CEREAL GRAIN DUSTS AS A CAUSE OF RESPIRATORY ALLERGY IN SOUTH AFRICA

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Cereals (especially wheat) are recognized among the important foodstuffs which on *ingestion* produce respiratory, gastro-intestinal or skin manifestations in food-sensitive persons. It is less well known, however, that the *inhalation* of dusts derived from cereals may induce symptoms of respiratory allergy—vasomotor rhinitis and bronchial asthma.

References to this subject in the literature are rather scant and generally describe a few cases only; and in some instances the causation of symptoms is attributed to contaminants in the cereal dust rather than to the grain flour itself.

Goodale[1] (1916), Walker[2] (1920) and Frugoni and Ancona[3] (1927) believed that flour dust could cause asthma and rhinitis. Walzer[4] (1931) stated that cereals, particularly wheat, acted as excitants of hypersensitivity by inhalation, ingestion and contact and referred to bakers with symptoms from the inhalation of flour dust but who could ingest flour in all forms. Rackeman[5] (1931) described cereal sensitivity in 8 bakers, 3 housewives and in 3 other persons. Duke[6] (1935) described 4 wheat millers with asthma but thought that the causative factor was a foreign-body reaction or a sensitization reaction to the small sharp wheat hairs and the outer cells that get into the air. He obtained positive skin reactions with an extract of the grain dust but the results of treatment were not satisfactory. Tuft[7] (1938) thought that wheat flour was the most important and the most frequent offender of the entire cereal group. Van Dishoeck and Roux[8] (1939) examined 262 workers in bakeries and mills in Amsterdam and found 25% of them sensitive by skin test to wheat, oat, or rye flours. Nearly all the positive reactors either suffered or had suffered from one or more 'flour illnesses' while in the negative reactors respiratory illness or eczema were seldom found. In the same year Najera and Dantin[9] reported asthma in 25 of 115 millers in Paris and noted that cutaneous lesions were also common. They believed however that both respiratory and skin lesions were due to mites (*Acari*) in the inhaled dust, especially in old oat and bean flour mills. Unger[10] (1945) stated that the inhalation of grain dust as a cause of asthma was important in farmers, in those connected with the flour industry and in housewives and that, while most bakers had no symptoms, those susceptible sooner or later developed rhinitis or asthma or both. He quoted Hlavack's report[11] (1937) of 8 out of 70 bakers sensitive to wheat and rye, and that of Rastelli and Brambilla[12] (1937) who obtained positive skin reactions to wheat in 25 of 100 exposed peasants, mill workers and unskilled labourers (there were only 2 persons with asthma amongst the 25 'positives'). He was of the opinion that the respiratory symptoms in farmers and mill workers were due to the flour itself or to moulds, smuts, rusts, and insects contaminating the flour.

The possibility that fungi, rust and smuts play an allergenic part in inhalant cereal sensitivity has long been considered. Blackley[13] (1880) suspected moulds and Cadham[14] (1934) reported asthma due to contamination of wheat by rust. Wittich and Stakman[15] (1937) found smuts spores in sputum and positive skin reactions to most grain smuts in persons exposed to wheat in mill dusts, and concluded that smuts frequently augmented the severity of symptoms in grain-sensitive patients. Since then Fawcitt,[16] Wittich,[17] and Harris[18,19] have described the association of moulds, rusts and smuts with cereals in producing symptoms and Wittich[20] (1940) in a consideration of various mill-dust allergens concluded that smuts allergy and grain-dust allergy were closely related although they did not possess the same allergens, and that mill-dust allergen not only included the grain flour itself but that pollens, moulds, smuts, rusts, bacteria and insect fragments present in the flour had a relative importance in producing respiratory and skin allergy.

CEREAL-GRAIN SENSITIVITY IN SOUTH AFRICA

In the course of my investigating patients with allergic vasomotor rhinitis and asthma over the years a broad pattern has emerged of respiratory allergy in persons handling cereals occupationally or otherwise, the symptoms in each instance resulting from the inhalation of the dusts of the cereals. This paper describes sensitivity to the inhalation of cereal dusts in South Africa and emphasizes the value of desensitization by the use of specific extracts.

