RESPIRATORY HEALTH AMONG WORKERS AT BAKERY COMPANY

NUR FATIHAH BINTI MOHD GHANI

Faculty of Engineering Technology
UNIVERSITI MALAYSIA PAHANG

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ABSTRACT

This study explained about the respiratory health among workers that working at bakery industry. Bakery is a small-scaled industry in Malaysia and not all respiratory health problems among workers that exposed to a variety of dusts in industries and generate dust during their production process have been well-documented. Bakeries can be highly contributed to many lung diseases as the working environment is mostly exposed to flour dust concentration. The objective of this study is to measure level of respiratory health problems among workers at bakery. A set of questionnaire about the demographic information and 12 respiratory symptoms were being distributed among 31 bakery workers. Then, spirometer was used in order to measure the level of lung function among them. A personal air sampling pump was used to measure the exposure of concentration $PM_{2.5}$. The data collected then has been statistically test by using simple linear regression, bivariate correlation and also multiple linear regressions. From the result, it is observed that all of the workers are having respiratory symptoms. Spirometric results showed that 84% of the workers were having abnormal lung function (obstructive and restrictive). Personal air monitoring showed the highest concentration $PM_{2.5}$ exposed by a worker is 2.2 mg/m^3, which higher than permissible exposure limit. The results demonstrated the total of symptoms experienced by a worker, lung function level and exposure of concentration $PM_{2.5}$ from different activities at the bakery. It is proven that workers that working at bakery sector has respiratory health problem due to exposure of flour dust.

ABSTRAK

Kajian ini membincangkan tentang kesihatan respiratori dalam kalangan pekerja yang bekerja di bakeri industri. Bakeri adalah industri berskala kecil di Malaysia dan tidak semua masalah kesihatan respiratori antara pekerja-pekerja yang terdedah kepada pelbagai habuk, dan menghasilkan habuk semasa proses penghasilan dikaji dengan mendalam. Bakeri dapat menyumbang kepada pelbagai penyakit berkaitan paru-paru kerana persekitaran kerjanya yang banyak terdedah kepada habuk tepung. Objektif kajian ini adalah untuk mengukur tahap masalah kesihatan pernafasan dalam kalangan pekerja di bakeri. Satu set borang kaji selidik yang berkaitan dengan maklumat responden (umur, jantina, sejarah pekerjaan, tempoh berkhidmat, berat, tinggi dan sejarah perubatan) dan juga tentang 12 simptom-simptom masalah pernafasan yang dialami oleh pekerja. Borang kaji selidik itu diedarkan kepada 31 responden yang juga merupakan pekerja bakeri. Kemudian, spirometri digunakan untuk mengukur tahap kemerosotan paru-paru pekerja. Kemudian, pam persampelan udara personal digunakan untuk mengkaji jumlah kepekatan $PM_{2.5}$ kalangan pekerja. Data yang didapati kemudian dianalisis menggunakan ujian statistikal menggunakan perkaitan bivariat dan juga regresi berganda. Kesemua responden mengalami simptom-simptom masalah paru-paru. Berdasarkan ujian spirometri, sebanyak 84% pekerja mengalami masalah kemerosotan paru-paru sama ada masalah untuk menyedut udara bagi memenuhi paru-paru dengan udara dan juga masalah menghembus udara untuk mengosongkan paru-paru dari udara. Pam persampelan udara personal menunjukkan jumlah kepekatan $PM_{2.5}$ yang paling tinggi terdapat di bakeri adalah 2.2 mg/m^3, yang melebihi jumlah pendedahan yang dibenarkan. Keseluruhan hasil kajian menunjukkan jumlah simptom yang dialami oleh setiap pekerja, tahap kesihatan paru-paru pekerja dan pendedahan kepekatan $PM_{2.5}$ terhadap pekerja yang terhasil daripada aktiviti-aktiviti yang berbeza di bakeri. Secara keseluruhan, pekerja di bakeri mengalami masalah kesihatan pernafasan yang disebabkan pendedahan yang tinggi kepada habuk tepung.

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CHAPTER 1

INTRODUCTION

This chapter explains about the background of study, problem statement, research objectives, research questions, scope of study, significant of study, conceptual and operational definition about this topic. This chapter provides an idea generally on the field of study which is focusing on the respiratory health problems among workers at bakery. As a researcher, he or she should know detail about his study so it will easier for him/her to proceed with the research. This can be fulfilled by referring a lot of sources such as articles, journals and also from the previous study as a guide.

