

ALLERGIES IN THE WORKPLACE

OCCUPATIONAL DISEASE IN BREAD BAKERS

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ABSTRACT

Bakers have one of the highest rates of occupational disease. They are exposed to a wide variety of irritants and allergens. Baker's eczema and asthma are major causes of significant morbidity and loss of income in this population; however, these occupational diseases continue to be under-recognised. This article reviews the most common irritants and allergens associated with baker's eczema and asthma and interventions to limit exposure.

INTRODUCTION

Occupational disease occurs as a result of exposure to physical, chemical, biological or psychosocial factors in the workplace. Multiple organ systems including musculoskeletal, respiratory, skin, neurological and psychiatric, cardiovascular, haematological, hepatic, renal and reproductive systems can be affected.

Occupational allergies result from an immune hypersensitivity to substances encountered at work and constitute 15% of all occupational diseases. Occupational allergy can vary from skin-related symptoms like contact dermatitis and urticaria to respiratory diseases, covering a range of conditions including rhinitis, bronchitis and asthma. Occupational allergies and asthma have the best prognosis with an early, accurate diagnosis and subsequent avoidance of exposure to the relevant sensitiser. Compared to other occupations, bakers are at high risk of developing occupational disease and, more specifically, occupational allergy. They are exposed to a wide variety of irritants and allergens during daily tasks. Wheat and cereal flours are the main causes of baker's allergy.

CASE REPORT

A 26-year-old woman, who had been working as a bread baker in a large supermarket-based bakery for 4 years, was referred to the occupational skin disease clinic. Her problem of 2 months' duration was pruritic, rough hands for which she had not used any treatment.

Her work involved prolonged exposure to 'wet work' and flour dust. A typical day started with preparing bread dough by combining preblended flour-based bread mix with wet ingredients. Baker's yeast is then added before the dough is spun to evenly mix the ingredients together. Lastly spices are added. The dough is then kneaded, rolled, cut and shaped to form rolls. Various seeds are then sprinkled on top (Fig. 1). The rolls are then placed on a baking tray and left to rise. After adequate rising the tray is placed in the oven. After removal from the oven, glaze, icing or other toppings may be applied. Cleaning of the kitchen and equipment is done several times a day using soaps, degreasers and detergents.



Fig 1. Bread sprinkled with different seeds, spices, flour and other toppings.

On examination she had lichenified plaques with excoriations on both wrists and prominent erythema of her fingertips with swollen proximal nail folds and loss of cuticles, suggestive of an irritant dermatitis. She was treated with a potent topical steroid and advised to wash her hands with bland soap and warm water and to use an emollient. Patch testing with 50 commercial allergens commonly implicated in contact dermatitis was negative and a workplace visit was scheduled.

THE BAKING INDUSTRY^{1,2}

The baking industry comprises a variety of different types of bakeries. Plant bakeries are large companies, using automated production lines to produce large quantities of products. Craft bakeries are small to medium-sized and produce a variety of products using a combination of machinery and handcraft skills. In-store bakeries are located within supermarkets and produce variable amounts of baked goods.¹ Innovation and modernisation of the baking industry (such as automation and fortification) has led to changes in the distribution of occupational disease in this industry.

The earliest breads produced from grains were mashed with water or milk and were eaten raw or cooked. By the twentieth century bread flour was replaced by bleached, bromated and enriched flour.² The grain is bleached and sterilised with chemicals to make it white and soft. It is

then enriched by adding back the vitamins and minerals destroyed in the processing. Breads produced by plant and in-store bakeries are produced to withstand packaging in plastic bags and to have longer shelf lives. They are frequently made with dough conditioners, emulsifiers and mould inhibitors. A dough conditioner makes it easier to handle the dough and helps to soften the crumbs. Emulsifiers amalgamate the dough, and mould inhibitors are sprayed onto the bread as it comes out of the oven to delay formation of mould. In addition to this, enzymes such as malt and alpha-amylase have been used in bread making. Amylases degrade starch and produce small dextrins to activate the yeast. This causes the dough to rise. If the amount of alpha-amylase is low, there is less dextrin production and subsequently less gas formation. This results in poor quality bread with decreased loaf size and inadequate texture. Other enzymes such as xylanase, cellulose and hemicellulose are also used. All of these products carry a risk for occupational sensitisation or allergy.

