

On shelf life of foods

What does “best before date” and “use by date” mean?

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This paper deals with the shelf life of food in relation to quality and food safety. It is stated that quality and food safety are two separate issues, and seeks to establish the conditions when shelf life becomes a food safety concern.

The paper has been drafted on a request from the Danish Veterinary and Food Administration to support the decision on the use of the terms “*best before date*” and “*use by date*”. The first term (“*best before date*”) conveys that the product may be consumed after the date set on the label, depending on the evaluation of the consumer on the quality of the product; whereas products should not be consumed after the other term (“*use by date*”). The Danish Veterinary and Food Administration requested identification on the situations where storage time would have a negative effect on the food safety of the product.

Food quality and food safety are two separate issues

Foods have a limited durability. From the moment a food is produced, processes are occurring that sooner or later will cause the food to lose its characteristics. The appearance, taste, texture and smell will change and at some point degrade to a level that is unacceptable for the consumer. The food is spoiled. This spoilage is caused by microorganisms, or by physical and chemical reactions. Microorganisms growing in the food may ferment carbohydrates, break down proteins and lipids with more or less acceptable results. Lipids may be oxidized resulting in staleness and so on. This kind of deterioration is fore and foremost related to quality, and not actually related to risk of getting ill from eating the food.

Through generations, foods have been stored under conditions where experience has proved to accomplish its purpose: to preserve nutrients without making people ill.

Preservation based on salting, curing, smoking, drying, or fermentation has - in combination with certain time/temperature conditions - proved to prolong the acceptability of foods. During storage microorganisms may grow, depending on the physical/chemical conditions in the food. Through the centuries, experience has been gathered on the storage conditions that will ensure safe foods. These experiences have in more recent times been supported by scientific data and computer-assisted predictive modelling programs.

For many foods, ambient temperatures will cause a rapid loss of quality. Using refrigeration, the shelf life of such perishable foods will be prolonged. Refrigeration also results in inhibition of growth of the majority of pathogenic microorganisms.

Foods stored at ambient temperature

For foods to be stored safely at ambient temperatures, growth of pathogenic microorganisms must be controlled. Some food categories may be stored at ambient temperatures - provided that certain characteristics are maintained. Grains, meats, fruits, etc. must be dried to a certain level, or contain sufficient salt, or have been through a microbial killing process and kept protected from re-contamination. If storage conditions are optimal such foods may keep almost indefinitely. However, if storage conditions are less than optimal, quality will be lost and risk may evolve. Pests may damage and contaminate foods, molds may grow, sunlight may bleach or oxygen may cause rancidness, etc. These conditions develop over time, but are not directly caused by prolonged storage time, but because of production error or unfit storage conditions.

It is a challenge for the food business operator to decide if a food may be safely stored at room temperature, or if it requires refrigeration to be able to control growth of pathogenic microorganisms. Experience from traditions can in many cases support this decision.

The conclusion is that foods stored at ambient temperatures may suffer from deterioration over time, and thereby, result in reduced quality - but they will not pose a risk to the consumer as a result of the storage time. The storage time is, therefore, not significant for the safety of foods stored at ambient temperature. Foods stored at room temperature for prolonged periods of time could, therefore, be labeled "best before date", and, thereby, leaving it up to the consumer to evaluate if the quality is acceptable, without risk of acquiring disease.

Foods stored with refrigeration

When pathogenic microorganisms are able to grow in the food, the shelf life of the food becomes a matter of food safety and not only a matter of food quality. In many cases, the quality will deteriorate to a degree that the consumer will find it unacceptable before pathogenic microorganisms will reach a point that presents a risk. However, in some cases the pathogenic microorganisms may reach a level of concern or risk while the food is still seemingly acceptable for consumption.