1.1 BACKGROUND OF STUDY

Many studies have shown that exposure to flour dust is associated with development of respiratory symptoms and varying degree of reduction in lung function (Ahmed et al., 2009). However, he claimed that these also depend on work environment and duration of exposure. Respiratory symptoms and lung function impairment are probably the most widely studied among organic dust-associated health effects. Bakers and pastry cookers are commonly exposed to flour dust and other aeroallergens during the food making process from the flour .Many respiratory effects have been described among bakers, such as chronic bronchitis, pneumonia and impairment of pulmonary function.

In 1999 the American Conference of Governmental Industrial Hygienists (ACGIH) proposed a threshold limit value (TLV) of 0.5 mg/m^3 for flour dust with a sensitization notation. As part of this study, a relationship between flour dust concentrations and respiratory symptoms were examined. The prevalence of cough,

phlegm, difficulty to breathe, and respiratory symptoms were higher in subject group, also during an 8-hour shift ventilatory function tests, it was demonstrated that respiratory capacities (FVC, FEV_1, PEF) in the flour workers decreased, however, there was no significant statistical difference between case and control groups. Some researcher stated that daily work related respiratory symptoms were significantly increased in cases compared with controls. Bakery workers who worked at prolonged time will significantly have lower FEV_1 and FVC. An exposure to flour dust causes increasing in work related respiratory symptoms in bakery workers who work for eight hours or more. In these workers prolonged exposure to flour dust causes significant reduction in lung function as measured by FEV_1 or FVC, percent predicted.

Many studies have shown that flour dust exposure causes respiratory symptoms and is associated with impairment of lung function (Bulat et al., 2004). Ahmad also claimed flour dust is an asthma-agent and is known to cause sensitization, allergic rhinitis and occupational asthma amongst bakers and millers. Flour dust can also act as an irritant and may give rise to short-term respiratory, nasal and eye symptoms, or it may provoke an asthma attack in individuals with pre-existing disease.

However, there is a lack of data regarding exposure among bakery's or pastry's worker, although respiratory conditions have been described in this young population. In the framework of a prospective study aiming at assessing on how non asthmatic bakery and pastry apprentices may develop airway inflammation in their training, an exposure study was conducted to assess personal exposure to flour dust and to identify the tasks that involve contact with flour in the bread-making and pastry confectioning processes. Measuring and comparing diseases pattern, and respiratory symptoms experienced among workers are helpful in reducing illnesses, improving working condition, increasing productivity, determining healthcare benefits and controlling cost.

1.2 PROBLEM STATEMENT

Bakeries can be a high risk working environment in relation to many lung diseases. The rise of bakery products consumption in Malaysia is in line with the population's growing affluence. Flour dust and enzymes in improvers are hazardous

substances that contributed to health of the workers in the industry. Exposure to flour dust and enzymes contained in improvers may also provoke an asthmatic attack in individuals with pre-existing asthma. High airborne flour dust levels are generated when flour is hand dusted or sprinkled, brushed, blown or vibrated. The main emphasis is to reduce exposure at source by promoting the careful handling of flour and avoiding practices that cause flour to become airborne.

Respiratory health effects have been documented in workers exposed to a variety of dusts in small and large-scale industries, which generate dust during their production process. Many studies have shown that flour dust exposure will causes respiratory symptoms and is associated with impairment of lung-function (Ahmed et al., 2009). Flour dust also is an asthma-agent and is known to cause sensitization, allergic rhinitis and occupational asthma amongst bakers (Elms et al., 2004). Workers who were directly exposed to the dust from flour, flavors and other preservatives could suffer the symptoms which are related to respiratory problems. Exposure from those substances also could create lung function impairments among the workers which may lead to many lung diseases if those substances exist at their workplace. The higher exposure of flour dust also will increase the prevalence of respiratory symptoms among the workers and decrease the lung volumes from predicted and normal volumes.