In addition to food products, bakers are also regularly in contact with cleaning chemicals and sanitisers. Common cleaning agents used include sodium hydroxide (used for cleaning hard surfaces and, in stronger concentrations, for cleaning ovens) and bleach (a mixture of calcium hydroxide and chlorine). These chemicals are irritants, typically to the skin with prolonged use during wet work, which can affect the eyes, nose and skin. Oven dust and gases such as nitric oxide, nitrogen dioxide and sulphur dioxide are other potential irritants.

BAKER'S ECZEMA

Definition

Baker's hand eczema is caused by exposure to allergens and/or irritants at the work place.

Epidemiology

Occupational skin diseases are among the most frequent occupational diseases. Bakers, confectioners and employees in the catering trades are at an increased risk of developing occupational skin disease. A Swedish study³ found that bakers have a 3-fold increased risk of developing hand eczema. The same study also found that female bakers were more commonly affected than male bakers. A possible explanation for this might be that women report more exposure to wet work and are also more likely to be exposed to allergens in their private life, e.g. cosmetics, detergents, etc. The same study also found that people with a history of childhood eczema or a family history of atopic eczema had a higher incidence of hand eczema compared to those without such a history. Another Swedish study⁴ reported the rate of hand eczema in bakers to be 8.37/1 000 person-years. A population-based study in Germany⁵ showed that the highest irritant contact dermatitis annual incidence rates were found in hairdressers (46.9/10 000 workers), bakers (23.5/10 000 workers) and pastry cooks (16.9/10 000 workers). Irritant contact dermatitis was also more common than allergic contact dermatitis, 23.5% and 10.9% respectively, among bakers in this study. There are no data on the prevalence of hand eczema in bakers in South Africa.

Risk factors and allergens

The development of occupational hand eczema is determined by a combination of individual susceptibility and exposure to allergens and irritants. Most cases of dermatitis in bakers are due to irritation. Allergic contact dermatitis is less common. Contact urticaria and protein contact dermatitis have also been described in bakers.

Irritant contact dermatitis (ICD)

ICD is a non-immunological local inflammatory reaction characterised by erythema, oedema, vesicles and blisters after a single or repeated application of a chemical substance to a cutaneous site. The amount and duration of application should be enough to cause keratinocyte damage.

Endogenous factors such as age, sex, ethnicity, pre-existing skin disease, especially atopic skin diathesis and the anatomical region exposed, all influence the risk of developing ICD.

Pre-existing atopic eczema is known to increase the susceptibility to irritants and is a known risk modifier for hand eczema. Studies³ show that bakers with an atopic background have an increased risk of developing baker's dermatitis.

Environmental influences, such as mechanical pressure, temperature and humidity, influence the integrity of the stratum corneum with consequent cracking and enhanced percutaneous absorption of water-soluble substances.

Bakers' skin is highly exposed to wet work. Hand hygiene is vital in food handling. Food safety standards require food handlers to wash their hands whenever handling food to avoid contamination with harmful bacteria. Many bakers wash their hands more than 20 times a day. Their skin is also intensely exposed to wet dough (Fig. 2). This is the most common cause of irritant dermatitis in bakers, followed by soaps and detergents used for cleaning. Antimicrobial chemicals influence the skin surface. They cause dissolution of fat from the skin surface, which influences the hydration status. They also increase the pH of the skin, increasing the risk for bacterial infection. They can cause chemical burns with a consequent disturbed barrier function and increased risk for ICD.



Fig. 2. Baker rolling dough to shape rolls.

Bakers are exposed to heat and thermal burns from hot ovens, pans and heated sugar to create sugar art, leading to impaired barrier function.

Baker's itch is a cutaneous reaction caused by bites of the *Acarus siro* mite. This is a flour mite, which is grey-white in colour with pink legs and is the most common mite found in food. Bakers are prone to develop monilial paronychia and interdigital monilial infections as a result of moist working conditions and repeated exposure to sugar.

