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Technical Paper

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UNDERSTANDING AND MANAGING MOULD GROWTH IN THE BAKERY

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What are Moulds?

Moulds (classified as fungi in botanical terms) are a group of microorganisms characterised by their ability to form colonies composed of a mass of fine threads (hyphae) which as they grow, typically become interwoven to form a felt-like mass. The cell walls of young hyphae are colourless but as they age, they change their form and show pigmentation. It is this pigmentation that gives mould colonies their distinct colouration and visibility to the human eye.

Mould spores are ever present in soils around us and growing crops. They are also present in the atmosphere which explains how they get from soils and plants into bakeries. The vast majority of moulds are aerobic organisms and need oxygen to grow. By-products of their actions are the release of carbon dioxide, water and volatile organic compounds. Moulds play a significant role in breaking down complex organic matter and in doing so commonly displace the water molecules that may have been held in that organic matter. It is the release of water which leads to mouldy bakery products feeling 'soggy'. They grow best in damp and dark conditions. The release of volatile organic compounds is responsible for the 'musty' smell associated with mould growth. Some moulds may also release mycotoxins

The functionality of moulds (like all microorganisms) is the result of the actions of many types of enzymes which are held within the cell wall of the mould spores. Enzymes can be considered as specialized proteins which are only able to carry out a single specific function. Often the specific action is described as a 'lock-and-key' mechanism, with each specific enzyme only interacting with a very specific substrate.

Enzymes are often described as biological catalysts because they are not changed as a result of their actions on their unique substrate. They are very stable and are only inactivated (denatured) by heat, typically at temperatures above 60ºC. They can carry on working at refrigerated temperatures, though their activity is much lower.

How do Moulds Differ from Other Microorganisms in a Baking Context?

While many microorganisms are associated with bakery product spoilage, mould growth is the most evident to us because of the formation of readily visible colonies, even if they are not vividly coloured. Mould (fungal) spores are only a few micrometres in size and as such, are not visible to the naked eye. Under suitable conditions, mould spores reproduce and the intertwining of the increasing numbers of hyphae and their pigmentation renders them visible to the naked eye. In contrast while yeasts and bacteria may multiply at similar rates to moulds, they do not normally develop any pigmentation and so they remain largely 'unseen' on products which present a greater risk of associated food poisoning in the case of bacteria.

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Moulds will grow under wide ranging pH and temperature conditions. In the case of pH, they can grow in the range pH 2-9+, which makes then very resistant to the effects of acids, such as those which might be used for cleaning in the bakery. Most microorganisms grow best under slightly different conditions of pH (acidity) and temperature.

Growth occurs readily between 10 and 35ºC, with the optimum growth temperature depending on the species concerned. Mould spores are only inactivated by heat (see below) and are able to survive under refrigerated and frozen conditions. If present in frozen foods, the spores can reactivate when the product is thawed and its temperature rises. They also survive in low moisture environments and will reactivate when sufficient moisture becomes available.

Mould spores can remain dormant for long periods of time but will readily revive when the conditions are right. One of the key drivers for mould growth is the availability of water which is present to differing amounts in all bakery products. Moulds will grow over a wide range of water activities (or equilibrium relative humidities) but are generally considered to grow best between water activities between 0.80 and 0.95 (80-95% ERH). Mould growth outside of this range can occur but will be slow. This water activity range covers a large number of bakery products including breads, cakes and some pastries.

Minimum water activity (a_w) for microbial growth	**Organism**
0.91	Most bacteria
0.85	Most yeasts
0.80	Most moulds
0.75	Halophilic bacteria
0.65	Xerophilic bacteria
0.60	Osmophilic yeasts

Footnote

Water activity and moisture content are related but are not the same property. Water activity will fall as moisture content falls, but it is the availability of that water to take part in chemical and physical reactions that is important, not least in the context of affecting the ability of microorganisms to grow.