There is a large variation in what consumers find acceptable as well as a large variation in the susceptibility of consumers, and different consumer groups (very young, old, immune-compromised, etc.), to foodborne diseases. Also the degree of acceptability of decay in foods differs between food types. Furthermore, the infectious dose vary a great deal between food types as e.g. fatty foods have shown to cause illness with exceptionally low levels of pathogens. **When growth of pathogens are possible, foods will constitute a risk if it is left to the consumer to evaluate the acceptability of the food, - as this can be based only on the organoleptic quality. Therefore, labelling such foods with “best before ...” would constitute a risk.**

The majority of pathogenic microorganisms will be restricted in their proliferation with descending temperatures; however, some microorganisms are able to grow at low temperatures. When these so-called psychrotrophic microorganisms are able to grow, the shelf life will be a determining factor for the safety of the food. In these cases the setting of a safe limit of the shelf life is a crucial task for the food business operator, - actually a case of do or die!

There are only a few pathogenic microorganisms that are able to grow at low temperatures: *Listeria monocytogenes*, *Yersinia enterocolitica* and some *Clostridium botulinum*. It could be argued that also *Aeromonas hydrophila* and some *Bacillus cereus* should be considered in this category, but these seem to be of more scientific than practical interest.

Listeria monocytogenes are the most important cold-tolerant microorganisms. In Denmark, approximately 50 persons per year are diagnosed as suffering from listeriosis, of which about 25% of the cases are fatal. It will grow even with temperatures around 0°C, depending on the pH, concentration of salt and other inhibiting factors. Therefore, *Listeria monocytogenes* may grow in a big range of refrigerated foods, making this a risk in ready-to-eat foods. For this reason, the EU has established microbiological criteria for *Listeria monocytogenes* in ready-to-eat foods.

The food business operator must be able to document that the level of *Listeria monocytogenes* in ready-to-eat foods will not exceed 100 cfu/g during the shelf life. Especially smoked fishery products, soft cheeses and cooked deli meat products have shown increased levels of *Listeria monocytogenes*, - and levels that exceed the critical limit as established by the EU.

Yersinia enterocolitica are cold-tolerant microorganisms that are able to grow at temperatures down to about 0°C. The number of cases in Denmark has been declining since 1985, and at present, approximately 200 cases are diagnosed per year. The disease, yersiniosis, may be serious and disabling, partly due to possible complications such as aseptic arthritis. Pork products have been identified as sources for human infection. Outbreaks have also been caused by milk and water.

Clostridium botulinum may cause is a very serious disease, botulism, from a toxin produced in the food during growth of the organism. In Denmark this disease is very rare. In general, outbreaks are caused by a serious break-down of production safety. Cold-tolerant types of the pathogen may grow at temperatures as low as 3°C, however, at low temperatures the growth and toxin production is very restricted, and only occurring at growth conditions otherwise close to the optimal for the organism. Heat treatment will have the effect that the toxin will be denatured. Therefore, in reality, the risk of botulism related to refrigerated foods with a limited shelf life is negligible.

It is remarkable that food may sometimes become safer during storage. If the growth of pathogens is inhibited, prolonged storage will cause these to decline. For example, sausages produced of raw meat and subjected to salting, curing and fermentation may initially contain pathogenic microorganisms, but at the time of sale and consumption the level will be reduced to safe levels. Also, hard cheeses that may be produced from raw milk may be safe at the time they are eaten, provided that sufficient time for storage and maturation has been allocated.

Conclusion

The situations where pathogenic microorganisms may grow, and pose a risk to the consumer seem to concern refrigerated stored foods, and only a limited number of microorganisms may play a role, *Listeria monocytogenes*, *Yersinia enterocolitica* and *Clostridium botulinum*.

In many situations, the foods that may allow growth of these pathogens will be subjected to processes such as heating, thus microorganisms and possible toxins are destroyed, and therefore, rendered safe by the time of consumption.

For refrigerated ready-to-eat foods that allow growth of pathogenic microorganisms establishing a shelf life stating the “*use by date*” will protect the food safety of the product and the health risk of the consumer.

For other foods the shelf life is more of quality concern and the labelling could state the “*best before date*”, without risk to the health of the consumer - leaving it to the consumer to decide if the food is acceptable.

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