Proceedings from the 12th Annual Marschall Invitational Italian Cheese Seminar 1975

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1975

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Marschall
Division
Miles
Laboratories
Inc.
P.O. Box 592
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Wisconsin 53701
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The following paper was presented by Gerald D. Weiner, Project Engineer, LADISH CO., Tri-Clover Division, Kenosha, Wisconsin 53140, especially for the 12th Annual Marschall Invitational Italian Cheese Seminar held at the Dane County Exposition Center, Madison, Wisconsin on April 28 and 29, 1975.

PROFIT POTENTIAL FROM CHEESE WHEY
By Gerald D. Weiner

Cheese whey is a valuable source of nutrition. Markets utilizing whey warranted the development of manufacturing facilities. The following records indicate the fast growth of whey. (1)

1957 - 1,037,000 lbs. of cheese whey was processed
1970 - 468,000,000 lbs. were processed.
1973 - Total whey amounted to 1,500,000,000 lbs.; of this, 800,000,000 lbs. was processed while 700,000,000 lbs. was not.

Protein has a great demand in the United States and the world. Soybean protein is the number one source. The following figures indicate the rapid rate of demand in the United States. (1)

1974 - Americans utilized, in one source or another, 96,000,000 lbs. of soy protein products.
1975 - Forecast of 137,000,000 lbs.
1980 - Forecast of 216,000,000 lbs.

This merely shows the need for developing more sources of protein.

Skim milk was a drug on the market in the 1940's. By changing some standards of identity, skim could be used in more products, and, thereby, a profitable market was developed. The Grade A label was a major factor in this change.

Cheese whey is going through the same process now. New standards of identity are being established. The Whey Products Institute Food Amendment Program provides a continual thrust for opening up new markets for the whey industry. Whey and modified whey products, whey protein and lactose are being utilized in an expanding market. Utilization has shown an increase in soft drinks, chocolate, whey soya drink in over-seas programs, margarine and ice cream, canned apple sauce, frozen peas, jellies and preserves, canned grapefruit and canned corn. The Whey Products Institute has submitted to the USDA-APHIS a petition to provide for the optional use of modified whey in smoked cooked sausage, such as hot dogs, bologna, etc.

The research and development of systems using ultra-filtration and reverse osmosis has been progressing for years. There are several companies presently involved in commercial applications of these processes.
Mr. Frank Thomas began working with these systems in 1969. In 1971 he came to Tri-Clover for assistance in various applications. Developments progressed and in June of 1973, Mr. Thomas started his first system on a commercial basis in his plant in South Dakota. From this start, he was able to develop a premium market for his protein powder as an animal feed.

The USDA has shown great interest in the development of systems for utilizing whey. Mr. Robert Semrad of the USDA has been assigned to work with the various systems to develop standards for a food grade product. After an inspection in October of 1974, a letter from George W. Fry, Acting Chief of the Inspection and Grading Branch, indicated they could see no obstacles in approving dairy plants using this equipment or in providing official inspection service on dairy product fractions made with this equipment. This letter pertained only to the protein fractionator.

The application of sanitary development for food grade products was necessary in many areas. A brief outline follows:

I. Developing a module
   A. Give proper flux (high transmission rate)
   B. Sanitary construction
      1. Cellulose acetate material.
      2. Spiral wound on PVC for greater capacity - 60 sq. feet of surface per cubit foot.
      3. Cover shroud used to wrap the module is heat shrunk.
      4. Seal on cover - insure flow through modules. Initially the seal was taped to the module. Presently it is being glued to the cover shroud to meet necessary standards.
      5. All materials used for construction of module are on the acceptable list of the F.D.A.

II. Develop equipment to hold the module.
   A. 4" stainless steel tube in desired lengths with sanitary fittings.
   B. Sanitary coupler to connect the modules, made of stainless steel and Buna N.
   C. Anti-telescoping device made of teflon - maintains modules in position.
   D. End connectors with necessary sanitary fittings for distribution.

III. Pumps, gauges, valves and controls.
   A. Use of two centrifugal pumps to develop necessary pressures.
   B. Micrometer valves are used to control pressures.
   C. Gauges are used to determine proper operation pressures.
D. Proper programming in conjunction with automatic valves, maintains correct flow patterns as required by USDA.

Presently there are several patents which have been received pertaining to the sanitary construction of this machine. Continued developments will be made along these lines.

A brief description of the protein fractionator system operation follows:

1. Separate and cool whey upon removal from vats. Whey is very unstable, thus, cooling reduces chemical changes and denaturization of protein.

2. Filter on way to fractionator.

3. Protein concentrate will account for 15% by volume. Total solids of 11% of this protein concentrate will give a 34% protein. This product, on a dry basis, is extremely similar to non-fat dry milk.

4. Pasteurize protein concentrate upon discharge from fractionator.

5. Evaporate protein concentrate to 45% total solids.

6. Dry, collect, and bag the powder. The protein powder recovery is 1.5 lbs. per 100 lbs. of whey.

The cleaning of the fractionator is done by CIP and is programmed into the controls. A enzyme product is used as the cleaning agent. The unit is sanitized prior to start-up with iodine.

Bacteria counts have been given much consideration in ultrafiltration. Tests conducted on whey after cooling average about 300,000 per milliliter. There are those who feel bacteria will not pass through the membranes, however, from tests run, this does not appear to be the case. The protein concentrate has bacteria counts similar to that of cooled whey. Pasteurized protein concentrate counts have been running less than 1,000 per milliliter.

The permeate (5% total solids) contains approximately 83% lactose. By utilizing a module for lactose, it is possible to recover lactose on another fractionator as it is discharged from the protein equipment. The lactose is then evaporated, dried, collected and bagged. Lactose recovery varies between three to four pounds per 100 lbs. of whey depending upon the type of cheese manufactured.

Sweet whey only has been processed on the fractionators. Mainly it has been colby and cheddar cheese. In March 1975, a system was started on acid whey. Protein recovery was slightly higher on acid whey than on sweet whey. The removal of fines from the acid whey presented somewhat of a problem initially. However, this was corrected.

The question is often asked, "Does the return justify the expense?" "Can a person make a profit on an operation for whey utilization?"
The answer is yes. Lynn Proteins, at Granton, Wisconsin built a new building, installed all equipment necessary and are operating on a profitable basis. It was possible to receive a profit and loss statement of 1974 on their operation. The statement is accurate and was used for determining their taxes. The following information is a breakdown of this operation on all costs. One cost factor which is not included in this information is depreciation. It is a variable factor from plant to plant and, therefore, was not included in these figures.

Cost Study from Profit and Loss Statement - 1974

1. Plant has been in operation since April 1, 1974.

2. First 11 months operation 60,822,982# of whey has been produced on a 5 day week operation.

3. 912,850# protein powder has been produced. Average Protein Content 34.52% equal 1.505#/100# whey. Yield 315,115# pure protein.

Composition of 34.5% Protein Powder

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<tr>
<td>Protein</td>
<td>34.5</td>
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<tr>
<td>Ash</td>
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<tr>
<td>Fat</td>
<td>3.6</td>
</tr>
<tr>
<td>Lactose</td>
<td>52.0</td>
</tr>
<tr>
<td>Moisture</td>
<td>3.5</td>
</tr>
<tr>
<td>TOTAL</td>
<td>100.0# Powder</td>
</tr>
</tbody>
</table>

4. Costs were based on daily average production of 250,000# whey, 5 days a week. All costs are based on 100# whey produced.

A. Labor

- Plant Manager
- Three Plant Workers
- One Part-Time Office 7.5¢ / 100# whey

B. Fuel

- Boiler
- Building Heat
- Processing
- Cleaning 5.7¢ / 100# whey

C. Utilities

- Refrigeration
- Heat
- Light
- Processing 2.96¢ / 100# whey

D. Module Replacement 6.51¢ / 100# whey

E. Miscellaneous Costs
5. Based on these figures, the following information is formulated:

250,000# whey/day @ 22 operation days/month = 5,500,000#
5,500,000 X .3338¢ Profit / 100# whey = $18,359 / month X
12 months = $220,308 NET / year.

6. The figures here are actual P & L statements for 1974 operation at this
volume. The equipment has the potential of handling 700,000# / day, 6
days/week. Putting all the same costs to this volume would give the fol­
lowing results:

700,000# whey/day @ 26 days/month = 18,200,000#
18,200,000# X .3338¢ = $60,751 Profit per month X
12 months = $729,019 / year.

7. Lactose is another phase of whey processing. At the present time, estimate
figures are available for determining costs. Lactose recovery will vary
with the type of cheese. Cheddar cheese will yield about 4# lactose / 100#
whey. The lactose product is 90% purity with fractionation.

The estimated cost of producing lactose from 100# whey would be .24¢. The
recent price received on a market is .24¢/#. On this basis the following
is figured.

100# of cheddar whey = 4# lactose @ .24¢/# = .96¢
Process Costs = .24¢
Profit / 100# Whey = .72¢

A net return of $1.00 per 100# of whey is the potential of a fractionator system.
On the basis of 10 pounds of cheese per 100 pounds of milk with a .01¢ profit per pound, yields net profit on cheese of .10¢ per 100 pounds milk.

The "Profit Potential from Cheese Whey" is clearly indicated from information
presented in this paper. An invitation to visit the Lynn Protein plant by ap­
pointment is extended.

REFERENCE
1) Whey Products Institute Seminar, September 18-19, 1974
The following paper was presented by Professor K.M. Nilson, Department of Animal Sciences, University of Vermont, Burlington, Vermont 05401 especially for the 12th Annual Marschall Invitational Italian Cheese Seminar, held at the Dane County Exposition Center, Madison, Wisconsin, on April 28 and 29, 1975.

DIRECT SALTING AND AUTOMATION

By Professor K.M. Nilson and F.A. LaClair

Complete or partial automation of the Mozzarella cheese industry is restricted without a method of direct salting. Once direct salting is developed automation can become a reality.

The objective of this paper was to show that direct salting is possible and how direct salting automation can be attained.

We will deal with the manufacture of the cheese and discuss a method to accomplish automation in each step.

First let's start with the manufacture of the cheese. Any method now being used to manufacture the cheese up to milling, hot water treatment and stretching can be used. In Figure 1 is found the first step in the automation process. Fig. 1 A is where the cheese comes from the curd table to be milled and elevated to the cheese cooker-stretcher. Any type cooker-stretcher machine now being used will fit into the system. The trays are stacked on the end of the primary conveyor (Fig. 1 B). They are then fed into the primary conveyor system as required. The cheese after stretching goes to the multiple shaper (Fig. 1 C). Cheese loaves are shaped to the desired size. The cylinder on the shaper has a pressure sensing device that determines when the desired loaf size is attained. Once the desired loaf size is attained the cheese is ejected automatically into the plastic mold tray. There are 32 individual compartments in each tray. The tray size would be determined by the loaf size desired. After the tray is full it moves to the presalter. (Fig. 1 D). While in the presalter position 0.8 of one percent salt is forced into each cheese loaf. If more salt is desired it can be added at this stage. Additional information pertaining to the pre-salting step will be discussed later. Once salted the tray moves to the next position (Fig. 1 E) where foot like pads with slight pressure, flattens the top of the cheese loaf for smoothness. Two to four minutes are required for this operation. The cheese tray then moves to the cold water tank (Fig. 2) for cooling. At this point a transfer station (Fig. 2 A) picks up the tray from the primary conveyor to the first position in the cooling tank. This tank can be built any size required. A temperature of 33°F would be required to cool the cheese to a desired firmness in one hour. Each tray moves through the cooling chamber in 64 minutes when 4800 lbs. of cheese is processed per hour. The tray moves one position every two minutes. When less than 4800 lbs. of cheese is processed per hour a longer cooling period is possible. If more than one hour is desired the cooling operation can be slowed down or a larger tank could be used.

Cooling water can be refrigerated by existing machinery if available or by new equipment.

After the cooling cycle is complete the cheese trays are removed from the chamber by means of another transfer station (Fig. 2 C). The tray is then flipped (Fig. 3 A) over with the loaves of cheese falling into the salt brining trays. Loaves that stick in the tray will be removed by the loaf ejector (Fig. 3 B).
The trays are then returned to the tray stacker (Fig. 1 B) by way of a tray return. Each tray passes through the inplace cleaning chamber (Fig. 1 G) where they are washed, rinsed, and sanitized before being used again. At the end of each operation the cooling tank is drained, cleaned and sanitized automatically.

The salt brine tank Fig. 3 is similar to the cooling tank. The trays used for salt bringing (Fig. 3 E) are the same dimension as the cooling trays except they are perforated with holes. When the salt brining tray is full it starts its movement down into the salt brine. It moves one position every two minutes. The second tray keeps the cheese in the first tray from floating out. After the complete salt brine cycle the cheese loaves are dumped by the unloading unit (Fig. 3 E).

The salt brine is refrigerated with its salt concentration automatically controlled.

The trays are then re-cycled back to the salt brine loading position for re-use. At the end of each days operation the salt brine trays are cycled through the C.I.P. section for cleaning and sanitizing. Then, when necessary the salt brine is pumped to a storage tank and the salt brine tank is automatically cleaned.

Once the cheese loaves are dumped from the salt brine trays they go through an alignment carousel (Fig. 4 A) for automatic feeding to the packaging and sealing operation (Fig. 4 B). From the sealer each loaf of cheese is weighed (Fig. 4 C) and stamped (Fig. 4 D). After boxing, each box is weighed automatically with its weight stamped on the outside.

In the pre-salting operation there were two methods studied. One was the direct addition of salt tablets to the cheese. Four tablets 1.6, 3.0, 5.0 and 10.0 grain in size were tested. The reason for using tablets rather than granulated or flake salt was the time required for the salt to dissolve. Its a known fact that when granulated salt is added or mixed with Mozzarella cheese curd the body and texture of the curd changes rapidly making it almost impossible to shape or mold a proper loaf. By using salt tablets the rapid change in body and texture does not take place until after the cheese is molded. It was determined that the 1.6, 3.0 and 5.0 grain salt tablets could be used satisfactorily if properly incorporated into the cheese. The 10 grain tablet was too large causing cavities or holes in the cheese after the salt had dissolved in the cheese.

Up to 1% salt was added directly to the cheese. One of the minor defects of the cheese was when 3 or 4 tablets would be concentrated in a small area causing a hole or cavity in the cheese after the salt had dissipated. The best method used to direct salt Mozzarella cheese was to place the cheese in the 5 lb. molds and then add the salt to the cheese by means of a pressure gun. Actually shooting the salt tablets into the cheese. With this method salt tablets up to 3 grains could be used. The cheese must be hot when the salt is added in order for the skin or outer surface of the cheese loaf to heal without scars. The salt tablets dissolved within two days with no apparent ill effects. After one hour of salt brining it was possible to attain a 1.5% salt content in the cheese. Also, the outer surface of each loaf was texturized by the salt brine treatment, along with helping to prevent mold growth. Cheese direct salted by the two methods discussed above were checked for meltability and stretching characteristics. There were no apparent ill effects by either method of salting.
The following paper was presented by Mr. William R. Thomas, Product Manager, Food Applications, FMC Corporation, Avicel Department, Marcus Hook, Pennsylvania 19061, especially for the 12th Annual Marschall Invitational Italian Cheese Seminar held at the Dane County Exposition Center, Madison, Wisconsin, on April 28 and 29, 1975.

MICROCRYSTALLINE CELLULOSE - AN ANTI-CAKING AGENT FOR GRATED AND SHREDDED CHEESE

By E. J. McGinley and W. R. Thomas

Caking and flow difficulties are common problems in industries producing or utilizing grated and shredded cheeses. High temperature stability, changes in relative humidity, pressure packing, and the composition and particle configuration of the cheese itself are some of the important factors affecting flowability.

