Preface

Pasteurization is a process in which the temperature of the raw milk is raised to a certain level for some time, and then immediately cooled to lower degrees to destroy most of the pathogenic bacteria. This is done to improve the keeping quality, taste and flavour of the milk. Undesirable taints of the milk are also removed by this process. This booklet decibels the concept, process and importance of pasteurization in detail.

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I. Introduction

Pasteurization is the process of exposing the milk to a controlled temperature for a specific time with the object of destroying all the pathogenic and souring bacteria, and cooling the milk immediately to a temperature low enough to retard the growth of the surviving bacteria.

The process of pasteurization is named after a French scientist, Louis Pasteur, who worked on wine during the year 1860 -1870 A.D. He observed that heating process improved the quantity of wine. Since then application of heat to improve the keeping quality of milk and milk products became a practice. Shortly after 1900 A.D. a commercial plant for pasteurization of milk was established in Germany and Denmark. At the present time, the practice of pasteurization of milk is popular throughout the world. Although boiling of milk in home is a common practice in India, almost all the dairies pasteurize milk before it is supplied to consumers.

It has been observed that a time-temperature combination of not less than 145° F and not more than 150°F maintained for 30 minutes or a temperate of not less than 161°F maintained for 15 seconds, followed by a rapid cooling to a temperature of not more than 50°F is sufficient to kill most of the common disease producing bacteria.

II. Advantages of Pasteurization

Pasteurization renders milk safe for consumption as it destroys the common disease producing organisms such as those of tuberculosis, typhoid fever, scarlet fever, diphtheria, etc. which may be present in the milk. It also destroys approximately 99% of all bacteria and most of the yeasts and moulds of milk. Thus, the keeping quality is improved, facilitating easy transport of milk over long distances.
In the case of pasteurized milk or cream, the desired type of ripening can be obtained more effectively. Pasteurization eliminates the undesirable traits from milk. Besides, the products prepared from pasteurized milk are of more uniform quality.

The temperature used for pasteurization neither affects the natural flavor of the milk nor the rising of cream as a distinct layer over the milk, which are usually caused when the milk is heated to higher temperature.

Boiling of milk at homes prior to consumption is probably on account of safety measures which is a common practice. It should be emphasized that raw milk should not be consumed as such. Since the atmospheric temperatures on India are comparatively higher all through year and the microbial count in raw milk is also very high, the keeping quality of such milk is very low. Normally, milk develops acidity which causes spoilage of milk within 4-5 hours of milking. In order to improve the shelf life of milk, it is necessary that the milk is properly pasteurized. Heating process destroys most of the organisms and the growth of those microorganisms which survive heat treatment is retarded due to proper cooling. When the milk is properly pasteurized and the bacterial load is not very high, it is expected that the milk will keep good for nearly 48-50 hours.

III. Temperature & Time Combination

The temperature-time combination for pasteurization process is principally based on the thermal death of the pathogenic organisms particularly Mycobacterium tuberculosis. This organism is one of the most heat resistant pathogenic organism. If this organism is destroyed by a particular temperature-time combination then all the pathogenic organisms present in the milk will be destroyed.

The phosphatase enzyme present in milk requires slightly higher temperature time treatment for its inactivation than the Mycobacterium tuberculosis does for its destruction. The temperature-time combination should, therefore, be slightly higher than that required for inactivation of phosphatase enzyme. The various temperature combinations for pasteurization process as effective against Mycobacterium tuberculosis and phosphatase enzyme are given here.

- 63°C for 30 min.
- 72°C for 15 sec.
- 89°C for 1 sec.
- 90°C for 0.5 sec.
- 94°C for 0.1 sec.
- 95°C for 0.05 sec.
- 100°C for 0.001 sec.

The bacterial quality of milk as received in the dairies in India is very poor. If the standard temperature for different methods are adopted for pasteurization of the milk, the keeping quality of the pasteurized milk improves. In order to have longer keeping quality, milk should be pasteurized slightly at a higher temperature than the standard temperatures. Since quality of milk change according to the variation in season, the temperature-time combination for pasteurization should be adjusted accordingly.

