Microbial update

product shelf life

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It is well accepted that packed foods do not stay in a static situation on the retail shelf or in the kitchen cupboard. Foods form a dynamic mixture of ingredients and associated micro-organisms that interact with each other over time causing changes to the food.

Such changes will affect the quality of the product as seen by the consumer, whilst some changes may render the food unfit for consumption or potentially hazardous. It is for these reasons that the shelf life is so important, and why the correct determination of shelf life must be done.

If the life is set too short, then product may be discarded when it is still quite fit to eat, causing great wastage; however, if the life is set too long, the food could become of unacceptable quality and potentially unsafe to eat.

Shelf life and legislation

The correct labelling of products by manufacturers is now entrenched within legislation in most countries. Labels will usually include details of the constituents of the product, its nutritional properties, the presence of any potential allergens and some form of durability indication.

In the European Union the requirement for durability indication is covered under EU law. The EU Food Labelling Directive 2000/13/EEC states that most foods sold in the EU must carry a durability indication.

The type of indication depends on the type of food, but there are two food types recognised:

- Microbiologically perishable foods, which must carry a Use By Date (UBD).
- Other foods, which must carry a Best Before Date (BBD).

It is an offence to sell any food after the UBD has passed, indeed consumers should have eaten the food before that date, as the foods on which the UBD appears are acknowledged to be perishable.

As such they will be liable to microbial growth during their life, and thus they will eventually become unfit for consumption and potentially hazardous, if stored for too long.

Non-perishable foods, however, have to carry a BBD, this is an indication of the time that a non-perishable food remains at the best quality.

There is no inherent indication that such a food will become unfit for consumption or unsafe when the BBD passes, but it may not exhibit the same high quality that it had when it was produced.

As well as the Food Labelling Directive, the requirement of manufacturers to understand more about the shelf life of their products has been increased through the publication of the EU Regulation on Microbiological Criteria for Foodstuffs (EC 1441/2007 amending Regulation 2073/2005).

This carries a requirement for manufacturers to specifically understand their products from the point of view of the risks associated with Listeria monocytogenes.

The Regulation requires producers to know if their products support the growth of L. monocytogenes and, if so, to set a shelf life that will ensure that if the food is contaminated at a 'standard' level with this organism, then numbers will not exceed 100/g by the end of the product's life.

In the UK there is also specific guidance from the UK Food Standards Agency (FSA) on the shelf life of chilled foods packed in low oxygen conditions (for example vacuum packed or low oxygen MAP packed).

These foods could potentially allow the growth of psychotrophic Clostridium botulinum, a pathogen producing a very potent neurotoxin.

The FSA guidance states that in foods that contain no other controlling factors for C. botulinum, the product life should not exceed 10 days, unless studies have shown that the organism cannot grow within that particular product.

Setting a shelf life

In order to correctly set a shelf life, the manufacturer has to understand their product and what is likely to limit life. They must be aware of whether the product is 'perishable' (must carry a UBD) or 'non-perishable' (can carry a BBD).

The life of products can be affected by many changes; in perishable foods the most likely thing to limit life is the growth of micro-organisms; in non-perishable foods there may be chemical changes leading to flavour alteration or taint, colour change, loss of structure or breakdown due to enzyme activity. All can lead to a food being perceived as poor quality.

Once the manufacturer has determined what could affect the shelf life, then tests can be done to determine what the true life could be.

Shelf life of perishable foods

As noted previously, one of the main limitations to the shelf life of most perishable foods will be microbial growth.

Excessive growth of micro-organisms will cause spoilage, and can make a food unsafe to eat if particular pathogens are present and are able to grow.

Studies on the rate of microbial growth in foods can take two forms:

- Shelf life testing.
- Challenge testing.

Shelf life testing

A standard microbiological shelf life test simply looks at the effects of normal microbial growth on the product throughout its life.

Usually a product produced in the 'normal way' on standard production equipment in the 'standard' factory will be stored at a defined temperature and tested for key micro-organisms over a set time period. The shelf life test considers standard naturally contaminated food and looks at the growth of the natural contaminants over time.

The microbiological tests should be designed to look at general microbial flora and potential spoilage organisms. There is usually no point in looking for pathogens in this type of test as they are very unlikely to be found, and if they are it shows a failure of the HACCP plan, rather than anything connected with shelf life.

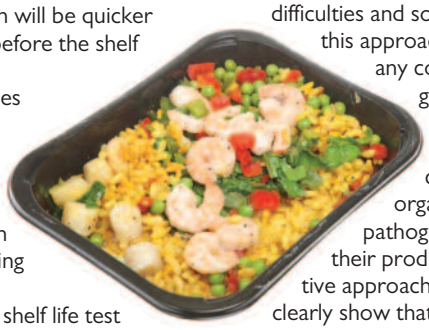
In some shelf life tests, microbiological testing can be supplemented with some form of organoleptic or visual test to gauge the appearance, smell or taste of the product throughout life.This can be a useful addition to microbiological testing when determining shelf life, but it is of the greatest importance that food is only tasted if it is

known to be safe to eat. Two of the key things to decide when setting up a shelf life test of this sort are the storage temperature and the sampling times. In perishable products, the product life will be linked to storage temperature.