Allergic contact dermatitis (ACD)

This is an immunological reaction that occurs in genetically susceptible people who have been

previously sensitised to an allergen. Patch testing is the gold standard method for diagnosing ACD.

In the study by Meding *et al.*⁴ 44% of bakers with hand eczema had a positive patch test. Most reactions were to standard patch test allergens; 24% of bakers had a positive patch test to nickel sulphate. In a study from Denmark (Bauer *et al.*⁶) the most common allergen in bakers was nickel sulphate (22.2% compared to 17.2% in a control group). This may reflect its presence in the baker's working environment. Bakers regularly handle nickel-releasing stainless steel cutlery, pans and pots.

Freshly milled wheat flour has a pale yellow colour due to its carotenoid content. Benzoyl peroxide has a long history of use in the food industry. It is a bleaching agent used to give flour, whey and milk a whiter appearance. It has been used in concentrations of up to 40 mg/kg. In addition to bleaching, it also has antiseptic properties. In the study by Brisman *et al.*³ 11% of bakers had a positive patch test to allergens in the bakery series. This was dominated by reactions to benzoyl peroxide; however their preceding exposure to this contact allergen was unclear as benzoyl peroxide has not been permitted as a food additive in Sweden, Denmark and the Netherlands since 1967, and in most European countries since then. (According to the South African Foodstuffs, Cosmetic and Disinfectants Act, benzoyl peroxide is allowed as a food additive to a maximum of 50 mg/kg in South Africa.) A high percentage of contact allergy to benzoyl peroxide was not found in the study by Bauer *et al.*⁶ 5.4 % of bakers had a positive patch test to benzoyl peroxide compared to 8.9% of people in non-food-processing occupations. Positive patch tests due to aromatic substances found in spices were also common in the study by Brisman *et al.*³ This was not the case in the study by Meding *et al.*⁴

Contact urticaria and protein contact dermatitis

Contact urticaria refers to a wheal and flare reaction following contact with a substance. This can be further divided into two broad categories: non-immunological contact urticaria and immunological contact urticaria that involves an immediate hypersensitivity reaction. Contact urticaria can vary from local cutaneous involvement to more generalised cutaneous and systemic involvement.

Bakers are at higher risk of developing contact urticaria to ammonium persulphate (used as a bleaching agent in flour), alpha-amylase and flour.

Protein contact dermatitis refers to an allergic skin reaction induced by proteins of animal or plant origin. Although the skin is relatively impermeable to large macromolecules such as proteins, exposure through damaged skin can induce immediate and delayed contact allergy. The most common cause of protein contact dermatitis in bakers is wheat flour.

Table I lists possible irritants and allergens responsible for baker's eczema.

Diagnosis

The diagnosis of baker's eczema is based on the combination of a thorough history, clinical examination, a workplace visit and patch testing. Obtaining a history of the patient's exposures both at home and work is vital. No diagnostic test exists for ICD. The diagnosis rests on the clinical appearance of the dermatitis at a site exposed to a known cutaneous irritant and the exclusion of ACD. The gold standard method for diagnosing ACD is skin testing with patch testing for type IV allergy and prick testing for type I allergic reactions. Selection of an appropriate series of allergens requires the physician to have sufficient knowledge of numerous allergens.

Table I. Baker's eczema – possible irritants and allergens

Irritants

Acids (acetic, ascorbic, lactic)
Flour (especially wet dough)
Sugar and spices
Soaps and detergents, oven cleaners
Persulphate bleaches
Fruit juices (especially citrus)
Essential oils (flavours)
Enzymes and wet yeast
Flavouring agents*

Allergens

Common allergens

Nickel sulphate (pots)
Fragrance mix
Balsam of Peru (flavours, spices)
Thiuram mix (rubber gloves)
Formaldehyde (cleaners)

Specific allergens

Ammonium persulphate (flour 'improver')
Alpha-amylase (flour)
Benzoyl peroxide (flour bleaching)
BHA & BHT (antioxidants for lards and greasers)
food dyes
Eugenol (cross-reacts with flavours)
Karaya gum
Lauryl gallate (antioxidant in margarines)
Propyl and lauryl gallate (preservatives)
Sorbic acid (preservative)
DL-alpha-tocopherol (antioxidant for fats)
Flavouring agents*

*Flavouring agents can be irritants or allergens and include: vanilla, cinnamic aldehyde, cinnamon oil, cardamom seed, citronella oil, coconut oil, eugenol, anise oil, ginger oil, limonene oil, methyl salicylate, mustard oil, nutmeg oil, laurel oil, clove oil, peppermint oil, cardamom oil, lemon oil, lemon juice

Adapted from Adams.⁷

Management and prevention

Occupational skin diseases carry a high financial burden. This involves direct costs for worker compensation, medical treatment and occupational retraining.

