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Yeasts and moulds - they get everywhere!

Fungi (yeasts and moulds) cause a variety of problems throughout the food industry - some of which are 'hidden'. Some fungi are also very useful to the industry - such as in the production of bread products and alcoholic drinks.

For a scientific overview of the problem issues in the food and drink manufacturing environment, *Yeasts and moulds - occurrence and control in the food factory (Campden BRI Review 58)* is particularly useful: see www.campdenbri.co.uk/publications/pubDetails.php?pubsID=56 for more details. Also of relevance is *Food microbiology: an introduction (Key Topic 12):* see http://www.campdenbri.co.uk/publications/pubDetails.php?pubsID=149

This brief factsheet highlights the major areas of interest and concern, and how the issues manifest themselves. It looks at the end problem and indicates where or how the problem originated. We have expertise in all of the areas highlighted, so if you have an issue of any type with yeasts or moulds, contact us on info@campdenbri.co.uk.

Although this factsheet concentrates on the problems caused by yeasts and moulds, they are of course vital to the production of alcoholic drinks and bread. We have specialist sections within Campden BRI with a century of expertise - see our website at www.campdenbri.co.uk for details of services offered within the brewing and cereals sectors. We also have expertise in how fungi are used in agricultural situations - e.g. as biological control agents.

Spoilage

Yeasts and moulds can cause spoilage - detectable by sight, smell or taste. Spoilage is not usually associated with an immediate health concern, but it is often detectable when the degree of spoilage is very low. The first indication that there is a problem is when a consumer contacts you with the comment "*this product tastes or smells a little bit 'off*"'. This will immediately trigger a series of questions: what is the taint?, what organism caused it? and how did it originate? To answer these needs a variety of skills, preferably within the same organisation. In some cases, we will have come across this problem previously. If so, we can make informed suggestions on what may be causing the issue.

Deciding what the taint is can be done by both sensory experts and analytical chemists. The sensory team can assess the taint or odour and accurately describe its characteristics. The chemists can then take this information and target analyses to try and detect and quantify what is causing it. In practice they often work together to make an informed prediction of what might be causing the problem. Recently for example, we have seen a number of incidences where 1,3-pentadiene has been produced by the mould-mediated degradation of the preservative sorbic acid in fruit beverages. The pentadiene has a strong "petrol-like" odour associated with it.

In some cases, the microbiology team might then be consulted to give its opinion on what organisms produce the offending compound. They might try and isolate the organism and identify it. In many cases, they will know what yeast or mould was at work without the need for this. They will be similarly involved if a product has visibly gone mouldy. In the case of pentadiene production, for example, moulds such as *Penicillium roqueforti* are known to produce pentadiene from sorbic acid. (Work carried out at Campden BRI on this issue is described in R&D report 314, 2011.)

Identification

Identifying an organism can be a key part of finding out where it originated from. The identification of yeasts and moulds is slightly different from identifying bacteria. At Campden BRI we often turn the problem around and, rather than just trying to name it, we describe its characteristics - which will help a company which has an issue or problem with fungal contamination understand how it can be dealt with. For example, if an isolate is shown to be susceptible to temperature or salt levels, then adjusting product formulation or processing conditions might eliminate the problem - without necessarily knowing what the organism was.

In other cases, it might be necessary to characterise the organism to the extent that it can be compared with other organisms that have been found in other products or in the factory environment, in an effort to determine the source and route of the problem.

If required, however, we do have an in-house identification service for yeasts, and can call upon additional expertise for the identification of mould to species level.

Mould-free shelf life

Yeasts and moulds are particularly associated with bakery products, as they can grow in quite dry (low 'water activity' (Aw) or low 'Equilibrium Relative Humidity' (ERH)) conditions. These conditions are usually unfavourable for bacterial growth, so fungal growth can predominate without competition. Yeasts and moulds are often the factor that limits the shelf life of a product. The mould-free shelf life (the length of time before a product becomes visibly spoiled) is therefore important to know. One of the critical factors in determining this is the water activity of the product - and we produced software (ERH-Calc™) some years ago to help bakery companies calculate this and so help determine the shelf-life of their product. Some of the routes by which bakery products can become contaminated are briefly described in Campden BRI Review 58.

In foodstuffs ('Intermediate Moisture Foods') with extremely low Aw values (0.85-0.60) - for example icings, marzipans, and dried fruits - 'specialist' moulds and yeasts dictate the shelf life of the materials.

To isolate these microorganisms in the laboratory requires the use of specialist microbiological media and techniques.

