Commentary

History, trends, and extent of pasteurization

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Pasteurization is one of public health’s triumphs over the ignorance and superstition of past ages. Within a short span of a century, the beverage milk industry evolved from virtual obscurity to the giant of the food industry. Pasteurization, as the parboiling process came to be called, was the single nucleus around which all developments centered. The practical benefits of pasteurization were so obvious to some milk distributors that the process stimulated commercial developments.

Heat Treatment of Foods

The heat treatment of foods antedates recorded history. Since the discovery of fire, man used heat to prepare foods to preserve them and enhance their flavor.

Applying heat to liquids is a relatively recent practice, at least so far as records are concerned. In 1782, the Swedish scientist Scheele used heat in the preservation of vinegar. In 1824, William Dewees, a professor of obstetrics at the University of Pennsylvania, recommended heating milk to near the boiling point and than cooling it before feeding it to infants. The knowledge of the beneficial effects of boiling milk was not new even in the early 19th century. Undoubtedly, housewives had resorted to cooking or boiling milk for ages, for such practices still exist where pasteurized milk is not available.

The real breakthrough in heat treating milk was the discovery of an entirely new principle, that of parboiling or under boiling. Credit for discovery of this principle must go to Louis Pasteur, for the classic study of the application of heat in controlling fermentation and preserving the liquid product. From 1860 to 1864, he worked on and finally solved the wine spoilage problem. He found that by heating the wine to a sufficiently high temperature and time to inactivate the spoilage organisms, the basic character of the product could be preserved. Later he successfully applied the same heating principle to beer. Despite current popular writing, records fail to show that Pasteur ever applied the principle to milk. Yet the parboiling heat-treatment process basic to the modern milk market industry takes its name, pasteurization, from Pasteur.

In 1889, American pediatrician Henry Koplik heat-treated milk for infants and set up a dispensary for the operation. Then Nathan Straus, a New York philanthropist, became fascinated with the potentialities of Koplik’s work. Being appalled at the mortality of children fed raw milk, he established milk depots in New York City. The lowering of the death rate among children as a result of Straus’s ventures was astounding. Thereafter the heat treatment of milk became a philanthropic obsession with him. He carried the message of pasteurization to not only every large city of the United States but to Europe as well.

Milk distributors recognized the merits of heat treating milk early and practiced pasteurization even before standards were established. Straus lived to see pasteurization of milk a common process in all the large cities of America.

At the turn of the century, veterinarians were the supervisors of the local milk hygiene and tested the cows for tuberculosis. Today they continue the supervision of dairy farms to ensure that cows are free of tuberculosis and brucellosis as well as mastitis and other diseases.

During this time, and even up to 1920, the fluid milk industry lacked cohesion and assurance. But two specific heat treatments of milk, namely flash and holder pasteurization, were to have marked effects on the solidarity and reputation of the market milk industry. Flash pasteurization connoted several nonspecific temperatures, always below boiling, to which the milk was heated momentarily. Generally the process involved a continuous milk flow. Temperatures usually accorded flash pasteurization were 68.3 to 73.9 C (155 to 165 F). Rosenau gave the following brief description of the process in the 1912 US Public Health Service Bulletin on Pasteurization.

“The flash method consists of heating the milk momentarily to a temperature of about 178 F [81 C] and chilling at once. This method is sometimes incorrectly called ‘commercial’ pasteurization. It does not give uniform results, is not entirely reliable and does not meet with the approval of the sanitarian. The method however is rapid and cheap.”

Despite its shortcomings, early flash pasteurization not only served its purpose, but also created an awareness of the necessity of pasteurization in the minds of a wary consuming public. In addition, flash pasteurization made ready the coming of holder or vat pasteurization, the basic process on which the foundation of the modern milk industry was built.

Early on it was recognized that Mycobacterium
bosis occasionally survived pasteurization. A University of Wisconsin scientist found that injection of hot air killed the tuberculosis organisms that survived in the foam that built up in the vat pasteurizer.

Objections to Pasteurization

Pasteurization was not always readily accepted by consumers as a necessary process in the distribution of milk. Many health food hygienists in the early 20th century frowned on the practice of parboiling milk, believing it to be little more than a substitute measure for sanitary milk production. However, time and research have proved the invalidity of many of the early beliefs against pasteurization of milk.