Cereals are members of the grass families (*Graminae*) which have edible starchy seeds or grains and thus yield food to man. The cereals include maize or mealies (*Zea mays*), wheat (*Triticum* spp), kaffir-corn (*Sorghum vulgare*), rye (*Secale cereale*), oats (*Avena sativa*), barley (*Hordeum vulgare*), rice (*Oryza sativa*).

The growing of one or more of the winter cereals—wheat, oats, barley and rye—constitutes a part of the farming practice in most districts of the Union of South Africa.

Maize (mealies) is the most important crop in the Union and is a basic South African foodstuff. It is the staple diet of the majority of the non-Europeans and of many Europeans and it is also extensively used in cattle feeding. Maize is grown mainly in the Eastern Transvaal highveld, the northern part of the Orange Free State and the central Western Transvaal. The so-called 'maize triangle' of the Union is indicated approximately by Bethal in the east, Lichtenburg in the west and Ladybrand in the south. On every farm maize is kept in store-rooms for cattle, pig and fowl feeding so that the inhalation of maize dust can occur at any time of the year.

Wheat, also a basic foodstuff in South Africa, is grown in the Western (Cape) Province, the Orange Free State, and districts in the Transvaal.

Kaffir-corn, traditionally used as a foodstuff in South Africa, has now largely been replaced by maize. The most important market for kaffir-corn is in the manufacture of malt for kaffir beer. It is grown mainly in the Northern and Western Transvaal.

In the period 1949-57, 128 'treatment sets' of extracts of cereals were issued for desensitization purposes in patients clinically sensitive to the inhalation of dusts from the various cereal grains. The incidence of specific cereal sensitivities is analysed in Table I. It will be observed that 76 (56·7%) of the treatment sets issued were for a single cereal and 52 (43·3%) for combined cereal extracts for simultaneous desensitization. Further, it will be noted that sensitivity to maize was en-

TABLE I. SPECIFIC CEREAL SENSITIVITIES AS REPRESENTED IN 128 TREATMENT SETS OF CEREAL EXTRACTS, 1949-57

Sensitivity	*Number*	*Maize*	*Wheat*	*Kaffir-corn*	*Oats*	*Rye*	*Rice*
One cereal only	76 (=56·7%)	43	21	5	3	1	3
Two or more cereals	52 (=43·3%)	49	29	24	16	8	5
Totals	128	92	50	29	19	9	5
		71·9%	39·1%	22·7%	14·8%	7·0%	3·9%

TABLE II. CEREAL SENSITIVITIES IN 76 PATIENTS INVESTIGATED, 1952-57

Sensitivity	Number	Maize	Wheat	Kaffir-corn	Oats	Rye	Rice
One cereal only	38 (=50%)	23 (13)	13 (8)	1 (0)	0	0	1 (1)
Two or more cereals	38 (=50%)	28 (13)	23 (11)	15 (7)	10 (6)	5 (4)	1 (1)
Totals	76	51 (26)	36 (19)	16 (7)	10 (6)	5 (4)	2 (2)

The numbers of patients in which sensitivity was confirmed by skin tests are shown in brackets.

countered in 71·9% of instances, to wheat in 39·1%, and to kaffir-corn in 23·7%. Too much should not be read into the significance of these figures because they probably merely reflect the relative degree of exposure of patients to these different cereals. It is clear, however, that sensitivity to cereal inhalation producing symptoms of respiratory allergy is a definite hazard in South Africa and should be borne in mind, particularly in persons who are brought into contact occupationally with maize and wheat. The cereal-inhalation aetiology of asthma and vasomotor rhinitis, especially in the maize areas of the country, is often overlooked.

The realization in 1952 of the significance of allergic sensitivity to cereals by inhalation in South Africa stimulated a close study of each case that subsequently came to our notice.

The milling, bagging and other handling of cereals in the Union are carried out largely in the rural districts, and for this reason it was only possible in relatively few cases personally to interview the cereal-sensitive patients involved in order to obtain full clinical and other details for proper scientific assessment. Under the circumstances it was necessary to enter into correspondence with the doctors about their patients. A large body of information was indeed collected in this way; but, as with all questionnaire-correspondence schemes, the necessary details were not always readily obtained and in some instances, in spite of repeated requests, hardly any particulars were submitted.