If a very low temperature is used in the study, then the apparent life of the product will be long, as the microbial flora will grow very slowly.

However, if the real storage temperatures that the product encounters in the marketplace are higher than those used in the study, then microbial growth will be quicker and the product may spoil before the shelf life is reached.

Conversely, if the study uses higher temperatures than those seen in the real marketplace, then the shelf life may be underestimated and product discarded when still acceptable, thus increasing waste.



The art of devising a good shelf life test is to understand the product and how it will be handled, then using this understanding to design the shelf life study. Most studies will incorporate three phases of storage temperature, one quite low to represent distribution temperatures, one higher temperature of short duration to represent purchase and transport from the retailer to the home, and a final lower temperature (but not as low as that used in the distribution phase) to represent domestic storage.

Accelerated shelf life testing

Many organisations are interested in the possibilities of accelerating the shelf life test to obtain results more quickly. This often occurs with longer life products, when companies do not wish to store products over very long periods to define their life, as this can extend product launch by many months.

There is a problem with the concept of accelerated shelf life testing in that methods used for acceleration will often affect the results. This is certainly the case for microbiological testing, where it is often suggested that storing the product at a slightly elevated temperature will allow results to be obtained more quickly.

It must always be remembered that most foods naturally contain a diverse range of micro-organisms and each type of organism will have its own distinct range of growth conditions.

So, by increasing the temperature in a study, what actually happens is that different types of micro-organism in the microflora are able to grow and the organisms that would normally grow under standard storage conditions may be prevented or inhibited from growing. The result of such an accelerated test may, therefore, be incorrect. There is often no substitute for shelf life studies being done at the accepted real storage temperature over the full life of the product, and this requirement should be built into the product development schedule for newly developed foods.

Challenge testing

Challenge testing is the term used to describe the deliberate inoculation of a food with known micro-organisms in order to determine if those organisms can grow in the product.

Challenge testing has many problems and difficulties and some are critical of this approach. However, for any company wishing to gain a real insight into whether a particular organism (this could be a spoilage organism or a pathogen) can grow in their product, this is an effective approach allowing them to clearly show that they have shown due diligence during the design and manufacture of a product.

As noted previously, challenge testing can be used to ascertain the growth potential of any specific organism in a particular food.

So, for example, if a company is producing an acidic or high sugar product, they may be concerned about the potential for growth of yeasts or moulds; this could be assessed by challenge testing.

Conversely, a company may wish to consider the potential for the growth of Listeria in a chilled product. In this case, the company's HACCP plan should include all factors to prevent the presence of listeria in the final product. However, surveillance results show us that in a very small number of cases listeria may still be found.

References

- Betts, G.D. et al. 2004. Evaluation of Product Shelf Life for Chilled Foods. Campden BRI. Guideline No. 46.
- Anon 2000. Council Directive 2000/13/EC on the approximation of laws of the member states relating to the labelling, presentation and advertising of foodstuffs.
- Anon 2007. Commission Regulation No. 1441/2007 amending regulation (EC) No 2073/2005 on microbiological criteria for foodstuffs.
- Anon 2008. Food Standards Agency guidance on the safety and shelf life of vacuum and modified atmosphere packed chilled foods with respect to non-proteolytic Clostridium botulinum. FSA
- Anon 2008. Technical Guidance Document on shelf life studies for Listeria monocytogenes in ready to eat foods, AFSSA. EU Community Reference Laboratory for Listeria monocytogenes.

It is in such circumstances that a manufacturer may need information on whether listeria is able to grow to a level that is considered unsafe, within the shelf life of the product. Challenge testing is a good approach to do this. As noted before, however, the design and running of a good challenge test is a very specialist exercise. There are many considerations, including which strain or strains of organism should be used; should the organisms be stressed before inoculation; how should the stress be applied; what inoculation level should be used; and how should the product be inoculated so that a more 'realistic' distribution of organisms is obtained?

All need to be properly addressed before undertaking the test and there is still an argument that such a test can never truly represent what would happen in a natural contamination, but there are very few other approaches that would enable a definitive answer to the question 'does a particular organism grow in your product?'

Predictive microbiology

This approach makes use of computer programmes that allow prediction of how various microorganisms respond to environmental conditions that could be found in a particular food.

So, by entering a modelling programme, it is possible to pick the organism of interest, and state what pH, water activity and storage temperature would be of interest, and the programme will tell you how that organism would respond. Predictions are easy and fast to do, but do take some expert interpretation of results. The output of models usually 'fail safe', so may say an organism can just about grow, when in reality it cannot. This is, however, much better than a fail dangerous situation. Modelling is very useful in many stages of product design and development in order to get an indication of potential microbiological problems and a possible shelf life. To get a more exact shelf life, however, shelf life testing or challenge testing may be better approaches.

Conclusions

The labelling of products with a durability indication is part of EU law. This requires manufacturers to gain knowledge of how a product ages, and what issues cause it to become unsuitable for consumption.

This may be due to a general quality loss, microbial spoilage or the presence of unacceptable levels of pathogens. Manufacturers must have a good knowledge of their product, and how it is manufactured, distributed and sold, in order to set a shelf life. Once this information is available, a suitable shelf life evaluation protocol based on some of the approaches can be designed. ■

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