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The Study on UHT Processing of Milk: A Versatile Option for Rural Sector

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Abstract: India is the largest milk producing country in the world. Most of the rural poor people are involved in the milk production. India has a tropical climate; milk cannot be kept for more than three hours at ambient temperature immediately after milking. Cooling equipments are not available in many parts of the country and if available, which are not affordable to rural people. Milk preservation prior to distribution and sale is major problem in India. So it is necessary to develop a new sciencitific and efficient method to overcome such problems. If low cost and highly effective technology for preservation of milk can be implemented in rural areas, it can be beneficial to rural people. Ultra-high Temperature processing (or UHT) is the partial sterilization of food by heating it for a short time, around 1-2 seconds, at a temperature exceeding 135°C and then kept inside the aseptic package. Such a high temperature required to kill spores in milk. The high temperature also reduces the processing time, thereby reducing the spoiling of nutrients and has excellent keeping qualities and stored for long period of time at ambient temperature. Aseptic packaging machines are very expensive and UHT milk depends entirely on it. There is a need to reduce its cost so that UHT processing and packaging machine can be approachable to rural poor farmers in India.

Key words: UHT · milk processing · sterilization · rural

INTRODUCTION

Milk, the first food man takes on birth, is a 'treasure-trove' of more than 200 ingredients, many with unique functional and nutritional properties which modern processing is capable of isolating and refining for a multiplicity of uses in the food and related industries [1].

Largest milk producing country in the world, India, milk production is more than 80 million tones per year. Out of the entire production, 55 per cent are consumed as fluid milk and rest 45 per cent are sent for industrial processing. Most of the poor Indian communities, who are staying in rural areas, are involved in milk production. Though India is located in tropical climate. Sufficient cold chain and refrigeration facilities are not available in many parts of the country. These are very expensive for the rural poor people. Although milk is produced mostly in rural areas, its demand is high in urban areas. Milk preservation prior to distribution and sale is a major problem in tropical climate of India. So new scientific and efficient method is required to over come such problems. Presently more than 77000 village dairy co-operatives societies have been opened up in India, where more than 10.4 million farmers are members. If a low cost technology for preservation of milk can be implemented in rural areas, it will be a boom to rural people [2].

The advent of Ultra High Temperature (UHT) treatment of milk has added a new dimension to marketing of liquid milk in urban centers as well as remote areas. The distinctive feature of UHT processed milk is that it is sterile-not pasteurized - and so has long shelf life at room temperature. The UHT milk also known as long life milk is emerging as an attractive commercial alternative offering a hygienic product of unmatched quality which can be bought anywhere, at anytime and in any quantity [3].

UHT treatment to a product means exposing it to such powerful heat treatment that all micro-organisms killed and these products have excellent keeping qualities and can be stored for long period of time at ambient temperature. If such low cost technology is developed and used by farmers then he can earn more, improve social economy life, simplify deliveries, use simple and cheaper distribution vehicles and eliminate return of unsold products.

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CONCEPTUAL FRAMEWORK OF UHT MILK PROCESSING FOR RURAL DEVELOPMENT

Indian national economy is strongly based on agriculture and animal husbandry. Most people in rural areas are poor and living on low productivity agriculture, cattle rearing, related casual work and lack techniques to increase, improve and preserve their products. Present focus should be to reduce the problems of the poor villagers and improve their socio-economic status by utilizing the agricultural raw materials. The solution is to link of know edge, skills and investments into the villages, not only keeping appropriate technology in subsistence level, but giving new approach in substantial manner so that large value addition even within the limited investment is affordable by them at villages themselves.

Milk production began 6000 years ago or even earlier. Practically everywhere on earth, man started domesticating animals. As a rule herbivorous animal, multipurpose animals were chosen to satisfy his need of milk, meat, clothing etc. Farmer produces the food for all human being, however today his status is weak. Milk production is the efficient crop to him and will help to improve their income. It is possible integrated dairy farming with small scale milk processing systems can be very much helpful to rural farmers. Therefore the main thrust argument is that we have to introduce selectively various forms of technologies (Knowledge/skills) into the lives of poor people in villages.