A number of ways of overcoming flow problems, to some extent, are employed commercially. These include: selection of cheese by composition, controlling particle size, drying to a low moisture content, and the addition of anti-caking agents.

The purpose of this study was to characterize the use of microcrystalline cellulose (MCC) as an anti-caking agent and flow aid for grated and shredded cheeses.

Cellulose, and particularly microcrystalline cellulose, may not be familiar to you. MCC is a non-fibrous form of cellulose in which the cell wall of the plant fiber has been broken into fragments ranging in size from a few hundred microns to a few tenths of a micron in length. (Figure 1). MCC is chemically identical to native cellulose and has the same x-ray diffraction pattern. Only the physical form of the cellulose raw material is changed in the course of manufacture of MCC; cellulose in fiber form is converted to cellulose in particle form. It occurs as bland, white, odorless, crystalline, flour.

The unique ability of MCC to convert cheese and other pasty oleaginous materials to a granular free-flowing form was demonstrated in 1959. Recently, the Swift Company, with the support of the National Cheese Institute, Inc. petitioned the federal government to allow the use of MCC as a flow aid for grated cheeses. The Federal Standard of Identity for grated cheese was formally amended on June 11, 1973 to include the optional use of MCC as an anti-caking agent not to exceed two percent by weight of the finished food (21 CFR 19.791).

The functionality of MCC (Avicel® - FMC trademark) as a flow aid for certain types of grated cheese blends has been proven in commercial situations and can be demonstrated visually simply by comparing a cellulose-based product to a control product. However, to instrumentally assess flowability by conventional methods is difficult due to the unusual configuration of shredded cheese particles and variability in fat and moisture contents between different types of cheese. Consequently, we had to develop a device and establish a method and set of conditions before we could measure relative differences in flow.
Conventional methods of flow measurement, such as angle of repose and angle of spatula, were not suitable for measuring the flow of shredded cheese. Several different constant delivery devices were constructed and evaluated in an effort to accurately characterize cheese flow in near absolute terms. The criteria in determining if a device was suitable was (1) its ability to reasonably duplicate the flow of a given cheese sample, and (2) its sensitivity was such that differences in flow between samples could be measured.

A stainless steel funnel with a vibrator attachment was selected as our delivery system. By trial and error with cheese samples representing extremes of flow we were able to determine the proper orifice size for our tests. Bridging at the lip of the funnel was minimized by cutting the orifice on a bias to form an elliptical-shaped opening 24 mm x 28 mm. (Figure 2).

In addition to measuring total flow as a function of time, it was also desirable to obtain a profile that would indicate the uniformity of flow. The grated cheese was metered through the vibrating funnel into an elongated container that was divided into six in-line compartments of equal volume and spacing. Exact alignment of the container to funnel was ensured by two channels that served as guides. The orifice was positioned directly on the leading edge of the first compartment of the container which in turn was attached to a constant speed motor with a nylon cord. Motor activation and stopper removal were initiated simultaneously. Each compartment required 1.66 seconds to completely transverse the orifice. When the cycle was completed, the sample deposited in each of the compartments was weighed. Neither the first nor last compartment containing sample was utilized in our calculations. The average of five consecutive cycles was calculated on a cumulative basis and represented graphically either as a flow profile or total flow versus time.

An indication of the precision of our method for measuring flow is shown in Figure 3. Duplication of a given sample was reasonably good, and relative differences between samples of different flow were easily distinguishable. Thus, a reliable laboratory method for flow measurement of shredded cheese was achieved that is essentially the principal of the tablet weight method used in the pharmaceutical industry.

Analysis of the results of 100 different tests has enabled us to categorize cheese flow according to our method. (Figure 4). Straight upright lines in the graph are representative of samples with good flow properties; broken lines are indicative of momentary bridging or interrupted flow; and, of course, in the case of poor flow, only a small amount of sample is collected in the prescribed time.

The flow profiles of various types of grated cheeses without flow aids is shown in Figure 5. Commercial blends A, B, and C, consist of Parmesan and Romano dehydrated to a 14-28% moisture
content and grated to a fine particle size. Conventional Parmesan and Romano grated to medium size particles exhibited a fair-to-good flow. The high moisture varieties such as Mozzarella, Cheddar, and a processed Gruyere exhibited very poor flow properties.

Except where cheese particle size was a variable, all samples were hand grated to an intermediate size consisting of irregular shaped particles 1 mm x 15 mm. Total sample amount was confined to 100 grams. Blending of the MCC powder with the grated cheese was accomplished by hand tumbling for a few minutes in a bowl. Different methods of blending were investigated with no significant differences noted between gentle tumbling methods. However, it would be advisable to avoid blending operations that exert pressure on the sample resulting in compaction of the particles.

MCC has an affinity for both moisture and free fat contained on the surface of cheese particles. The large particle size of the MCC in comparison to the micro fine size of other anti-caking agents allows for a uniform distribution of the cellulose on the cheese.

Figure 6 indicates that sufficient cellulose to cellulose contact rather than cheese to cheese contact will greatly minimize caking. Even when pressure is exerted during blending or storage and compaction results in a cheese to cheese bond between the cellulose particles, the surface area involved is small enough and the bonds weak enough that gentle agitation will quickly break them apart.

Grated Cheddar or Mozzarella cheese particles are very moist, cake readily, and exhibit a poor flow profile. (Figures 7 and 8). When MCC is added to the cheese at gradually increasing use levels, the slope of the curve sharply increases resulting in more product being delivered per given time unit at a more uniform rate.

The size and configuration of the particles are an important consideration when evaluating the flow of any food product. Generally, the smaller (up to a point) and more uniform the particle size the better the flow. Cheddar cheese was grated to three different particle sizes; namely, (a) small uniformly shaped particles 1 mm x 2 mm, (b) intermediate particles 4 mm x 15 mm, and (c) large, irregularly shaped particles 5 mm x 30 mm. (Figure 9). Due to the poor inherent flow properties of the Cheddar, we were unable to determine the effect of particle size on the flow of the control sample; however, the application of 2% MCC to the same cheese made the effect of particle size on flow quite apparent. In addition to functioning as an anti-caking agent, MCC also facilitates the flow of large, irregularly shaped cheese particles.

Four one hundred gram samples of grated Cheddar cheese blended with two percent MCC were conditioned at 40, 70, 85, and 105°F for twenty-four hours then immediately subjected to the flow test to determine the ability of MCC to counteract high temperature flow problems. (Figure 10). Caking at 40°F is primarily due to
surface moisture, and the effect of the cellulose anti-caking agent is readily apparent. At 85°F the grated Cheddar cheese containing the anti-caking agent is far superior in terms of flow than Cheddar containing no MCC at 40°F. Above 85°F a gross separation of the melted butterfat occurs which even MCC is unable to contain.

Two percent MCC was applied to a blend consisting of equal parts high moisture Mozzarella, Cheddar, and Romano cheeses. Initial moisture content of the blend was 37%. Samples of the blend were conditioned at 15, 33, and 97% relative humidity for 24 hours prior to evaluation. Changes in sample moisture content were as follows:

- Control blend @ 15% RH - 25% moisture loss
- Control blend @ 33% RH - 4.5% moisture loss
- Control blend @ 97% RH - 1.1% moisture gain
- MCC/cheese blend @ 15% RH - 23% moisture loss
- MCC/cheese blend @ 33% RH - 3.2% moisture loss
- MCC/cheese blend @ 97% RH - 0.45% moisture gain

As can be observed in Figure 11, MCC will counteract the effects of high relative humidity on the flow of this cheese blend.

In conclusion, MCC is an ideal anti-caking agent and flow aid for certain types of grated high moisture cheeses; namely, Cheddar and Mozzarella. MCC blends easily with the shredded cheese particles without creating the dusting problem associated with the micro fine anti-caking agents. MCC can be easily distributed on the surface of the cheese so as not to distract from product appearance. Adverse temperature, humidity, and particle size conditions can be overcome when MCC is applied to grated or shredded high moisture cheeses.
STRUCTURE OF FIBROUS CELLULOSE AND AVICEL PH

AVICEL® - FMC trademark for microcrystalline cellulose

FIBROUS CELLULOSE FROM WOOD PULP
375X

FIGURE 1

AVICEL PH
375X
Apparatus Used to Evaluate Free Flow Characteristics of Shredded Cheese

FIGURE 2
Indication of Precision of Our Method for Measuring Flow

AVICEL® - FMC trademark for microcrystalline cellulose
Measurement of Flow as Determined by Categories

Figure 4
Flow Profiles of Various Types of Grated Cheeses

TEST CONDITIONS:
40%RH
75°F
MODERATE VIBRATION

Commercial Grated Cheeses

Blend A
Blend B
Blend C

Romano

Parmesan

Cheddar

Mozzarella (hi moisture)

Gruyere (processed)

TIME IN SECONDS

CUMULATIVE PERCENT

Figure 5
Effect of Avicel PH-101 on the Flow of Grated Low Moisture Part Skim Mozzarella Cheese as a Function of Time

TEST CONDITIONS:
40% RH
75°F
MODERATE VIBRATION

FIGURE 7

AVICEL® - FMC trademark for microcrystalline cellulose
SHREDDED LOW MOISTURE, PART-SKIM MOZZARELLA

AVICEL® - FMC trademark for microcrystalline cellulose
Effect of Avicel PH-101 on the Flow of Grated Cheddar Cheese as a Function of Time

TEST CONDITIONS:
40% RH
75 °F
MODERATE VIBRATION

AVICEL® - FMC trademark for microcrystalline cellulose
Effect of 2% Avicel PH-101 on the Flow of Grated Cheddar as a Function of Particle Size and Time

TEST CONDITIONS
40% RH
75 F
MODERATE VIBRATION

CHEESE PARTICLE SIZE
a = small, uniform
b = intermediate
c = large, irregular

AVICEL® - FMC trademark for microcrystalline cellulose
Effect of 2% Avicel PH-101 on the Flow of Grated Cheddar Cheese at Various Temperatures as a Function of Time

TEST CONDITIONS
40% RH
MODERATE VIBRATION

FIGURE 10

AVICEL® - FMC trademark for microcrystalline cellulose
Effect of 2% Avicel PH-101 on the Flow of a Grated Blend of High Moisture Mozzarella, Cheddar, and Romano Cheeses at Various Relative Humidities as a Function of Time

**TEST CONDITIONS**

75°F
MODERATE VIBRATION

**FIGURE 11**

AVICEL® - FMC trademark for microcrystalline cellulose
The following paper was presented by Jack Fowler, Western Regional Engineer, CREPACO, Inc., Oakland, California, and Robert Elliott, Product Manager, Automation, CREPACO, Inc., Chicago, Illinois, especially for the 12th Annual Marshall Invitational Italian Cheese Seminar held at the Dane County Exposition Center, Madison, Wisconsin, on April 28 and 29, 1975.

FLUID FLOW AND PROCESS AUTOMATION IN THE CHEESE PLANT

By Jack Fowler and Robert Elliott

Crepaco, Inc., began its service to the Dairy Industry in 1887 when it was organized as the Creamery Package Manufacturing Company. In the early days manufacture and sales were aimed at the butter industry, but since that time marketing programs were expanded to cover stainless steel equipment and refrigeration systems which are utilized by the entire Food Industry. The development of Food Industry equipment has been accompanied by the mechanization and automation of the fluid flow and process control necessary for individual components to be integrated into an automated system.

About fifteen years ago, Crepaco introduced to the Market Milk industry "High Efficiency" milk plants. These plants were designed to process large volumes of a few products. The term "chain-store plant" or "super-market plant" was quickly assigned to this type of milk processing factory. Today's milk plants use the same design principles, but some of the automation gear has been improved and simplified. The equipment involved consists of large volume silo-type storage tanks, high capacity high-temperature, short-time pasteurizing units of 6,000 to 10,000 gallons per hour, air operated valves for automatically routing products around the processing plant, and high speed packaging equipment that fills, cases, and stacks the cases of milk cartons before transferring them to the cold storage warehouse. The control of the plant is from a master control panel where the operation automatically controls most product routing functions of the plant. The plant is cleaned daily by a central C.I.P. System, thus eliminating manual cleaning of the tanks and other processing equipment. The stainless steel piping is of all-welded construction, eliminating any take-down piping. The product piping is also cleaned daily by the plant C.I.P. System.

Recently the cheese industry, along with other food processors, has been faced with economic and ecological problems. Automated fluid flow offers cheese factories a solution for some of these problems. Presently, because of consolidations and expansions, cheese factories with a daily intake of 300,000 to 2,000,000 lbs. per day are not unusual. For factories of these capacities, the investment in automation can offer economies in labor utilization, inventory control of processing time and temperatures, control of cultures, and a systemized approach to daily cleaning of equipment. When these advantages are achieved, a better yield in product quality and lower product losses are the ultimate result. Since much of the cheese milk processing prior to innoculation is similar to that for market milk, the installation of equipment acceptable for market milk, provides flexibility for future product consideration at little or no extra cost.
A typical cheese factory flow diagram (See Figure 1) traces the movement of raw milk until cheese is produced. The flow chart also denotes the routing of by-products through the plant. These different areas all lend themselves to automated fluid flow. Because of the short time available, discussion is confined to only one of these areas -- automation of the pasteurizing and standardizing area. Not only can temperature be controlled, but the butterfat of the milk can be continually monitored to assure uniform fat content during the run. The high-temperature, short-time system is made for continuous processing. Its use eliminates the need for extra storage tanks, pumps, and air-operated valves. A continuous system, such as this reduces product damage from excessive pumping and air purging. A typical efficient continuous processing system might follow the scheme illustrated in Figure 2.

Raw milk is transferred from the raw milk storage area to the constant level tank of the high-temperature, short-time (H.T.S.T.) pasteurizer system. At this point, the level in the balance tank is sensed to assure that the feed tank will not reach too high or too low a level. Raw milk is then transferred from the balance tank to a deaerating vessel. The deaerator maintains a vacuum condition in the tank which draws from the milk any entrained air that has been incorporated during over-the-road transport, mechanical and air agitation, and product pumping operations.

After leaving the deaerating chamber, the raw milk is heated by regenerative heating from 38°F to 125°F in the plate heat exchanger. The heating media in this case is previously heated milk passing on the other side of the plate thus conserving heat. At this point with raw milk at the discharge of the raw regenerator section at 125°F, the flow is split. Half of the milk is transferred to a positive type pump for a constant flow rate. This pump is equipped with a pulse generator to signal the gallons per minute flowing through the head of the pump. The other half of the milk is sent to an automatic desludging separator/clarifier.

The separator/clarifier has a fixed flow orifice at the inlet to assure a constant feed rate. A back pressure valve is installed in the skim discharge to maintain a constant back pressure in the skim line. The cream line from the separator is the key to the continuous composition control system. An adjustable orifice installed in the cream discharge acts as a cream screw to regulate the flow and ultimately, the butterfat test. This is usually set to produce a 40% raw cream. There are two air-operated valves in the cream line, one allowing cream to combine with the skim from the separator. The other permits the excess to be pumped through a cooler to storage. The pump is a positive type with a variable speed drive. The rotative speed of this pump is regulated by control equipment according to the actual butterfat content of the product in the downstream area of the H.T.S.T. unit. Automatic sampling is performed with milk samples transferred to a continuous on-line butterfat test. The continuous tester requires approximately 30 seconds to sample, test, compare results, and initiate action to speed up or slow down the excess cream pump. Sampling may be as
frequent as desired. During a long run, sampling may occur as infrequently as every 8-10 minutes.

The raw milk, made up by combining cream, skim, and milk, is then sent to the heater section of the H.T.S.T. system. Quality control managers of individual plants dictate pasteurizing temperature and holding time which will be used, but 170°F for 16 seconds is a typical pasteurizing treatment.

