Hurdle technology essay sample

[Food & Diet]

The spoilage and poisoning of foods by micrnorgenisms is a problem that is not yet under adequate control, despite the range of preservation techniques available (e. g. freezing, blanching, pasteurizing and canning). In fact, the current Consumer demand for more natural and fresh-like foods, which urges food manufacturers to use only mild preservation techniques (e. g. refrigeration, modifed-atmosphere packaging and bio-conservation), should make this problem even greater. Thus, for the benefit of food manufacturers there is a strong need for new or improved mild preservation methods that allow for the production and fresh-like, but stable and safe foods. The concept of hurdle technology is not new but addresses this need in full. Hurdle technology (also called combined methods, combined processes, combination preservation, combination techniques or barrier technology) advocates the deliberate combination of existing and novel preservation techniques in order to establish a series of preservative factors (hurdles) that any microorganisms present should not be able to overcome.

These hurdles may be temperature, water activity (a,), pH, redox potential, preservatives, and so on. It requites a certain amount of effort from a microfganism to overcome each hurdle. The ‘ higher” the hurdle, the greater the effort (i. e. the larger the number of orgenisms needed to overeome it). Some hurdles, like pasteurization, can be high for a large number of different types of microorganisms whereas others, like salt content, have a less strong effect or the effect is limited in the range of types of microorganisms it effects. The fact that a combination of preservative factors influences the microbial stability and safety of foods has been known for many centuries. Tbe concept is more or less unconsciously used in many traditional foods, especially in the developing countries. It was re-invented some 15 years ago in the meat industry where the conscious employment of hurdles was found to be highly favonrable for the production of shelf-stable sausages. The concept is now ready to be introduced for use with much wider range of food products, including fruits vegetables, bakery products, dairy products, fish, and so on.

Several novel preservative factors (e. g. gas packaging, bioconservation, bacteriocins, ultra high pressure treatment, edible coatings, etc. that specifically facilitate this development have been assessed. Hurdle technology is a crucial concept for the mild conservation of foods, as the hurdles in a stable product concertedly control microbial spoilage and food poisontag, leaving desiged fennentation processes unaffected. Because of their concern sometimes synergistic effect. individual hurdles may be set at lower intensities than would be required if only a single hurdle were used as the preservation technique. The application of this concept has proven very successful as an appropriate combination of hurdles achieves microbial stability and safety and also stabilizes the sensory, nutritive and economic properties of a food EXAMPLES OF HURDLE EFFECT A food product is mlcrobiologically stable and safe because of the presence of a set of hurdles that is specific for the product, in terms of the nature and strength of their effect. Together these burdles keep spoilage or pathogenic organisms under control because these microorganisms cannot overcome (‘ jump over’) all of the hurdles present. Exmnples of sets of hurdtes are illustrated in figure below (a to e).

The example shown above represents a food containing six hurdles: high temperature during processing (F value), low temperature during storage (t value), low water activity (aw), acidity (pH) and low redox potential (Eh), as well as preservatives (pres.) in the product. Some of the microorganisms present can overcome a number of hurdles but none can jump over all the hurdles used together. Thus the food is stable and safe. This example is only a theoretical case, because all hurdles are depicted as having the same intensity, which is rarely the case in practice. More likely, hurdles are of different intensity, as shown in the second example figure above (see fig b), where aw and preservatives are the main hurdles and storage temperature. pH and Eh are minor hurdles. If there are only a few microorganisms present at the start (see fig. c), fewer different hurdles or hurdles of lower temperature may achieve microbiological activity.

On the other hand if high numbers of microorganisms are present owing to poor hygienic conditions, the usual set of hurdles may not suffice to prevent spoilage or food poisoning (see Fig. d). The example shown in Fig. e is a food rich in nutrients and vitamins, which may allow for short term, strong growth of the microorganisms, and as a result their initial number is increased sharply (‘ booster effect’). In the examples shown in Figs Id and Ie, additional or higher hurdles are needed to assure product stability. EXAMPLES OF GURDLE PRESERVED FOODS Using hurdle technology, salami-type fermented sausages can be produced that are stable at ambient temperature for extended periods of time.

The microbial stability is achieved by the use of a combination of hurdles that are important in different stages of the ripening process, leading to a stable final product. Important hurdles in the early stage of the ripening process of salami are the preservatives salt and nitrite, which inhibit many of the bacteria present in the meat batter. However. other bacteria multiply, use up oxygen and thereby cause a drop in Eh, which inhibits aerobic organisms and favours the selection of lactic acid bacteria. The lactic acid bacteria then flourish, causing acidification of the product and a decrease in pH. During long ripening of the salami, the various hurdles gradually become lower:, nitrite is depleted, the number of lactic acid bacteria decreases, Eh and pH increase. On the other hand, aw decreases with time, and thus becomes the main hurdle in long-ripened raw sausage. Increased awareness of the concerted effects of the various hardles used in combination has made the production of fermented sausages less empirical.