IV. Methods of Pasteurization

The methods commonly used to pasteurize milk are: (1) low temperature - long time (LTLT) or holding method, and (2) high temperature short time (HTST) method.
1. The low temperature process

In this process, the milk is brought to about 145 to 150°F and is held at that temperature for at least 30 minutes (63°C for 30 minutes). Then it is quickly cooled to a temperature of not more than 50° F. The low temperature process can be carried out in two different methods: The batch method and the holding (multi vessel) method. The latter is also called the retarding method. In the case of the batch method, the milk is heated or cooled in individual batches in one or two or sometimes three tanks. This system is suitable for capacity up to 1000 litres (220 gallons) per hour only.

In the case of holder or retarding system, a number of tanks are used, in which the filling, holding and discharging operations are carried out automatically in a timely cycle.

2. The high temperature -short time process

This is also known as the continuous flow or flash system. In this system, the milk is treated in a continuous flow at higher temperatures and held for a much shorter period than in the other systems. The temperature of the milk is quickly raised to at least 161°F for not less than 15 seconds as it passes through the machine, followed by a quick cooling to not more than 50°F. This system is suitable for all capacities from 230 litres (50 gallons) per hour only.

3. Advantages of HTST system

In the case of the HTST system) all the milk is uniformly pasteurized and cooked. As compared to the other system, it takes less time and is a continuous operation. The pasteurization process in this case is generally completed within three minutes from the time the raw milk has entered the plant, while in the other system, it takes about three quarters of an hour before the milk is ready for cooling and distribution.

The initial cost of an HTST plant is low. Also, the labour and time required for cleaning a HTST plant is less than the other types of plants as its cleaning is almost automatic, which consists of circulating detergents through the plate heat exchanger and pipelines. The operation costs are also comparatively less.

The HTST plant, which requires a relatively small boiler to operate, occupies less space. This plant is also more suited for the fitting of devices for automatic control. There are less chance of any valves getting opened accidentally. In case something goes wrong during the operation, very little quantity of milk is held over. The effect on the nutritive value and flavour of milk pasteurized by HTST method is negligible.

V. Other Methods of Pasteurization

Some other methods of pasteurizing the milk are described in detail here.

1. Flash pasteurization

This process is similar to HTST process but in this method temperature of milk is raised to 80°C for practically no holding period. This process destroys all the pathogenic organisms that might be present in the milk and makes it safe for human consumption. The major advantages of this process are (i) the reduction in nutritive value of milk due to heat treatment is less in this method as compared to other process, and (ii) the time taken for pasteurization is less as compared to other methods of pasteurization.

This method is not common in the milk industry of India. Although dairies invariably pasteurize milk by heating it to 80- 82°C for 16 seconds in the HTST pasteurizer. This practice
of higher heat treatment to the market milk is primarily due to higher bacterial count in the milk and poor quality milk received by the plants from the rural producers.

2. Bottle pasteurization
   In this method of pasteurization raw milk is filled in glass milk bottles which are tightly sealed with special caps. These bottles are subjected to heat treatment ranging from 63 - 66°C for a period of 30 minutes. Later on, they are passed through a spray of cold water which cools the milk to 5 – 7° centigrades. In our country the bottle pasteurization is not commonly practiced because of the reasons mentioned here.

   1. More chances of bottle breakage.
   2. Heat transfer during heating as well as cooling is very low.
   3. Special caps/capping machines are required.
   4. Over sized bottles are required to allow expansion of milk during heating.
   5. Vacuum pasteurization.

   This process of pasteurization is also called vacreation. The advantage of pasteurizing milk by this process is to remove off flavour from milk as well as from cream meant for butter making. It is an effective means of removing off flavours particularly due to feeds. Machine used for vacuum pasteurization is known as vacreater.

4. Ultra high temperature (UHT) pasteurization
   In the UHT process, milk is heated either by direct steam injection, swept surface, heat exchanger or turbulent heat exchanger. Milk is heated to about 135 -1500°C for practically no holding time. Heating of milk is usually done in two stages. The second stage is being UHT process under pressure, etc. Milk is aseptically packed while it is hot. Milk pasteurized by UHT process has additional advantages such as maintaining the nutritive value, colour and flavour similar to that of raw milk.