After leaving the heating section, holder tube and flow-diversion valve, the cheese milk is sent through the pasteurized regenerator-down section of the H.T.S.T. where it will leave the plate unit at approximately 82°F. At this point the cheese milk is ready for transfer to the cheese vats. The raw product has been automatically transferred from raw storage through the H.T.S.T. System, and the cheese vat filling is an automatic, sequenced operation. This is a typical system. A metered, or controlled volume, system may be used where somewhat more control sophistication is desired.

Previously made starter is fed by a volumetric meter into the cheese milk as it leaves the H.T.S.T. System. The amount of starter required for each vat is preset at the central control panel by the system operator. Because starter is added during vat filling, it is distributed quite uniformly throughout the vat.

The Milko-Tester control loop eliminates any manual setting required by the H.T.S.T. operator, thus assuring a consistent day-to-day testing procedure for butterfat. The entire H.T.S.T. System can be cleaned-in-place with chemicals automatically injected at the balance tank. A C.I.P. programmer controls the time, temperature, and pH relationship of the cleaning cycle. The use of air operated routing valves, metering pumps, and controls enables the entire system to be monitored from a central control panel.

In conclusion, there is a trend to automating cheese factories. Air operated valves, meters, and C.I.P. Systems reduce plant labor. Since the advent of the automatic butterfat tester, automation engineers have been able to design systems that close the loop between automation devices and control equipment. The future for cheese factories appears to indicate the use of large volume, more nearly maintenance-free equipment with sophisticated control systems to assure greater precision of composition control and accurate processing steps -- all leading to lower production costs and more uniformity in quality of cheese.
TYPICAL FLOW PATTERN OF CHEESE PLANT
TO CHEESE VATS

RAW MILK IN

BALANCE TANK

BOOSTER PUMP

BOOSTER PUMP

TIMING PUMP

SEPARATOR CLARIFIER

CREAM PUMP

EXCESS CREAM COOLER

FLO DIVERSION VALVE

PLATE HEAT EXCHANGER

HOLDER TUBE

BUTTERFAT TESTER

RAW MILK
The following paper was presented by Professor Frank V. Kosikowski, Department of Food Science, Cornell University, Ithaca, New York, especially for the 12th Annual Marschall Invitational Italian Cheese Seminar held at the Dane County Exposition Center, Madison, Wisconsin, on April 28, 1975.

THE WHITENING OF MOZZARELLA CHEESE

By Professor Frank V. Kosikowski

Color of a food carries with it a deep psychological meaning for the individual which is difficult to explain. It may have originated from some happy or sad personal experience or from a group syndrome which once accepted was carried over for years by succeeding generations. How does one explain that consumers in New York prefer yellow colored Cheddar and white shell eggs whereas in the Boston market, it is white Cheddar cheese and brown eggs. The color of foods issue is often emotionally charged and it is real.

Cheeses come in all colors and it may surprise some that for Mozzarella cheese, pure white is a basic requirement. Why then did we settle for white and not a nice buttercup yellow or a sunset red or a Kelly green?

This particular consumer desire stems from history relating to the experience of parents brought up in Central Europe, the Mediterranean Sea area, and Southwest Asia where cheeses of the Mozzarella, Feta, Lightvan, and Roquefort varieties were snow white. They were white because the usual milking animals of the area, the water buffalo, sheep and goat gave milks that were flat white. In America these animals are either unavailable or their milk is not used for cheesemaking. The cow is dominant and unlike the above milking species, the cow introduces a yellow component into her milk, b-carotene. Its amount varies with season existing at higher levels in the spring and summer. For example, butter contains 2.7 μg carotene/gram in the winter and 6.1 μg/gram in the summer (2). Cheese made from cow’s milk, unless artificially dyed or decolorized, gives a yellowish-white product of irregular intensity. Generally, the appearance conveys a sordid, unappetizing melange of dirty yellow. So historical traits and unsightly appearances explain why most present-day Mozzarella cheese is white.

Natural Ways to Whiten Cheese

The easiest natural way for making white Mozzarella is to replace for cheesemaking all cows with water buffaloes as was done in the southern area of Italy around Naples, but it is not the most practical. Water buffaloes are docile animals who produce 4,000-6,000 pounds of milk annually and require only one daily milking. Their milk is pure white the year around. But, unfortunately or fortunately, we are geared to the cow and it is extremely doubtful that the amazing water buffalo could survive in our environment or would be very happy here because of her gentle, sensitive nature and the need to submerge herself in water holes up to her neck.

Another natural way is to select more cow’s milks with proportionately large numbers of small fat particles as usually occurs in milk of late lactation or to mechanically reduce the size of the fat globules by homogenization so that the majority are about 1 μm in diameter. Smaller fat globules, more of which are found in milk from Holstein than Guernsey cows, do not absorb light so readily as larger globules and preferentially reflect light better thus giving surface whiteness. But for Mozzarella, one cannot reverse the seasonal character of this cheesemaking – to the winter when less carotene exists and to the fall when most cows are nearing the end of lactation. Though made the year around, much of this cheese is produced in spring and summer and the milk of the Holstein cow dominates. Homogenization
of milk at 500-1,000 psig single stage gives whiter appearing cheese, but unfortunately, a significant part of the curd stretch quality is lost - so homogenization, which has been tried, is no open door to success.

In the Po Valley of Italy, some Mozzarella cheese is produced white throughout the year from cow's milk which has received no artificial decolorization. Inquiry has produced no fully satisfactory answer but the temperature of setting such milk for starters and rennet is low, about 85°F and it may be a contributing factor. Also, the average carotene level of the Italian cows may be low throughout the year which, of course, raises the issue as to whether cows could not be bred to produce milk of high colorless Vitamin A and low yellow-colored carotene, or fed special feeds during the summer months to counteract the carotene-rich grasses.

Some cheesemakers, meanwhile avoid the entire problem by applying food-grade yellow dyes to their cheesemilk and obtain a uniformly colored straw-yellow cheese as occurs with some imported Blue cheese and perhaps some Mozzarella.

Decolorization of Cheesemilk

In industrial cheesemaking, three usual means of reducing the uneven yellowish color of cow's milk cheese include:

a) adding neutralizing dyes which absorb yellow color
b) bleaching the b-carotene with benzoyl peroxide
c) masking yellow taints with titanium dioxide

The usual neutralizing dyes have been chlorophyll complexes and FD&C No. 1 blue. Recently, some questions have been raised about the long term effects upon man of such chlorophyll so reportedly this dye is less popular. Because blue-green color dyes absorb yellow, their addition to cheesemilk is for this purpose. In practice, the principle works, but a problem is created when the amount of blue color added is in excess of need and as a result a green color predominates in the cheese. Some consumers just don't like green. Carotene, of course, varies throughout the year and for each cattle breed. Thus, unless its level is specifically measured beforehand, the amount of neutralized dye to add is guesswork and excesses do occur.

Benzoyl peroxide belongs to the group of compounds known as diacyl peroxides with the following general formula:

\[
\begin{align*}
\text{R} & \quad \text{O} \quad \text{O} \quad \text{R} \\
\text{O} & \quad \text{C} \quad \text{H} \quad \text{O} \\
\text{H} & \quad \text{C} \quad \text{H} \\
\end{align*}
\]

The diacil peroxides burn with great intensity and once started, the flame is difficult to put out. Accordingly, containers containing materials with diacil peroxides should be stored carefully away from sunlight, open flames and oxidation reduction agents. Precautions listed for preventing skin and eye contact by handlers should be followed. However, in commercial blends, the presence of CaSO₄ and MgCO₃ stabilizes them to reduce these dangers to a great extent. Benzoyl peroxide, also referred to as pigment white 6, is used in the bleaching of soaps, waxes, and fats including butterfat.
As a bleaching agent, benzoyl peroxide is legally permitted for the whitening of cheesemilks for Blue and certain Italian types including Mozzarella. The application is time consuming as cream is usually separated from the cheesemilk and treated with 0.001-.002% benzoyl peroxide at 145°F or higher for 45 to 120 minutes. To determine color intensity of the fat and optimum levels of bleach, the cream in small lots may be churned beforehand. Because carotene is destroyed up to 50 percent by benzoyl peroxide bleaching, there is a legal requirement that the cheese-milk or cheese must be supplemented with colorless Vitamin A. The bleaching treatment may adversely change the stretching property of the Mozzarella cheese and may cause oxidized flavors. For decolorizing Blue cheese, it has been an effective technic (2).

Titanium dioxide, also known as Lucidal 88, is a white inert, highly insoluble powder with the formula TiO2. It is distributed by the H. Kohnstamm Company, New York, in two forms of about equal whitening power - Atlas White, not easily dispersible, and Kowet, highly dispersible. The latter is preferable for cheese. As far as is known, titanium dioxide does not destroy b-carotene. The use of this whitening compound is permitted in New York State and perhaps other states, but the United States Food and Drug Administration has not taken a decision on the matter, although one is expected soon. The Administration, however, permits the addition of titanium dioxide up to 1 percent in other foods, including white candies such as bonbons.

Technique for Administering Titanium Dioxide

The process is extremely simple for Mozzarella cheese but there are some precautions. Titanium dioxide as a white powder is weighed out, depending upon season and cattle breed at 2.0-4.0 lbs. to 10,000 lbs. cheesemilk. This powder is next mixed with 15-20 quarts of lukewarm water, to prevent localized white particles development in the cheese, and then applied to the warm milk being mechanically stirred in the vat before rennet addition. Following proper addition of rennet, all stirring of milk ceases and when the curd forms, cheesemaking proceeds as usual.

Some Experiments with Titanium Dioxide

Research on the application of titanium dioxide to whiten Mozzarella cheese was reported in 1969 by Kosikowski and Brown (1). Atlas White was the compound used in these experiments, initially from 0.02 to 0.05 percent by weight of cheesemilk. This range gave the most satisfactory results and improved color qualities as detected by the eye and by the Hunterlab Model D25 Color and Color Difference Meter, Table 1, Figure 1. In practice, 0.03 percent was satisfactory for most conditions and seasons. For milk of Jersey or Guernsey cows, slightly higher levels are required but a 0.04 percent addition covered all contingencies. After treatment, the Mozzarella cheese assumed a uniform, white satiny appearance. The experience with low moisture Mozzarella cheese is more limited and certain aspects of the making such as the agitation used during cooking and the higher fat levels of the cheese indicate more titanium dioxide, .04-.06 percent, may be required.

In the Cornell experiments, excessive levels of Atlas White titanium dioxide also were added to note their effects. Using 0.1-0.4 percent, the immediate result was that all utensils and vats coming into contact with the milk were coated with a fine white film and the resulting finished cheese showed white patches and flaking of pigment when surfaces were handled manually or mechanically. It proved that amounts of titanium dioxide added to milk were self-limiting at very low levels for good manufacturing practice and high quality cheese. Unlike neutralizing dyes, however, amounts larger than recommended do not turn cheese green, it always remains white, and unlike benzoyl peroxide application, there is no apparent need to use supplementary Vitamin A. Where Mozzarella cheese is directly acidulated with acetic acid, some irregular color striations may appear. Titanium dioxide addition corrects this defect.
The Ethics of Decolorizing Food

It is naturally better to produce white cheese naturally but market circumstances may lead to decolorization practices, as has happened for much Mozzarella cheese. The immediate temptation is to condemn out of hand the use of food bleaches or decolorizers which have parallel industrial uses such as soap decolorizers, or as paint pigments. Some perspective may be achieved if one considers that single cell protein foods now being advocated for animal and human feeding, are derived from petroleum or industrial wastes of papermaking. Furthermore, food grade algae now being produced in Mexico for unlimited consumption by humans and animals also finds a very good market as a green paint pigment. The essential criteria for utilization of additives in foods are that they must be: (1) proven harmless to man and animals, (2) subject to regulatory control, and (3) used under good manufacturing practices.

Of titanium dioxide, intensive study has shown that it is extremely inert and does not react with biological tissue. The WHO/FAO Expert Committee on Food Additives (4) in 1970 did not establish a titanium dioxide limit on its intake for humans as all the evidence indicated it was free from toxic effects in foods. The only limits were those of good manufacturing practice.

During the past year, both benzoyl peroxide and titanium dioxide have been in short supply for a variety of reasons including expanded utilization. As a result, since 1972 the price of titanium dioxide has risen 53 percent. But now the shortages no longer exist and users are no longer restricted. It is hoped that where the need is demonstrated for foods, the application of decolorizers will be conducted with restraint and under proper supervision.

REFERENCES


Figure 1. Effect of titanium dioxide on white and yellow color in Mozzarella cheese.
The following paper was presented by Mr. Gerald F. Humiston, President, Pollution Control, Inc., Wilson Place, P.O. Box 208, South Barre, Vermont 05670, especially for the 12th Annual Marshall Invitational Italian Cheese Seminar held at the Dane County Exposition Center, Madison, Wisconsin, on April 28, 1975.

THE APPLICATION OF AEROSPACE TECHNOLOGY IN THE DAIRY INDUSTRY

by Mr. Gerald F. Humiston

Technology is defined as the science underlying the industrial arts or actual education in the branches of learning useful in manufacture and industry. So technology is really a recent term for something that has been in existence for a long long time. However, technology is not usually divided equally among the various industries - and for many good reasons.

Certain industries often demand rapid changes in technology by their very nature. Wars, for instance make tremendous technical demands on industries such as automotive, aerospace, and armaments and associated industries. True wars also put added demands on the food, wood, and other industries but these demands are usually more in the form of temporary increased production demands.

The most dramatic advance in technology have come in the middle of this century. The Manhattan project which gave us the atomic bomb which resulted in the many peaceful uses of atomic energy and the space program which resulted not only in the technical advances in specific flight hardware, but a whole spectrum of advances in the technology of materials, medicine, electronics, energy, etc. In fact the total impact of the space program in technology that affects other industries can not even be visualized.

Now that we have landed a number of men on the moon successfully the accomplishment fades somewhat and we don't tend to look at it with of awe that accompanied the first flights.

So to get this accomplishment in its full perspective let us go back to 1960 and ask ourselves, of the following three technical goals which would we have considered the most impossible:

1. A cure for cancer
2. Food production to feed the world's hungry
3. Landing men in a space ship on the moon

Of course we would consider the last to be the more impossible. Yet it was accomplished first. The reason is academically simple. There was a national commitment. It could not have been done if it wasn't a national commitment.

Now let's add the energy problem to the two other existing technical goals and we now have three.

For these three technical goals there is no national commitment and there are many including myself that do not believe that these three problems can be fully solved without a national commitment.
At present we are collecting nickels, dimes and dollars from the population to fight cancer.

We are negotiating over a table with the hungry nations to see what the food producing nations are willing to commit to help feed the hungry.

On energy we have been successful in defining the problem several dozen ways and have suitably impressed the public with the consequences of no action to solve the energy problem which is an oil dependency problem. On solutions we have done little.

But coming closer to home - the dairy industry and more specifically the cheese industry must work on its problems of energy and productivity on its own, the old fashioned American free enterprise way.

And help is coming from a strange direction. The aerospace industry, for which hundreds of thousands of engineers were educated and additional hundreds of thousands of technicians were trained have loosened its hold, because of reduced programs, on many of these people. This vast reservoir of technical knowledge and skill is drifting into the industry and as of my own personal knowledge, in the dairy and cheese industries.

The problems of energy and productivity and just rearing their ugly heads in these industries. Some are even choosing to ignore or minimize the problems. But, the fact is that inflationary costs on one side and more controlled purchasing on the other, leaves a middle man - energy time.

Many industries must do firm constructive planning in the fields of energy or in the future do without energy (go out of business) or pay recklessly for energy substitutes to stay in business. On productivity - your employees must earn more money to exist at inflationary prices and if you give them increased wages without an associated increase in productivity you must absorb the loss.

But the technology is currently available to solve both of the problems - the aerospace technology bought and paid for by the American government has many, many applications. They will be applied to the industry in the form of consulting, engineering, manufacturing, cost control and planning.

