

## Relevance of Hurdle Technology in India: Opportunities in Dairy Processing Industry

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### Reprint Request

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### Abstract

Hurdle technology was explored several years ago as a conception to ensure food safety and stability against food pathogens. This technology deliberately combines hurdles which secures the microbial safety and stability as well as retains the organoleptic, nutritional quality and economic viability of food products. It is amiable, accessible and multi-target method of effective preservation with effective applications. This technology is of paramount importance in developing countries like India due to lack of storage facilities and nowadays more or less used in many foods at industrial level. In excess of 50 different hurdles are identified for food industries. Besides the common ones, potentially valuable options can also be applied in any kind of food industries. This technology can boon the food industry which is running successfully with the hope of more scopes to arrive in future.

**Keywords:** Hurdle; Dairy; Preservation; Food; Spoilage.

### Introduction

Food contamination with pathogenic and spoilage microorganisms makes the food unhealthy and unfit to eat, has become a global problem instead of applying preservation methods [14]. Among chemical, physical or microbial degradation rate of spoilage is much faster by microbial growth than by microbial extra or intracellular enzymes in the absence of viable microbial cells [4]. According to US Public Health Service in the "Food Service Sanitation Manual, 1962" the milk is one of the potentially hazardous foods (PHF), i.e. the foods which are perishable with rapid growth of microorganisms.

The Indian dairy sector is characterized by soaring fragmentation. It is dominated by the unorganized sector comprising maximum share to rural households. Further the condition is more aggravated by recurrent ravages of epidemics across all species. Although milk produced by the farmer is reasonably clean, there is a lack of infrastructure for handling of milk in the rural areas. The Indian dairy industry is moving steadily towards self-reliance. It lacks necessary processing facilities and appropriate infrastructure to procure quality milk from the producers. Therefore it is essential to preserve the milk i.e. to adopt a process to maintain the original quality of food by means to prevent its spoilage or

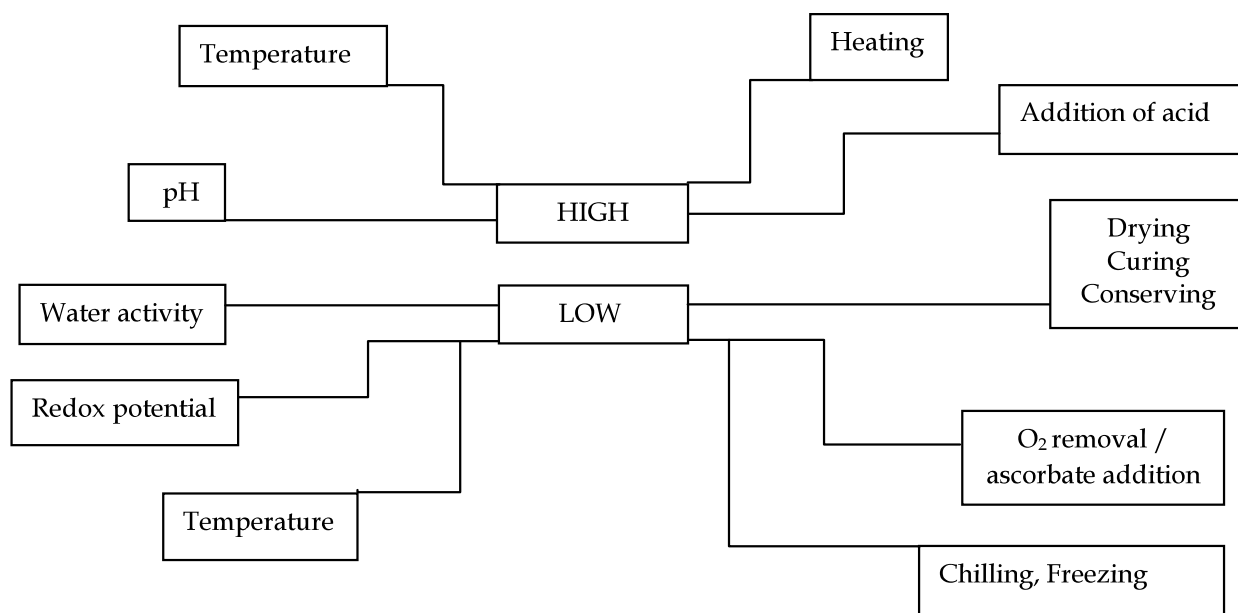
deterioration. Food-borne threats can disrupt markets and can lead to substantial economic losses for everyone from farm input traders to customers. Thus it's the responsibility of food industry researchers to escalate the efforts for augmenting food safety throughout the globe. Variety of conventional and novel techniques has been assessed to solve food safety-related problems and a need to redirect the focus toward food quality assurance is essential to find feasible solutions.