Similar combinations of hurdles in other types of fermented foods (e. g. cheese and vegetables) are responsible for the stability and quality of the products.

The hurdle technology approach has also been established for use with non-fermented foods, for instance in the production of torteilini, an Italian pasta product. In this case, reduced aw and mild heating are the principal hurdles employed during processing, in addition to a modified atmosphere of ethanol vapour in the package chilling of the product during storage and retail display. A recent survey of foods traditionally preserved using hurdle technology, conducted in 10 Latin American countries, identified some 260 different food items derived from fruit, vegetables, fish, dairy products, meat and cereals, which often had a high aw (sometimes as high as 0. 97) and that were stable at ambient temperature (25-35°C) for several months.

Based on the increased knowledge of the principles underlying hurdle technology, the Latin American scientists involved in this study are now applying the concept to design shelf stable innovative food preparations based on tropical and subtropical fruits (peach, pineapple, mango, papaya etc.) An overview of combition of hurdles that have either been studied or already employed, to date, in a range of food products is given in Table below.

In a number of recently developed food products, in almost infinite shef life can be obtalned. An examination of this is canned peas marketed in the UK. In which the heatstable bacteriocin nisin is used as an extra hurdle. Normally heating and pH reduction are the only two hurdles employed, but these do not suppress the growth of surviving acidtolerant, spore-forming clostridia which are completely inhibited by nisin. HEMEOSTASIS AND HURDLE TECHNOLOGY An important phenomenon that is crucial with regard to hurdle technology is the so-called hemeostasis of microorganisms.

Homeostasis is the constant tendency of microorganisms to malntain the the stability and balance (uniformity) of their internal environment. For instance, although the pH values in different foods may be quite variable, the microorganisms living in them expend considerable effort keeping their internal pH values within very nawow limits. In an acid food, for example, they will actively expel protons against the pressure of a passive proton influx. Another important hemeostatic mechanism regulates the internal osmotic pressure (osmohomeostasis). The osmotic strength (which is inversely related to the aw) of a food is a crucial physical property, which has a great effect on the ability of organisms to proliferate. Cells have to maintain a positive turgor (pressure) by keeping the osmolarity of the cytoplasm higher than that of the environment and they often achieve this using so-called osmoprotective compounds such as praline and betaine. Preservafive factors (hurdles) may disturb several or just one of tbe homeostatic mechanisms of the microorganisms and as a result will not multiply or instead remain inactive or even die.

In fact, food preservation is achieved by disturbing the homeostasis of microorganisms in foods, either temporarily or permanently, and the optimal way to do this is to deliberately disturb several of the homeostatic mechanisms simultaneously. This means that any hurdles included in a food should affect the undesired organisms in several different ways, for example by affecting the cell membrane, DNA, enzymes, pH, Eh and aw homeostasis systems. This multi-targeted approach is the essence of hurdle technology. Furthermore, this approach is often more effective than single-targeting and enables the use of hurdles of lower intensity, and thereby has less of an effect on product quality. Also, it is possibile that different hurdles in a food will not just have an additive effect on stability, but might act synergistically. In practical terms this could mean that it is more effective to use a combination of different preservative factors with low intensities that affect different microbial systems or act synergistically than to use a single preservative factor with a high intensity. Moreover, in the hurdle technology concept, the objective is to inhibit the growth and preliferation of undesired organisms rather than to actually kill them, thus allowing for the use of hurdles that are not too extreme.

Another phenomenon of practical relevance is referred to as the auto-sterilization of stable, hurdle preserved foods. In some ambient-temperature stable meat products containing clustridin and bacilli that had survived the heat treatment applied during processing. It has been observed that some of these spores are able to germinate to form vegetative cells, but that these appear not to be viable and therefore din off. The viable spore count thus shows a gradual decrease during storage, The same phenomenon has been observed for several bacteria, yeasts and moulds in hurdle preserved fruit products stored without refrigeration. A general explanation for the phenomenon might be that, because, of the elevated temperature, which favours and probably triggers microbial growth, vegetative cells strain every possible repair mechanism to overcome the various hurdles present. In doing so, they become metabolically exhausted; they completely use up their energy sources and die. Thus, because of such autosterilization, hurdle-preserved foods that are microbiologically stable become even safer during storage, especially at ambient temperatures.

