Faculty of Occupational Medicine

Wilf Howe Memorial Prize 2009

Winning submission by Dr Trevor Smith

The reduction the incidence of baker's asthma and rhinitis in a large food group

1. Clear description of innovation, initiative or intervention

The project aimed to reduce the incidence of baker's asthma and rhinitis in a large food group whose principal interests are flour milling, bread baking and cake baking. The first step was to define the circumstances responsible for new cases of symptomatic sensitisation and this was then followed by the implementation and monitoring of control measures. The work spanned a period of ten years and brought together data from health surveillance, cross sectional studies and dust surveys.

The initial observations from the health surveillance work led to a working hypothesis that enzymes within bread improver, rather than flour, exposure could be the main source of sensitisation to ingredient dusts. Cross sectional studies on dust exposed groups in flour mills, bread bakeries and cake bakeries were carried out to examine and provide support for the hypothesis.

Using information from dust surveys, it was then possible to implement control measures directed specifically towards limiting bread improver dust exposure. The health surveillance programme was used to evaluate the ongoing effectiveness of the control measures by monitoring the incidence of new cases.

Over the ten year period, a marked reduction in the incidence of new cases of asthma and rhinitis associated with ingredient sensitisation was achieved. During the first five years of the programme, the incidence of symptomatic sensitisation was 2085 per million employees per year. In the subsequent five years the rate fell to 405 per million employees per year.

2. Description of working population

The food group employed a total of around 20000 employees, of whom 3450 were exposed to food ingredient dusts in the course of their normal work. The numbers in each of the four principal manufacturing sectors and the ingredient dusts to which they were exposed are shown in the table below.

Manufacturing Sector	Number of employees	Ingredient Dust Exposures
Flour milling	400	Grain, wheat flour
Bread baking	1650	Wheat flour, soya flour, rice flour, gluten, bread improvers (containing fungal amylase and hemicellulase), baking powder
Cake baking	550	Wheat flour, soya flour, rice flour, sugar, powdered egg, baking powder
Others	850	Wheat flour, sugar, powdered egg, spices

3. Reasons for choosing 1 and 2, including organisational context

Baker's asthma is one of the oldest recognised occupational diseases, having been described by Ramazzini in 1700. Despite the considerable research interest into asthma and rhinitis in the baking industry over the last thirty years, progress towards its prevention has been slow. For example, grain and flour dust exposure is currently still the second commonest reported cause of occupational asthma in the United Kingdom. Furthermore, the national incidence of asthma due to grain and flour dust, as recorded by the SWORD scheme, has remained largely static, with an estimated annual incidence of 811 cases per million employed.

The static year-on-year incidence of new cases is disappointing, since both the regulatory bodies and the flour-using industries have devoted considerable effort towards reducing exposures to flour dust. Within the food group in which this project took place, cases of asthma and rhinitis with an allergic aetiology had continued to arise, suggesting that the strategy concentrating principally on reducing flour dust exposure would not provide a full solution to the problem.

It was for this reason that the food group examined alternative explanations for ongoing cases of sensitisation and consequently changed the emphasis of its control strategies.

4. How did you measure outcomes?

A programme of health surveillance was used to monitor the incidence of new cases throughout the ten year period. Dust exposed employees underwent annual surveillance using a nurse-administered questionnaire. Those who gave a history of

symptoms which arose solely at work or were worse at work were referred to an occupational physician for follow up. In addition, employees were identified with similar symptoms through self referral, management referral in the interval between the annual surveillance interviews.

The subsequent occupational physician consultation consisted of a structured interview and skin prick testing to both common environmental allergens and specific work-related allergens. Where appropriate, serial peak flow readings were also performed.

5. What were the health benefits?

The incidence of new cases of asthma and rhinitis associated with ingredient sensitisation was reduced from 2085 per million employees per year in the first five years of the programme to 405 per million employees per year in the subsequent five years. The numbers of new cases of both asthma and all symptomatic sensitisation, according to the year in which the symptoms began, is charted in Figures 1 and 2. The reduction in incidence may have been even more marked but for four new cases of sensitisation arising in employees of a bread baking company acquired in 1998 whose dust control measures were considerably worse than elsewhere in the organisation.