**Hurdle technology** Hurdle concept is applied to compel the microorganisms to death by putting them in a hostile environment [21]. The microbial safety,

stability as well as the sensory and nutritional quality of most foods is based on combined preservative factors known as hurdles. These hurdles are assurance of safe, unspoiled, microbially safe food through maintaining nutritional and organoleptic properties. These include temperature, water activity  $a_w$ , pH, redox potential, modified atmosphere, organic and inorganic preservatives etc. [6]. Another group of hurdle i.e natural/green preservatives (spices and their extracts, lysozyme, chitosan, pectin hydrolysate etc.), are preferred non-synthetic and cheaper [18]. Food hurdles can be of different types, categorized in Table 1 and the most commonly used are shown schematically.

**Table 1:** Types of Hurdles

Types	Examples
Physical	Temperature, electromagnetic energy, photodynamic inactivation, UV and ionizing radiation, ultrahigh pressure processing, ultrasonication
Physicochemical	$a_w$ , pH, Eh, NaCl, NaNO <sub>2</sub> , CO <sub>2</sub> , O <sub>2</sub> , SO <sub>2</sub> , organic acids, spices and herbs, surface treatment agents, smoking, ethanol, Maillard Reaction Products (MRPs), lysozyme
Microbial	Competitive flora, starter cultures, bacteriocins, antibiotics



**Fig. 1:** Schematic diagram of some of the most commonly used Hurdles with their inferences

*Need of Hurdle Technology*

Food hygiene and security are the basics of public health, in fact are of much concern. As a result food safety and its awareness have become very essential. So, proper hygienic measures and prevention of food spoilage have to be adopted. Thus the preservation method called Hurdle Technology is the best way to protect food and extend their usable time by preventing nutritional, sensory damage and microbial action through respective mechanisms

using respective tools (Hurdles) in respective areas. It's a versatile process, can be used in any kind of food [2]. Microbial control assurance in food is the foremost, careful and sensitive agenda of this regard. From hurdle effect, hurdle technology has been extracted, a process which discusses the improvement by combination of hurdles, the safety, quality and economic properties of foods [17]. It also prevents unnecessary side-effects, lowers concentration of each element and saves energy [22].

**Table 2:** Examples of Hurdle Technology

Hurdles	Used in	Advantage	Source
a <sub>w</sub> : 0.97, pH: 5.0, @35 °C	Indian paneer	Prolonged shelf life	[16]
a <sub>w</sub> : 0.85-0.70, pH: 5.9-5.7, NaCl: 3-5 %, Sugar: 4-20 %, vacuum packaged	Chinese La Chang (meat)	Prolonged shelf life	[16]
4% sucrose, 0.1% citric acid, 0.1% sodium benzoate, Packaging : HDPE	Kilishi (West African traditional dried meat product)	Elimination of <i>Salmonella</i> and <i>Staphylococcus</i> spp.in ambient storage	[1]
Vinegar and sake	Sous vide packaging	Longer storage with minimal loss of quality	[12]
Citric acid	Dambu-Nama	Increase protein quality, Prolonged shelf life	[5]
3% NaCl, 0.3% citric acid	Coconut gratings	Prolonged shelf life	[8]
Spices and heating	Zobo (traditional sorrel drink)	Inhibition of <i>Aspergillusflavus</i> and <i>A. niger</i> growth	[11]
Ascorbic acid, Potassium sorbate, Sodium bisulphite	Sugar syrup of fresh mango slice	Maintains its colour for a month	[13]