1.3 RESEARCH OBJECTIVES

The purpose of this study is to examine the respiratory symptoms and lung function impairment among two groups who are the workers in flour-mill itself. The objectives of this study are:

1.3.1 To measure concentration of $PM_{2.5}$ exposed by the workers.

1.3.2 To observe the activities carried out in the bakery that affects the concentration $PM_{2.5}$.

1.3.3 To measure level of lung functions impairment among bakery workers.

1.3.4 To measure respiratory symptoms experienced among workers at bakery.

1.3.5 To identify the relationship between concentration of $PM_{2.5}$ and lung function impairment of workers.

1.4 RESEARCH QUESTIONS

This research questions are developed according to the objectives of the research. Hence, the future expected result will be based on the research objectives and research questions. The research questions are:

1.4.1 What is the concentration of $PM_{2.5}$ exposed by the workers?

1.4.2 What are activities carrying out in the bakery that affects the concentration of $PM_{2.5}$?

1.4.3 What are levels of lung function impairment having by the workers?

1.4.4 What are respiratory symptoms experienced by workers at bakery?

1.4.5 How was lung function impairment associated with the concentration $PM_{2.5}$?

1.5 CONCEPTUAL FRAMEWORK

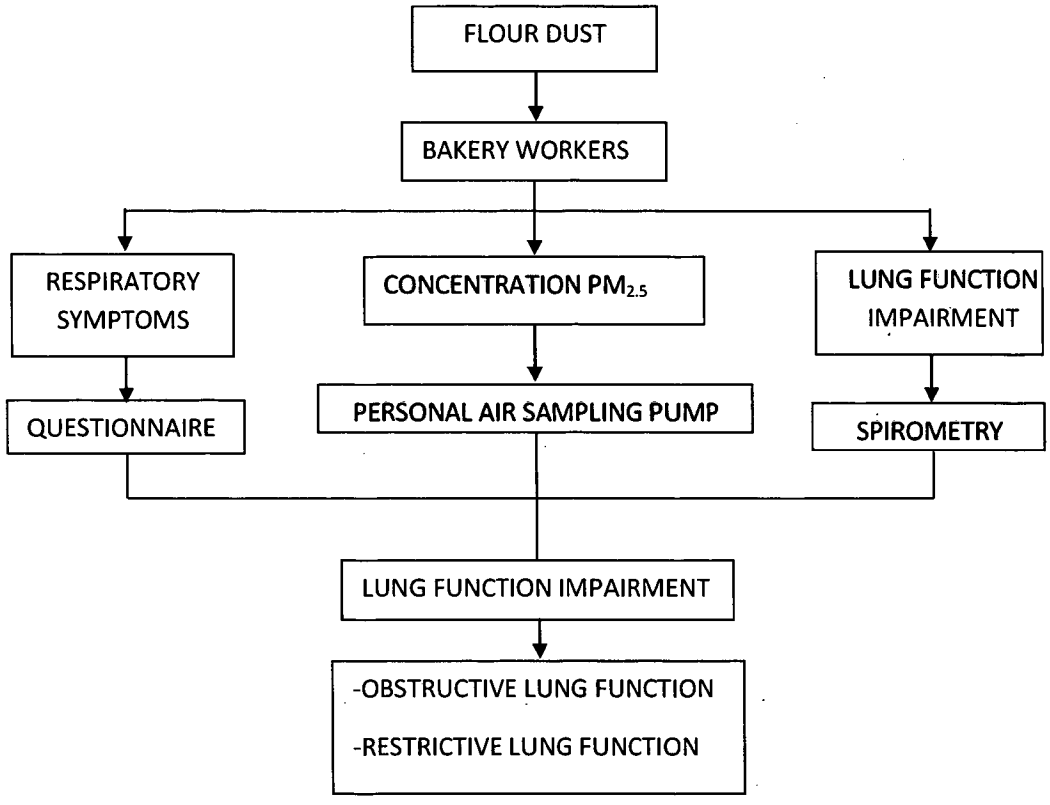

Figure 1.1: Conceptual framework that will be studied

1.6 HYPOTHESES

H_1: There is significant relationship between exposure concentration $PM_{2.5}$ with lung volumes.

H_2: There is significant correlation between concentration $PM_{2.5}$ and respiratory symptoms experienced by workers with lung function impairment.

H_3: There is significant relationship between lung function impairment with other risk factors.

1.7 SCOPE OF STUDY

The scope of study is to identify twelve types of respiratory symptoms which are cough, phlegm, wheezing, breathless, breath shortness, wheezing in the morning, chest discomfort, exhausted easily, unpleasant chest attack, disturbance cough, cough make tired, cough with phlegm among 31 workers. A bakery in Pahang was selected for the purpose of collecting sample data and also for personal monitoring.

This research was covered all the respiratory symptoms experienced among exposed workers. Lung function impairment among workers will be measured by using spirometer. In conducting the personal monitoring, flour dust that exists in the workplace has been monitored in order to identify the relationship between the flour dust and the lung disease. This study was conducted from August until October 2014.