POTENTIAL HURDLES Up to now, around 50 different hurdles have been identified for use in food preservation. The most commonly used important hurdles are high temperature, low temperature, low aw, acidity, low redox potential, competitive microorganisms (e. g. lactic acid and bacteria) and preservatives (eg. Nitic, sorbate and sulphite). However, many other hurdles are of interest because of their potential use in fnod preservation. Among others, the emerging hurdles include ultra high pressure, MAP, bacteriocias and edible coatings. The combination of various hurdles in the processlng and storage of foods has the primary target of obtaining safe foods that are stable with respect to microbial spoilage, using as mild a treatment as possible. However, the concept of hurdle technology may also contribute to improving the organoleptic quality or total quaity of foods as perceived by consumer, and developments in this respect are also expected in future.

MORE NOTES ON HURDLE TECHNOLOGY

Hurdle technology is a method of ensuring that pathogens in food products can be eliminated or controlled. This means the food products will be safe for consumption, and their shelf life will be extended. Hurdle technology usually works by combining more than one approach. These approaches can be thought of as “ hurdles” the pathogen has to overcome if it is to remain active in the food. The right combination of hurdles can ensure all pathogens are eliminated or rendered harmless in the final product. Hurdle technology has been defined by Leistner (2000) as an intelligent combination of hurdles which secures the microbial safety and stability as well as the organoleptic and nutritional quality and the economic viability of food products.[2] The organoleptic quality of the food refers to its sensory properties, that is its look, taste, smell and texture. Examples of hurdles in a food system are high temperature during processing, low temperature during storage, increasing the acidity, lowering the water activity or redox potential, or the presence of preservatives.

According to the type of pathogens and how risky they are, the intensity of the hurdles can be adjusted individually to meet consumer preferences in an economical way, without compromising the safety of the product. HURDLES Each hurdle aims to eliminate, inactivate or at least inhibit unwanted microorganisms. Common salt or organic acids can be used as hurdles to control microbials in food. Many natural antimicrobials such as nisin, natamycin and other bacteriocins, and essential oils derived from rosemary or thyme, also work well. Principal hurdles used for food preservation (after Leistner, 1995) Parameter High temperature Low temperature Reduced water actvity Increased acidity Reduced redox potential Bio preservatives other preservatives Symbol Application F T aw pH Eh Heating Chilling, freezing Drying, curing, conserving Acid addition or formation Removal of oxygen or addition of ascorbate Competitive flora such as microbial fermentation Sorbates, sulfites, nitrites “ Traditionally, fermented seafood products common in Japan, provide a typical example of hurdle technology.

Fermentation of sushi employs hurdles that favour growth of desirable bacteria but inhibit the growth of pathogens. The important hurdles in the early stages of fermentation are salt and vinegar. Raw fish is cured in salt (20–30%, w/w) for one month before being desalted and pickled in vinegar. The main target of these hurdles is C. botulinum. Growth of lactic acid bacteria during fermentation results in acid production from metabolism of added sugars and rice. The result is a pH hurdle important in controlling growth of C. botulinum.”[1] [Types of hurdles used for food preservation (from Ohlsson and Bengtsson, 2002)[Type of hurdle Physical Examples Aseptic packaging, electromagnetic energy (microwave, radio frequency, pulsed magnetic fields, high electric fields), high temperatures (blanching, pasteurization, sterilization, evaporation, extrusion, baking, frying), ionizing radiation, low temperature (chilling, freezing), modified atmospheres, packaging films (including active packaging, edible coatings), photodynamic inactivation, ultra-high pressures, ultrasonication, ultraviolet radiation

Carbon dioxide, ethanol, lactic acid, lactoperoxidase, low pH, low redox potential, low water activity, Maillard reaction products, organic acids, oxygen, ozone, phenols, phosphates, salt, smoking, sodium nitrite/nitrate, sodium or potassium sulphite, spices and herbs, surface treatment agents Antibiotics, bacteriocins, competitive flora, protective cultures

Physicochemical

Microbial SYNERGIC EFFECTS

There can be significant synergistic effects between hurdles. For example, Gram-positive bacteria include some of the more important spoilage bacteria, such as Clostridium, Bacillus and Listeria. A synergistic enhancement occurs if nisin is used against these bacteria in combination with antioxidants, organic acids or other antimicrobials. Combining antimicrobial hurdles in an intelligent way means other hurdles can be reduced, yet the resulting food can have superior sensory qualities