This does not mean that you have some new cheese makers coming. Cheese making is an accepted craft and will always remain a craft in which there is no substitute for experience and craftsmanship. However, the science of increased productivity, repeatability and cost reduction without affecting the quality born into the cheese by the cheese-makers are noble engineering goals.

The osmosis of knowledge between the more technically oriented aerospace industry and the cheese industry is occurring and will continue to occur at an increasing rate to the benefit of the cheese industry.
The following paper was presented by Mr. Giuseppi Serati, Sales Manager - Packaging Group, Grace Italiana, S. P. A., Via Trento 7, 20017 Passirana di Rhio, Italy, especially for the 12th Annual Marschall Invitational Italian Cheese Seminar, held at the Dane County Exposition Center, Madison, Wisconsin, on April 28, 1975.

**CHEESE PACKAGING IN ITALY**

By Giuseppe Serati

**Production of Natural Cheeses (expressed in thousand tons)**

<table>
<thead>
<tr>
<th></th>
<th>1972</th>
<th>1973</th>
<th>1974</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>8840</td>
<td>9070</td>
<td>n.a</td>
</tr>
<tr>
<td>U.S.A.</td>
<td>1540</td>
<td>1570</td>
<td>n.a</td>
</tr>
<tr>
<td>Europe</td>
<td>3890</td>
<td>4010</td>
<td>n.a</td>
</tr>
<tr>
<td>Common Market</td>
<td>2510</td>
<td>2600</td>
<td>n.a</td>
</tr>
<tr>
<td>France</td>
<td>860</td>
<td>890</td>
<td>n.a</td>
</tr>
<tr>
<td>West Germany</td>
<td>550</td>
<td>570</td>
<td>n.a</td>
</tr>
<tr>
<td>Italy</td>
<td>420</td>
<td>430</td>
<td>450</td>
</tr>
</tbody>
</table>

*For 1974 the official figures of the other countries are not yet available.

As you now realize, Italian production is the third largest in the Common Market and about 30% of the total U.S. production.

The Production of Italian cheese is characterized by an extremely large variety of types, which can be divided into five main groups, taking the names of the most important cheeses:

- Grana
- Provolone and other hard types
- Gorgonzola
- Italico and other soft types
- Pecorino

**Total exports**

for 1972 tons 23,000 which is equal to $48,000,000
for 1973 tons 22,000 which is equal to $41,500,000
for 1974 tons 24,000 which is equal to $55,000,000
Exports to the U.S. in 1974

<table>
<thead>
<tr>
<th>Cheese Type</th>
<th>Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grana</td>
<td>400</td>
</tr>
<tr>
<td>Pecorino</td>
<td>3,600</td>
</tr>
<tr>
<td>Provolone and Italico</td>
<td>1,500</td>
</tr>
<tr>
<td>Others</td>
<td>140</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>5,640</strong></td>
</tr>
</tbody>
</table>

for a total amount of $15,000,000

Export is only a small part of the total Italian production, in fact about 5%; as you can see on this slide the import is about seven times larger, mainly emmenthal and cheddar.

1974 Italian Situation Summary

<table>
<thead>
<tr>
<th>Category</th>
<th>Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Italian production</td>
<td>450,000</td>
</tr>
<tr>
<td>Import</td>
<td>146,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>596,000</strong></td>
</tr>
<tr>
<td>Export</td>
<td>24,000</td>
</tr>
<tr>
<td>Home consumption</td>
<td>572,000</td>
</tr>
<tr>
<td><strong>Pro-capite consumption:</strong> 10.9 kilos (24 pounds)</td>
<td></td>
</tr>
<tr>
<td><strong>Total value of the Market</strong></td>
<td>$1,350,000,000</td>
</tr>
</tbody>
</table>

The emmenthal is imported to be distributed in wheels or packaged; the cheddar is almost totally processed.

No we shall proceed to analyse the different types of cheeses produced in Italy.

1) **GRANA** type cheese

1974 production:

<table>
<thead>
<tr>
<th>Cheese Type</th>
<th>Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grana Padano</td>
<td>75,000</td>
</tr>
<tr>
<td>Parmigian Reggiano</td>
<td>69,000</td>
</tr>
<tr>
<td>Vernengo</td>
<td>16,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>160,000</strong></td>
</tr>
</tbody>
</table>

Grana is a hard cheese, slowly matured in an air conditioned room at a constant temperature of 15-18°C and a controlled humidity (90-95% relative humidity). Sixteen liters (just over 4 gallons) of milk are required to make one kilo of grana (about two pounds).

This type of cheese is protected by a registered trade mark, certifying its origin. The production of grana is limited to a small territory, laid down by law, in Northern Italy and is only made with milk from locally reared heifers.
All producers of milk in this particular area are associated in a "Consortium", or a co-operative which aims at promoting production and facing marketing and sales problems in the best way possible. The excellent quality of the product destined for export is guaranteed by the mark "Export", besides the registered trade mark certifying its origin.

Grana Padano and Vernengo are produced all the year round, the best maturing is reached in 16 to 18 months; it keeps its excellent state of preservation to between 24/30 months.

Parmigiano Reggiano is produced only from April 15 to November 15; the maturing is reached in 22 to 24 months and keeps in a good state to between 32 to 36 months.

Each cylindrical barrel has an average weight of 30/32 kgs. (abt. 70 pds.) They are traded through wholesalers and distributors and reach all points of sale.

Some barrels are cut into quarters, eighths, sixteenths and packaged in Cryovac bags and are destined for gross markets, institutions, restaurants and small shops that do not purchase a complete barrel. Some barrels are cut into small rectangular portions, weighing about 300 grams (about half a pound) and packaged under vacuum conditions in pre-formed or thermoforming pouches made from laminated film. This packaging allows the cheese to reach consumers in an excellent state and with a conservation of more than three months in the refrigerator. The packaging cost is equal to 4-5% of the product-cost for the bigger portions packaged in Cryovac bags, and to 13-15% for the smaller portions packaged in laminate pouches.

2) Gorgonzola

1974 production: 27,000 tons

Gorgonzola is a typical soft cheese of Northern Italy, it can be mild or strong.

An average wheel weighs about 12 kilos (26 pounds), while the cheese for export generally weighs 6 kilos (about 13 pounds). It is a cheese which must be kept exposed to oxygen; in fact the wheels are simply wrapped in very thin aluminum foil and then in a sheet of water-proof paper.

Only the strong type, which has a harder paste, is cut into small portions and packaged in low barrier laminate by some producers, thus assuming a very attractive appearance and retaining a longer shelf life.

The next cheese is the most exported to the USA and Canada.

3) Pecorino

The production in 1974 was 30,000 tons divided as follows:

<table>
<thead>
<tr>
<th>Type of Pecorino</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roman Pecorino</td>
<td>15,000 tons</td>
</tr>
<tr>
<td>Pecorino of the roman type produced outside the typical zone.</td>
<td>5,000 tons</td>
</tr>
</tbody>
</table>
### Pecorino

Pecorino belongs to a classical cheese family and is produced in the South of Italy and in Sardinia and Sicily.

Sheep's milk cheese is divided into two families:

1. **The Roman Pecorino** is a cheese made from sheep's milk plus rennet derived from suckling lambs. It has a slow maturation and a long preservation.

2. **Fresh table cheese of ready consumption; Ricotta, Fiore Sardo, Toscanella, Caciotta, Canestrato.**

The Roman Pecorino is the Italian cheese most exported to the United States. It has a cylindrical shape weighing about 18 kilograms (about 40 pounds), has an eight/nine month maturation and a shelf life of two and even three years. 4/5 of the production is made in Sardinia, 1/5 in Rome. Seven liters (1.8 gallons) of milk are required for one kilogram (abt. 2 pounds) of Roman Pecorino. It is produced from January to June. All the Roman Pecorino which is consumed in Italy is cut into quarters, packaged in Cryovac bags and distributed through wholesalers.

The cost of the packaging in Cryovac bags is equal to four percent of the cost of the product.

All fresh sheep's-milk cheeses are produced and distributed every day, wrapped in water-proof paper. Only part of the Ricotta is salted, dried, vacuum packed in Cryovac and exported to the United States and Canada. Through these processes the product has a shelf life of over one year.

Let's talk now about the next cheese: **Provolone**

### Provolone and other hard or semi-hard cheeses

<table>
<thead>
<tr>
<th>Cheese</th>
<th>1974 Production (tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provolone</td>
<td>42,000</td>
</tr>
<tr>
<td>Asiago, Montasio, Fontal, Fontina</td>
<td>43,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>85,000</strong></td>
</tr>
</tbody>
</table>

Provolone is a cheese made from cow's milk coagulated with lamb or kid rennet. There are two types; mild provolone and strong provolone.

It is a table cheese and has a maturing time of about 6 months for the milk type, and over one year for the strong one.

The bigger cylinder shapes are generally destined for export, which constitutes a very important sector for this cheese.

It is traded through wholesalers or directly by producers. The milk provolone is mostly packaged in Cryovac bags to avoid loss of weight, and to maintain the right maturity; it is then sold to retailers in the same package.
Strong Provolone is mostly coated with paraffin wax and then sold without any packaging.

Some of the biggest producers cure Provolone directly in Cryovac bags.

Slices of provolone - weighing 250 - 300 gr (just over 1/2 pound) - are packaged with thermoforming laminate or pre-formed pouches and have a good share of the market.

Asiago, Montasio, Fontal, Fontina are much the same type of cheese and have different names depending on the locality in which they are produced. They are all semi-hard table cheeses, are sold locally, only part of them packaged under-vacuum conditions in Cryovac bags. Most is cut into small portions and packaged under-vacuum in laminate pouches for consumer use.

5) Italico and other soft cheeses

Italico, Crescenza, Quartirolo, Mascarpone, Taleggio, Bel Paese, Mozzarella, etcetera.

The production in 1974 was 148,000 tons.

These are perishable, soft cheeses which are mostly sold uncured and have a very short shelf-life. They do not require, except in a few cases, any particular type of packaging, and vacuum packaging can be harmful. Normally they are wrapped in water-proof paper or aluminium foil, and the distribution is usually local.

Mozzarella is a special case. It is packaged in Cryovac bags, in loaves of 2 kilograms (about 4 pounds), mainly distributed to restaurants and pizza shops.

Most of mozzarella production is distributed, on national scale, in packages of 100/150 grams (about half a pound) with the addition of brine in barrier laminated pouches, non transparent packaged automatically with vertical form fill seal machines (Hassia, Hayssen, etcetera).

The distribution of our cheeses is made through a large number of small shopkeepers and a few supermarkets.

The following distribution patterns might exist for all types of cheese:

- Dairy ------ wholesaler ------ shops or caterers
- Dairy ------ gross market ------ shops
- Dairy ------ supermarket-chain
- Dairy, by depots, ------ shops using van salesmen

The above pattern may exist or not according to the number of supermarkets in the area and to the cheese consumption.

This situation has stimulated the demand for Cryovac packaged products (that the shopkeepers can utilize day by day) rather than the use of small portions in laminate pouches, generally sold in supermarkets.
The type of packaging depends on:
- the characteristics of the cheese (to prolong shelf life, to retain original taste)
- type of distribution (local or national, retail or wholesale)
- size of cheese unit sold

As a consequence the package may be under-vacuum or not, as follows:

**Under-vacuum packaging**

* Cryovac multilayer and shrinkable bags

* Laminates roll stock or pre-formed pouches:

  made from one basic support - nylon or cellophane or polyester - according to the type of cheese to be packaged. The above are united to a thermo sealing film.

The choice between bags or laminates is:

- bags for over two kilos units (over 4 pounds). Packages cost about 5% of cheese cost;

- bags or laminate pouches for half/one kilo and a half units (1 to three pounds). Packages cost about 8% of cheese cost;

- laminates for units smaller than half a kilo (about 1 pound). Packages cost about 13% of cheese cost.

**Other Packaging**

* water-proof paper
* aluminum foil
* no barrier films like PVC, polyethylene, polypropilene.

**Equipment**

**Cryovac bags**

- Manual clipping nozzle vacuum machines, for small utilizers: 2 - 3 pc. per minute with one operator

- Automatic vacuum chamber clipping machines for bigger utilizers: 5-7 pc. per minute with one operator.

**Laminates**

- Pre-formed pouches:

  Electrical impulse-thermosealing machines with vacuum chambers of several types depending on customer requirements. The machine shown has an output of 1200-1500 pouches per hour.
- Roll stock:

Thermoforming automatic vacuum machines. For large production: 2,000 - 4,000 pc per hr.

The machine shown has an output of 2,000 - 2,400 pc per hr.

### NATURAL CHEESE PRODUCTION

(Thousand Tons)

<table>
<thead>
<tr>
<th></th>
<th>1972</th>
<th>1973</th>
<th>1974</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL</td>
<td>8840</td>
<td>9070</td>
<td>n.a</td>
</tr>
<tr>
<td>U.S.A.</td>
<td>1540</td>
<td>1570</td>
<td>n.a</td>
</tr>
<tr>
<td>Europe</td>
<td>3890</td>
<td>4010</td>
<td>n.a</td>
</tr>
<tr>
<td>Common Market</td>
<td>2510</td>
<td>2600</td>
<td>n.a</td>
</tr>
<tr>
<td>France</td>
<td>860</td>
<td>890</td>
<td>n.a</td>
</tr>
<tr>
<td>West Germany</td>
<td>550</td>
<td>570</td>
<td>n.a</td>
</tr>
<tr>
<td>Italy</td>
<td>420</td>
<td>430</td>
<td>450</td>
</tr>
</tbody>
</table>

### ITALIAN CHEESE IN 1974

(Thousand Tons)

<table>
<thead>
<tr>
<th>TYPES</th>
<th>PRODUCTION</th>
<th>EXPORT TOTAL</th>
<th>EXPORT TO U.S.A.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grana</td>
<td>160</td>
<td>7.3</td>
<td>0.4</td>
</tr>
<tr>
<td>Gorgonzola</td>
<td>27</td>
<td>4.0</td>
<td>-</td>
</tr>
<tr>
<td>Pecorino</td>
<td>30</td>
<td>6.0</td>
<td>3.6</td>
</tr>
<tr>
<td>Provolone and Other Semi-Hard Ones</td>
<td>85</td>
<td>6.7</td>
<td>1.6</td>
</tr>
<tr>
<td>Italico and Other Soft Ones</td>
<td>148</td>
<td>)</td>
<td>)</td>
</tr>
<tr>
<td>Total</td>
<td>450</td>
<td>24.0*</td>
<td>5.6 **</td>
</tr>
</tbody>
</table>

* Equal to 55 Million Dollars

** Equal to 15 Million Dollars
ITALIAN CHEESE IN 1974

* BALANCE

<table>
<thead>
<tr>
<th></th>
<th>THOUSAND TONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOME PRODUCTION</td>
<td>450</td>
</tr>
<tr>
<td>IMPORTS</td>
<td>146</td>
</tr>
<tr>
<td>EXPORT</td>
<td>24</td>
</tr>
<tr>
<td>HOME CONSUMPTION</td>
<td>572</td>
</tr>
</tbody>
</table>

* TOTAL MARKET VALUE 1.350 BILLION DOLLARS

"GRANA" CHEESE

* PRODUCTION IN 1974

<table>
<thead>
<tr>
<th></th>
<th>THOUSAND TONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>GRANA PADANO</td>
<td>75</td>
</tr>
<tr>
<td>PARMIGIANO REGGIANO</td>
<td>69</td>
</tr>
<tr>
<td>VERNENGO</td>
<td>16</td>
</tr>
<tr>
<td>TOTAL</td>
<td>160</td>
</tr>
</tbody>
</table>