5. Stassanization
   The credit of developing this process of pasteurization goes to a French scientist Hcnri Stassno. The process is now in use to a considerable extent in milk plants of France, Denmark, Italy and certain other countries.

   The principle of its operation is heating of milk to the desired temperature by passing it through two water heated pipes through a narrow space of 0.6 to 0.8 millimeter. The milk is forced through the narrow space where it comes in contact with heating surface. The temperature of milk is raised to about 74°C for 7 seconds and immediately cooled to 4.5° centigrades.

6. Uperization
   The process of uperization is one of the modern inventions of the market milk industry. This process has been developed in Switzerland. It is gaining popularity due to several advantages which have been claimed by its inventor. In this process milk is heated with a direct steam of 150°C for a fraction of a second. The method of uperization consists of filtration or clarification of milk immediately after receiving, followed by cooling and storage in raw milk tank. This milk is then subjected to uperization process which consists of three stages.

   (i) Preliminary heaters
   (ii) De-aerating unit
   (iii) High temperature treatment and depressurizing unit.
In the first unit, the milk is pre-heated to 48.8°C (110OF) before passing through the vacuum or de-aerating system. De-aeration is considered necessary to remove dissolved oxygen and to save the ascorbic acid in the uperised milk, which is very oxygen sensitive. A large part of the volatile gases are also removed. The de-aerated milk then passes to the second unit of the tubular heater in which it is heated to a temperature of 71.1°C (160°F). From here it enters the uperization tube, where steam injection raises the temperature to about 148.8°C (300°F) in less than a second. The milk is channeled into another vacuum chamber where it is depressurised and partially homogenized. The partial steam distillation taking place during depressurising removes volatile gases. The advantages of uperization are a given here.

(a) Complete sterilization of milk.
(b) Removal of feed and other volatile of flavours.
(c) Increased resistance of milk fat to oxidative spoilage.
(d) High nutritional value.
(e) Inactivation of harmful enzymes.

The storage of raw milk and its transportation in warm climates of India is a difficult proposition. The uperization process can be very satisfactorily adopted for this purpose. The milk treated by uperization shall remain fit for human consumption for long periods, when aseptically filled into sterile and hermetically sealed tanks. The uperised milk can be transported at leisure in non-insulated tanks without refrigeration and sold even in the hottest weather. These possibilities for convenience and low cost transportation should be of great interest to milk distributors and dairymen in India.

VI. Boiling vs. Pasteurization

It can easily be argued that when every housewife boils milk in Indian homes why milk being pasteurized in the dairies. Pasteurization of milk increases the cost of market milk. In order to understand and justification of pasteurization of milk in the dairies one should know the basic differences between pasteurization and boiling. Boiling of milk would mean raising the temperature of milk to its boiling point under atmospheric temperature and pressure. The boiling point of milk is 100.17°C which is decidedly higher than the usual temperature adopted in holding method of HTST pasteurization process. Boiling of milk certainly destroys all the pathogenic organisms and makes it safe for human consumption, but there is no need for heating the milk for such a higher temperature when the same objective is fulfilled by pasteurization process. Extra heating of milk will amount to loss of heat energy and nutritive value of milk which other wise could be avoided. Also, in boiling process, there is no cooling involved hence the growth of those microorganisms which survive heat treatment is not retarded and, therefore, boiled milk has lower keeping quality than the properly pasteurized milk.

Boiling of milk is uneconomical and practically impossible in the dairies where large volumes of milk is handled every day. For individual household consumer; boiling of milk prior to consumption is certainly a useful practice. The common belief amongst the older generation that drinking of raw milk as it is obtained from the udder of animals is the best way of its consumption has to be contradicted on scientific grounds. This concept is rather more important in the present days where organized dairies collect milk from various sources and the hygienic practices in handling of milk are still far from satisfactory. The health of a large population will be at stake if milk is distributed without any resources to heating.