Figure 1 - New Cases of Asthma due to Sensitisation According to the year in Which Symptoms Developed

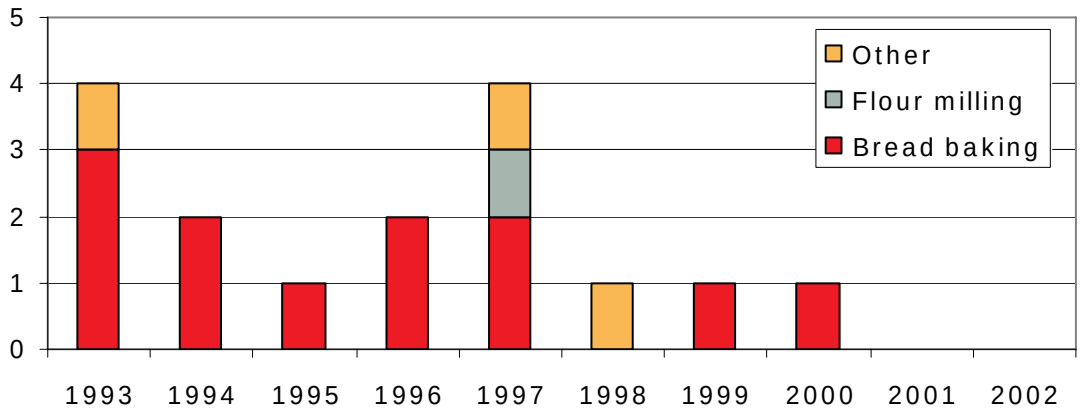
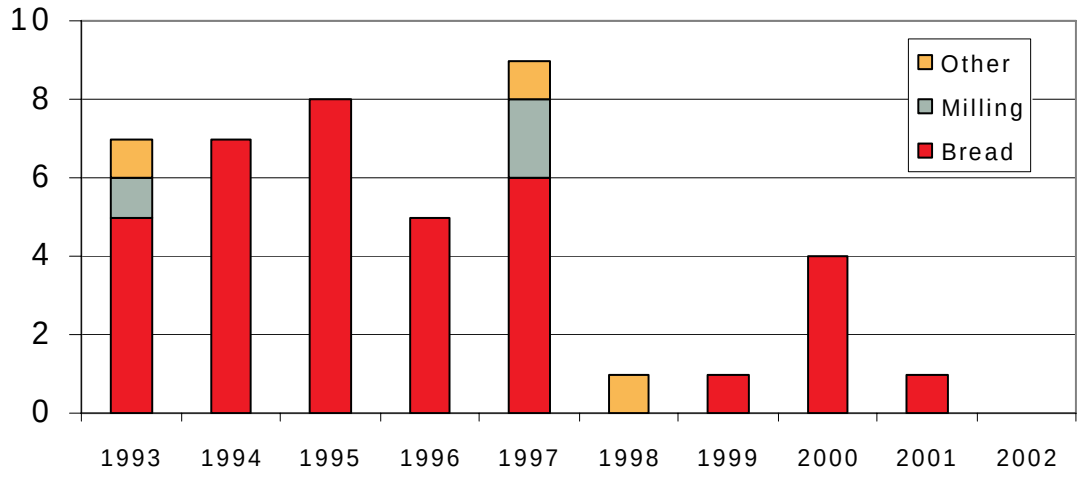


Figure 2 - New Cases of Symptomatic Sensitisation According to the Year in Which Symptoms Developed



6. Give an account of the difficulties / obstacles that arose and how they were addressed

The formal programme of health surveillance was introduced across the food group in January 1993. An important observation was made during the initial phase of physician follow up of employees with positive symptoms, in that some cases were identified in bread bakeries where the clinical picture was highly suggestive of allergic occupational asthma but skin prick tests were negative to flour dust. In the autumn of 1993 a skin prick test solution for fungal amylase, an important constituent of bread improver, became available. The cases where there was a good history to suggest ingredient sensitisation but no evidence of specific IgE to flour, were retested against the new amylase solution. A number of these cases demonstrated a strong response to fungal amylase.

At this point, the notion that amylase could be an important sensitiser within the organisation was quite novel. Although fungal amylase had been highlighted as a sensitiser in the detergent industry in 1979 and the first reported cases in bakeries was published in 1986, the issue of amylase sensitisation was largely an unknown quantity within the UK food industry. Such was the absence of understanding that the first problem was to find out where it was actually being used within the different food manufacturing processes. Enquiries determined that fungal amylase was added to certain flours during the milling process at a concentration of around 0.000125% by weight. However, it is also a significant constituent of powdered bread improvers used in the bread baking process at a considerably higher concentration, ie in the range 0.025 - 0.055%.