* CHEESE PROTECTED BY A BRAND NAME
* PRODUCTION IS RESTRICTED TO A SMALL TERRITORY
* PRODUCERS ASSOCIATED IN A"CONSORTIUM"
* ADDITIONAL GUARANTEE TO EXPORT BY A SPECIAL MARK IMPRESSED ON THE CHEESE
CRYOVAC PACKAGES FOR "GRANA"

* BAGS FOR QUARTERS, EIGHTHS AND SIXTEENTHS OF BARREL
* LAMINATE FILMS OR POUCHES FOR SMALL PORTIONS, ABOUT 300 GR.
* BAGS COST IS APPROXIMATELY 5% OF CHEESE COST
* LAMINATES COST IS APPROXIMATELY 15% OF CHEESE COST

PECORINO CHEESE

(THOUSAND TONS)

* PRODUCTION

<table>
<thead>
<tr>
<th>Type</th>
<th>Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROMAN PECORINO</td>
<td>15 (ROME AND SARDINIA)</td>
</tr>
<tr>
<td>OTHER ROMAN TYPE PECORINO</td>
<td>5</td>
</tr>
<tr>
<td>RICOTTA</td>
<td>5</td>
</tr>
<tr>
<td>FIORESARDO, TOSCANELLO,</td>
<td>5</td>
</tr>
<tr>
<td>CACIOTTE, ETC.</td>
<td></td>
</tr>
</tbody>
</table>

* IT IS THE MOST EXPORTED IN THE U.S.A.
* IT NEEDS 8/9 MONTHS MATURATION AND HAS 2/3 YEARS OF SHELF LIFE
* QUARTER CUTS ARE DISTRIBUTED, BY WHOLESALERS, IN CRYOVAC BAGS
* CRYOVAC BAG COST IS ABOUT 4% OF CHEESE COST
* ALL FRESH CHEESES PRODUCED FROM SHEEP MILK ARE DISTRIBUTED WRAPPED IN WATER-PROOF PAPER.
* PART OF SALTED RICOTTA IS EXPORTED IN CRYOVAC VACUUM PACKAGES
**PROVOLONE CHEESE**

(THOUSAND TONS)

* **1974 PRODUCTION**

<table>
<thead>
<tr>
<th>Cheese Type</th>
<th>1974 Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provolone</td>
<td>42</td>
</tr>
<tr>
<td>Asiago, Montasio, Fontal, Fontina</td>
<td>43</td>
</tr>
</tbody>
</table>

* **MATURING TIME:**
  - 6 MONTHS FOR MILD ONE
  - 12 MONTHS FOR STRONG ONE

* MILD TYPE IS PACKAGED IN CRYOVAC BAGS FOR CURING OR FOR DISTRIBUTION
* STRONG TYPE IS COATED ONLY WITH PARAFFIN WAX
* SLICED, IN 250-300 GR. PORTIONS, IS PACKAGED IN LAMINATE FILM OR POUCHES

---

**ITALICO AND OTHER SOFT CHEESES**

* **1974 PRODUCTION:** 148,000 TONS

* MOSTLY SOLD UNCURED AND WITH A VERY SHORT SHELF LIFE
* NORMALLY WRAPPED IN WATER-PROOF PAPER OR ALUMINUM
* PACKAGED MOZZARELLA HAS LONGER SHELF LIFE:
  - IN CRYOVAC BAGS (2 kilos) TO RESTAURANT AND PIZZA SHOPS
  - IN BARRIER LAMINATE POUCHES WITH BRINE ADDITION (100-150 GR.)
  - USING FORM FILL SEAL MACHINES
CHEESE PACKAGING

UNDER VACUUM PACKAGING

* CRYOVAC MULTILAYER AND SHRINKABLE BAGS

* LAMINATES ROLL STOCK OR PREFORMED POUCHES:

MADE FROM ONE BASIC SUPPORT, NYLON, CELLOPHANE, POLYESTER, ACCORDING TO THE TYPE OF CHEESE TO BE PACKAGED. THE ABOVE ARE UNITED TO A THERMO SEALING FILM.

BAGS OR LAMINATES:

- BAGS FOR OVER TWO KILOS UNITS. PACKAGES COST ABOUT 5% OF CHEESE COST

- BAGS OR LAMINATE POUCHES FOR 0.5/1,500 KILOS UNITS. PACKAGES COST APPROXIMATELY 8% OF CHEESE COST

- LAMINATES FOR UNITS SMALLER THAN 0.5 KILO. PACKAGE COSTS 13% OF CHEESE COST

OTHER

* WATER-PROOF PAPER

* ALUMINUM FOIL

* NO BARRIER FILMS, SUCH AS PVC, POLYETHYLENE, POLYPROPYLENE

DISTRIBUTION SYSTEM

* SUPERMARKET-CHAINS REPRESENT ONLY 9% OF TOTAL DISTRIBUTION

* 406,000 RETAILERS SELL MILK AND CHEESES, 180,000 OF WHICH DEAL ONLY IN CHEESE.

* FOLLOWING DISTRIBUTION PATTERNS ARE POSSIBLE FOR ALL TYPES OF CHEESE:

- DAIRY ----> WHOLESALERS ----> SHOPS OR CATERERS

- DAIRY ----> GROSS MARKET ----> SHOPS

- DAIRY ----> SUPERMARKET CHAINS

- DAIRY, BY DEPOTS, ----> SHOPS USING VAN SALES MEN
The following paper was presented by Mr. Verle W. Christensen, Manager, Madison Operations, Marschall Division, Miles Laboratories, Inc., P.O. Box 592, Madison, Wisconsin 53701, especially for the 12th Annual Marschall Invitational Italian Cheese Seminar held at the Dane County Exposition Center, Madison, Wisconsin on April 29, 1975.

AN UPDATE OF ITALIAN CHEESEMAKING FUNDAMENTALS

by Verle W. Christensen

At the Marschall Italian Cheese Seminar in 1972, a concentrated effort was made to present a complete review of cheesemaking principles as they affected the manufacture of Italian type cheeses. With rapid changes in the cheese industry because of the shift from small to large cheese plants, changing milk supplies, and increased mechanization, there is a need to review these principles as they relate to cheese manufacturing today.

I. Milk Quality

A. Microbiological

In the last 25 years milk quality has improved from the standpoint of sediment and types of bacteria present. However, there still are incidents of high coliform counts in milk. Although these organisms should be destroyed in pasteurization, some may survive the heat treatment if present in large numbers. It has been reported that many of these organisms inhibit lactic acid type bacteria. Some types affect the rods more than the coccus and others may cause a greater inhibition of the coccus than the rod.

The efficient cooling of milk at the farm level and at the plant level has helped to control the growth of many undesirable organisms. However, multiplication of psychrotrophic microorganisms may sometimes be great enough to affect the fat and protein content to such an extent as to cause rancidity, coagulation, and cheese manufacturing problems.

These have been reviewed previously at our seminars and I will not discuss this further except to say their presence or absence is still an important part in the manufacture of good quality cheese.

One of the most significant milk problems for the cheese manufacturer using the coccus and rod culture organisms is the presence or absence of inhibiting substances in the milk. Generally this is related to the control of mastitis at the farm level. Through the use of various antibiotic tests and constant work by our academic and governmental agencies, the use of antibiotics has been fairly well controlled. However, we are once again encountering proven cases of antibiotics in cheese factory milk supplies and this still warrants your attention.

In past years the most common mastitis infection was that by staphylococcus types. Recently there has emerged greater incidence of infection by streptococcus organisms which may infect only one quarter of the cows udder and
is difficult to detect. This microorganism has proven to be very resistant to the common antibiotic treatments. Not only can the presence of this infection and the associated antibiotic treatment cause inhibition of the starter organisms but it can drastically change the chemical composition of the milk. For those of you interested in tests to determine antibiotics, I suggest you obtain a copy of the bulletin "Antibiotic Residues in Milk, Dairy Products, and Animal Tissues: Methods, Reports, and Protocoli" Reprinted December 1974 by the Department of Health, Education and Welfare, Washington, D.C. This bulletin also covers the test methods for identification of antibiotics in cheese and other dairy products.

B. Chemical Composition

Milk quality is not only related to bacterial content of the milk but also to its chemical composition. In cheesemaking the milk solids are generally divided almost equally between the curd and whey and it is the balance between the major constituents of the curd, the fat, and casein which determines the quality and yield of the cheese.

The chemical composition of the milk influences the formation of the curd, firming of the curd, and the rate of acid production by the culture. Milk is a variable mixture of complex ingredients and unfortunately most manufacturers know little about its composition on a day to day basis. They rarely know the daily content of solids-not-fat present and its casein composition.

In cheese making we should be interested mostly in the casein content because it is this constituent that precipitates to form the curd and is primarily involved in the shrinking of the cubes of curd on cutting, and has a direct relationship to yield. The attention to milk composition and especially the protein phase has been studied to a great extent in European countries and Canada. This data has been used to bring about herd improvement and the buying and selling of milk based on solids recoverable in the cheese making process.

One reason I have particularly dwelled on the chemical composition of the milk as related to cheese quality is the recent findings that the United Kingdom and Canada have reported about protein composition of milk. As many of you know this may vary because of the breed, age of the cow, stage of lactation, and the amount and quality of feed consumed. It is also related to the health of the animal.

The protein in milk is made up of casein and the soluble serum protein. Nearly all the casein and only 20% of the serum solids is recovered in the cheese making process. The remaining 80% of the serum solids is lost in the whey. Recently it has been shown that although some milk supplies contain the normal amount of total protein, the casein is low and the serum solids high. This is especially true of cows that have mastitis infections or where feeding problems exist. It is therefore important that a great deal of attention be given to analyzing your milk supply for evidence of mastitis and protein composition if yields of cheese are lower than anticipated.
II. Clarification of Milk

Generally clarification of milk leads to upgrading the milk supply for cheese making. However, sometimes a decrease in cheese moisture and yield may be noticed in clarified milk as well as an increase in fat losses in the whey. The clarification effects can be related to the temperature and speed of clarification. Generally detrimental effects of clarification can be decreased by clarifying at a relatively low temperature (70°F) and slow bowl speeds (3500 RPM).

Clarification can affect culture growth because of an increase in the oxygen content and decrease in the carbon dioxide in the milk during the centrifugation process.

III. Cultures

A. Seed stocks:

Much attention has been given to cultures needed for Italian type cheese. It has been shown that cultures having good activity and with a ratio of equal parts cocci and rods perform best in the cheese manufacturing process.

Over the last five years much improvement in culture developments has been made to eliminate the problem with plant transfers. Included are the concentrated bulk set cultures and the CR 150 gallon bulk set cultures for use with Thermostar™ culture media.

B. Culture Handling & Storage Procedures:

Coccus and rod cultures are more delicate and sensitive to storage and handling than the common lactic cultures used for cheddar cheese. Therefore every effort must be made to insure they are both transported and stored properly on receipt at the cheese plant. Cultures must be completely frozen when received at the cheese plant.

Cultures shipped using ABS liquid nitrogen transportation and storage methods must always remain either in the liquid or gas state of liquid nitrogen to avoid damage to the cultures. When a culture in liquid nitrogen storage undergoes the change from a liquid to gas and back to a liquid the flexing of the lid caused by this action can break the seam on the can allowing for liquid nitrogen to seep into the can. When the can is removed from the liquid nitrogen the rapid expansion of the liquid can cause the can cover to "pop".

Proper handling procedures are sent to customers for those cultures stored and shipped in nitrogen refrigerators. You should be sure your cheese factory personnel is thoroughly familiar with these instructions. Copies of these instructions are at our Marschall booth.
Cultures can be stored in special mechanical low temperature freezers. It is important to remember that these freezers must be maintained at a constant frozen temperature. Cycling of cultures in freezers where the temperatures may vary 10 to 15°F or more in the frozen state can be detrimental to the culture as complete thawing and re-freezing.

C. Culture Media - Preparation, Setting Temperatures, Inoculation, Ripening Times, & Titration for Cooling:

1) Preparation of Media:

Culture media recommended for use with coccus and rod cultures include the use of Thermostar™ and reconstituted pre-tested low heat non-fat-dry-milk. The use of these media has been covered in past Italian Cheese Seminars. However, because of unusual problems in using these media I will list some of the problems we have encountered at various cheese plants. We hope this will prove to be helpful to you in your daily startermaking activities.

Medium solids should be added to the water at the proper rate. For Thermostar™ this should be 100 pounds of media to 97 gallons equivalent to 810 pounds exactly of water. 100 pounds of Thermostar™ will make up approximately 104 gallons of Thermostar™ medium. The water should be measured out first. Never guess at the amount. When adding the medium it is preferred that a powder funnel be used and that the water first be heated to 125 to 130°F.

The reconstituted medium should be heated quickly to 190 to 195°F and held for 40 minutes and then cooled rapidly to the setting temperature. It should have only a slightly tan color. The acidity titration before inoculation should be between 0.50 to 0.56, calculated as lactic acid.

For NFDM medium we recommend a usage level of 12% solids. The rate of usage is 12 pounds of solids to 88 pounds of water. The use of a funnel and heating as for Thermostar™ is recommended. On cooling to the setting temperature, the NFDM medium should titrate in a range from 0.20 to 0.23, calculated as lactic acid.

2) Setting Temperatures:

Field observations with setting temperatures of the bulk starter medium have shown that there is a wide variation in temperatures used by cheese manufacturers. We have tried using temperatures from 100°F to 112°F with varying results. Generally it was believed that when a culture failed to work it was because the rod failed to come through in the bulk starter and in the cheese making process. As the optimum or best temperature for growth of the coccus is 100°F and for the rod ranges from 104-112°F, it was believed that a higher setting temperature would favor the growth of the rod organism.
Recently we have found the opposite may happen. When the culture has been incubated at a temperature of 104°F a better mixed culture with better activity was noted. This is probably related to the knowledge and theory that the growth of the coccus organism is first necessary to stimulate the initial and fast growth of the rod in the later stage of culture growth. Therefore it appears desirable to use an incubation temperature of about 104°F which tends to favor the desirable early growth of the coccus organism.

We have also observed that at the higher incubation temperature the medium can become destabilized because of the additional heat present. This can cause wheying off of the medium which can eliminate nutrients from the growing organisms, and settling of the organisms in the culture tank.

3) Inoculation and Ripening of Starter:

The bulk set cultures should be carefully thawed and added to the culture media following the instructions as specifically outlines in our culture data sheets. Cultures should be removed from the freezer just prior to inoculation and not left to stand and thaw slowly over a period of time. They should be allowed to thaw quickly in cool clean tap water containing a small amount of chlorine to prevent contamination of the culture when opened. Thaw only for about five minutes until the contents are loose in the can. Add the partially thawed culture to the medium and agitate for 10 minutes. After 30 minutes re-agitate for another 10 minutes to mix in any culture that may have been on the surface of the tank previously in the form of ice crystals. These would float on the surface unless re-agitated.

The culture should ripen 6 to 9 hours depending on the temperature of incubation, to reach a titration when cooled of 1.35 to 1.50% in Thermostar™ and 1.35 to 1.45% in 12% NFDM. To arrive at this final acidity cooling must start at lower acidities depending on the cooling rate as determined whether "chilled" water or just well water is used.

We have found that excessive agitation of the starter in cooling is harmful to the activity of the rod organism. Therefore slow agitation with chilled water is preferred. Do not over-agitate for long periods of time with ripened starter.

It has also been shown that low cooling temperatures can be harmful to the mixture culture. Cool only to 55 to 60°F in order to maintain the cell count and activity of the starter organisms. Below 55°F the temperature seems to shock the organism so they lose their activity more rapidly.

