occupation. However, one of the farmers (case No. 37 in Table 1) was suffering from airborne dermatitis to hops grave enough to certify an invalidating occupational disease which was acknowledged by the local sanitary authority. In five farmers with dermatitis and one with pruritus, the SPT with hop extracts remained negative, which makes the type I allergy to hops less probable. In most of them, the clinical course (rapid onset of symptoms after starting work and rapid resolve after cessation of the activity) may suggest irritation mechanism, possibly by a volatile factor. Of interest in this aspect may be two cases described by Newmark: a chemist who developed urticaria, rhinitis, conjunctivitis and asthma after six months work as a hop selector for a brewery [18], and a hop farmer with an occupational respiratory disorder [19]. Both cases were probably caused by the acyclic terpene beta-myrcene, a

constituent of volatile oil released from hop cones. Another case, that of a laboratory worker who developed conjunctivitis, rhinitis, bronchitis and dermatitis to hops, was described by Raith and Jäger [20]. In farmer No. 10 of our study group, the mechanism of irritant contact dermatitis could be assumed, as his disease was provoked by many activities, especially by wet work. Contact dermatitis is most probable in farmer No. 28; however, the possible mechanism could not be clarified – her symptoms appeared only at contact with hop plant in the field and besides skin symptoms, she complained also of conjunctivitis, rhinitis and cough. The relatively late onset of symptoms (after 2 hours work), negative SPT results and long duration of dermatitis (2 days) might suggest contact dermatitis. Cookson and Lawton recorded 22 cases of hop dermatitis in 1952 in Herefordshire (UK), among them 11 workers who were forced to give up hop picking because of the severity of the disease [3]. To our knowledge, only one systematic study on hop-related skin diseases has been previously carried out by Tsyrukunov [27], who examined 156 Ukrainian hop-workers and found hop-related skin diseases in 15% of them, compared to 11% in our study group.

Until recently, grain was regarded almost exclusively as the source of respiratory disease in farmers [11, 21]. However, in our previous study, 16 of 101 grain farmers complained of skin symptoms provoked by grain dust [25], and among 49 cow and pig breeders, grain dust was indicated by nine farmers as a factor provoking skin symptoms [24]. In the present study, positive SPT results with grain were recorded in four farmers (5.5%); this figure does not differ substantially from the results of Iversen and Pedersen, who found positive SPT with grain in 3% of pig farmers and in 8% of cow breeders [11]. In our study, working with grain was a cause of skin problems in four farmers (5.5%). Three farmers complained of hand dermatitis (Nos. 9, 13 and 42) and one – of pruritus (No. 60). SPT with grain dust was negative in all of them. In farmers No. 13 and 42, the late onset of skin changes (2 hours after starting work) and their persistence for several days suggests contact dermatitis. This kind of reaction to barley dust was described by Cronin in 1979 [4]. In farmer No. 9, the rapid onset of hand dermatitis suggests an immediate reaction; SPT with grain was negative, but revealed a strong type I reaction to storage mites, which may well explain the cause of disease, as well as his hand dermatitis caused by contact with straw. In farmer No. 60, rapid onset and resolving of pruritus both after grain, straw and hay exposure, together with negative SPTs with these substances may suggest an irritant reaction. Exposure to hay was the cause of pruritus in four farmers (5.5%) – in three cases the symptoms were provoked by dry hay and in one case – by freshly cut hay. In this group, farmer No. 36 developed positive SPT reaction to hay and the storage mite *Lepidoglyphus destructor* – the most common mite species in stored hay [26].

Storage mites are widespread on farms and avoiding exposure by a farmer seems impossible [10]. Franz *et al.* in a study on 20 farms found 22 mite species and have found that even in the living areas on farms storage mites are more abundant than house dust mites [9]. In our study, 26.0% farmers had positive SPT reaction to at least one storage mite allergen, among them 9.6% to *Acarus siro*, 17.8% to *Lepidoglyphus destructor*, and 13.7% to *Tyrophagus putrescentiae*. These figures are higher than those found in Danish farmers, in whom positive SPT with these species of storage mites were recorded in 8.0%, 6.4% and 7.0%, respectively [11]. In Sweden, IgE antibodies specific to storage mites were found in 6.2% of all farmers and 37.8% of atopic farmers with respiratory symptoms [12]. In a study of 149 consecutive atopic patients of a German lung clinic, IgE antibodies specific to storage mites were found in 25.5% of patients compared to 57% positive to house dust mites [6]. In a study of 54 Swiss patients with confirmed allergy to house dust mites, IgE antibodies specific to storage mite *T. putrescentiae* were found in only 7%, which may suggest that allergy to storage mites is exposure-specific [28]. Storage mites are considered mostly as a cause of asthma and rhinitis [5]. In our study, skin symptoms of the farmer No. 9 (Tab. 1) could well be explained by allergy to storage mites. She had complained of hand dermatitis provoked by contact with grain and straw, but did not suffer from any respiratory problems. Her hand itching and erythema appeared already 5 minutes after starting work with these materials, with gradual resolving starting 30 min since discontinuing the activity. In this farmer, skin tests with grain and straw remained negative, however, a strong sensitisation to *A. siro* (++) , *L. destructor* (+++), and *T. putrescentiae* (+++) was found. Also, farmer No. 36 complained of pruritus without respiratory symptoms, starting approx. 1 hour after starting work with hay and disappearing approx. 2 hours after cessation of these activity. His skin problems may be well explained by positive SPT to hay (++) but possibly also to the storage mite *L. destructor* (+++).

Farmers can be exposed to large quantities of airborne microorganisms and their products which constitute a considerable risk of respiratory diseases [7]. To our knowledge, there were no reports about skin symptoms caused by allergens of airborne microorganisms. Also in our present study group, there was no case of skin symptoms which could be convincingly explained by sensitisation to such allergens. This might be due to a relatively low level of microbial contamination of hop dust, which was described by Aleksandrov and Georgiev, who explained it by a purported antimicrobial properties of hops [1]. However, in cases No. 9, 36 and 37, besides the allergens in foreground, sensitisation to microbial allergens was also found. In farmers No. 9, besides storage mites and hops leaf, antigen of the Gram-negative bacterium *P. agglomerans* also elicited positive SPT reaction. Taking into account that *P. agglomerans* is

abundantly present on plants and possesses strong allergenic properties [7, 8, 17], its complementary role in the pathogenesis of skin reaction cannot be excluded. In farmer No. 36, who complained of hay-related pruritus, as well as to hay and *L. destructor*, positive SPT results with *P. agglomerans*, *S. rectivirgula*, and *A. fumigatus* were also recorded. The last two species are typically found in stored hay [8]. In farmer No. 37, who complained of airborne dermatitis when working with hops, besides very convincing SPT results with hop extract, sensitisation to *S. albus* was also found. This actinomycete is present in high amounts in plant material and soil [8]. Taking these observations together, it cannot be excluded that microbial allergens play also a role in skin disease.

### CONCLUSIONS

Skin symptoms related to work with hops and other crops are relatively common and mostly mild; however, severe invalidating disease may also happen in individual cases.

Work with hops is the kind of plant production associated with most frequent skin diseases (11.0%), followed by work with grain (5.6%), hay (5.5%) and straw (4.1%).

Results of skin prick tests do not correlate well with symptoms at workplace, however, in three of 14 farmers with work-related skin symptoms, the tests results played a crucial role in identifying the cause.

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