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Make use of advanced processing technologies to sustain dairy Industry

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ABSTRACT : The uses of advanced processing technologies discussed in with this are most effectual for inactivation of micro-organism and extension of shelf-life of milk and milk products. In addition, these technologies have no harm physico-chemical, nutritional and sensory qualities of milk and milk products.

KEY WORDS : Milk, Processing, Sustainable, Technology

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INTRODUCTION

Since, last 13 years India is the largest milk producer in the world. This has been largely achieved through a combination of favorable policies and institutional network that has supported to the millions of rural milk produces, through small scale dairy farming. The growth of this network of institutions has been acknowledged to be a key factor in the growth of the Indian dairy sector. India is witnessing winds of change because of increased milk availabilities, a changeover to market economy, globalization and the entry of the private sector in dairy industry. The value addition and variety in availability of milk products are on every body's agenda. There is an increasing demand for new milk products and process. The main reasons are an increase in disposable incomes, changes in consumer concerns and participation on nutritional quality and safely, arrival of foreign brands, increasing popularity of satellite/cable media and availability of new technologies and functional ingredients.

Pattern of milk utilization in India indicates that about 50 per cent of total milk produced is utilized for the manufacture of variety of traditional milk products, which occupies a prominent place in Indian economy (Khan, 2006). Increased market demand and the accompanying value addition present a great opportunity to take up the production of dairy products on industrial scale by application of newly emerging technologies in a cost effective (Sahu, 2008).

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Advances in milk processing technology :

Dairy industry has to cope-up with the newer and advanced milk processing technology coming-in. Some of them are listed and discussed in this paper.

High pressure processing (HPP) :

The basic principle behind HPP is that pressure cause a decrease in the available molecular space or an increase chain interaction. A reduction involves the formation of hydrogen bonds, are favoured by high pressure. Bonding results in a decrease in volume. Using high pressure can quickly pasteurize or in some case sterilize milk products with little or no heat treatment. This results in products that have a good natural taste and texture while retaining those nutritional factors that would otherwise is degraded by heat. The aim here is to replace either pasteurization or microfiltration with high pressure. It has been found that milk pasteurized by high pressure can kept as refrigeration temperatures for several weeks. Pasteurization at 7,000 atmospheres for 10 minutes at 20^0C can reduce to normal micro flora of milk on acceptable level (Table 1).

Bactofugation :

Bactofugation is the process of separation of micro-organisms especially bacterial spores from milk, at very high centrifugal force, in a specifically designed centrifuge called a bactofuge. It is high speed centrifugal process that remove about 99 per cent of the spore present in milk thereby increasing the shelf-life of fresh pasteurized milk and minimizing the occurrences of defect in milk during storage.

The bacteriological load of milk produced in India is in the range 2 to 10 million per milliliter, depending upon the season. It comprises of both the dead and vegetative cells. In bactofugation involves subjecting milk to high speed centrifuging at around 20,000 rpm to remove bacteria of milk. The process can be adopted selectively before or after pasteurization depending on the equipment. The process removes 70-80 per cent of bacterial cells from milk depending on the initial load. During bactofugation, the separated bacteria are removed in the form of a concentrated suspension in a small quantity of milk called bactofugate, volume of which corresponds to 2-3 per cent of the treated milk. Shelf-life of pasteurized milk can be enhanced by 3-5 days if bacteria from raw milk are removed beforehand through bactofugation. Bactofugation also did not significantly affect acidity, taste and aroma of pasteurized milk (Sanyal *et al.*, 2008).

Aseptic packaging :

In this packaging, milk and milk products after sterilization or UHT processing are filled under aseptic condition in multi-layer high barrier package. This permits enhancement of their shelf-life from 15 days to six months at the ambient temperature. The shelf-life depends upon the type of material used for packaging (barrier properly), packaging system composition and pretreatment of the product. The types of packages under aseptic packaging are as Retort pouches as flexible laminates. The rigid laminates include Tetra Brik, Gasti DOG aseptic, Liqui-Pak, Bag-in-Box, Combiflock, Conofast, Steriglen and Starasept systems.