Specific extracts were prepared from clean dry cereals free from visible mould or other foreign matter and microscopically not in any way grossly contaminated with rusts and smuts. These extracts were sent to all practitioners reporting cases of cereal sensitivity and they were asked to perform skin tests to confirm the clinical suspicion of cereal sensitivity. In addition, in order to complete the pattern of reaction to inhalant substances, each patient was also to be tested with extracts of other inhalant substances commonly of significance in South Africa, viz. pollens (compositae, grasses, acacia, cypress), animal dander (cat, dog and horse), feathers (chicken and goose) and house-dust. Many of the patients were also submitted to skin tests with extracts of air-borne fungi representing the commoner local varieties of atmospheric moulds.[21] This was done to ensure that cereal sensitivity reactions were not complicated by sensitivity reactions to moulds, which are universally present and may be associated with growing cereals and other plants. There was, however, no evidence that such fungi played a part in the hypersensitivity symptoms of the patients. The patients were not especially tested with extracts of rusts and smuts as the cereals used in extract preparation were free from appreciable contamination with these.

In the 5-year period ending June 1957, 76 patients with cereal sensitivities were investigated and the details of their sensitivities are shown in Table II. It will be seen that 50% of the patients investigated were specifically sensitive to a single cereal only whilst the remainder were simultaneously sensitive to a number of cereals. In the latter group of 38 patients as many as 23 (60·5%) were sensitive to both maize and wheat with or without sensitivity to other cereals, and 15 (39·5%) showed a sensitivity to lucerne in addition to sensitivities to various cereals. It will be observed also that in the cases studied 53·3% of clinical cereal sensitivities were confirmed by skin tests. In the remaining 46·7% skin tests had, for one reason or another, not been carried out. In no instance, however, was a negative skin reaction obtained in a clinically sensitive person; on the contrary, in a number of patients where skin tests were systematically done with a series of different cereal extracts, positive skin reactions were obtained to cereals to which the patient evinced no clinical sensitivity.

It will again be noted in this group of cases that the incidence of maize sensitivity was the highest, followed by sensitivity to wheat and kaffir-corn and to a considerably less extent to oats, rye and rice.

The occupational distribution of patients with their specific cereal sensitivities is shown in Table III. It will be observed that most of the patients were employed on farms, mills and grain stores. In a few instances housewives unassociated with farming life developed symptoms when handling wheat or other flour during baking. Of 34 workers on farms 16 were sensitive to maize, 7 to wheat, 4 to oats, 2 to kaffir-corn and 3 to other cereals.

Desensitization of Cereal-sensitive Patients

In every case where a patient was found sensitive to cereals by inhalation we recommended desensitization by the use of the specific cereal extracts prepared singly or in combination as indicated. Desensitization was carried out entirely by the *intracutaneous* technique, proceeding gradually

TABLE III. OCCUPATIONAL DISTRIBUTION OF 76 CEREAL-SENSITIVE PATIENTS, 1952-57

Occupation	Maize	Wheat	Kaffir-corn	Oats	Rye	Rice
Farm[a]	16	7	2	4		
Grain-store Workers	4	3	1	1		1
Mill[b]	5	3	2	1	1	
Bakery Workers		1				
Housewives	2	4	1			
Others[c]	9	7	1	3	3	1
Not known	15	11	9	1	1	

(*a*) Farmers, farmers' wives and farming students. (*b*) Millers, graders and fitters. (*c*) Children, students and others.

