Application of Hurdle Technology in Traditional Indian Dairy Products

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Hurdle technology is a method of ensuring that food products will be safe for consumption and extending their shelf life. It also ensures that pathogens in food products will be eliminated. Hurdle technology is used in food industry for the gentle but effective preservation of foods. The shelf life, sensory and nutritional quality of foods are based on applications of combined preservative factors (called hurdles). The principle hurdles used for food preservation and their applications are presented in Table 1.

Need for hurdle technology

With the fast growing economy and more and more working women, income amongst middle class has increased and the ongoing trend has been to eat out. Therefore, the demand for processed food has increased in recent times. Moreover, consumers now a days are demanding fresh, natural and minimal processed ready to eat food products.

Table 1 - Principal hurdles used for food preservation

Parameter	Symbol	Application
High temperature	F	Heating
Low temperature	T	Chilling, freezing
Reduced water activity	a_w	Drying, curing, conserving
Increased acidity	pH	Acid addition or formation
Reduced redox potential	E_h	Removal of oxygen or addition of ascorbate
Biopreservatives		Competitive flora such as microbial fermentation
Other preservatives		Sorbates, sulfites, nitrites

(Source: Leistner, 1995)

The most important hurdles used are food preservatives (e.g. nitrite, sorbate, sulfite) and competitive microorganisms (e.g. lactic acid bacteria) (Leistner *et al*., 1981).

In hurdle technology, hurdles are deliberately combined to improve the microbial stability and the sensory quality of foods as well as their nutritional quality of foods and economic properties. Thus, hurdle technology aims to improve the total quality of foods by application of an intelligent mix of hurdles (Leistner, 2000).

An important phenomena that is crucial to hurdle technology is homeostasis of microorganisms. Homeostasis is the constant tendency of microorganisms to maintain a stable and balanced (uniform) internal environment. Preservative factors functioning as hurdles can disturb one or more of the homeostasis mechanisms, thereby preventing microorganisms from multiplying and causing them to remain inactive or even die. Food preservation is achieved by disturbing the homeostasis of microorganisms. The best way to do this is to deliberately disturb several homeostasis mechanisms simultaneously (Raso *et al*., 1998). Another phenomenon is referred to the auto-sterilization of stable, hurdle preserved foods. It has been observed that because of elevated temperature which favours and probably triggers microbial growth, vegetative cells strain every possible repair mechanism to overcome the various hurdles present. Thus, because of such autosterilization, hurdle preserved foods that are microbiologically stable become even safer during storage, especially at ambient temperature (Leistner and Gorris, 1995). The various types of hurdles used for food preservation is presented in Table 2.

Nisin has been shown to enhance the microbial reduction achieved by HP, due to sub-lethal injury and sensitization caused to target cells. Studies carried out on milk demonstrated that Gram negative bacteria, such as *Pseudomonas fluorescens* or Escherichia coli, and Gram positive bacteria, as *L. innocua*, are inactivated by HP treatment, although Gram - positive bacteria seemed to be rather resistant (Black *et al*., 2005). Hence, the degree of inactivation achieved by the combined use of HP and antimicrobials such as nisin should be higher than that achieved by the sum of the inactivation achieved by the individual treatments. Treatment at 500MPa for 5min in the presence of 500 IU/ml nisin completely inactivated *Ps. fluorescens* and *E. coli* and reduced *L. innocua* by more than 8.3 log units, whereas those treatments, when applied separately, produced a decrease of only 3.8 and 1.5 log units, respectively.

Table 2 - Types of hurdles used for food preservation

Type of hurdle	Examples
Physical	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
Physico-chemical	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
Microbial	Antibiotics, bacteriocins, competitive flora, protective cultures

(Source: Ohlsson and Bengtsson, 2002)

In dairy industry, use of thermal pasteurisation (TP) is the established food technology for commercial processing of milk. However, degradation of valuable nutrients in milk and its sensory characteristics occurs during TP due to substantial heat exposure. Pulsed electric fields (PEF) and microfiltration (MF) both represent emerging food processing technologies allowing gentle milk preservation at lower temperatures and shorter treatment times for similar, or better, microbial inactivation and shelf stability when applied in a hurdle approach compared to TP. Comparing PEF, MF, and TP for the reduction of the native microbial load in milk led to a 4.6 $\log_{10}$ CFU/mL reduction in count for TP, which was similar to 3.7 $\log_{10}$ CFU/ml obtained by MF (P≥0.05), and more effective than the 2.5 $\log_{10}$ CFU/ml inactivation achieved by PEF inactivation (at 815 kJ/l. Combining PEF and MF in a hurdle technology for 'cold' pasteurisation of milk proved to be more effective than conventional TP and even higher antimicrobial efficacy of PEF/MF for longer preservation of the microbial milk shelf life can be expected if the processing temperature is increased to a moderate level (≥50 to 65 °C) (Walkling-Ribeiro *et al*., 2010).