Sick leave due to limitation of manual skills, the risk of spread of infection, rejection by colleagues and a negative image by the worker also lead to loss of income.

Barrier creams, gloves and good skin care are established personal protection measures in bakers. A study by Bauer *et al.*⁸ demonstrated skin disease improvement and resolution in 73% of bakers, confectioners and employees in catering trades after application of adequate skin protection products combined with a training programme. Another study by Bauer *et al.*⁹ evaluated the efficacy of standard prevention techniques versus skin hardening with UVB in bakers' apprentices. General skin protection measures were more effective than UVB skin hardening although the difference was not statistically significant.

BAKER'S ASTHMA

Definition

Occupational asthma is characterised by variable airflow obstruction, airway hyper-responsiveness and airway inflammation attributable to a particular exposure that causes primary sensitisation or aggravation of existing asthma in the workplace.

Epidemiology

Baker's asthma is one of the leading forms of occupational asthma. Ramazzini first described it in 1700. Its prevalence varies from 5% to 17% depending on different studies. In a study by Baadjies *et al.*¹⁰ 13% of supermarket bakery workers in the Western Cape province of South Africa were diagnosed with occupational asthma.

Allergens

Flour

Bakery dust consists mainly of flour (wheat, rye, soy bean and barley) and is the main cause of asthma in bakers. Specific IgE-antibodies in baker's asthma are usually against cereal flours (wheat, rye and barley), but other non-cereal flours such as soy and buckwheat have also been described as sensitisers. There is a high antigenic cross-reactivity between the different cereal flours. Grass is also taxonomically related to cereals and cross-reactivity is possible. Wheat is composed of water-soluble proteins including albumin and globulin, as well as water-insoluble proteins including gliadins and glutenins. The majority of bakers with work-related respiratory symptoms have IgE antibodies to the water-soluble proteins.

Enzymes

Modernisation of the baking industry has introduced new allergens including fungal amylase. It is produced by *Aspergillus oryzae*. The use of alpha-amylase varies between countries and bakeries. In some bakeries it is routinely added to flour while in others it is not used at all. Sensitisation to fungal alpha-amylase varies across different studies. No exposure data are available for bakeries in South Africa.

Baadjies *et al.*¹¹ assessed inhalable exposure to flour dust, wheat, rye allergens and fungal alpha-amylase in supermarket-based bakeries in South Africa. In this study bakers performing weighing tasks and using premixed flour products were associated with an increased exposure to fungal alpha-amylase. The same study also observed a significant reduction in exposure to alpha-amylase after physical separation of departments within bakeries was done. No exposure data are available for bakeries in South Africa.

Other

The environment within a bakery is complex and bakers are exposed to a wide variety of allergens. Case reports of baker's asthma caused by eggs, sesame seeds, nuts, yeast, moulds and insects have been described.¹²

Table II lists allergens associated with baker's asthma.

Risk factors

The intensity of the exposure is the most important factor in the development of baker's asthma. A dose-response relationship between the exposure and both the prevalence and incidence of baker's asthma has been demonstrated. Reducing the exposure intensity in the workplace can reduce the number of occupational-induced asthma attacks. Working in bakeries is often associated with exposure to high levels of airborne dust, especially during the process of dough making (Fig. 3).

In a South African study by Baadjies *et al.*¹⁰ risk factors for developing occupational asthma include recurrent childhood chest infections, ocular-nasal symptoms such as rhinitis or rhino-conjunctivitis, a personal history

of high general exposure to dust, fumes and vapours causing asthma symptoms and current job status (managers and supervisors were more likely to develop occupational asthma).



