CHEESE
AND
FERMENTED MILK FOODS

Volume II
Procedures and Analysis

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Heat-treated cheeses in the U.S. and many other countries must be handled and labelled like raw milk cheese, i.e. held for at least 60 days. The temperature over that period must be at least 1.7ºC.

Heat-treated milk hard ripened cheeses have achieved an excellent safety record over the past 45 years. Nevertheless, more and more hard ripened cheese is being produced from pasteurized milk due to the new technology now in place which permits the addition of flavor and texture enzymes to cheese milk or curds, leading to increased typical cheese flavor and acceptable body.

Thermization

Thermization of milk means to initially heat-treat milk short of minimum pasteurization, but its origins and major objective differ. Whereas heat-treatment of milk is limited to cheese making and the practice occurred before the development of bulk tanks on the farm, thermization occurred with the advent of bulk tanks on the farm and silos at the plant. Its major objective is to arrest the activity of psychrotrophic bacteria in long held milks intended largely for the fluid milk market by preliminary heat-treatment, followed shortly thereafter by pasteurization. This does not exclude its use in cheese making, particularly for pasteurized milk cheeses.

Scandinavian countries were among the first to appreciate the benefits of thermization and researchers there conducted many early and basic experiments. Biorgum from Norway in 1974 reported that thermization of refrigerated milk at 66ºC - 15 seconds maintained the quality of raw milk up to the point of pasteurization, the ultimate quality control mechanism. An international standard for time and temperature has yet to be officially established for thermization.

UHT Milk

Ultra high temperature (UHT) milk, 150ºC - 2-1/2 seconds as an example, is not generally accepted as good manufacturing practice for standard cheese making. This is because rennet coagulation of the milk is seriously impaired. However, when ultrafiltered whole milk is ultra high temperature (UHT) treated, such concentrates can be successfully used in most cheese making. Maubois et al. in 1973 discovered this anomaly, and that rennet coagulation proceeds normally under this new circumstance.

CHEMICAL TREATMENT OF CHEESE MILK

Hydrogen Peroxide

There is no universal use of H_2O_2 in cheese making, but the U.S. federal Food and Drug Administration permits the chemical sterilization of milk intended for Cheddar and Swiss cheese with not more than 0.05 percent hydrogen peroxide. Excess hydrogen peroxide, which remains after having destroyed the milk bacteria, is removed by the addition of the chemical or microbial catalase.

At the levels permissible in cheese milk, hydrogen peroxide kills most, but not all of the bacteria in the milk. Its effectiveness depends upon the initial amount added, the time and temperature of exposure, and the bacterial flora of the milk. The catalase which follows, decomposes the residual hydrogen peroxide to water and oxygen in the reaction:

$$2\,H_2O_2 \rightarrow 2\,H_2O + O_2$$

If this reaction did not go to completion, the residual hydrogen peroxide would destroy the incoming starter bacteria. Although apparently all residual hydrogen peroxide is removed by the catalase to give a negative potassium iodide, KI, test, in practice, catalase treated milk does not support the growth of active lactic starter bacteria strongly until about one hour after starter addition. It acts significantly like a "slow" milk during this recovery period.

Hydrogen peroxide for cheese making is strictly limited to the electrolytic process type. pharmaceutical hydrogen peroxide cannot be used in foods because it may contain heavy metals.

Cheddar and Swiss cheese from peroxide-catalase-treated milk have had their quality grades raised, and no doubt exists that cheese made by this method is often superior in quality to that from raw or pasteurized milk. Sometimes, however, a chemical-flavored, softer pasty cheese results, with excessive retention of hydrogen peroxide.

Some disadvantages in the use of H_2O_2 for cheese making are: (1) it raises the cost of chéese making; (2) the cheese must be held for 60 days as there is no guarantee that the treatment destroys all pathogens; (3) it leads to a delay in cheese-making operations requiring extra steps and careful administration.

Formaldehyde

Adding formaldehyde to cheese milk legally to suppress the clostridia and other spoilage bacteria has been closely associated with Grana cheese production in Italy. The small amounts of formaldehyde remaining are regarded as harmless by Italian authorities, and during the long ripening of these cheeses, the formaldehyde in the cheese suppresses spoilage bacteria.