Use of hurdle technology in enhancing shelf life of traditional dairy product

Paneer is a highly perishable product. It was reported that the freshness of paneer remains intact only for 3 days at refrigeration temperature (Bhattacharya *et al.,* 1971) at room temperature paneer does not keep good for more than one day. In order to increase the shelf life of paneer, additives, modification in paneer manufacturing process, surface treatments and packaging materials have been recommended by various workers.

Several hurdle techniques have been used by researchers for increasing shelf life of paneer. One of the hurdle technology involved mild heat treatment, minor reduction in water activity (0.95) and acidification (pH 5.0) to extend their shelf life of paneer to 14 days at 30°C. Use of 1% each of sodium chloride, sucrose and glycerol to decrease the water activity of paneer led to shelf life extension of paneer (Rao and Patil, 1992). In another study, the shelf life of paneer curry was extended using hurdle technology. The product was formulated to have a water activity of 0.95, pH of 5.0 and potassium sorbate content of 0.1%. The product kept well for about 1 month and had a better quality than the heat-sterilized product stored under similar conditions (30°C) (Rao and Patil, 1999).

Dipping of paneer in 5% brine, acidified brine (5% NaCl, pH 5.5) and hydrogen peroxide solution (0.2%, v/v) with or without delvocid (0.5%, w/v) extended the shelf life of paneer cubes of small size (1.0 × 0.25 × 0.5 inches) to 22, 20, 32 and 22 days respectively compared to 10 days for control at 8–10°C. It was observed that smaller paneer size helped in better diffusion of the solution and thus longer shelf life (Sachdeva and Singh, 1990).

Brown peda, a traditional Indian heat desiccated milk (khoa)-based confection characterized by caramelized colour and highly cooked flavour, is expected to have good shelf life in comparison with other khoa-based sweets due to low moisture content, higher amount of sugar and severe heat treatment applied during its preparation. However, brown peda is also very much susceptible to microbial spoilage due to unhygienic conditions adopted during its manufacture and handling and its poor packaging. Hence, with a view to improve the shelf life of brown peda by packaging interventions. Panjagari studied the effect of conventional cardboard boxes, modified atmosphere and vacuum packaging techniques on the sensory, physico-chemical, textural, biochemical and microbiological quality of brown peda during storage for 40 days at 30°C. They reported that the rate of loss of most quality attributes was rapid in control and modified atmosphere packaged samples compared to vacuum packaged samples. Based on the results obtained the authors concluded that brown peda could be best preserved up to 40 days at room temperature (30±1°C) without appreciable quality loss (Panjagari *et al*., 2007).

Gasasase (poppy seeds) payasum is product prepared from poppy seeds and rice and by application of retort processing (f0 value 6 at steam pressure of 1.04 bar) to this product, there was a marginal change in its pH, acidity and HMF content and viscosity take place during storage which led to extension of its shelf-life to 6 weeks at 37°C temperature (Geetha, 2005).

Curd rice is another traditional dairy product popular in South India. Normally shelf-life of curd rice is 24 h at 30°C, but attempts were made to increase self-life of curd rice by incorporating fresh ginger along with other spices (for seasoning) in milk and boiled for 2-3 min and it is then used for curd preparationof rice as per standard method and it was found that ginger added curd rice has shelf-life of 7 days at 37°C storage and 12 days at refrigerated storage (4 to 6°C). The acidity and water activity of fresh curd rice were 0.54 % and 0.994 respectively. The culture pH and natural preservative like ginger has been identified as probable hurdle for improved shelf-life of curd rice (Balasubramanyam *et al*., 2004).

Dudhchurpi, a product of Himalaya region (Bhutan, Sikkim and Dargeeling) made from milk of yak or cow and is self-stable for several months without refrigeration. Most important for dudhchurpi is its texture (elasticity), since people living at high altitude chew it as 'energy tablets'. Sensory analysis and microbial stability of dudhchurpi was optimized by Hossain using combined several hurdles like heating, acid coagulation, addition of sugar and sorbate, smoking, drying and packaging in a closed container (Hossain, 1994).

Conclusion

Today public concern is toward minimal damage to food product with maximum protection of food to microorganism. So any one preservation technique lead to damage to nutritional value or sensory damage. So hurdle technology is the best way by which we can improve both of these characteristic. In dairy industry we can use this technique and improve quality as well as it is possible to make some value added product by this technique.

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