In the process, the economic well being of farmers can be secured. Various recent studies and data suggest that dairying has enormous potential to improve the socio-economic status of the large proportion of rural population. Cattle are perhaps their only tangible asset and mainstay for their security.

Integrated dairy farming with processing, increase food production, rural employment. It directly helps in increasing crop production through making funds available for the purchase of essential inputs, e.g. seeds, fertilizers, pesticides etc. Thus the contribution of dairying to the nation's health and economic welfare is rather unique.

Milk production in India involves millions of small producers with little or no land, each of them raising one or two low yielding, non-descript cows or buffaloes. From the point of milking to the dairy, there are milk losses during milking, handling, transportation, processing etc. One more thing is that farmers are getting less value for money due to milk adulteration.

It is necessary to reduce losses in handling and processing of milk. There is need to develop processing methods to add value, increase shelf life. For this purpose, small scale processing and packaging machines, relevant in rural areas, will have to be developed [1].

STUDY ON UHT PROCESSING

Development of UHT: Louis Pasteur already carried out experiments on sterilization of milk in bottles, but it was not until around 1960, when both aseptic processing and aseptic filling technologies became commercially available, that the modern development of UHT processes started. UHT-treated milk and other UHT-treated liquid food products are now accepted worldwide, but it has not always been like that. The first UHT plant operated on the principle of direct steam injection. Compared with the in-container sterilization plants, the new UHT plants soon gained a reputation for producing an excellent flavour. The first indirect plant was introduced on the market some ten years later. Research and development have been intense since UHT was first introduced. Modern plants deliver a superior product with colour and nutritional values practically unchanged.

UHT milk in India: A pilot plant was set up in 1970 at Baroda to produce aseptically packed UHT milk. Initially, four packaging stations were started at Surat, Indore, Jaipur and Guntur. For more stations were later added at Baroda, Allepey, Vijaywada and Salem. In May 1990, a market study in Delhi was carried out by the Hindustan Packaging Company Limited (HPCL) to evaluate the buying behavior of consumers in a locality served by UHT milk. The study revealed that UHT milk did so on account of three factors: better health, convenience and aseptic packaging [3].

As to the milk quality, the microbiological standards within Europe, set by the council of the European Union (EU) to safeguard human and animal health, are shown in the Table 1.

Since heat treatment has become the most important part of milk processing and knowledge of its influence on milk better understood, various categories of heat treatment have been initiated as shown in Table 2.

Main categories of heat treatment

Thermisation: "Thermisation" is a heat treatment applied to raw milk aimed at reducing the number of organisms in milk and permitting longer storage of the milk prior to further processing. In many large dairies it is

Table 1: EU Standards for bacteria count in milk, in force 1 January 1993

Products	Plate count (CFU ml^{-1})
Raw milk	<100 000
Raw milk stored in silo at the dairy for more than 36 hours	<200 000
Pasteurized milk	<30 000
Pasteurized milk after incubation for 5 days at 8°C	<100 000
UHT and Sterilized milk after incubation for 15 days at 30°C	<10

CFU= Colony Forming Units

Table 2: The main categories of heat treatment in the dairy industry

Process	Temperature (°C)	Time
Thermisation	63-65	15 Sec
LTLT pasteurization of milk	63	30 min
HTST pasteurization of milk	72-75	15-20 Sec.
HTST pasteurization of cream	> 80	1-5 Sec.
Sterilization in container	115-120	20-30 min
UHT (flow sterilization)	135-140	A few seconds

not possible to process all the milk immediately after reception. Some of the milk must be stored in silo tanks for hours or days. Under these conditions, even deep chilling is not enough to prevent serious quality deterioration. Many dairies therefore preheat the milk to a temperature below the pasteurization temperature to temporarily inhibit bacterial growth. The milk is heated to 63-65°C for about 15 seconds. To prevent aerobic spore-forming bacteria from multiplying after thermisation, the milk must be rapidly chilled to 4 °C or below and it must not be mixed with untreated milk.Thermisation should be applied only in exceptional cases. The objective should be to pasteurize all the incoming milk within 24 hours of arrival at the dairy.