Formaldehyde as a bacteriostatic agent is blended with the milk prior to pan setting overnight in cool areas during which time the cream separates by gravity. Agglutination of fat globules and bacteria occur during this period and many spoilage bacteria are removed with the cream. Approximately 25 to 40 ppm formaldehyde are added to the milk but within a month, this concentration in the cheese drops to 3 to 5 ppm, Table 54. An alternative practice has been to add 4-hexamethylene tetramine to the cheese curds. This compound used in fish preservation eventually breaks down to formaldehyde to give the cheese protection against late gas blowing clostridia.

TABLE 54. Formaldehyde in Five Representative Samples of Grana Milk, Whey and Cheese

	Samples				
	1	2	3	4	5
			--ppm--		
Vat milk	25.4	27.5	33.6	32.2	25.2
Whey right after cooking	21.6	22.4	27.0	27.8	22.4
Cheese - 6 hours long	3.7	3.7	5.1	5.1	3.4

Botazzi, V. 1974. Proceed. 11th Annual Marschall Invitational Italian Cheese Seminar, Madison, WI.

Optional Ingredients or Chemical Additives in United States Federal Standards

The degree to which a food may be protected against spoilage is usually clearly specified in the various countries' standards of identity, Tables 103 and 104. Different nations take different views of what constitutes an acceptable chemical addition or treatment. These views vary widely, not only between countries but also in the same country over a period of time. Some European countries, for example, permit the addition of sodium nitrate ($NaNO_3$) to cheese curds in the vat to prevent gas production, a control measure not permitted in this country. The U.S. Food and Drug Administration, on the other hand, allows the hydrogen peroxide treatment of some cheese milk, but this practice is not permitted in most European cheese-producing countries. Italy was, at one time, very liberal in its chemical additive policy with respect to foods, but since 1963, new, strict laws have been imposed. For example, nothing can be added to Italian milk used for cheese except rennet, color, formaldehyde, and salt. Hydrogen peroxide and even innocuous stabilizers, like locust bean, are expressly forbidden for cheese. The United States policy was highly restrictive a decade

TABLE 103. Some Additions and Treatments Permitted by United States Federal Standards of Identity for Natural Ripened Cheese

Addition or treatment[1]	Maximum amount of resulting chemical	Purpose
1. Hydrogen peroxide	0.05% wt. milk	Destroy milk spoilage organisms
2. Benzoyl peroxide	0.002% wt. milk	Bleach fat to remove unsightly yellow in curd
3. Vitamin A		Reinstate vitamin destroyed by bleaching
4. Antimycotic agent as sorbic acid in slices and cuts only	0.3% wt. cheese	Prevent mold growth
5. Harmless enzymes	0.1% wt. milk	Increase or improve flavor
6. Green and blue dyes	Amt. necessary to neutralize yellow color of curds	Remove unsightly yellowish tinge of curd
7. Calcium chloride	0.02% wt. milk	Firm the curd
8. Artificial smoke	No specification	Flavor
9. Spice or spice oils	0.19 g/kg cheese	Flavor

[1]Not applicable to all cheeses. Check general standards, reference section, for specific cheese coverage.

Hydrogen peroxide treatment requires post addition of enzyme, catalase, less than 20 ppm wt. milk, to destroy excess peroxide.

Benzoyl peroxide preparations contain inert material, potassium alum, calcium sulfate and magnesium carbonate which are restricted to 6 × weight of active benzoyl peroxide.

qualitative test indicates that no H_2O_2 remains. The maximum amount of catalase permitted is 20 ppm of the weight of the milk treated.

Determining H_2O_2 in Milk after Catalase Addition
9:00 A.M.

Pipette 5 milliliter portions of the treated peroxide-catalase milk into clean test tubes. Then add 3 drops of fresh 30 percent potassium iodide (KI) solution.

A canary yellow color indicates the presence of residual H_2O_2; a white color, normal for milk, indicates its absence. Run positive controls. If the yellow color persists, either extend the waiting period or add an additional small amount of catalase to the milk.

