

SENSITIZATION TO FLOUR AND FLOUR ILLNESSES AMONGST FLOUR WORKERS

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FROM the point of view of industrial hygiene, it is important to estimate the occurrence of asthma, rhinitis vasomotoria and eczema and of the sensitization to flour amongst unselected groups of bread bakers, cake bakers and millers. For this purpose we have examined 262 flour workers, who formed the entire working staffs of certain bread bakeries, cake bakeries and milling companies in Amsterdam.

All these workers were tested with the scratch method, namely by applying dry pure proteins of wheat, barley, oat, buckwheat, rye, corn (maize), rice and yeast obtained from Lifa Co., Leyden, on superficial scratches which did not draw blood. On many a general allergic examination with proteins from various sources was also performed and a large number were tested for sensitiveness to ammonium persulphate by applying to the skin a pad moistened with a 5% solution for 24 hr. under adhesive plaster. We have shown that reactions to these proteins are seldom positive in normal persons (not bakers), allergic patients (not bakers or hay-fever patients) or persons suffering from eczema (not bakers).

Table I. *Hypersensitiveness to flour amongst 262 working
bakers and millers*

Occupation	Number	Flour reaction		Sensitiza- tion	Probable error*	Flour illnesses	
		Positive	Negative			Of re- spiratory tract	Eczema
Bakers in twelve small factories†	77	34	43	44%	(±6)	24	28
Bakers in five large factories	60	15	45	25%	(±5)	12	11
Cake bakers	15	4	11	27%	(±11)	4	2
Millers	110	13	97	12%	(±3)	9	6
Total	262	66	196	25%	(±3)		

* The probable error ϵ of the percentage p in a number of cases n is obtained from the formula:

$$\epsilon = \sqrt{\left(\frac{p(100-p)}{n}\right)}.$$

† These are bakeries with less than ten employees.

Amongst the 196 flour workers with negative reactions ailments of the respiratory tract or eczema were very rare. On the other hand nearly all the sixty-six workers with positive skin reactions were suffering or had suffered from one or more flour illnesses. Omitting exceptional cases, it seems that the flour illnesses, rhinitis vasomotoria, asthma and eczema, are usually associated with positive skin reactions to flour proteins.

The number of sensitized workers amongst the 262 whom we examined was unexpectedly large. Baagoë (1935), using the scratch method with unprepared wheat flour, found five positive reactors (12 %) amongst forty-two workers. Colmes, Guild & Rackemann (1935) and Havláček (1938), using intracutaneous injections of wheat flour extracts, found fifteen positive reactors (47 %) amongst forty-three workers and five (7 %) amongst seventy workers respectively.

The differences in the figures obtained by these investigators are in our opinion due to the methods of investigation. Many cases of sensitization are not detected when the scratch method with unprepared wheat flour is used, whereas by using the intracutaneous injection method, with wheat flour extracts, many pseudo-reactions occur as shown by observations on controls. Moreover it is not sufficient to test with the particular flour only which the baker uses. In Holland flour for bread is prepared entirely from wheat, the cake bakers only using other kinds of flour mixture. It might be expected, therefore, that all sensitized bread bakers would show a positive reaction to wheat flour, but that was not the case. The proportion hypersensitive to wheat is considerably greater than to other kinds of flour, but the extraordinary fact remains, that some patients suffering from flour illnesses show strong reactions to oat or rye only, flours with which they seldom come in contact, though they are in daily contact with wheat flour.

From Table II it can be seen that of the sixty-six hypersensitive persons fifty-two gave positive and fourteen negative reactions to wheat flour. These fourteen reactors were sensitive to oat or to rye flour only.

If we had restricted our investigations to wheat only, we should have got negative results in 21 % of cases of flour illnesses, but by using the scratch method with pure proteins of different kinds of flour we were able to demonstrate positive skin reactions in nearly all cases of flour illness.

We examined ten patients with the following wheat constituents, gliadine, globuline, glutenine, leucosine and proteose. The wheat proteose always gave rise to the strongest reactions. Consequently the proteose component should be preferred for diagnostic work.

Our investigations showed that the percentage sensitized in the small bakeries (44 %) was considerably greater than in large bakeries (25 %) and in cake bakeries (27 %). This difference was probably due to several factors. In the small bakeries the exposure to flour dust is greater, more work is done by hand, the employees do not report their complaints so readily and the sick worker is not dismissed so easily. Amongst the bakers in the small

Table II. Survey of sixty-six flour workers with positive reactions to flour, yeast, pollen and persulphate