LTLT pasteurization: This method is called the *holder method* or the *low-temperature-long-time* method. This is a typical batch method where a quantity of milk is placed in an open vat and heated to 63°C and held at that temperature for 30 min. Sometimes filled and sealed bottles of milk are heat-treated in shallow vats by that method and subsequently cooled by running water.

HTST pasteurization: The term is an abbreviation of high-temperature-short-time. The HTST process for milk involves heating it to 72-75°C with a holding time of 15-20 seconds before it is cooled. Depending upon the quality of the raw milk and the degree of refrigeration, the shelf life may be from 2 days to 16 days. The primary purpose of heat treatment is to kill all micro-organisms capable of causing disease. Pasteurized milk must be entirely free from pathogens. The actual time/temperature combination varies according to the quality of the raw milk, the type of product treated and the required keeping properties. Cream is heated to a temperature above 80°C, with the holding time of about 5 seconds.

Sterilization: Conventional Sterilization is the original form of sterilization which involves in-container sterilization usually at temperatures from 115-120°C for 20-30 minutes. Sterilization is a process which causes complete destruction of microorganisms and their spores. Commercial sterilization does not always meet this definition, because some harmless, heat resistant bacteria may still be present. The criterion for food sterility remains to be a process, which will ensure no surviving botulism bacteria or their spores. The original form of sterilization, still used, is in-container sterilization, usually at 115-120°C for some 20-30 minutes. After fat standardization, homogenization and heating to about 80^{O}C, the milk is packed in clean containers-usually glass or plastic bottles for milk and cans for evaporated milk. The product, still hot is transferred to autoclaves in batch production or to a hydrostatic tower in continuous production.

UHT treatment: Milk can be made commercially sterile by subjecting it to temperatures in excess of 100° C and packaging it in air-tight containers. The milk may be packaged either before or after sterilization. The basis of UHT, or ultra-high temperature, is the sterilization of food before packaging, then filling into pre-sterilized containers in a sterile atmosphere. Milk that is processed in this way using temperatures exceeding 135° C, permits a decrease in the necessary holding time (to 2-5 s) enabling a continuous flow operation that takes place in a closed system that prevents the product from contaminated by airborne microorganisms.. This kills microorganisms, which would otherwise destroy the products. The product passes through heating and cooling stages in quick succession. Aseptic filling, to avoid reinfection of the product, is an integral part of the process.

Production of long life milk: Two methods are use for the production of long life milk.

A) In container sterilization, with product in package (container) being heated at about 115-120°C for 20-30 minutes. Ambient storage.

B) Ultra high temperature (UHT) treatment with the product heated at 135-150°C for 4-15 seconds followed by aseptic packaging in packages protecting the product against light and atmospheric oxygen. Ambient storage.

General UHT operating phases: These operating phases are common to all UHT systems.

Pre-sterilization: Before start of production the plant must be pre-sterilized in order to avoid reinfection of the treated product. The pre-sterilization involves:

- Hot water sterilization at the steam temperature as the product shall Undergo. Minimum time of the hot water sterilization is 30 minutes from the moment the relevant temperature has been reached in the whole aseptic part of the plant.
- Cooling the plant to conditions required for production.

Production: The heating medium and product are not in direct contact, but separated by equipment contact surfaces. Several types of heat exchangers are applicable:

- Plate
- Tubular
- Scraped surface

The production phases vary according to the different processes. The procedure described here is of the indirect UHT plant based on plate heat exchanger.

The product at about 4°C is pumped from the storage tank to the balance tank of the UHT plant and from there by the feed pump to the regenerative section of the plate heat exchanger. In this section the product is heated to about 75°C by the UHT treated milk, which is cooled at the same time. The preheated product is then homogenized at pressure 180-250 bars. The preheated, homogenized product continues to the heating section of the plate heat exchanger where it is heated to about 137°C. The heating medium is a closed hot-water circuit with the temperature regulated by steam injection in to the water. After heating, the product passes through the holding tube dimensioned for about 4 seconds.