**Table 3:** Applications of Hurdle Technology in Indian Dairy Industry

Item	Aim	Hurdles	Conclusion	Source
Paneer	To increase shelf life	1% sodium chloride, 1% sucrose, 1% glycerol	Successful	[23]
Paneer	To increase shelf life	a <sub>w</sub> - 0.95, pH-5.0 and 0.1% potassium sorbate	Successful	[24]
Paneer (cubes)	To increase shelf life	Dipping in 5% NaCl, pH 5.5, Hydrogen peroxide solution (0.2%, v/v), with/without delvocid (0.5%, w/v)	Successful	[25]
Gasasase (poppy seeds) payasum	To increase shelf life	Retort processing (f0 value 6 at steam pressure of 1.04 bar)	Change in pH, acidity, HMF content and viscosity	[7]
Curd rice	To increase shelf life	Ginger	Successful	[3]
Dudhchurpi	Microbial stability	Heating acid coagulation, addition of sugar and sorbate, smoking, drying and packaging in a closed container	Successful	[10]

Moreover offers synergistic advantages compared to individual cases by hitting different targets by different hurdles [26]. Some examples of the same are listed in Table 2.

Now-a-days the physiology and behavior of microorganisms i.e. their homeostasis, metabolic exhaustion, stress reactions in foods are taken in account [19] and the progress allows more upgraded application of hurdles. Homeostasis is the maintenance of uniformity and stability in the organisms by forcing them to remain in lag phase [15]. Moreover, maintenance of a defined pH is prerequisite which is applied to higher organisms and microorganisms [9].

#### *Opportunities in Indian Dairy Industry*

India stands at first position for milk production

all over the world. India continues to be the largest producer of milk in world. FAO reported 1.8% increase in world milk production from 789 million tonnes in 2014 to 803 million tonnes in 2015. Milk production during 2014-15 and 2015-16 is 146.3 million tonnes and 155.5 million tonnes respectively showing an annual growth of 6.27%. The per capita availability of milk is around 337 grams per day in 2015-16. This represents a sustained growth in the availability of milk and milk products for growing population. The per capita availability of milk has reached a level of 337 grams per day during the year 2015-16, which is more than the world average of 299 grams per day in 2015. The Indian dairy industry is divided into the organized and unorganized segments. The unorganized segment consists of traditional milkmen, vendors and self consumption at home and the organized segment consists of

cooperatives and private dairies. As per the Annual Report for FY17 of Dept. of Animal Husbandry, Dairying & Fisheries, Ministry of Agriculture & Farmers Welfare, GOI, co-operatives & private dairies still procure only about 20% of the milk produced in the country, while 34% is sold in the unorganized market and about 46% is consumed locally. During the last five to ten years, India has seen dramatic shift towards consumption of value-added products such as cheese, yoghurt, UHT (ultra-heat treatment) milk, flavored milk, and whey. To tap the advantages of the changing consumer food preferences, most organized players are expanding product portfolios in the value-added segment. This segment offers high growth potential and better margins versus the liquid milk and Skimmed Milk Powder (SMP) segment.

As a tropical country with a hot and humid climate, which is not particularly conducive to milk production, growth in India's milk production is impressive as compared to major milk producing developed countries that benefit from a temperate climate.

Therefore, it provides an immense opportunity for processors to use hurdle technology at sub optimal doses together to enhance shelf life of milk and dairy products. In dairy industry, withholding of the product temperature (ripening/ageing) procedure is often utilised. Use of thermal pasteurisation (TP) is established 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.

Also heat treatment of milk with lower intensity than pasteurization (Thermization), processes using high centrifugal forces (Bactofugation), recirculation over a microfilter (Microfiltration), high hydrostatic pressures (> 3000 Bar) (High-pressure treatment), high intensity ultrasound (18-500 MHz) (Ultrasonication) are also taken in account. Moreover, usage of electromagnetic energy i.e., Electromagnetic energy treatment (E.g., microwave energy (thermal effect), radio-frequency energy (non-thermal effects) or high electric field pulses (10 – 50 kV/cm, non-thermal effects)) and beams of photons/electrons i.e., Low-intensity irradiation process are emerging recently. Some of the applications of Hurdle technology in Indian dairy industries are listed in Table 3.

## Conclusion

For improving the quality parameters of foods, Hurdle Technology is the most essential and suitable approach of food safety and security since 1978, when Lothar Leistner first introduced this. The concept is reported as very valuable since its merits with microbial control assurance in food being the first priority. Inclusion of multi-hurdle provides synergy which augment effectiveness at inactivating microorganisms than the use of any single factor. As a result the process enables the food to be self-stable which in turn helps play in their storage. The technology improves quality, saves resources, maintains integrity and minimizes side effects. Thus this technology in dairy food industry can be use as essential tool to improve quality assurance as well as for the expansion of certain value added products.

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