1.8 SIGNIFICANCE OF STUDY

There are still has no specific study in Malaysia on occupational exposure of workers at flour-based industry. This shows that there are still lacks of awareness among workers about the occupational disease in flour-based industry and did not take serious about health of workers in bakery. Some people do not have enough information about the flour exposing that will cause many respiratory symptoms and will lead to many dangerous respiratory problems.

Thus, this study hopefully will giving a positive impact to bakery industry so they can take a reasonable action in order to prevent or control the dust exposure among the workers that works in that industry. This study also hopefully will give some information to people on factors that will contribute to the respiratory problems if continuously exposed to the risk substances during work. I also hope that management of the bakery/ flour mill will review some of recommendations provided in order to improve the respiratory health of the workers and reduce the occupational hazards risk among the workers.

As the several studies of respiratory health problems among workers at bakery has been well-conducted by a few researcher at other country, my hope to see this study also give a beneficial knowledge and can be reviewed by other researchers to conduct further research on this topic.

1.9 CONCEPTUAL DEFINITION AND OPERATIONAL DEFINITION

1.9.1 Conceptual Definition

Forced vital capacity (FVC)

The maximal amount of air that can be exhaled forcefully after a maximal inspiration or the most air a person can blow out after taking the deepest possible breath. The FVC are useful to detect restrictive diseases, since lower than expected results may be a sign that the lungs cannot inflate normally. The FVC also can be reduced in severe obstructive diseases (NIOSH 2003).

Force expiratory volume in one (FEV_1)

It is the volume of air exhaled during the first second of a forced expiratory maneuver started from the level of total lung capacity. The FEV_1 is useful to detect obstructive disease since a person with obstructive airways will not be able to exhale as much air in the first second as a person with normal lungs. The FEV_1 may also low if the person has severe restrictive disease (NIOSH 2003).

Peak expiratory flow rate (PEFR)

Measurements of PEFR are of value in identifying air flow limitation. The correlation between airflow and symptoms is variable, some patients being poor perceivers of changes in airway patency, whereas others efficiently perceive small changes (Quanjer et al., 1997).

Restrictive lung diseases

Diseases associated which are characterized by reduced volume. They are characterized by reduced total lung capacity, vital capacity or resting lung volume (Tulchinsky and Varavikova, 2009).

Obstructive lung disease

A group of disease where there are limitation of air flow into or out of the lungs. Common diseases of obstructive lung is asthma, which are commonly found in children and adults, and also chronic obstruction pulmonary disease (COPD), that are usually found in person who 50-year-old and above (Hallberg, 2008).

1.9.2 Operational Definition

Forced Vital Capacity (FVC)

Accelerated decline of force vital capacity shows that the person impairs an adverse acute and chronic respiratory and lung function health effect. The results of FVC in the lung function may lower, when it is found in area that has higher rate of air pollutants.

Force expiratory volume in one (FEV_1)

Person who is working in the area with higher levels of air pollutants has lower forced expiratory volume in one, (FEV_1).

Peak expiratory flow rate (PEFR)

An increase of PEFR is a result as increasing of the concentration of total suspended particulate matter, nitrogen oxides, and sulphur dioxide.

Restrictive lung diseases

Inorganic dust (example are asbestosis and talc) and organic dust (example are dust of vegetable and animal) exposure might be one of the factors of this type of disease.

Obstructive lung diseases

Chronic cough is one of the associated symptoms in the development of chronic obstructive lung diseases.

CHAPTER 2

LITERATURE REVIEW

This chapter is discussed about the parameters and health effects among the bakery workers who are exposed to the particulate matter of flour dust. Potential health effect and types of allergenic agent from the flour dust highlight the information of upper respiratory symptoms, lower respiratory symptoms, lung function abnormalities, and the emission of flour dust in the bakery.

2.1 BAKING INDUSTRY

Flour-dust-exposed work as a baker has long been associated with occupational asthma and rhinitis, the latter condition being the more common (Brisman et al., 1998). Many industries, including flour mills, generated dust, which is released into the air and later inhaled during industrial process, such as cleaning, crumbling of the product, packaging and shipping (Meo et al., 2005). Bernardino Ramazzini reported illnesses associated with milling and baking as early as 1700 which included symptoms such as cough, shortness of breath, hoarseness, asthma, and eye problems (Hossienabadi et al., 2013).

Based on Maric et al., 2009, flour-based products are specific because, besides of odor and taste, their quality largely depends on appearance and crumb texture. To be able to evaluate some product properly, panelist has to be familiar with basic characteristics of the product, and technology of its production. A baking industry can be characterized with a variety of different products that can be found on market (Maric et al., 2009).