Illnesses				Flour reactions									Yeast	Pollen	Pt sulph 5%
Rhinitis vaso- motoria	Asthma	Eczema present	Eczema in the past	Wheat	Rye	Maize	Buck- wheat	Barley	Oat	Rice					
Bakers in factories with less than ten employees															
+	-	+	-	+++	-	-	+	++	+	+	-	+	-		
+	-	+	-	-	-	-	+	+	+	-	-	-	-		
+	-	+	-	+	+	-	-	+	+	+	-	-	-		
-	-	+	-	+	-	+	+	+	-	-	-	-	-		
+	-	+	-	-	-	-	-	-	+	-	-	-	-		
+	-	+	-	+	-	-	-	-	-	-	-	-	-		
-	-	+	-	+++	+	-	-	+	++	-	-	++	-		
+	+	-	-	+	-	-	-	+	+	-	-	-	-		
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-	-	+	-	+	+	-	-	-	+	-	-	-	-		
-	-	+	-	+++	-	-	-	-	-	-	-	-	+		

bakeries we found more suffering from eczema than from rhinitis vasomotoria. Amongst the bakers in the large bakeries and millers, however, illnesses contracted through the respiratory tract were in the majority. Rhinitis vasomotoria was present in one-half of the cases of eczema. Asthma was rarely combined with eczema, but in nearly all cases was combined with rhinitis vasomotoria.

Hypersensitiveness to flour is most probably an inhalation allergy like those due to dust and pollen. Sensitization through the digestive tract by the eating of bread seems to be rare, as amongst 150 normal people, who regularly consumed bread, only one positive reactor to flour, a gardener, was found.

From the personal histories of the flour workers it appears that amongst the sixty-six patients 37 % had developed symptoms within the first 5 years of employment and 57 % within 10 years. The bakers, in the small bakeries especially, were sensitized when still young. The millers in the big hygienic factories develop their symptoms considerably later in life. Amongst our patients the hereditary factor was negligible. Amongst sixty-six workers hypersensitive to flour, only eight patients had near relations suffering from allergic illnesses, whereas amongst the relations of the normal flour workers cases of asthma and hay-fever were fairly frequent.

In a paper, about to appear shortly in the *Journal of Allergy*, we have shown that the flour improver ammonium persulphate causes an epithelial hypersensitiveness of the same type as pantocain and some other chemicals. According to Prausnitz & Küstner passive transference and sensitization of guinea-pigs was not successful in the case of persulphate hypersensitiveness, whereas in the case of flour hypersensitiveness we were able to show the transference in all our twelve cases and sensitization in three out of five guinea-pigs.

By the patch test method we found that only ten amongst thirty cases of active eczema gave a positive reaction with ammonium persulphate. Therefore we think that ammonium persulphate is not the primary cause in every case of flour hypersensitiveness (Zitzke, 1934; Prakken, 1936). On the contrary we think that sensitization to flour is the main cause of the flour illnesses, including flour eczema, and on this ground in some cases an epithelial persulphate hypersensitiveness also develops. In all our cases of persulphate hypersensitiveness we found a strong positive flour hypersensitiveness.

We are of opinion that flour reactions are reliable aids to diagnosis. If in a case of rhinitis vasomotoria, asthma or eczema in a flour worker the flour reactions are negative, it is probable that the illness is not due to flour, and some other cause must be looked for. The persulphate reaction can also be used for diagnosis, but a negative reaction does not exclude flour workers' eczema.

These reactions might be used for the selection of candidates, especially in bakers' schools. Candidates who suffer from hay-fever should be refused because they soon become sensitized to flour. In addition, the systematic

examination of workers in the first years of their employment might detect incipient flour illnesses. If early hypersensitiveness to flour is found, these young people should be advised to take up some other profession. When hypersensitiveness is noticed later in life in a flour worker, he should work as little as possible with dough to prevent eczema and with the mixing of flour to prevent asthma and rhinitis vasomotoria.

For flour mixing a suitable mask might be recommended. Flour dust in the bakeries ought to be reduced as much as possible by improved ventilation. The large number of young people sensitized in the small bakeries, in contrast to the small number in the large and more hygienic bakeries, in cake bakeries and in milling establishments, shows that there is room for improvement in the hygienic conditions of the bakers' trade.

The treatment of flour illnesses is similar to that of other allergic conditions, avoidance of the allergen being the most important factor. In a patient, who comes into contact daily with an excess of allergen, desensitization therapy can only be successful with highly potent extracts. For such patients we are now using with satisfactory results the very effective proteose constituent of wheat. The fact that, in spite of their work, a number of flour workers recover from their complaints is encouraging for the active immunization therapy.

SUMMARY

Amongst 262 working bakers and millers in Amsterdam a sensitization to flour (wheat, oat or rye) was found in 25%. Nearly all who showed positive skin reactions either suffered or had suffered from one or more flour illnesses, whereas in those who showed negative reactions respiratory illnesses or eczema were seldom found. Flour reactions are therefore reliable aids to the diagnosis of allergic conditions in flour workers. Hypersensitiveness to flour is probably an inhalation allergy in which heredity is of very little importance. A large proportion (44%) of workers in small bakeries soon become sensitized, but in the large, more hygienic factories a smaller proportion (12%) becomes sensitized and the symptoms appear later in life.

Our observations suggest that improvement in the hygienic conditions in bakeries, especially in the small ones, is desirable, and that early allergic examinations of the bakers might be useful in detecting impending illnesses due to flour. Desensitization with the very potent proteose constituent of wheat has been tried.

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