IV. Ripening Time & Setting Temperatures of Milk for Using Coccus & Rod Cultures

The ripening time is the time from adding the starter to the vat to the time of adding the coagulant. Generally for Italian cheese this is 20 to 30 minutes. During this time the culture adjusts to its new milk environment and begins growth to produce new cells and with it the fermentation of the lactose to lactic acid.
As the optimum growth temperature for combined coccus and rod organisms is 100° to 105°F little growth can be realized when the setting temperature of the milk is at 88°F as for cheddar cheese. 88°F is the optimum growth temperature for the common lactic culture and at this setting temperature the bacteria multiply rapidly. If one were to consider ripening and setting his milk on the same basis for coccus and rod cultures used in Italian cheese, then a similar setting temperature based on the culture optimum growth factor would be 100 to 105°F.

Obviously there are reasons these higher temperatures are not used for Mozzarella type cheeses. Milk is generally coagulated at a lower temperature for soft cheese than for hard cheese. Great differences in the texture of the cheese can be produced by varying the coagulation temperature. Lower setting temperatures result in soft pliable curd while higher setting temperatures give tough and rubbery curd. It has also been demonstrated that the elasticity of the coagulum increases directly with an increase in temperature up to 105°F.

With these factors in mind and when we consider the growth temperature requirements for coccus and rod organisms, obviously little is accomplished by ripening the vat for 30 minutes at 88°F. Actually this does work to our disadvantage as it can allow for bacteriophage infection of the coccus organism during ripening. Furthermore, if the culture does not grow at this temperature and fails to produce some lactic acid, poor setting of thevat will be realized because of "sweet milk".

For this reason vats should be set at temperatures of 92 to 95°F so as to insure some growth of the coccus organisms during ripening. Coagulation will then proceed normally and the starter will be conditioned to grow properly during the rest of the cheese processing.

We have also found that yields are greatly affected by the ripening time and setting temperature. The relative efficiency of the coagulation process at various temperatures with fixed amounts of rennet and acidity between 70° and 120°F has been determined. Based on this information the efficiency of coagulation is at a maximum of 100% at 106°F, 83% at 93°F and 70% at 86°F.

Therefore with this in mind we suggest you investigate these setting temperatures that work best for you within the guidelines I have discussed.

V. Control of Bacteriophage for Coccus Organisms - Plant Procedure

Bacteriophage for coccus organisms has been clearly demonstrated as shown in papers at our previous Italian cheese seminars by Reinbold and Reddy of Iowa State University. (1) We also have covered the use of our bacteriophage preventative medium, Thermostar™, for protection of the bulk starter.
Although the culture can be protected through the bulk starter stage, it no longer is protected when it is added to the vat of milk. Therefore it is extremely important that proper safeguards be taken to keep bacteriophage levels in the plant at their lowest level so as to not infect the culture so it will continue to produce acid.

We have found two important safeguards to reduce bacteriophage contamination: (1) thoroughly wash the curd particles from the vat surface and chlorinate with a minimum of 500 PPM chlorine solution if the vats are used more than once per day and (2) elimination of a cycling buildup of bacteriophage resulting from separator whey mists which re-cycle in the atmosphere through pasteurizer surge tanks, holding tanks and the pasteurizer itself. Pasteurization does not destroy most of the bacteriophage strains that get into the milk supply. Some bacteriophage strains even resist boiling temperatures for as much as five minutes holding time.

VI. Milling Acidities & pH's

An excellent paper on this subject was presented by Professor Frank Kosikowski at our 1972 Marschall Italian Cheese Seminar, entitled "The Mixing and Molding of Mozzarella Cheese" (2) I suggest that if you are having stretching and molding problems, that you review this excellent paper.

For cheese that is stretched and molded the ideal pH lies between pH 5.4 and 5.1. The optimum pH range varies with the type of milk, length of contact with the acid for equilibration of the cheese ingredients especially the casein, and the type of starter used. Milling acidities will vary throughout the year, based on the seasonal supply of milk received. The milling acidities should be adjusted accordingly to the pH of the curd that gives best stretching and molding properties.

VII. Water Supplies

Recently the quality of water has become a large problem for many cheese plants. Many people take their source and quality of water for granted as being suitable for use in all cheese processing.

Water should pass certain standard tests as outlined in the "Standard Methods for the Examination of Water and Waste Water." (3) This states that water must, in addition to complying with sanitary requirements, be free from micro-organisms that could cause spoilage of dairy products.

Generally speaking, most water supplies meet these requirements. However, with the shift from a plants' own water supply to city and municipal supplies, other factors are often involved. Water supplies are now treated chemically with water softening products such as soda ash, chlorine, and fluorine. As water is used for diluting the coagulant when added to the cheese vat, and directly to the curd when making stirred curd, Colby, and similar types of cheese, these water treatments can create problems.
High levels of chlorine and fluorine could inhibit culture growth in the washed curd or cheese. Water softening salts could raise the sodium, carbonate and pH levels. This could cause precipitation of calcium on the surface of the curd and may raise the pH of the curd to a level that might cause problems in molding and curing of the cheese.

Water with high pH values over pH 7.0 can also destroy the coagulation ability of coagulants, if allowed to stand for periods of time before addition to the vat. Therefore, we suggest you check your water supply at regular intervals to see if it is suitable for diluting your coagulant and otherwise meet your cheesemaking requirements. Good quality water is necessary and should not be taken for granted in the cheese manufacturing process.

VIII. Salting & Brining

Salting and brining is perhaps one of the most misunderstood and neglected aspects of Italian cheesemaking. Yet it is one of the very important and critical parts of cheesemaking that has a direct influence on the quality of cheese produced.

Two excellent papers on salting and brining have been presented previously at our Italian Cheese Seminars. One by L.R. Strong (4) in 1967 and one by Prof. K.M. Nilson and L.C. Fife (5) in 1972. I strongly recommend you review these papers, especially the paper by Professor Nilson and L.C. Fife covering the chemistry of salting Italian cheese.

In view of the need today for fast manufacturing procedures, mechanization of the cheese process, and cost of salting tanks and equipment, a great deal of attention must be given by the cheese manufacturer to the salting and brining process.

The length of time for the cheese components to reach equilibrium so that the salt is uniformly distributed throughout the cheese, depends on the salt concentration, method of application, temperature of the cheese at salting, temperature of the brine, moisture in the cheese, and size and shape of the cheese salted. In the case of cheddar manufacture, you have direct addition of salt to the milled curd. Thus, in this method, the salt is evenly distributed throughout the cheese fairly rapidly and near equilibrium is reached in a matter of approximately 15 hours. However, when a 5 pound block of Mozzarella cheese is salt brined for 8 hours and stored at 40°F, the attainment of equilibrium can take up to 1,000 hours.

Therefore, study your salting operations and make periodic salt tests on your cheese to see that your salting method is suitable and doing the job you intended for your operation.

I have tried to cover some of the problem areas we see developing in the Italian Cheese Industry in 1975. Undoubtedly these will need to be up-dated in the future as new processing techniques are learned and used.
It is important that we understand the significance of the biological, chemical, and physical aspects of cheesemaking as they relate to new mechanical processing techniques.

The Marschall Division of Miles Laboratories is dedicated to keeping you informed of these changes as they may affect your operations.

Thank you for your kind attention.

REFERENCES


The following paper was presented by Professor Frank V. Kosikowski, Department of Food Science, Cornell University, Ithaca, New York, especially for the 12th Annual Marschall Invitational Italian Cheese Seminar held at the Dane County Exposition Center, Madison, Wisconsin, on April 29, 1975.

THE MANUFACTURE OF MOZZARELLA AND RELATED CHEESE BY ULTRAFILTRATION

By Professor Frank V. Kosikowski

The term ultrafiltration has become increasingly familiar to the dairy industries of the world. Ultrafiltration was introduced as a means to separate protein from sweet and acid whey and it has taken hold very firmly. There are now many operating whey ultrafiltration units. In Spain, France, New Zealand, and the U.S.A., units each processing about 200,000 pounds of whey daily to give a continuous flow of a 50 percent protein concentrate, are operating successfully.

Of more direct interest to cheesemakers, however, is the unique maxima concept originated in 1969 by French scientists Maubois and Mocquot (4) that enabled ultrafiltration to become a potential continuous tool for cheesemaking of soft, fresh, and ripened types.

They introduced the novel idea that if milk, usually skim milk, were concentrated by ultrafiltration to approximately the protein solids of a cheese desired after injection of fat, the liquid concentrate which resulted needed only microbial culture and rennet to make it that cheese. No significant whey drainage occurred from the curd and all the whey proteins previously lost to the whey are retained by the concentrate. Essentially, selective concentration of the milk to the maxima for a given cheese is a unique feature. Partial concentration by ultrafiltration would still require considerable traditional whey removal and the whey proteins would depart with this free whey without increasing cheese yield much.

The Principles of Ultrafiltration of Cheesemilk

A number of ultrafiltration units of acceptable sanitary design are now available in the USA, France, and Denmark. Each has its own characteristics and apparently all can make cheese (3).

Skimmilk, the usual starting material for cheese by ultrafiltration, is cycled either at 2-4°C, 50-52°C, or a combination of 4°C and 30°C, or 4°C and 52°C across a membrane, usually cellulose acetate, in a forced turbulent flow. The choice of temperature depends upon concentration of protein solids desired but when 30°C is used, a starter culture must be added to the cycling milk. This then is called direct ultrafiltration with simultaneous fermentation.

The membranes may be plates, straight tubes, or spiralling spaghetti tubes and are mounted for support on stainless steel standards. These membranes have a maximum average pore diameter of 30 μm and the milk moves under a pressure of 1 to 50 kg/cm². Cycling of the milk through the interior of these membranes is maintained until the concentrate on the inside attains the maximum protein solids desired or until the soluble components of the skim milk concentrate no longer pass through the membrane. The membrane permits the passage of water and soluble components like lactose and certain salts and prevents the passage of protein (casein, albumin and globulin), fat, insoluble salts, and bacteria, thus leading to a selective concentration. Material that passes through is the ultrafiltrate or permeate and is similar to whey but still different.
The material that remains on the inner side of the membrane is the retentate or concentrate. It leads to cheese and prior to rennet addition, is called the liquid precheese. Depending upon the nature of the cheese, the retentate may be concentrated 2 to 6 fold.

Thus, the retentate moves across the membranes, back to the holding tank, then again across the membranes during a number of hours until the cheese maxima concentration is achieved. A certain amount of ultrafiltrate or whey equivalent exits through the membrane during each passage and is collected separately. It is usually crystal clear, devoid of protein and with a pH 6.5 although the cheese resulting will be acid. A considerable amount of nonprotein nitrogen is present in this ultrafiltrate.

When the retentate, or liquid precheese, attains its maxima concentration, it is warmed or cooled to 32°C and diverted to an injection and blending apparatus where plastic cream, starter, cultures, rennet, salt and color are introduced to make it a complete but still liquid cheese. Then the viscous liquid is introduced into cheese molds or forms where, as for Camembert, in 5-6 minutes a finished, firm curd forms without significant whey drainage. This is the young, green cheese which is then ripened normally.

The advantages of ultrafiltration for cheesemaking are higher yields, continuous movement, closed sanitary systems, better control of cheese sizes, significantly lower requirements for rennet and production of whey with lower BOD and neutral pH.

Current Applications of Ultrafiltration Cheesemaking

It is to Europe that one must look, particularly France, to observe the industrial progress of this new cheesemaking concept. The advance has been remarkable.

The first cheeses adapted to ultrafiltration technics were the soft, acid ripened types like Fromage Frais and Petit Suisse and the second, the soft ripened types like Camembert and Coulommiers from cow's or goat's milk. Several large production units exist and are functioning in France under the new French policy of building great food-producing units with government cooperation.

One good example of such an operation which started October 2, 1974, is at the Cadet Rousseau Plant in Auxere, France just 10 miles from the famous Burgundy wine center of Chablis. Here there are four French Raune-Poulanc ultrafiltration units, looking like plate heat exchangers with a potential capacity of 200 m² of membrane. These four units ultrafilter 160,000 pounds of cow's milk daily at 4°C over 16 hrs. to give Fromage Frais and Petit Suisse liquid precheeses concentrated to 2.5 times the initial protein solids of skim milk. The fresh cheeses formerly had been produced by mechanical separation but centrifuges no longer are needed. One major reason for the shift to ultrafiltration at this plant was due to greater yields of product.

At Celle-Sur-Belle in Western France, north of Bordeaux, a successful cheese factory now undergoing great expansion is producing soft ripened, white-mold cheese from goat's milk, representing about half of the milk intake. Goat's milk cheese attains even greater yields than cow's milk because of the higher level of albumin and globulin in the milk. The plant has been using two vertical Danish-type (DDS) ultrafiltration units to produce liquid retentate from goat's milk in the flush spring and summer season and then spray-drying this liquid precheese. The dried product
is reconstituted about December and is blended with fresh liquid precheese to maintain an even flow of cheese production during the period of low milk intake. In the new expanded sector, 90 m² of membrane are being installed. Other French companies are using ultrafiltration units to commercially make or to pilot-plant test cheeses like Camembert and St. Paulin.

Ultrafiltration for Making Mozzarella

At Cornell University for almost two years, ultrafiltration feasibility studies have been underway on the making of Cream, Cottage, Cheddar and Mozzarella cheeses (1,2). These cheeses have not received much attention in Europe and for various reasons may be more difficult to apply to ultrafiltration.

Mozzarella cheese has come a long way in utilizing mechanized concepts but the point between the setting of milk with rennet and heat processing and molding curd still is largely commercially conducted in vats and involves free whey drainage of curd. If ultrafiltration can be successfully adapted for Mozzarella cheese, it would fill this highly manual gap and make Mozzarella cheesemaking more truly continuous. This then was the objective of the study (1) undertaken by my recent student, Dr. Hector Covacevich, presently Director of the National Dairy Research Institute of Chile. It was essentially exploratory. Also, because the concept is new, the steps of making the experimental Mozzarella were not traditional.

Retentates or concentrates were obtained from skimmilk by continued cycling at 50°C through an Abcor Model UF 22S unit, under an outlet pressure of 49 lbs./in.². A small portion was freeze-dried and sufficient amounts of the dried retentate were blended with the standard liquid retentate in a Hobart mixer to increase the total solids to 33.6 percent. This was the precheese mixture for our Mozzarella experiments. The Mozzarella cheese was formed by adding plastic cream, homogenizing the precheese mix hot, cooling at 90°F and incorporating proper levels of salt, starter culture (S. cremoris) and rennet. These precheese mixes were then packaged and held until an optimum acid pH 5.3 developed, then were stored cold.

The cheese, upon examination, looked like Mozzarella and its texture was excellent, but it had one fault - it did not stretch under hot water even though cheese was held for up to 4 days of acid ripening. Holding this cheese in brine did not improve matters. The problem apparently was related to its high buffer capacity and the large amounts of insoluble calcium salts found in these direct ultrafiltrated cheeses.

Diafiltration - Simultaneous Fermentation

In another approach, diafiltration coupled with simultaneous fermentation was applied, that is, during the cycling of the 30°C skimmilk through the ultrafiltration tubes, clean water in considerable quantity and starter culture were added. This had the effect of removing more insoluble calcium salts, increasing the protein content and reducing buffer capacity. Mozzarella cheese was made and tested similarly to the cheese obtained by direct ultrafiltration. This diafiltrated cheese, which had an appearance and texture similar to the commercial product, showed very good stretching qualities after 24 hrs. at 5°C but its meltdown was minimum. Holding the cheese several weeks at 5°C greatly improved meltdown properties.

The use of direct acidulation techniques and more intensive acid-producing bacteria like Lactobacillus bulgaricus were initiated but our studies in this area are incomplete.
Summary

It is evident that the direct ultrafiltration of milk for the making of Mozzarella cheese is not to be so adaptable as was that for fresh acid cheeses or Camembert, although the results are only preliminary. More promising results were obtained with diafiltration and simultaneous fermentation and attention is focused on the feasibility of making Mozzarella cheese in this manner.

