

Case Report

Baker's Asthma With a Predominant Clinical Response to Rye Flour

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Background *Relatively little attention has been paid to rye flour as opposed to wheat flour in clinical and epidemiological research into Baker's asthma.*

Methods *This report describes the investigation of a baker with asthma who reported a workplace response to rye flour and none to wheat flour, despite co-reactivity to both wheat and rye antigen.*

Results *Skin prick tests, RASTs and basophil stimulation tests were positive for both wheat and rye antigen, but quantitatively greater for rye than wheat. Bronchial challenge elicited a much greater response to the rye-wheat flour mix used in the bakery than to 100% wheat flour.*

Conclusions *The greater clinical response to rye than to wheat may be immunologically mediated, but could also be due to physical characteristics of rye flour such as greater dose of inhaled airborne particles or an irritative effect. This information may be useful for medical management and occupational hygiene control, and should stimulate further research into rye flour in Baker's asthma.* Am. J. Ind. Med. 48:153–155, 2005.

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KEY WORDS: Baker's asthma; rye; wheat; basophil stimulation test

INTRODUCTION

Baker's asthma typically involves a type I allergic response to a variety of cereal antigens, including wheat, rye, soya, corn and barley, or to fungal enzymes [Houba et al., 1998]. Of these causal agents, wheat has received the most attention in the published literature, with relatively little attention to rye flour.

In the course of making the diagnosis of Baker's asthma in a series of bakery employees from a multichain supermarket, we became aware that rye flour rather than wheat flour was identified by a number of these patients as the trigger of their symptoms. This difference in clinical response occurred despite the fact that these patients worked with rye in a minority of products and had positive responses to both rye and wheat antigens on skin prick testing.

The aim of this case investigation was to establish the clinical and laboratory features of Baker's asthma in which rye flour rather than wheat flour was the predominant trigger of symptoms despite co-reactivity to wheat and rye.

CASE REPORT

A 38-year-old male baker presented with a 2 months history of rhinitis and asthma symptoms as well as urticaria on the arms on exposure to rye flour at work. These symptoms

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did not occur in any other situation and specifically not on exposure to any other material in the bakery, including wheat flour or baking mixes from which rye was absent. He was a non-smoker with a childhood but no adult history of asthma. He also had a history of childhood pulmonary tuberculosis and surgical resection of his right lung at the age of 12 years. He had worked as a baker for the previous 15 years. As he was currently the bakery manager, he was able to minimize his exposure to rye flour, which was used for a minority of products.

On inquiry it was found that two types of rye flour were used, a "100% rye mix" and a "50/50 Austrian rye mix." The 100% rye mix contained a mixture of rye flour, "dry sour" (rye flour fermented with vinegar), soya, corn starch, alpha one amylase, lecithin, ascorbic acid, and salt. The "50/50 Austrian rye mix" had in addition to the above, white bread flour and crushed rye.

Physical examination was consistent with a right pneumonectomy, but was otherwise unremarkable, with no wheezing. Chest X-ray confirmed the pneumonectomy with some compensatory hyperexpansion of the left lung. Spirometry was mildly obstructive. Pre-bronchodilator forced expiratory volume in 1 s (FEV1) was 2.73 L (78% of predicted), forced vital capacity 3.62 L (87% of predicted) and FEV1/FVC ratio 75%. After inhaling 200 µg of salbutamol, the FEV1 increased to 2.95 L, a non-significant increase of 8%. Histamine challenge test was negative, with FEV1 falling by a maximum of 15% at a dosage of 7.68 mg/ml histamine.

Skin prick tests were carried out with ALK extracts (ALK-ABELLO, Denmark, supplied by LabSpec). The positive histamine control produced a wheal 10 mm in diameter. There was a positive response to a variety of common aeroallergens, including house dust, grasses, feathers, dog hair, and molds. The largest wheal diameters were obtained with grains, including barley (20 mm), rye (14 mm), wheat (10 mm), oats (8 mm), and corn (6 mm).

Total IgE (UniCAP 100 system, Pharmacia Diagnostics AB, Uppsala, Sweden) was 77.8 Ku/L (reference <100 Ku/L). Specific CAP RASTs showed values of 20.3 Ku/L (grade 4) for rye and 8.3 Ku/L (grade 3) for wheat. CAP RASTs for alpha amylase, soya, corn and rye grass were all negative (<0.3 Ku/L).