TABLE IV. DESENSITIZATION OF PATIENTS SENSITIVE TO (*a*) MAIZE, (*b*) WHEAT, (*c*) MULTIPLE CEREALS, (*d*) RICE

Case No.	*Sex, Age, Occupation*	*Clinical Condition*	*Family History of Allergy*	*Skin Reactions to Commoner Inhalants*	*Cereal Sensitivity (a)*	*Circumstances of Sensitivity*	*Densensitized with Extracts of:*	*Results of Desensitization (b)*
					(*a*) MAIZE			
2	Man, 44. Store-manager	Vasomotor rhinitis and asthma	Sister asthma	Nil	Maize	Symptoms commence when working with mealie meal, or 'fowl food' containing maize.	Maize	Complete absence of symptoms since treatment—*a signal success. Patient says, 'My life was a hell on earth and now I feel like a municipal bull'.*
22	Man, 19. Agricultural student	Vasomotor rhinitis and asthma	Yes	Compositae and grass pollens	Maize	Attacks occur after crushing mealies and cutting up maize for silage. Has had hayfever from childhood which has continued ever since. Asthma from 7-11 years of age. He has a number of food sensitivities but is able to eat maize porridge.	Maize	*A few weeks after desensitization commenced there were no longer symptoms when harvesting maize. There has been a steady improvement. No more hayfever.*
28	Housewife, 33	Vasomotor rhinitis		Compositae and grass pollens, feathers, house-dust, orris root	Maize	Symptoms from inhalation of maize dust and maize products; also when passing a maize field in flower (probably grass pollen sensitivity)	Maize, compositae and grass pollens, feathers, house-dust, orris root	*She has had no further symptoms from maize meal.*
30*a*	Farmer's wife	Vasomotor rhinitis and asthma		Nil	Maize	Symptoms develop when entering the store where the grain is kept and when feeding fowls.	Maize	*After desensitization she has had no further attacks in spite of her continuing her former activities. A most successful result.*
35	Boy, 14. Scholar	Vasomotor rhinitis and slight asthma	Yes		(Maize)	Symptoms follow the inhalation of dust from the milling of mealies. Urticaria developed on one occasion from the eating of porridge made from unwashed mealie meal. Can eat this porridge if the maize is first washed.	Maize	*Excellent result. No more asthma and only occasionally hayfever.*
37	Farmer's wife, 51	Vasomotor rhinitis	Yes		Maize	Symptoms are associated with the handling of maize.	Maize	*After a few injections of maize extract the attacks began to decrease in severity after handling maize meal. After completing the course there were still some symptoms when in contact with maize but the attacks are much milder and easily controlled by antihistamines; whereas before the course of injections she had just about all the antihistamines on the market with no beneficial effect at all.*
39	Housewife, 38	Vasomotor rhinitis, asthma and summer hayfever (grass pollen)	Yes	Compositae and grass pollens	Maize	Symptoms occur when working with maize meal, bagged mealies and samp.	Maize, grass pollens	*Very marked improvement after the first course of injections.*
52	Man, 35. Shopkeeper	Vasomotor rhinitis and slight asthma	No		Maize	Symptoms occur when serving in the shop once or twice a week. Has worked with cereals for nearly 10 years intermittently. He vomits after eating mealie-meal porridge.	Maize	*After desensitization there was a marked improvement to the inhalation and ingestion of mealie meal.*
57	Man, 18. Farmer	Vasomotor rhinitis and summer hayfever (grass pollens)	Yes	Grass pollen feathers, housedust	Maize	Symptoms occur during the milling of maize on the farm.	Maize, grass pollen, house-dust	*There was marked improvement until desensitization injections were neglected.*
					(*b*) WHEAT			
16	Man 48. Wheat-grader	Vasomotor rhinitis and asthma	Daughter hayfever	Compositae and grass pollens, feathers, house-dust	Wheat	Symptoms commence when entering grain store during wheat-testing time and when working in the sheds with wheat.	Wheat	*Benefited from the first course of injections. Desensitization re-started 6 months later helped a little.*
17	Woman, 16. Bank-clerk	Vasomotor rhinitis	Sister sinusitis		Maize wheat, kaffircorn, rye	Symptoms occur when baking and also from the inhalation of wheat flour dusted on to cakes and pastries, with occasional urticaria under those circumstances.	Maize, kaffir corn, wheat, rye	*Definitely a marked improvement. No further attacks of urticaria and only occasional hayfever.*