Soft and alcoholic drinks

Yeasts and moulds can also be a problem for the drinks industry; as well as being able to grow in dry conditions, their tolerance to low water activity environments means they can also thrive in high-sugar conditions. Of course, yeasts are the basis of many alcoholic drinks, and separating the good guys from the problem organisms is another specialised task. Amongst the many molecular applications that can be used to identify and characterise brewing yeasts are CHEF Karyotyping, Chromosomal characterisation of brewing yeast, and Wild Yeast characterisation using Random Amplified Polymorphic DNA. This can be allied to practical studies of fermentation characteristics, which can be achieved in a small-scale reactor, such as the one we have available at our Nutfield site.

Dairy products

Yeasts naturally occur in raw and pasteurised milks at low levels (<1000 cfu/g). In the absence of bacterial competition (such as might occur in sweetened milk), some yeasts are able to grow to high levels without necessarily being a cause for concern. Lipolytic species of *Candida, Rhodotorula* and *Cryptococcus* can grow on cream and on the surface of butter, leading to the formation of taints. Species of the genera *Candida* and *Kluyveromyces* are the most predominant yeasts found in yogurts.

Food poisoning

Food poisoning from fungi is usually via the production of toxins, rather than via infection with the organism itself. Many mycotoxins are neurotoxic or carcinogenic. They are sometimes associated with the flour used to produce bakery products. In these cases, they are found to be associated with the outer parts of the wheat kernels from which the flour is made. Perhaps the best-known mycotoxin is **aflatoxin,** which is produced by certain strains of the common storage moulds *Aspergillus flavus* and *Aspergillus parasiticus* and causes cancer of the liver. Certain species of *Penicillium* and *Fusarium* also produce mycotoxins. Corn, beans, nuts and nut products appear to be the most affected but these toxins have also been found in wheat, oats and barley.

There are some rare reports in the literature of yeasts giving rise to allergies and gastroenteritis.

Legislation

Not surprisingly, permitted mycotoxin levels in foods are closely controlled by legislation. There are specific levels for aflatoxins, ochratoxin A, patulin, deoxynivalenol, zearalenone, fumonisins and trichothecenes in or on a variety of products. These levels will vary, depending on whether the product is going to be further processed before sale or consumption. The need to analyse for mycotoxins will also vary, depending on circumstances, so it is prudent to get expert advice to see if you might have a problem.

Prevention

If you have a fungal problem, whether it be spoilage or mycotoxin formation, one of the first things to ascertain is the source of the problem. Is it ingredient related or associated with more general environmental issues? If ingredient related, is it originating from the field or developing during storage? This question is particularly relevant for bulk contamination of ingredients such as cereals, nuts and seeds, dried fruit, and coffee. If it isn't associated with any specific ingredient, then it may be gaining access to the food in the factory environment. Cardboard is regarded as a potentially significant source of moulds. Simply storing packaging too close to the product coming off the production line in the factory, could lead to contamination. Of course, it is important to bear in mind that fungi are part of the environment in general - they will often colonise food products after they have left the production area, including in the home, and the answer may be to formulate your product to prevent spoilage.

Factory hygiene

Yeasts and moulds are ubiquitous in the environment. As well as being natural contaminants of many ingredients (especially dry ingredients), spores in the air are a particular concern. Controlling them in the factory environment is difficult. Specialist knowledge and procedures are required to maintain air hygiene, and to remove contamination once it occurs. Publications dealing with cleaning and disinfection in factories in general (Guideline 55) and on air hygiene (Guideline 12) are available to help.

Processing conditions

Whatever the source of the fungal problem, if it is inherent in the product, then it may be possible to remove it through processing, depending on the product. Knowing the heat resistance characteristics of the organism of concern is likely to be necessary to control it, without unnecessarily detrimental effects on product quality. Campden BRI Guideline 68 (Microorganisms and their control) contains details on the growth limits for several fungi.

Product formulation

In many cases, the final product may be naturally susceptible to fungal colonisation and/or spoilage. It may be possible to advise the consumer on how to minimise this (e.g. with specific storage instructions). However, in many cases, it may be necessary or desirable to ensure that the product formulation itself minimises the problem - e.g. by reducing water activity (such as via the addition of salt or sugar), or by including preservatives in the recipe. In any product development situation, it is important that the recipe change does not adversely affect the final product, and that the addition of preservatives is within legal constraints. Consumers' opinions on the former might be useful - not only from the perspective of 'does the product taste different?', but also 'is it acceptable for the shelf-life of this product to be extended by the addition of extra salt/sugar/preservatives?'.

If you have any issues with yeasts and moulds, contact Phil Voysey on +44 (0)1386 842069
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References:

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Members can obtain a free electronic copy of R&D reports by sending an e-mail to auto@campden.co.uk with the subject line: **send RDxxx** where xxx is the number of the report.

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