If a successful procedure emerges, it will then be necessary to critically appraise yields, costs, potential for developing a continuous process and sanitizing aspects. The latter cannot be overlooked in any calculation because despite the excellent CIP features of the UF units, the human factor for upsetting the best laid plans of automatic machines is always present and sometimes mechanized designs of different models may not fit every contingency.

Our present work which bears the seed of some promise must go into greater depth regarding the effects on stretching and meltdown of products containing higher than normal protein and insoluble salts. But already inherent in these studies is an implicit note that perhaps the UF process may lead to a successful intermediate-fat ripened cheese. Such a ripened cheese of perhaps 10-15 percent fat and lowered solids would appear highly suited to ultrafiltration operations.

The ultrafiltration process is destined to change our thinking on cheesemaking, but any success likely to emerge on this side of the Atlantic with its special cheeses will require plain hard work, imagination, experiments, accurate observations and chancetaking by industry.

REFERENCES


Economic Outlook

I do not propose to be an economist, however, I would like to share briefly with you a few observations relative to the current economic situation.

*Current Economic Situation

It would appear we can stimulate ourselves out of the recession, however, the real question is "can we control inflation?"

Short term money at present is more available than long term. The country is saving at a rate of 9 - 10%, this is an encouraging sign allowing a build up of loanable funds while improving bank liquidity.

Business ended in 1974 with $20 billion excess inventories, an extraordinary figure. The reason for the severity in the decline was that in 1974 firms margined to build inventories and then rushed to "reliquify" - which, when imposed on a normal slowdown, caused much of the problem.

1975 Signs of Progress

In early 1975 there have been some signs of progress.

A. Inventories - Auto inventories decreased due to rebate programs and production cutbacks—a $12 billion swing from fourth quarter, 1974 to first quarter, 1975. Consumer interest in furniture and textiles has shown spotty improvement.

B. Inflation—He feels that the inflation picture is much better than the official figures indicate. There have been few formal price cuts because firms are afraid of wage/price control on a recovery, however, rebates, discounts, extended payment terms, etc. are forms of price reductions not reflected in official statistics.

C. Monetary policy—At least allowing the economy to reliquify.

D. Fiscal stimulus—Primarily in reference to the tax refund.

Negatives

A. The consumer may "give way" again, but the signing of the tax cut bill has improved this picture.

B. Business rush to restore liquidity could result in a cumulative down spiral. If a number of major bankruptcies result, we could get a house of cards effect.

*Comments by Robert Dederick, Senior Vice President & Economist of Northern Trust Company, Chicago, Ill.
The Other Side of The Valley

A. Once inventory liquidation stops, we could get a good boost in production.
B. An incredible amount of slack is being generated, therefore, we could get strong recovery without straining the seams. This is different than the 1970 recovery.
C. Due to energy problems we need a substantial amount of spending to adjust to a high energy cost economy. If business is afraid to spend, they could "abort" a recovery.

Interest Rates

Current phenomenon—Borrowers rushing to borrow because rates may not go lower and lenders holding back looking for higher rates later this year. Nevertheless, with the inflation picture improving, he sees the following:

Federal funds 4 1/2% floor
Commercial Paper 5% floor
Prime rate 7%
Long rates 8% Aa Utility (at Best)

But we could get a steep runup on recovery—this is dependent on the federal reserve and what it thinks we can afford in terms of a monetary shot. If we get a sharp increase, someone will be in trouble.

1. Banks-credit allocation
2. Federal reserve-congressional intervention

Mr. Dederick feels that this fiscal 1976 deficit of $75 billion is manageable—but will the market?

Conclusion

Basically these are unprecedented times. Therefore, it is very difficult to make any forecast with certainty. Problems in the Mid East for example. We believe, however, the shape of the economy in coming months is one of continued weakness, followed by a bottoming out and a fairly good recovery starting in the fourth quarter or earlier. This expectation leans heavily on a dramatic easing on the fiscal side (the tax rebate mainly), aided by continued loosening on the monetary side. These would provide the right ingredients for a recovery in real incomes, in housing, in confidence, and later in business investment. The risks in 1975 are that the fiscal and/or monetary stimulus is too little and too late or that confidence and incomes do not really recover. In addition, if poorly handled, the size of the deficit could put too much upward pressure on long-term interest rates, aborting the expected recovery in housing and disrupting the capital markets. This unfortunate coincidence of events, aggravated by negative expectations feeding on themselves, is possible but unlikely. At present, after balancing the positives and the negatives, we believe that a cautiously optimistic view is warranted.
Agricultural Finance Outlook

The financial condition of farm operators is expected to change little in 1975, but a modest increase in the number of those having debt repayment problems is likely. Actual developments will depend mainly on the extent of recovery in livestock prices, on the size of the feed crop harvest, and on the strength of foreign demand for farm products.

Demand for operating and real estate loans is expected to remain strong but demand for intermediate term financing (for machinery, equipment, and livestock) is expected to slacken.

Net flows of loan funds are forecast at $14 to $17 billion during 1975, a $3 to $6 billion increase from 1974. Total debt outstanding January 1, 1976, is forecast to reach $108 to $111 billion.

Loan funds are expected to be available to meet these demands. Increases in funds from lenders with access to the national money markets, or individual land sellers, will offset any limitations on funds from lenders who draw from local sources.

Total assets are forecast at $598 to $608 billion at the beginning of 1976. And the debt to asset relationship will remain nearly unchanged at about 18 percent.

Although some decline in interest rates can be expected in the first half of 1975, it appears unlikely that rates will average more than 1/2 to 1 percentage point below the level of 1974.

Although real estate prices are expected to continue upward in 1975, the increase is likely to be less rapid than in 1974, perhaps ranging from 13 to 17 percent, depending on farm income developments and interest rates.

Net worth and income positions of farm operators at the end of 1974 reflect the wide divergence this year between incomes of crop and livestock farmers, continuing strong export demand, the vagaries of weather, rising input prices and storages of inputs, and the impact of tightening credit markets in the latter months of the year. In general, producers of crops are better off and producers of livestock and livestock products are worse off although realized net farm income (after paying production costs) for all farmers is expected to be the second highest on record, near $27 billion.

Because of the diverse income picture, the financial condition of farmers is also quite diverse. Farmers and lenders will have to face some tough financial decisions this year. Major

*National Economic Analysis Division, Economic Research Service
U.S. Department of Agriculture, Washington, D.C. 20250
repayment problems will arise for some livestock ranchers who recently expanded their operation or began ranching, because of their large debt commitments and relatively low income. Also, crop farmers who lost their crops because of 1974's weather reverses can be expected to carry over a large volume of short term debt and will also require large operating loans to finance their planned production. However, the number of such farmers is relatively small and lenders are not expecting significant repayment problems this year.

Demand for real estate loan funds remained strong throughout 1974 but eased for non-real estate lending. Real estate borrowing reflected the continuing advance in farm real estate prices which are expected to be up 15 percent during the March 1, 1974-March 1, 1975 period, trailing the 25 percent rise for the previous year. Values increased 10 percent from March 1 to November 1, 1974. Demands for non-real estate funds have been fueled by increasing prices and large purchases of current operating items such as feed, seed, fertilizer and other goods, and by the desires of farmers to delay crop marketings. However, the depressed state of cattle feeding operations and their reduced demand for loan funds slowed the overall rise in non-real estate debt.

Total real estate and non-real estate debt outstanding is up an estimated 13 percent from January 1, 1974, to January 1, 1975. However, the rate of increase has slowed in recent months because substantial numbers of lenders (mostly bankers and insurance companies) reported in September that they were loaned up, were not making loans to new borrowers, were rationing funds among borrowers, or were being more selective in making new loans. Most lenders anticipate that they will have at least as large a volume available for 1975 as for 1974.

A Banks Responsibility

Much has been written and more has been said regarding the responsibility of bankers to their customers and to their community. I would like to review with you our concept of a bank's responsibility to its depositor, its stockholder, its community, and its borrowers.

Depositors - We believe our first responsibility is to our depositors. These are the people who "loan" the money to the bank to enable the bank to make loans and provide the services needed by the community. Our first obligation in managing the bank is to make loans and investments that will insure the safe return of these deposits to our customers when they want their money. We also have an obligation to pay the highest rate of interest on savings consistent with good bank management.
Stockholders - We believe we have an obligation to the people who invest their money in the bank's stock. This is the money required for building, equipment and as a cushion for protecting the depositor's money. We believe these investors have a right to expect us to provide sufficient profit to pay dividends and build capital to support the continued growth of the bank.

The Community - We have an obligation to our community to provide leadership and loans for every worthwhile project and request. We acknowledge our responsibility to make the type of loans needed to help our community grow and prosper. We are also aware that it is our responsibility to make some loans on the basis of the needs of our community even when the loans carry more risk than we would like to take. We also accept the responsibility of encouraging our staff to participate in all worthwhile community activities.

Loans - We accept the responsibility to be aggressive in seeking out and making all the good loans for which we have funds available. This includes all types of loans and to all members of our community.

Serving The Agricultural Community

Farm Loan Participations are an important part of our correspondent service. We have a vital interest and concern for the community bank. Our bank's philosophy parallels the American Bankers Association marketing theme "To Help You Make Things Better". We believe strong respondent banks serve to build the economic base of their communities and we are interested in assisting them to achieve their goals through sound farm loan participations. We further believe a well managed respondent bank, whose personnel are agriculturally oriented and who attempt to keep abreast with "Financing Agribusiness - The Dynamic Growth Industry", will likewise, strengthen the correspondent bank. We are dependent on one another if we are to accomplish the job of serving the credit needs of our agricultural customers.

Charting Change

There have been many changes taking place on the farm scene these past few years. That's hardly news to anyone who deals with farmers. But yet, do we fully consider the full dimensions of those changes?

Certainly the implications for all of us will be most significant. The tendency is to try to formulate credit and service programs to meet the needs of all farmers in a trade area. Yet the data indicates that two-thirds of the U. S. farm products that are produced and marketed today come from only one-sixth of the farms. And, the needs of the managers of that one-sixth are certainly far different than the rest.
So, what of the future? If the trends of the '60's continue through this decade as are predicted, what will be the dimensions of your business as an agri-businessman and that of your banker on agricultural financial matters?

The answer to that and other questions will vary by area. It will depend on the pattern of change in your local community. An on-going study of that should be given high priority.

More Detailed Profile

As changes occur it becomes increasingly difficult to gain a clear picture of the differences within groups of business prospects. Still, differences do exist. And, services need to be tailored to meet the needs of each segment.

The research department of Farm Quarterly magazine, in looking toward the 1980's, attempted to segment the agricultural sector into characteristic groupings.

Descriptions of these groups are most interesting. You may want to try using such a breakdown to classify your customers and prospects. Here is how the Farm Quarterly people describe them:

The Elite. These are the most successful operators...the entrepreneurs. Included in this group are the operations that are vertically integrated - encompass production through marketing and, in some cases, processing of their business.

Today there are only about 50,000 of these operations (2.5 percent of the total). That number will probably grow to around 100,000 by 1980. They would then represent around six percent of the total number of farm units.

The Innovators. These men will be the leaders, enamoured with the business of farming. They will be keen minded businessmen and will have expertise in financing, marketing, and labor management as well as production.

While not large in number, they will be a most important segment. You may have difficulty understanding them. They are the ones to first jump in on a new idea. But it is the better managers within this group that reap the early profits.

Commercial. These are the "professional" producers. They will be aggressive forward thinkers, and their success will be exceptional. It will be to their credit that the U. S. will continue to need fewer people to feed the rest than any nation in the world.
These top three groups - the Elite, Innovators, and Commercial - will probably account for only about 20 percent of the farm units at the end of this decade. But, they will account for a massive share of the business generated in the local community - for supply dealers, and for credit and business management services, as well.

The Beginners. These are the "young tigers". They will be in low equity positions. They won't have the capital to own land, but they'll not be afraid to go into debt.

Some of these will be ambitious young renters of land. Perhaps some will have taken over from their father, or inherited some land from parents of other relatives. Of course, some won't be able to "make a go of it" but others will be destined to become the big commercial operators of the 1980's.

The Stagnant Ones. Characterized by conservative attitudes toward debt, they will have had a profitable farm business in the past but not enough aggressiveness to keep up with their forward thinking neighbors in the decade of the '70's.

They are sort of the "in-betweeners" - too much invested to quit, but not enough to really make a good living at farming. Too young to retire, yet too old to successfully begin a new life elsewhere.

Part-Timers. These are the "week-end" farmers. The guys with a full time job in town. Some will work a day shift, others a night shift; then use their remaining time - days and weekends - to farm.

While some will be relatively small in farm business volume, others will be quite intensive. Labor savings will be a priority requirement. And, they'll have unique service needs. As customers and prospects, it'll be important to remember that their salaried job will be a big key in their purchasing power and loan repayment capacity.

The Hangers-On. When people talk about numbers of farms, these will represent the biggest number - around 40 percent of the total by 1980. They're the "farmers without a future"; the aging ones with stagnant attitudes.

Either because of advanced age, lack of ability or other factors, you can't count on these as ever becoming good farm business customers. One day they'll finally sell out to a neighbor who needs more land to remain competitive.

Advisors and Consultants. This is a group of growing importance on the farm scene. This group included bankers and other agricultural lenders as well as professional farm managers, veterinarians, professional consultants, dealers,
salesmen and others with whom farmers maintain close business contact.

While relatively few in number, people in these influence groups will be of ever increasing importance. Each will deal with a large number of farm operators and managers on a regular basis. And, what they say and how they react to their clients' questions will have an influence on their future as farm businessmen.

As agri-businessmen, I believe we will all want to develop and maintain close relations with these advisors and consultants. They can influence the soundness of advice or loans made to farmers.

There's really no question but what change is going to continue to run pell mell through agriculture. It's going to bring with it new challenges as well as opportunities. And, those who do the best job of anticipating these changes then tailor their programs and services to meet the changing needs, will reap the rewards of growth and profits.

Yes, in this new era that agriculture has entered, the farmer is truly a businessman. Like other businessmen, he needs to be financed not on his net worth but on the profit-making ability of his year-to-year operations. He needs the same type of "enterprise analysis" that bankers provide for business and industry. Therefore, we can equate the business side of financing the dairy farmer with the same basic requirements as the cheese industry. Let us look at Dairy financing.

**Dairy Financing**

Dairy farming today is a dynamic, highly competitive ball game. To establish and maintain a dairy farm requires an exceptionally large amount of capital associated with superior farm and money management. Dairy farming is in a period of substantial and far reaching adjustments. Dairymen are faced with strong economic pressures to improve the efficiency of their operations and to increase the dollar volume of their businesses. This calls for substitution of capital for labor. All dairy farmers do not show equal ability in making necessary adjustments for business success. Some are becoming stars in the capital-oriented league composed of large-scale dairy operations; some have proven successful - but remain in the labor-oriented league of more traditional farming; while others are struggling to improve their league status or are on their way out of the ball game.

**What League Do You Want To Be In?**

Each dairy farmer must ask himself three basic questions on a relatively continuing basis.
First, Where am I? Am I in the big league, the minors, or on my way out of the game all together?

Second, Where do I want to be, and what am I willing to commit to get there? That is, what league do I want to play in and what status in the league do I wish to achieve?

Third, How can I best get there from where I am?

By the same token, we as agricultural bankers, can ask ourselves the same questions - what league do we want to be associated with? Where will be the greatest potential and profitability for our bank, our customer and our community?

Knowledgeable Bankers

It will be far more necessary in the future for the banker to thoroughly understand how his dairy farm customers operate their business than it has been in the past, and the dairyman will, out of necessity, have to become much more knowledgeable than he has been in the past in the proper use of credit. He will have to rely more heavily on his banker for the advice and council necessary, with respect to the proper use of debt financing of his operation. It will be essential to keep his banker informed to sustain a close working relationship - teamwork.