Case No.	Sex, Age, Occupation	Clinical Condition	Family History of Allergy	Skin Reactions to Commoner Inhalants	Cereal Sensitivity (a)	Circumstances of Sensitivity	Densensitized with Extracts of:	Results of Desensitization (b)
48	Housewife, 55	Vasomotor rhinitis	Yes		Wheat	Symptoms occur when baking bread or cakes in the last 10 years, although has been working with flour for 40 years.	Wheat	*After completion of the course the patient said she had not felt so well for many years and was once more able to indulge in her favourite pastime—baking.*
49*a*	Housewife, 46	Vasomotor rhinitis and summer hayfever (grass pollens)			(Wheat)	Symptoms from inhalation of wheat flour during baking	Wheat, compositae and grass pollens, acacia, cypress, cat and dog hairs, feathers, house-dust	*After desensitization her hay-fever and sensitivity to wheat have greatly decreased.*
					(*c*) MULTIPLE CEREALS			
10	Schoolboy, 8	Asthma			Maize, kaffircorn	Symptoms appear when feeding the large number of fowls his parents keep and also on entering the feeding sheds.	Maize, kaffircorn	*This small boy, who was getting severe attacks of bronchial asthma as a result of the exhibition of maize and kaffircorn dusts, made a marked recovery. There has been no major attack since desensitization began. His mother says he has never looked so well. He is eating and sleeping much better, is less irritable, and is gaining weight.*
40	Man, 21. Miller	Vasomotor rhinitis and asthma	Yes		Oats, wheat, maize, kaffircorn, rye	He has been working for a year in his father's mill. Symptoms occur when in contact with cereal dusts. As a child he developed urticaria when playing in kaffircorn heaps. Has had vasomotor rhinitis since the age of 10 years.	Oats, wheat, maize, kaffircorn, rye	*Slight improvement only. He now spends much less time in these dusts and only sneezes now.*
54	Storeman-grader in mill, 43	Asthma			Wheat (maize)	Symptoms occur when loading wheat and maize on trains.	Maize, wheat	*The patient has had 2 courses of injections. He has been almost completely free from asthma since. He is still at his old job, but is so much better that he is able to continue, whereas before the injections I was on the point of letting him resign.*
67	Man, 50. Grain-elevator operator	Vasomotor rhinitis and asthma	No	House-dust	Maize, wheat	Symptoms occur on contact with wheat and maize.	Maize, wheat	*Although he still handles wheat and maize there has been marked improvement since desensitization. Previously he had to use decongestants 4-hourly, which are now used perhaps once at night. Two polyps in the left nasal passage had become markedly reduced in size.*
					(*d*) RICE			
72*a*	Woman. General dealer's assistant	Vasomotor rhinitis			Rice	Symptoms occur in the store when weighing out and packaging rice.	Rice	*Considerable improvement.*

(*a*) Where the name of the cereal in this column is enclosed in brackets the sensitivity was not confirmed by skin testing. In all the other cases the sensitivity was confirmed by skin testing.
(*b*) The comments of the practitioner in the case are printed in italics.

with injection of extracts from 1/1,000 to a 1/1 (concentrated) strength given 2-3 times a week, aiming with each injection to produce a wheal about 2 cm. in diameter. With the concentrated extract the intervals between the injections were gradually increased until the patient received a 'maintenance' injection every 8-12 weeks.

Results of Desensitization. It was possible in 18 cases to follow up the progress of patients who had been submitted to the recommended courses of desensitization. The relevant details of these patients are given in Table IV.: (*a*) 9 cases of maize sensitivity, (*b*) 3 cases of wheat sensitivity, (*c*) 5 cases of multiple cereal sensitivities, (*d*) 1 case of rice sensitivity. A study of these cases shows that the results of desensitization with extracts of the specific cereals to which the patients were sensitive was, in general, very effective.

SUMMARY AND CONCLUSIONS

An investigation is described into the occurrence of allergic vasomotor rhinitis and bronchial asthma resulting from the inhalation of cereal grain dusts in the Union of South Africa.

Sensitivity to maize and wheat showed the highest incidence in 128 cases that came to notice but sensitivity to kaffir-corn, oats, rye and rice also occurred.

A study was made of 76 patients with single or multiple cereal inhalation sensitivities.

Cereal-dust sensitivity occurred mainly in persons occupationally handling the grain, as in farmers and workers in mills and grain stores. It was, however, also found in housewives and others who only occasionally had contact with grain dusts.

Details and the circumstances of sensitization are given

of 18 cereal-sensitive patients with symptoms of respiratory allergy. In these patients the progress could be followed and the results of desensitization assessed.

Specified cereal desensitization in inhalant cereal respiratory allergy is shown to be very satisfactory.

Thanks are due to the physicians in various parts of South Africa who made this investigation possible by notifying us of cases of cereal-dust sensitivity that came to their notice and by kindly supplying clinical and other details of their patients at our request. A special word of gratitude is expressed to the medical men who carried out specific cereal densensitization and reported their results.

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