In above mentioned system, except steriglen and Bag-in-Box, the rest use packages like cartons performed plastic tubs or roll stock (Web) material. In aseptic packages, the bottom sealing help to minimize presence of air inside the packed carton. The tubs, cups and the lid are sterilized by hydrogen peroxide and UV radiation. Subsequently hydrogen peroxide is removed by heating and evaporation prior to filling of the product. The UHT (Ultra High Treatment) technology combined with aseptic packaging is already being used for packaging a variety of fresh milk and products like *lassi*. Rapid advances have also made if feasible to pack particulate matter, suspended in liquid phase. This technology holds promise of packaging other milk products such as *Rabadi*, *Basundi*, *Shrikhand*, *Rasmalai* and *Dahi* to increase

Table 1 : Results of application on HPP

Application	Use/Result	References
High pressure processing for pasteurization of milk (680 Mpa for 10 min at room temperature)	5-6 log reduction in microbial number	Hite *et al.* (1914)
Milk treated with 50 Mpa pressure for 3 days	Accelerated ripening of cheddar cheese and increased proteolysis in milk protein and increase amino acid content	Yokohama *et al.* (1992)
High pressure treatment in the range of 300-600 Mpa	Increased the cheese yield	Drake *et al.* (1997)
High pressure of 400 Mpa for 15 min at 20^0C	Increase cheese yield (2 % on dry basis) and moisture content in cheese	Arias *et al.* (2000)
Combined use of high pressure (200-250 Mpa) with bacteriocin such as lacticin	Synergistic effect in controlling microbial flora of milk	Morgan *et al*. (2000)
Cheese prepared from raw and pressure treated goat milk (800 Mpa 15 min, 20^0C).	Cheese is firmer less fracturable and less cohesive than pasteurized milk (72^0C, 15 Sec.)	Buffa *et al.* (2001)
Combined use of high pressure treatment (250-500 Mpa, 5 min at 20^0C) with Nisin (0, 200 or 500 µ/ml)	Greater inactivation of gram positive bacteria than when either was applied individually	Black *et al.* (2005)

their shelf- life and facilitate their national and international marketing (Aneja *et al.*, 2002). Modha *et al*. (2009), listed following advantages of aseptic packaging (1) Higher quality of product is obtained by using HTST sterilization especially for large containers, (2) Usage of a wide variety of packaging materials, many package sizes and shapes are possible, (3) The sterilization and packaging procedures used are continuous.

Membrane processing technology :

Dairy industry is probably the largest user of membrane technology in food processing since the introduction of membrane processing to the dairy industry in the late 1960's. Separation of dairy fluids using semi permeable membranes has been used to clarify, concentrate and fractionate a variety of dairy products. The time honored and tested applications involving whey processing, the by-product of cheese making, have introduced a plethora of refined protein and commercial use for a once wasted by product.The same concentration method of reverse osmosis used in whey processing is often a favourable alternative to evaporation technique used in milk processing. The fractionating of whey proteins from the lactose in whey processing also has an alternative benefit in the fractionating of the same lactose from the milk protein in fluid milk using the same ultra filtration techniques. Microfiltration fills the separation profile of membranes out by further fractionating the specific milk protein of casein and serum protein away from each other.

In a sense, membrane processing of fluid milk is acting like a harvester of specific milk components without imparting a phase change by the adding of heat, as is typical for evaporation, or an enzyme, as done in most cheese making techniques. The milk is modified by separating clarifying or fractionating a selected component in milk from other components using differences in their relative molecular weights and pore size of the membranes (Kumari and Chandra, 2008) (Table 2).

