10
Bread Spoilage and Staling

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10.1. Introduction

Bread is the most important staple food in the Western world and it is recognized as a perishable commodity, which is at its best when consumed ‘fresh’. Unfortunately, bread remains truly ‘fresh’ for only a few hours after it leaves the oven. During storage it is subjected to a number of changes which lead to the loss of its organoleptic freshness. The factors that govern the rate of freshness loss in bread during storage are mainly divided into two groups: those attributed to microbial attack and those that are result of a series of slow chemical or physical changes which lead to the progressive firming up of the crumb, commonly referred to as ‘staling’.

10.2. Microbiological Spoilage of Bread

The most common source of microbial spoilage of bread is mould growth. Less common, but still causing problems in warm weather, is the bacterial spoilage condition known as ‘rope’ caused by growth of Bacillus species. Least common of all types of microbial spoilage in bread is that caused by certain types of yeast.

10.2.1. Mould Spoilage

Mould spoilage of bread is due to post-processing contamination. Bread loaves fresh out of the oven are free of moulds or mould spores due to their thermal inactivation during the baking process (Ponte and Tser 1978). Bread becomes contaminated after baking from the mould spores present in the atmosphere surrounding loaves during cooling, slicing, packaging and storage.

The environment inside a bakery is not sterile because dry ingredients, especially flour, contain mould spores, and flour dust spreads easily through the air. It has been estimated that 1 g of flour contains as many as 8000 mould spores. In some bakeries a similar number of spores settle on 1 m² of surface every hour (Doerry 1990). Production operations such as weighing and mixing
of ingredients increase the mould count in the air. In larger bakeries where segregation is possible, the flour handling areas are separated from the cooling and packaging area of the finished bread.

Bread crust is rather dry (Cauvain and Young, 2000) and if the relative humidity of the atmosphere is below 90%, moulds will not grow on it. Also, moulds are relatively slow to develop, so that in dry climates the surface of a slice of bread may dry before mould growth is sufficient to be visible. In a humid atmosphere, however, and especially on a loaf inside a wrapper, moulds will grow rapidly. This is true especially if the bread is wrapped hot from the oven so that droplets of water condense on the inside surface of the wrapper. When bread is cut, the inner, more susceptible surfaces are exposed to mould infection. Sliced, wrapped bread is more at risk, because the moist, cut surfaces are an ideal substrate for moulds to grow on and the packaging prevents the moisture loss.

The rate of mould growth in various breads depends on the recipe and the processing method (Seiler, 1992). Brown and wholemeal (wholewheat) breads appear to become mouldy rather earlier than white breads because mould growth is often more clearly visible on the darker surfaces. Cultured breads, such as rye bread (Chapter 13), tend to have a slightly longer shelf-life because of their increased acidity and lower pH. The processing method has also been shown to have an effect on the rate of mould growth. For example, bread made from no-time dough, that is Chorleywood Breadmaking Process (CBP) and Activated dough development (ADD), has a slightly shorter shelf-life than bulk-fermented bread. This difference is considered to be largely due to the higher alcohol content in fermented breads.

The most common bread spoilage moulds are *Penicillium* spp., although *Aspergillus* spp. may be of greater significance in tropical countries (Legan, 1993). In wheat-breads a wide range of spoilage moulds including *Penicillium*, *Aspergillus*, *Cladosporium*, *Mucorales* and *Neurospora* have been observed (Table 10.1). *Rhizopus (nigricans) stolonifer* is the common black bread mould. It has very fluffy appearance of white cottony mycelium and black sporangia. *Neurospora sitophila* is another type of mould which is reddish in colour, and is found in bread stored at a high humidity or wrapped while still warm. Storage temperature has an effect on the type of moulds growing in bread. *Aspergillus* spp. was reported to be the dominant mould spoilage of bread in India, while the 90% of moulds isolated from a range of bread in Northern Ireland were *Penicillium* spp. (Legan, 1993).

In addition to spoilage, some moulds present a severe risk to public health because they can produce mycotoxins. Exposure to mycotoxins can occur either directly by eating bread spoiled by mycotoxigenic moulds or indirectly as a result of people consuming the products of animals fed contaminated bread. Mycotoxins are very resistant and can survive the heating process designed to kill moulds. It has been reported that 10% of *Aspergillus* spp. and *Penicillium* spp. are toxic to mice (Silliker, 1980). As a significant amount of mould growth is needed to form mycotoxins in bread, the risk to public health from mycotoxins