He also claimed that quality parameters of bakery products, according opinions of consumers, ranked according their significance, are:

i. Flavors (odor and taste)
ii. Appearance of crust
iii. Volume
iv. Keeping manner
v. Choice of packaging and procedure
vi. Symmetry of form

Based on study Skjold et al. (2008), he found that bakers have the highest incident of occupational asthma. His research also stated that the primary allergens in bakeries are component of wheat and rye-flour proteins including α-amylase.

2.1.1 Activities in Bakery

Table 2.1 shows work category and sample taken in bakery (Bohadana et al., 1994), while Table 2.2 shows the job or activities done by the workers in bakeries according to their ranking of exposure risk at bakery industry (Jeffrey et al., 1999). Table 2.3 shows the activities associated with flour manipulation among the bakers based on research carried out by Geyssant et al., 2007.

Table 2.1: Work category and sample taken in bakery

Workers category	Worker	Sample	Rank
Deliverymen	6	0	0
Croissant maker	7	4	1
Oven handler	5	6	2
Frozen dough handler	8	2	3
General baker	14	4	4
Special baker	4	5	5
Total	44	21	-

Source: Bohadana et al. (1994)

Table 2.2: The job categories in bakeries ranked according to perceived dustiness

Rank	Work practice	Job Category
10	Dough break/ roll machine	Category A
9	General cleaning	
8	Weighting and mixing	
7	Dividing and moulding	
6	Cake mixing	
5	Hot Plate	Category B
4	Lidding/ filling	
3	Pie shell making	
2	Sugar confectionery	
1	Proving and baking finishing/packing/glazing/shop/office	

Sources: Jeffrey et al. (1999)

Table 2.3: Daily frequencies of activities associated with manipulation of flour dust for bread and pastry production

	Bakery apprentices n: 30	**Pastry apprentices n: 40**	**Volunteers n: 20**
Weighting flour for bread production	4	11	2
Weighting flour for pastry production	5	9	4
Loading flour in Mixer	7	5	3
Mixing	4	8	4
Dividing and shaping dough into pieces (manual or automatic)	6	4	3
Moulding dough pieces(manual or automatic)	4	3	4

Source: Geyssant et al. (2007)

2.2 DUST

According to the International Standardization Organization (ISO 4225 - ISO, 1994), dust is a small solid particles, conventionally taken as those particles below 75 μm in diameter, which settle out under their own weight but which may remain suspended for some time (Hazard Prevention and Control in the Work Environment: Airborne Dust, WHO/SDE/OEH/99.14).

According to Environmental Protection Agency (EPA) of United States (2009), stated that smaller dust particles in environment can be hazardous for humans. In many jurisdictions dust fractions at specified particle sizes in working environments are required to be measured. Based on the research, there are 3 types of dust that can be found in surrounding.

Inhalable Dust

The airborne particles which can enter the nose and mouth during normal breathing. Size of particles of 100 microns diameter or less.

Thoracic Dust

Particles that will pass through the nose and throat, reaching the lungs. Particles of 10 microns diameter and less. Referred to as PM_{10} in the USA.

Respirable Dust

Particles that will penetrate into the gas exchange region of the lungs. A hazardous particulate size is less than *5 microns*. Particle sizes of *2.5 micron* ($PM_{2.5}$) are often used in USA.

The total allowable particle concentration - building materials, combustion products, mineral fibers and syntetic fibers (particles less than 10 μm) - specified by EPA (U.S. Environmental Protection Agency):

i. 50 $\mu g/m^3$ (0.000022 grain/ft^3) - allowable exposure per day over the course of 1 year
ii. 150 $\mu g/m^3$ (0.000022 grain/ft^3) - allowable exposure over 24 hours

Source: United States Environmental Protection Agency (2009)

According to the "Glossary of Atmospheric Chemistry Terms" (IUPAC, 1990), dust is defined as small, dry, solid particles projected into the air by natural forces, such as wind, volcanic eruption, and by mechanical or man-made processes such as crushing, grinding, milling, drilling, demolition, shovelling, conveying, screening, bagging, and sweeping. The source also claimed that dust particles are usually in the size range from about 1 to 100 μm in diameter, and they settle slowly under the influence of gravity (Hazard Prevention and Control in the Work Environment: Airborne Dust WHO/SDE/OEH/99.14).