When the milk becomes white upon testing, proceed with cheese making as normally practiced by first adding starter, color, and rennet. Allow a milk ripening period for Cheddar cheese of as long as 60 minutes to avoid incipient "slowness".

Precautions and Notes

The amount of H_2O_2 used under the legal limit is a variable, depending on the number of bacteria in the cheese. Large numbers require more peroxide. The working range is usually 330 to 660 milliliters per 1,000 kilograms of milk (150 to 300 milliliters per 1,000 pounds).

Hydrogen peroxide, at the rate of 594 milliliters of 35 percent H_2O_2 solution per 1,000 kilograms of milk, is equivalent to 0.02 percent of 100 percent H_2O_2. Concentrated H_2O_2 is corrosive; avoid any contact with skin or eyes.

Single service testing strips, EM Quant (EM Science, Cherryhill, NJ, USA) turn color on contact with milk containing residual H_2O_2.

Always use electrolytic H_2O_2; never that purchased from pharmaceutical sources. Do not employ other than stainless steel or aluminum vats and equipment when treating milk with H_2O_2. Tin and copper are easily corroded, and even brief contact may ruin kettles or vats.

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curd mass.

Ricotta cheese can be made with different combinations of acid and heat, but 80ºC and 0.30 percent titratable acidity is the usual combination for whole milk. Heating may take place using culinary steam in 2,000-liter or larger steam jacketed kettles fitted with removable direct steam injectors and noise mufflers. Direct steam injectors serve to agitate the milk while raising its temperature. The direct steam injector pipes are removed after curd formation, but then steam pressure is applied slowly in stage-like steps from 35 to 300 kiloPascals in the jacket. The continued heating efficiently raises the submerged curd particles to the surface. The kettles are never filled to the top because milk expansion occurs during heating, causing overflow and foaming problems.

Miscellaneous accessory equipment includes cooling sinks, or refrigerated drums, large spatulas, perforated scoops, pumps for introducing starter, packaging machines for cartons 224 grams or higher, starter making equipment, and perforated bulk containers from 1 to 45 kilograms.

Composition and Yield

Ricotta cheese is characterized by a high moisture content very similar to that of creamed Cottage cheese. Its fat content is related to the amount of fat in the milk. Typical composition of fresh commercial samples of Ricotta and Ricotone cheese made at various fat levels is indicated, Table 42. New York State standards require, in part, that Ricotta cheese from whole milk contain at least 11 percent fat and not more than 80 percent moisture. Salt content may be less than 0.2 percent. In some Ricotta, no salt is added.

Yields of Ricotta, Impastata, and Latin-American white cheese, Table 43, are among the highest because the application of high heat and acid precipitates considerable lactalbumin and lactoglobulin. To attain maximum lactalbumin and lactoglobulin, however, may require a secondary acetic or citric acid precipitation which for whole milk Ricotta cheese adds about 18 kilograms cheese to the first 180-kilogram lot. Curd from the primary precipitation is soft and tender, while that from the secondary is harder and tougher. The two are usually blended to mitigate to some degree the "ugly duckling" features of the latter.

TECHNICAL HIGHLIGHTS OF RICOTTA CHEESE PREPARATION

Precipitation Influences

In Ricotta cheese making the bulk lactic starter, when held cold for 24 to 48 hours after curdling with unchanged acid, is, for reasons unknown, considered by the industry more effective as a coagulating agent than a freshly curdled starter. It is reported to have a "greater kick". Perhaps a change occurs in milk casein micelles or in salt combinations, as affected by age and acid, that allows them to help initiate a clean precipitate.

This bulk lactic starter, added to whole milk for Ricotta cheese, actually precipitates the milk due to the introduction of free hydrogen ions. At a high temperature, the net electrical charge of the casein is reduced, driving the system towards a final equilibrium, precipitation.

Precipitation of curd from milk for Ricotta and related cheeses is attained through partial dehydration of all the proteins in milk and an accompanying high rate of particle collision induced by high heat. The pH, at 5.9 to 6.0, is low enough to accelerate the precipitation but yet high enough to give the cheese a sweet curd, Table 44.