Finally, cooling is performed regeneratively in two sequences: First against the cool end of the hot water circuit and then against the cold incoming product. The product that leaves the regenerative cooler continues directly to aseptic packaging or to and aseptic tank for intermediate storage. At temperature drop during production the product is diverted into a reject tank and the plant is flushed by water. The plant must be cleaned and sterilized before restart. If one of the packaging machines incidentally stops the aseptic tank take care of the surplus product during the stoppage [4].

Packaging for aseptic processing: Aseptically processed liquid foods and beverages are sterilized outside the package using an ultra-high temperature process that flash heats and cools the product before containers are filled. Time (generally 3 to 15 seconds) and temperature (90° to 140°C) are tailored to place the least amount of thermal stress on the product, while ensuring bacteriological safety. The *sterile food* product is then placed in an air-tight *sterilized package* with a within a *hygienic environment*. This preserves the food without chemical preservatives or refrigeration. The most important point to remember is that it must be sterile. All handling of product post-process must be within the sterile environment.

There are five basic types of aseptic packaging lines:

- Fill and seal: preformed containers made of thermoformed plastic, glass or metal are sterilized, filled in aseptic environment and sealed
- Form, fill and seal: roll of material is sterilized, formed in sterile environment, filled, sealed e.g. tetrapak
- Erect, fill and seal: using knocked-down blanks, erected, sterilized, filled, sealed. e.g. gable-top cartons, cambi-bloc
- Thermoform, fill, sealed roll stock sterilized thermoformed, filled, sealed aseptically. e.g. creamers, plastic soup cans
- Blow mold, fill, seal

There are several different package forms that are used in aseptic UHT processing:

- Cans
- Paperboard/plastic/foil/plastic laminates
- Flexible pouches
- Thermoformed plastic containers
- Flow molded containers
- Bag-in-box
- Bulk totes

It is also worth mentioning that many products that are UHT heat treated are not aseptically packaged. This gives them the advantage of a longer shelf life at

refrigeration temperatures compared to pasteurization, but it does not produce a shelf-stable product at ambient temperatures, due to the possibility of recontamination post-processing [5].

DISCUSSION AND CONCLUSIONS

- UHT milk remains fresh without refrigeration.
- UHT milk can be used anywhere and at any time.
- UHT milk is safe to drink with good keeping quality (i.e. for several months).
- The great advantage of UHT milk is the ability to transport it long distances and to store it atmospheric temperature.
- UHT treatment of milk saves time, lobour, energy and space.
- It is high -speed process and has much less effect on the flavour of milk.
- UHT plants are often designed with great product flexibility in order to enable processing of wide range of products in the same plant.
- The high sterilization temperature of milk causes denaturation of proteins, which are deposited onto the heat transfer surfaces to form fouling layer which reduces heat transfer.
- The milk is unsuitable for UHT treatment if it is sour and it has wrong salt balance.
- Little bit, the flavour of the milk is changed, due to high temperature.
- High heat treatment affects the nutritional quality of milk to a little extent.
- Once UHT package is opened, it should keep under refrigeration.
- UHT is more expensive process due to expensive packaging and therefore require more specific equipment.
- A small scale packaging machines need to be developed so that UHT milk can be produced on dairy farms, because the success of UHT milk is depend on only packaging machine.
- UHT treatment to milk can be stored at room temperature hence no need of costly refrigeration.
- Rural employment can be increased.
- Rural farmers will be aware with the technology.
- Dairy farm integrated with UHT milk plant, can be helpful for rural industrialization.
- Due to on-farm milk processing, milk adulteration can be minimized, resulting more customer satisfaction.
- It is necessary to reduce losses in handling, transportation and processing of milk to add value, increase shelf life, reduction in cost of preservation.
- For this purpose, small scale processing and packaging machines, relevant in rural areas, will have to be developed.

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