Examples of the types of dust found in the work environment include:

i. mineral dusts, such as those containing free crystalline silica (example: quartz), coal and cement dusts;
ii. metallic dusts, such as lead, cadmium, nickel, and beryllium dusts;
iii. other chemical dusts, such as many bulk chemicals and pesticides);
iv. organic and vegetable dusts, such as flour, wood, cotton and tea dusts, pollens;
v. biohazards, such as viable particles, moulds and spores

Source: Hazard Prevention and Control in the Work Environment: Airborne Dust WHO/SDE/OEH/99.14

Dusts are generated not only by work processes, but may also occur naturally, such as pollens, volcanic ashes, and sandstorms.

2.2.1 Flour Dust

"Flour dust" refers to dust coming from finely milled or otherwise processed cereal. Hypersensitivity reactions as well as irritant symptoms caused by flour dust constitute a well-recognized occupational problem world-wide (Scientific Committee on Occupational Exposure Limits for Flour Dust, 2008). Most data on flour dusts have been derived from studies on wheat (Triticum sp.) and rye (Secale cereale), and to a lesser extent on barley (Hordeum sp.) and oats (Avenea sativa).

A study has told that wheat flour is a complex organic dust with a large diversity of antigenic or allergic components. The antigens involved can be wheat flour proteins, flour parasites, silica, fungi, insects or technical additives such as enzymes (Dhillon et al., 2012). He also claimed albumin and globulins appear to be the most important proteins contributing to immediate hypersensitivity reaction to wheat proteins. The albumin portion of flour is the main cause of allergies that known as "Baker's asthma" (BA) and inhaling it leads to the stimulation of the specific antibodies, increased allergies, respiratory disorders and ultimately asthma (Hossienabadi et al., 2013). He also stated that an exposure to flour dust and related enzymes is one of the most common causes of allergic rhinitis, chronic respiratory disorders including asthma and occupational airway diseases.

Many studies have shown that flour dust exposure causes respiratory symptoms and is associated with impairment of lung functions (Dhillon et al., 2012). Through his study, Dhillon claimed that the dust can be absorbed through the skin or swallowed but most frequently it is inhaled irritating the portal of entry and leading to various obstructive lung diseases.

Meo (2005) has told in his study that flour dust has a varied composition, including particles of husk, cuticulars hairs, pollen, starch grains, bacteria, mucous spore and particles of mineral origin(free silica). Flour dust is a hazardous substance with respiratory sensitizing properties and gives rise to respiratory, nasal and eye symptoms (Meo et al., 2005).

However, study shows that flour from corn or maize (Zea mays) is not included to give a risk to the workers as the maize flour seems to present a low allergenic potency (Crippa and Pasolini, 1997 and Park et al., 1998) and less cross-sensitization with other cereal grain flours (Heiss et al., 1996, Baldo et al., 1980 and Kalveram and Forck, 1978). Other sensitizing flour dusts from non-cereal grains, such as soy (Glycine hispida) and buckwheat (Fagopyrum escalentum) are also not included for taxonomical reasons.

The flour dust in the bakery industry may contain several other non-cereal components, so called dough-improvers, such as a variety of enzymes, chemical ingredients, flavourings, spices, and other additives, as well as contaminants such as storage-related mites and microbes (Scientific Committee on Occupational Exposure Limits for Flour Dust, 2008). Several of these components are sensitizers. The research found that α-Amylase is an important sensitizer small amounts of which (0.1 to 1.0 mg/g flour) are naturally present in wheat (Jauhiainen et al 1993; Burdorf et al 1994). α-Amylase may be of different origin which may determine its 2 allergenic properties (Vanhanen, 2000); most commonly it is derived from fungal organisms such as *Aspergillus oryzae* or *A. niger*. Based on Bohadana et al., 1994, exposure to wheat flour dust in the baking industry may cause respiratory illness of varying nature and severity, ranging from simple irritant symptoms to allergic rhinitis or occupational asthma.

The dose-response data used for the present risk assessment are derived from studies on cereal flour dust sensitization, and therefore this recommendation applies to flour dust from wheat and other cereals (Scientific Committee on Occupational Exposure Limits for Flour Dust, 2008). He also searched that, flour or grain mill workers have been reported to exhibit a variety of clinical manifestation, including conjunctivitis, grain fever, lung fibrosis, rhinitis, allergic alveolitis, impairment of lung function and chronic pulmonary disease.

2.2.2 Flour Dust among Bakers

Flours from cereal grains are used for human and animal consumption (Scientific Committee on Occupational Exposure Limits for Flour Dust, 2008). The