Hurdle processing technology :

The use of several parameters has been termed as hurdle technology or combined methods approach. This approach involves manipulating the pH, Eh (redox potential),a_w (water activity) solute type and concentration, giving heat treatments, incorporating chemical preservatives, using effective packaging techniques and maintained chilling condition of storage. Through hurdle processing, a non-sterilized food can be made safe for consumption as well as its taste kept fresh over an extended period of time to facilitate its marketing over a wide distribution network. Each of the parameters listed above posses a hurdle to pathogenic and spoilage micro-organism. Hence, the name 'hurdle technology' several of these hurdles act in a synergistic manner (Aneja *et al.*, 2002).

Microwave processing :

Microwave radiations is that part of the electromagnetic radiation spectrum that falls between frequencies of 300 to 3,00,000 MHz and wave lengths of 1 mm to 1 m in air. They are made up of electrical and magnetic waves which are oriented at right angle to each other. They are non-ionic and do not break chemical bonds. Microwave are generated by supplying electrical power to a magnetron tube which converts 50-60 Hz. Power into an electric field with centers of positive and negative charges that change direction billion of times per second. Food material exposed to microwave energy convert the energy absorbed to heat as a result of dipolar radiation or by ionic polarization. The heat generated by the above electrical interactions is transferred throughout the product by conventional conduction phenomenon

The exact mechanism by which microwave destroy micro-organisms is not much clear. However, it is believed that microwave inactivate microbes by conventional thermal mechanism e.g. thermal denaturation of microbial protein and nucleic acids. At a molecular level microwave could interfere with the mechanism of bonding of

Table 2 : Basic aspect of ultrafiltration (UF) and reverse osmosis (RO)

Characteristics	(UF) **Ultrafiltration**	(RO) **Reverse osmosis**
Membrane pore size	1-50 nm	0.5-2.0 nm
Operating pressure	1-15	15-75
Permeate	Water + micro molecules	Water
Retentate	Over 1000 molecular weight	Less than 500 molecular weight
Use	Pre-concentration of milk, recovering protein from cheese whey, dairy effluent treatment	Concentration of whey, skim milk, milk, lactose from UF whey permeate

dipicolinic acid to calcium and/or cause reorientation in the thermo stable protein content of the DNA of microbes. Microwave inactivation by microwave depends on same time/temperature relationship as in conventional heating.

Milk pasteurization by both batch and continuous methods using microwave system was first reported by Hamid *et al.* (1969). Later, Jaynes (1975) also reported a continuous microwaves pasteurization of milk. High casein: whey protein ratio was observed by Merin and Rosenthan (1984) in microwave pasteurized milk. This also suggested a higher whey protein denaturation. Villamiel *et al*. (1996) observed that shelf-life of microwave heated milk was 15 days more than that of milk heated in the plate heat exchanger and microwave treated milk received a high sensory score during 10 days of storage.

Pulsed electric field :

It involves the application of pulses of high voltage *i.e.* 20-80 kv/cm to foods placed between two electrodes. It is conducted at ambient, sub ambient, or slightly above ambient temperatures for less than 1 second, as a result the energy loss due to heating or food is minimized. This technology has been applied to preserve the shelf-life milk (Modha *et al*., 2009).

Irradiation :

It is called as cold pasteurization because it kills bacteria without heat. Food irradiation is the process of exposing food to ionizing radiation to destroy micro-organisms infested food. It is useful in the preservation, sterilization, control of sprouting ripening and insect damage, control of food born illness etc. International health and safety authorities have endorsed the safety of irradiation for all foods upto a dose level of 10 Kay (1 K Gy = 1000 Gy) (ICGFL, 1999). According to Codex Alimentarius (2003) the maximum does of 10 KGy recommended by the codex general standards for irradiated foods.

High intensity light :

If the food material equipment surfaces, packaging materials is passed through high intensity broad spectrum white light *i.e.* 1 to 20 flashes/sec. It helps to destroy micro-organisms, insects, parasites etc. and enhance the shelf-life and quality of food.

Infrared treatment :

In current era, this technology has been used in military industries, household appliances and food processing and preservation and biochemistry industry with appreciable result (Jain, 2009).

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