A flow cytometric basophil activation test was performed on the patient's blood using purified wheat and rye flour extracts (Buhlmann, supplied by Laboratory Specialities). In the non-stimulated background control, the percentage of activated basophils was 2%. The percentage of activation given by CD63 up-regulation was 17% with wheat flour, and 37% with rye flour.

"Workplace simulation" bronchial challenge tests were set up with the flours used by the patient in the bakery. In the first challenge, the patient sieved dry 50/50 Austrian rye/wheat mix for 15 min in a small chamber in the lung function

laboratory. The same test, using 100% wheat flour, was repeated 1 week later.

During the rye/wheat mix exposure, the patient became visibly distressed with loud respiratory effort. Post-exposure examination revealed prolonged expiratory phase and tachypnoea, although no wheeze could be auscultated. FEV1 fell by a maximum of 13% and peak expiratory flow rate (PEFR) by 30% immediately, recovering slowly over 2 hr and being reversed with 200 µg of salbutamol at 2 hr post exposure. There was no late occurrence of symptoms nor decline in peak expiratory flow during the subsequent 20 hr.

The challenge with 100% wheat flour was conducted 1 week later. During the exposure, the patient remained comfortable and reported no symptoms, although an expiratory wheeze was heard on auscultation immediately post-exposure and at 10 min post exposure. There was little response in FEV1. PEFR fell by 13% at 20 min before recovering spontaneously. There was no late occurrence of symptoms over the next 20 hr.

DISCUSSION

These investigations were prompted by the patient's insistence that it was only on exposure to rye flour that he experienced asthma and rhinitis symptoms in the bakery despite skin prick tests showing positive responses to wheat and rye. Co-reactivity to rye and wheat was further confirmed by RAST and basophil activation testing. Tests of non-specific bronchial hyperresponsiveness were negative at a time when he was actively avoiding rye flour exposure. The bronchial challenge with the rye-containing mix was impressive in the respiratory distress that it provoked although the fall in FEV1 was only 13%, less than the 20% used as a criterion for a positive test. However, PEFR fell by 30%, which could be regarded as a positive response [Ramsdell et al., 1982]. The symptomatic and physiological responses were in strong contrast to those obtained on challenge with wheat flour alone, thus confirming his clinical history of greater rye "sensitivity."

An immunological basis for the greater clinical reaction to rye than to wheat is suggested by the rye predominance in all of the immunological tests using purified rye extracts, namely, skin prick testing, RAST and notably the basophil activation test.

An alternative explanation for the greater clinical response to rye flour could lie in different physical characteristics of rye flour. In one controlled study using a dust meter, rye flour generated considerably more dust than wheat flour [Kniel et al., 2001]. An analysis of particle size distribution in another study [Sander et al., 2004] found a greater thoracic fraction of rye than wheat particles, that is, under 10 µm (19% vs. 10%). A given mass of rye flour might thus generate more airborne particles and smaller particles than wheat, resulting in greater respiratory tract penetration.

Other possibilities are that rye flour is more irritating to the respiratory tract than wheat flour or that rye flour particles are “stickier” and therefore less likely to be exhaled.

A greater physiological response to rye flour than wheat flour, confirmed on bronchial provocation tests, has been previously reported in subjects with occupational asthma who were sensitized to both rye and wheat [Baldo et al., 1980; Bensefa et al., 2004]. In the first case study [Baldo et al., 1980], rye flour was more potent in inducing a bronchial response than wheat flour. In a recent study, Bensefa et al. [2004] measured the dose of flour inhaled during bronchial challenge testing and calculated the rate of “deactivation” of allergen. In their subjects, rye induced a stronger early bronchial response than wheat. Response was also influenced by the dose rate of allergen inhaled and by the rate of deactivation. The measure of deactivation was not significantly different between wheat and rye.

These findings suggest that further research into the immunological and physical characteristics of rye flour is needed to enhance our understanding of Baker's asthma. Differences in flour characteristics may need to be taken into account in occupational hygiene control measures. Practitioners treating patients with Baker's asthma should also be aware of a possible rye predominance in the course of managing such cases. While ideal management of Baker's asthma is to recommend total removal from flour exposure,

economic realities may require some accommodation within the bakery environment especially if the asthma is mild. In such cases, avoidance of rye flour may serve to improve the patient's clinical state, although close medical surveillance would be required.

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