Not until much research in milk production, processing, nutrition, and public health had been made, and America had been well launched by the late 1930s into a dairy technologic era, were most of the early objections to pasteurized milk overcome. Even then, educational forces claiming the virtues of pasteurized milk were confronted often with some milk consumer’s firm but false belief that the best milk was raw milk.

When undertaking a survey of the obstacles to be overcome in the minds of consumers, one appreciates more fully the dedication of the milk industry to the benefits to mankind. For the most part, the objections involved sanitary, nutritive, or economic aspects (Appendix). Only when furnished and fortified with data proving that raw milk could be a potential health hazard, did city officials adopt milk ordinances compelling the pasteurization of milk sold within their jurisdiction.

Defense of Pasteurization

With so many unfavorable beliefs about the pasteurization of milk, one is astounded that the process was ever successfully introduced. The final acceptance of pasteurization by milk distributors, the public health officials, and eventually by the consumers is little short of phenomenal. The fact that virtually all of the bottled beverage milk in the United States is pasteurized short of phenomenal. The fact that virtually all of the bottled beverage milk in the United States is pasteurized, that tuberculosis would become rampant, and that milk's nutritive qualities for feeding calves was pasteurized, and gave impetus to the control of bovine tuberculosis in calves fed this milk.

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Milestones in the Pasteurization of Milk

Certain discoveries, introductions, and processes aided the development of milk pasteurization to its present high level of achievement. Among them were:

1870s—In Denmark, Professor N.J. Fjord applied the Pasteur process for retaining the quality of wine and beer to milk.

1885—Milk was pasteurized on a commercial scale in Denmark and Sweden.


1890—Pasteurization of cream for butter making, first introduced to Denmark, became a common practice by 1890. A continuous heater, which momentarily heated the milk to 85°C (185°F), was developed in Denmark. Hence, the skim milk returned to the farm for feeding calves was pasteurized, and gave impetus to the control of bovine tuberculosis in calves fed this milk.

1900—Russell and Hastings established that 60°C (140°F) for 20 minutes destroyed M tuberculosis and other pathogens.
study “The Thermal Death Points of Pathogenic Microorganisms in Milk.”

The first compulsory pasteurization law in the United States that affected all milk sold within the city (with the only exception of milk from tuberculin-tested cows) became effective in Chicago.

1948—Introduction of ultra-high temperature pasteurization

1966—Sterile concentrated milk is commercially marketed worldwide and has proven safe for weeks after container is opened. Within the decade, a new treatment combining the advantages of pasteurization and sterilization has resulted in ultra-high temperature milk. This semi-preserved milk has a bacterial composition approaching sterility, an absence of organoleptic defects, and a superior keeping quality compared with pasteurized milk.

Raw Milk and Foodborne Diseases

A review of the epidemiology of raw milk associated with foodborne diseases reported in the United States 1973 to 1992 follows:

“The hazards of drinking raw milk are evident from the list of infectious diseases that may be acquired from this product; these include campylobacteriosis, salmonellosis, yersiniosis, listeriosis, tuberculosis, brucellosis, staphylococcal enterotoxin poisoning, streptococcal infections and *Escherichia coli* O157:H7 infection.”

The purpose of that report was to produce a description of the epidemiology of outbreaks of disease associated with raw milk reported to the Centers for Disease Control and Prevention (CDC) from 1973 through 1992. Furthermore, a determination was made of the rates of reported raw-milk-associated outbreaks among states in which the sale of raw milk was legal at the time of the outbreak and states where the sale of raw milk was illegal. Finally, investigation was undertaken to determine whether the mean annual number of outbreaks reported for the period prior to 1987 differed from that beginning in 1987, when the US Food and Drug Administration implemented a ban on the interstate sale of raw milk.

Forty-six raw-milk-associated outbreaks were reported to the CDC from 21 states during the study period. The median number of persons who became ill in the outbreaks was 19 (range 2 to 190). Thirty-eight reported outbreaks occurred prior to 1987 (mean, 2.7 outbreaks/y), compared with 8 outbreaks after 1987 (mean 1.3 outbreaks/y). In 38 (86%) reported outbreaks, the implicated raw milk was produced at a commercial dairy.

Survey responses regarding the legal status of raw milk sales were received from all 52 jurisdictions (the 50 states plus Puerto Rico and the District of Columbia). At the time of the survey, 28 (54%) states permitted the intrastate sale of raw milk. In all states where the sale of raw milk was legal, the estimated volume of raw milk sold as a percentage of the total milk sold (ie, pasteurized and unpasteurized milk) was less than 1%.