Fig. 3. Flour being spun during dough mixing.

Table II. Allergens associated with baker's asthma

Cereal flours

Wheat
Rye
Barley
Hops
Maize
Rice

Non-cereal flours

Buckwheat
Soybean flour

Additives

Enzymes – alpha-amylase
Cellulose
Xylanase
Papain, other proteases
Glucose oxidase
Nuts – almonds, hazelnuts, peanuts
Colour – carmine red
Spices

Egg powder

Milk powder

Insects

Flour beetle (*Tribolium confusum*)
Flour moth (*Ephestia kuehniella*)
Cockroach (*Blattella* spp.)
Granary weevil (*Sitophilus granaries*)
Storage mite (*Lepidoglyphus destructor*)

Moulds

Sesame seeds

Adapted from Brisman¹² and Baadjies *et al.*¹⁰

The likelihood of developing the disease is also influenced by a variety of host factors, including atopy, cigarette smoking, and genetic predisposition. Atopy is consistently associated with sensitisation to high-molecular-weight (HMW) agents and atopic individuals are at an increased risk of developing asthma due to occupational HMW agents.¹³

Cigarette smoking is also a risk factor for sensitisation to some HMW occupational allergens. The role of human leucocyte antigen (HLA) molecules in antigen presentation has been implicated in the pathogenesis

of occupational asthma but is more associated with low-molecular-weight chemicals.

Diagnosis

The diagnosis is based upon a combination of exposure history, time course of symptom onset, pulmonary function test, evidence of reversible airflow limitation, and specific testing to establish an occupational contribution to asthma. In addition to history, special investigations are available to confirm a diagnosis of asthma.

Peak flows or spirometry should demonstrate features consistent with asthma and improvement in periods away from work. Chest radiographic imaging is typically performed to exclude other possible causes of the patient's symptoms.

A bronchoprovocation inhalation test is not routine, but might be helpful in patients who have normal spirometry and other pulmonary function tests.

Skin-prick testing might also be useful to identify sensitivity to animal dander, mould, dust mites and latex.

Prevention and management

Prevention includes assessing of bakery dust levels and risk, controlling dust levels, wearing protective clothing and equipment and health surveillance for respiratory problems. Allergen avoidance includes the reduction of exposure by dust control or relocation to a less exposed job. Dust control in bakeries includes adequate local exhaust ventilation and good work practice like avoiding spillages, immediate cleaning, avoidance of compressed air lines for cleaning, use of a scoop to transfer flour and starting mixers on a slow speed to avoid dust particles spreading into the air (see 'Tips for bakers').

Protective clothing can be used when good work practice does not provide adequate control. This includes respirators, which are usually not well tolerated because of heat, discomfort and limitation of physical tasks.

CONCLUSION

Bakers are exposed to a wide variety of irritants and allergens. Identification of specific agents can be difficult. With appropriate preventative measures, environmental control, adequate training and early diagnosis, occupational disease in bakers can be reasonably managed.

An occupational hygienist is vital to educate employers and employees about the hazards of their work, train them, and control the environment within the workplace.

In this case a workplace visit did not identify any additional allergens. The patient was treated for an irritant contact dermatitis. Unfortunately she was lost to follow up but later telephonically confirmed improvement and that she was able to continue her work.

TIPS FOR BAKERS

- Handle flour and powdered products carefully. Dropping flour from a height will cause dust.
- Avoid damage to ingredient bags.
- Minimise the use of dusting flour.
- Use sprinklers to spread dusting flour.

- Avoid spillages and clean up immediately if they occur.
- Avoid raising dust when loading ingredients into mixers.
- Start mixers on slow speed until wet and dry ingredients are combined.
- Minimise the creation of airborne dust when folding and disposing of empty bags. One effective method is to roll the bag up from the bottom while tipping, avoiding the need to flatten or fold empty bags.
- Avoid the use of compressed airlines for cleaning.
- Do not use brushes to dry-sweep dust as they cause high levels of airborne dust. Use high-efficiency industrial vacuum cleaners for general cleaning. Shovel up larger amounts gently.
- Wear a suitable respirator for essential, short-term, dusty tasks.

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