The question as to whether amylase was a major factor in sensitisation was addressed

by performing cross sectional studies which looked at the prevalence of IgE sensitisation to the different ingredient substances across dust exposed groups in the different manufacturing sectors, ie flour mills, bread bakeries and cake bakeries. Specific IgE to fungal amylase could be demonstrated in 16% of bread bakers exposed to both improver dust and flour. In the same group, only 6% had evidence of IgE to flour, suggesting that amylase might have a principal sensitising role in bread bakeries. In flour mills the rates of sensitisation for fungal amylase and wheat flour were 1.2% and 0.9% respectively. The prevalence of specific IgE to wheat flour in cake bakeries was 3%. Only one cake baking employee (1%) had a positive skin prick test to fungal amylase and he had previously worked in a bread bakery. Notably, IgE sensitisation to amylase could not be demonstrated in a cake bakery population who had regular exposure to amylase-containing flour. This finding suggested that exposure to amylase-containing flour would typically fall below the threshold to produce sensitisation. Although prevalence can only provide an indirect measure of risk, the findings of these studies pointed to the control of exposure to bread improvers as the likely key to reducing the incidence of sensitisation.

Whilst cross sectional studies and a health surveillance programme permitted quantification of the risk of sensitisation, a parallel programme of dust sampling was also necessary to characterise the type of exposures responsible for this degree of risk. The dust surveys showed that exposures for any single job were variable from person to person and day to day. In a large majority of cases, the measured exposure is the result of a series of short term high levels of exposure, rather than a continuously steady background dust level. Furthermore, before the application of controls, some 20% of all personal samples exceeded the statutory U.K. exposure limit of 10 $mg.m^{-3}$ (eight hour time weighted average).

Existing information on probable sensitising levels for enzymes was already available from the detergent industry, suggesting that the target exposure to fungal amylase would need to be around 10 $ng.m^{-3}$ or less, in order to prevent the development of new cases of sensitisation. In a bakery setting, the equivalent exposure to bread improver, expressed as total inhalable dust, would be 1 $mg.m^{-3}$. It was therefore possible to set two separate in-house exposure limits, according to the constituents of ingredient dusts. Firstly bread improver exposures would be limited to 1 $mg.m^{-3}$ as an eight hour time weighted average. Secondly all other ingredient dusts, including flour, would be limited to 10 $mg.m^{-3}$.

Taking the exposure limits outlined above and the information on actual exposures from the dust surveys, it was possible to determine the types of practical measures which would be needed to meet the limits. Essentially there were three possible measures to limit exposure:

- Installation of local exhaust ventilation (LEV)
- Introduction of improved working practices
- Use of respiratory protection

A combination of control measures was gradually implemented from 1995 onwards, with specific emphasis on limiting exposure to fungal amylase from bread improvers. Each of the measures and their potential contribution are outlined in more detail below.

Installation of Local Exhaust Ventilation (LEV)

For bakery applications, LEV might take the form of either walk-in booths or hoods, depending upon the particular circumstances. The two activities which lend themselves readily to a LEV solution are sieving and weighing of ingredients. Whilst LEV is demonstrably effective in limiting exposures, the reduction it achieves still falls short of the 1 $mg.m^{-3}$ in house target for the key activities where bread improver is used, ie sieving, weighing and mixing. It is therefore necessary to apply additional controls where bread improvers are handled.

Introduction of Improved Working Practices

Across the milling and baking industry, the shopfloor attitude to the handling of powdered ingredients has traditionally been very casual, with a general disregard for health effects associated with inhalation of dust. A programme of education and training was introduced to raise awareness of the need to handle powdered materials with greater care. The training package, aimed at shopfloor operatives, was developed in collaboration with the plant baking trade organisation in the U.K., the Federation of Bakers. It was delivered to all dust-exposed personnel across the different sites. In addition, an information leaflet was produced, both for general circulation and for induction training, highlighting how employees themselves can reduce their personal risk.

Use of Respiratory Protection

Mandatory wearing of respiratory protection was introduced whenever bread improvers were being handled. This measure has been mandated even when LEV is in place, since evidence from dust surveys has confirmed that LEV alone cannot always guarantee reducing exposure levels below the in-house targets. Suitable training in the use of dust masks was given to the workforce as part of the overall training package in the reduction of exposure to ingredient dusts.

7. Explain how this might be used elsewhere

The approach to controlling exposure to dust in bakeries, based on separate exposure limits depending on whether bread improver is being handled, is applicable to the whole of the bread baking industry within the UK. It has received endorsement from the Federation of Bakers, who represent the large scale plant baking sector.