Some countries in Europe continue to have epidemics traced to raw milk. In May 1997, a major outbreak of gastroenteritis occurred in six kindergartens in a small town in Saxony-Anhalt. One hundred eighty-six of 412 (45.1%) persons (children and staff) were affected (gastroenteritis associated with high fever and in 16% of persons, with bloody feces). *Campylobacter jejuni* was isolated from the fecal specimens as the only agent. All persons involved had eaten the same meals delivered from a mass catering kitchen, but not all delivered components of the meals had been consumed by each of them.

“The established clonal identity of isolated campylobacter strains from raw milk and bovine feces of the corresponding milking cows with the outbreak strain suggests the obviously inadequately heated raw milk to have been the vehicle of the causative agent.”

A few years ago, a question was raised about the heat inactivation of *Mycobacterium paratuberculosis* in raw milk. Studies at the National Animal Disease Center demonstrated effectively that all *M paratuberculosis* were effectively killed at 72 C for 13 seconds.

Subsequently the US Food and Drug Administration affirmed that current pasteurization standards are sufficient to ensure complete killing of *M paratuberculosis* in raw milk.

More recently Van Kuuringen, DVM, MD has reviewed the Johnes’ disease/ *Mycobacterium paratuberculosis* and Crohn’s disease. He concludes that the pathologic, microbiologic, serologic, and epidemiologic features do not support a common cause of Johnes’s disease in animals and Crohn’s disease in humans.

“Cow’s milk and its products are safe, healthful, and exceptionally nutritious foods that play an important role in the American diet. Certain components of milk may even be helpful in the prevention or management of may disease states. Cows’ milk and its products should not be eliminated from government guidelines or programs.”

References


Sanitation:
- Pasteurization is an excuse for the sale of dirty milk.
- Pasteurization may be used to mask low-quality milk.
- Pasteurization promotes carelessness and discourages the efforts to produce clean milk.
- Compulsory pasteurization would diminish the incentive to clean milk production.
- Pasteurization would remove the incentive for producers to deliver clean milk.
- Pasteurization enables the distributor to sell stale milk to the public, and so eliminates the necessity for the dairyman to get milk from the farm to the consumer as quickly as possible.
- Heat destroys great numbers of bacteria in milk and thus conceals the evidence of dirt.

Public Health and Safety:
- Pasteurization may be carelessly done. It is therefore not infallible.
- Unless the milk is handled and bottled sanitarily after pasteurization, "the safety factor" of pasteurized milk is lost.
- Pasteurization is often inefficient.
- Imperfectly pasteurized milk is worse than raw milk.
- Toxins present as result of disease-bacterial action are not destroyed by pasteurization.
- The toxins formed by disease bacteria may not be destroyed by pasteurization, or possibly dangerous substances might be formed by destruction of other bacteria.
- Pasteurization fails to destroy bacterial toxins in milk.
- Some of the poisonous toxins are not killed at the temperatures used.
- Products of bacterial growth are not destroyed.
- Organisms developing in pasteurized milk form harmful products.
- Pasteurized milk may diminish resistance to disease.
- Pasteurization, by eliminating tuberculosis of bovine origin in early life, would lead to an increase in pulmonary tuberculosis in adult life.
- Pasteurization is unnecessary, because raw milk does not give rise to tuberculosis.
- The death rate from tuberculosis remains uniformly lower in rural areas where all milk is drunk raw than in cities where all milk is pasteurized.
- Pasteurization would discourage the eradication of disease in dairy cattle.
- Universal pasteurization would lead to the elimination of tuberculosis of the bovine type, and so result in an increase in tuberculosis of the human type.
- Compulsory pasteurization would remove the stimulus to the eradication of diseased animals from milking herds.
- Pasteurization affects the disease resisting property of milk.
- Pasteurized milk interferes with the proper development of the teeth and predisposes to dental caries.
- Pasteurization has often been accused of possessing the great disadvantage of producing scurvy and rickets.
- Pasteurization of milk diminishes the fertility of animals fed on it, and might increase the present fall in the birth rate.
- Pasteurization would lead to an increase in infant mortality.
- Pasteurization of all the milk supply of a community may not be desirable.
- The certified milk and the special milk free from contamination may not need it. Certain invalids and babies may require raw milk.
- The medical profession is not unanimous in support of pasteurization.
- Pasteurization is not advocated by the Pasteur Institute.
- It is wrong to interfere in any way with nature's perfect food.
- Pasteurization gives a false sense of security.