Why Do Dairy Farmers Stay In Business?

"Why do dairy farmers stay in business?" This question is frequently asked by laymen. Little do they know once a man has farmed, it is hard for him to leave that farm. The farm is a man's kingdom and domain. He exerts a degree of freedom that very few city people would understand. That is one of the reasons why he has not left the farm, according to Louis Longo, prominent New York dairy farmer and writer.

The second point which is preventing farmers from liquidating is the low beef and cattle prices. Beef that was selling for 40 to 42 cents a pound live weight in this area a year ago now is selling for 20-22 cents a pound live weight. In some cases, liquidation perhaps would not even pay off the debt.

Others are staying in business with the hope that something can be done about the price of milk, and that they may someday enjoy some share of a growing economy. Some are staying, of course, because land values are accelerating from year to year. They are able to pay their taxes and interest on their loans, but the return for their efforts may be only in the acceleration of land values. And that only will be true if land values do not become depressed as they were many years ago when conditions were somewhat similar.
I believe that the dairy business can survive, but with certain qualifications and reservations. The dairy business can survive if the dairy farmer has a keen sense for money management which is vital in every industry.

**Young Dairy Farmers**

Every year more and more young people are getting into dairy farming. Some are doing it on their own and others in partnership with their parents.

A new and different breed of young men and women, who want to make something of themselves are entering farming. This new breed of dairyman is intelligent, well-read and constantly searching for new and better farming methods.

For the most part, money is the limiting factor to their success.

On many of the farms I visit it seems priorities are out of focus. Some young farmers put top priorities on owning the latest farm machinery - such as 100 horsepower tractors, covered self-unloading wagons and automatic reset plows - while little emphasis was placed on the profit capabilities of the cows in their barns that were paying for everything.

To make the first five years of farming financially sound, I believe that priorities must be equitably placed on the dairy herd and other farm investments.

Many young dairymen I have visited know all there is to know about such machinery mechanics as engine bore, rpm, pto and torque but show little concern with predicted difference, production and type qualified sires, profit per cow, production testing and the other mechanics of dairy cattle breeding. Although I realize the necessity of good farm machinery, we must also emphasize the need to start with high producing, functionally sound cows or as we say the working end of the business.

**Ingredients For Success**

Is this a good time to get started in dairy farming? The question has been asked as long as we have had a dairy industry. And a general answer, today, is no better or worse than it has been at any time in the past. For a young person who has what it takes to be successful in dairy farming, now is not only a good time to get started but it may be the only time for you.

Among the most important ingredients for success are good health, a combination of experience and education, ambition, desire, proper attitude and a willingness to forego some spending for personal consumption. Vitally important are financial arrangements which will provide land, buildings, livestock, and machinery resources in sufficient quantity and
quality to give the owner a chance to practice good management. If married a mate who is interested in dairy farming is a great asset.

All of the above prerequisites for success have long held true. But meeting the requirements of sound financial arrangements represents a different problem today than it has in the past. Capital investment in dairy farms has increased at an astounding pace in the past 10 years.

Farm Credit Analysis

Records, properly and accurately kept, provide the banker with the financial information needed for prompt handling of credit requests. The banker who has records of the borrower's business is able to compare the borrower's past performance against standards for the area. Basically, the young farmer (Tiger) who offers our bank future growth must have the potential of an expanding earning capacity and capital growth characteristics. The banker has to determine if the man in management can put operational and financial management together into a profitable dairy operation. Therefore, it would seem that the bank's program of analysis should be sufficient to protect the assets of the bank as well as to maintain a steady and dependable flow of credit applicants.

We recognize the importance of working together (rural and urban people alike) - they call that teamwork. Teamwork is important in athletics and is equally important in agriculture. It takes teamwork between the banker and the customer to plan a sound financial program. The banker needs to understand the customer's credit needs while the customer has to have proper understanding of credit itself. Through this mutual understanding and confidence the foundation is built for planning and developing a successful business.

Teamwork between the banker and the customer will avoid unnecessary credit problems. Teamwork will build financial strength for the farm family, for agriculture, and for the community in transition. In conclusion, I believe the following poem expresses the Christian ideal of working and sharing together in our changing society:

All have a share in the beauty;
All have a share in the plan.
What does it matter what duty,
Falls to the lot of a man?
Someone has carried the plaster;
And someone has carried the stone.

Neither the man nor the master
Ever has builded alone.
Making a room from the weather,
Building a house for the king.
Only by working together
Has man accomplished a thing.
The following paper was presented by Mr. Jack Stephan, President, Stephan & Brady, Inc., P.O. Box 1588, Madison, Wisconsin 53701, especially for the 12th Annual Marschall Invitational Italian Cheese Seminar held at the Dane County Exposition Center, Madison, Wisconsin, on April 28 and 29, 1975.
INCREASING ITALIAN CHEESE SALES

WHAT CAN YOU DO?

The U.S. Italian cheese industry has been a growth industry. During the last 70 years in the United States, you've made tremendous strides ... from better methods of production to development of identity standards to more convenient packaging ...

Until today, you've pushed the annual U.S. consumption of Italian cheese to close to three and one-half pounds per capita!

What has caused this tremendous growth in your industry? It's been your dedication to producing the finest cheese possible ... plus the high price of beef and other protein sources ... plus a growing consumer acceptance of cheese ... plus the popularity of Italian ethnic dishes and the success of the pizza industry.

But even with this increased sales and growth, you're not satisfied.

And rightly you shouldn't be. You feel confident there's even a larger sales potential. Of course, the potential is there. But the real question each of you should ask is, "How" -- "How can I increase my sales of Italian cheese?"

Can I increase my sales to the industrial market?
<table>
<thead>
<tr>
<th>11) Food service</th>
<th>Can I increase my sales to the foodservice market?</th>
</tr>
</thead>
<tbody>
<tr>
<td>12) Consumer</td>
<td>And very importantly, how can I increase my sales at the consumer level?</td>
</tr>
<tr>
<td>13) No &quot;magic&quot; method</td>
<td>Gentlemen, there is no one answer. There is no magic method. The way to increase sales lies in taking specific, yet different, steps to sell to these very different markets.</td>
</tr>
<tr>
<td>14) Sales</td>
<td>Your primary markets -- Industrial, Foodservice and Consumer -- contain very different buyers, looking for very different benefits.</td>
</tr>
<tr>
<td>[Industrial] [Consumer][Foodservice]</td>
<td></td>
</tr>
<tr>
<td>15) Frozen pizza packages</td>
<td>Sales to your industrial (or ingredient) customers must be the bread and butter for many of you right now.</td>
</tr>
<tr>
<td></td>
<td>The U.S. pizza industry alone annually represents over a $3 billion business. This is a huge market. The cheesemaker who sells to John's Pizzas or Gino's ... is practically guaranteed volume production. However, this is no gravy train. For there's competition here. Fierce competition when you're making huge quantity sales. Price is a very determining factor.</td>
</tr>
<tr>
<td>16) Cheese production photo</td>
<td>These buyers really don't care how you make it. And probably don't care all that much about you. They care about themselves and their products. They care about value.</td>
</tr>
<tr>
<td>17) 1. Product 2. Price 3. Quality 4. Delivery 5. Packaging 6. Supply</td>
<td>To sell effectively to this market, the cheese you produce must be right for them. It must be the right product. It must be the right price. It must be the right quality. It must be delivered reliably and packaged protectively. And you must be able to have the continuing supply to guarantee performance to the needs of the buyer.</td>
</tr>
</tbody>
</table>
18) Selling to ingredient buyers

Those of you who sell successfully to the industrial market know this well. But, what should you do if you're not one of the manufacturers who's selling well to industrial accounts? You know how to make the finest Italian cheese possible -- I won't quarrel with that. But once you've made the right product, how on earth do you successfully get it out the back door ... and generate sales to ingredient buyers?

19) 1. Product  
2. Price  
3. Quality  
4. Delivery  
5. Packaging  
6. Supply

When you're selling cheese to the industrial market, it generally takes much more than a quality product and a fine reputation.

Let's go back and review. Remember, you must first make sure you have the right

- product
- price
- quality
- reliable delivery
- protectively packaged
- and be able to
- guarantee continuing supply.

20) Then what?

If you've done all these things ... then you have to tell people about it.

21) Benefits

And you go about doing that by telling specific potential customers about the specific benefits to them if they specify and buy your product. That's where marketing, advertising, promotion and public relations efforts pay off ... but only if they're coordinated with your sales force and their efforts.

Many of you in this audience have already been doing a fine job of using these tools. Your ads are loudly and clearly selling qualities in your cheese which make a difference from your customers' point of view. You're selling benefits.

22) Cover photo from Slice of Pizza

I can't show everybody's ads, but here are a few examples; ads appearing in recent issues of SLICE OF PIZZA ...
23) Grande ad
Grande--The main selling point here is flavor. Grande is saying, "Since cheese can make up to 60% of your pie's flavor and appearance, you should use no less than the very best mozzarella cheese."

24) Tolibia ad
Here's an ad from Tolibia. The selling advantage here is convenience--cheese which is already shredded, grated, measured and blended--and according to Tolibia--with convenience comes profits.

25) Doskocil ad
Doskocil takes another angle -- the appearance and texture of the final pizza depends on the cheese put on it.

26) Grande ad
This Grande ad creates a psychological advantage--your pie deserves the best. This could well appeal to the manufacturer who's very proud of his product name and quality.

27) Tolona ad
Tolona offers variety and purchasing convenience with many other pizza ingredients available besides cheese.

These are just a few examples of the promotional efforts being used by Italian cheese manufacturers to sell the ingredient (or industrial) market.

28) Benefits
All sell benefits of one kind or another. Do your ads sell benefits? Do they sell the discernible difference? Are you even promoting to this market?

29) Picture of iceberg
When attempting to sell Italian cheese, you're not just battling the competition for market share among yourselves. You've got a new, lurking competitor which can only be seen as the tip of an iceberg right now. But it could possibly emerge as a strong competitive factor for you in the future.

30) Anderson Clayton ad
And, that emerging competition is the imitations. We just mentioned the importance of selling benefits and illustrating a discernible difference in advertisements.

Here Anderson Clayton is advertising an imitation cheese. They claim a $100 difference per week based on 500-pound usage. Saving $100 a week on cheese ingredient costs could be the motivating factor which will encourage some manufacturers to try it.
JPC Corporation has a "non-dairy" pizza topping they claim has all the qualities of real cheese yet is less expensive and in good supply. Will this make a difference to a pizza manufacturer?

It might. It was said that vegetable protein analogs would never catch on--consumers would not like the taste--but if they ever did try it they'd go back to the real thing. Yet, look at the success of Morningstar Farms' products.

My point here is that I don't think you can sit back and be smug and assume that just making great cheese will guarantee your future markets. Perhaps the non-dairy Italian cheese industry does not loom as a threat now. But it might. I'm not suggesting any specific course of action. And I don't have any instant answers to the potential threat. What I'm doing is raising questions.

It's extremely important to be ever mindful of new developments occurring in your own back yard.

Another such development you're probably keeping an eye on is the urging on the part of your industrial and food service customers for uniform USDA grading standards. Currently you have established standards of identity for your cheese and you know that that was a tough battle. But would it be beneficial to campaign for establishing grading standards? This could possibly help in ingredient sales as well as foodservice and consumer sales. People just plain want to know what they're buying today. They are demanding a yardstick for quality. Perhaps grading is the answer.

We've just talked about ingredient (or industrial) sales. There are two other important marketing areas, foodservice and consumer.

Let's talk about the huge foodservice industry. A growing industry. Already, at least one out of every three meals is eaten away from home.
Most food products sold to the foodservice field are handled by distributors contacted by brokers. Are you really helping them sell your products? They're dealing with your customers every day! What type of training program do you provide brokers which will enable them to train distributor salesmen? What tools or advertising support must you provide them so they can develop loyalty to your products? Your foodservice customers or potential customers establish their buying patterns through their local distributor. Generally, they trust and respect their distributor. They rely upon him to furnish the right ingredients for their businesses ... the right product, the right price, the right quantity and prompt delivery.

What kinds of incentives could you be offering your distributors or potential distributors?

What is it you might be able to provide a distributor which will help him sell more of your Italian cheese?

Could you sell more cheese by going directly to large foodservice chain operators who manufacture and/or distribute and/or specify to their own and franchise outlets? Somebody is selling an awful lot of cheese to the Pizza Huts ...

And to Shakey's Pizza Parlors.

And, aren't you glad God invented the pizza. 75% of all the Italian cheese produced is mozzarella and fully 85% of all the mozzarella is sold for industrial and foodservice use. Just since 1957 mozzarella cheese production has increased over 900%.

One recent Gallup poll reports that pizza is the most preferred quick snack of youth today -- even over hamburgers!

Since pizza has been so important to your growth, it stands to reason, if you help the pizza industry grow even more, that growth will in turn help your sales.
Can you do this by providing placemats, menu clip-ons or attractive wall posters to restaurants for display?

Think of the suggestive selling you could do with a wall poster ... a luscious, attractive wall poster of a fresh, hot pizza, dripping with golden mozzarella cheese ... and, if ...

Lasagne "travel" posters are a good idea, why not produce old world posters suggesting that lasagne is a taste of sunny Italy?

There are so many ideas for selling to the foodservice industry, but Stan has his timer ... and I long ago learned that a speech to be eternal does not have to be everlasting!

Let's move on quickly to the consumer who buys Italian cheese in her favorite store.

When you're dealing with consumers purchasing Italian cheese, the biggest potential being in supermarkets, the approach and psychology you must take to increase sales is a whole different ball game.

With today's food dollar shrinking ever rapidly, all consumers are searching for value ... however

Value to one customer may be purchasing the lowest-priced product available, regardless of quality ...

Value to another may mean a trade-off between price and quality ... seeking the best quality she can afford ...

And value to still another may mean purchasing the best product available, regardless of price.

The reason I mention "value" here is because not all consumers know the "value" of purchasing Italian cheese varieties. They have no yardstick to evaluate quality versus quantity against price.
They have not become educated enough. They have not been offered a "valuable" alternative to meat and potatoes.

She doesn't know that by purchasing a pound of Italian cheese she will get the equivalent amount of protein as purchasing a pound of lean hamburger or steak.

She doesn't really know that the price of Italian cheese per pound is roughly the same as the price per pound of cheddar.

She doesn't know that most Italian cheese has a pleasing flavor and aroma. She doesn't know what provolone is. She doesn't know that ricotta is a very mild and delicate cottage cheese type. Somehow ricotta is as foreign sounding as Roquefort ... and she knows how strong Roquefort is. Besides, the only thing Roquefort is used for is salads!

Therefore, the most pressing concern you have for increasing Italian cheese sales at the consumer level is to do a massive education job.

Of course, everybody eats pizza, but I'll bet the vast majority of those consumers don't even know it's mozzarella they're eating.

Let me give you an analogy. Did you know that oranges were literally sold to the American public? The orange on the tree never grew with the word "breakfast" on it. In fact in England, they think a slice of orange is what you eat when you're having afternoon tea and crumpets.

Yet, a bunch of growers got together, called themselves "Sunkist" and sold us all a bill of goods.

If a bunch of guys selling orange things growing on funny looking trees can do that to the American breakfast habits, imagine what you could do with promoting quality Italian cheeses that take real skill and dedication to make.
And there's a real need for it! Supermarkets and consumers alike are practically begging to see promotional work done on Italian cheese varieties. And why not? Look at the Italian cheese section in supermarkets. Not too inspiring. Supermarket operators would jump at the chance of putting on a major "Italian Cheese Week" campaign in their stores. And not a one-shot campaign ... they'd be willing to have special in-store promotions twice a year -- or more! Supermarkets around the country would be more than open to such a promotion. But ... no one manufacturer can do it alone ... and working together on promotional efforts could pay fantastic dividends.

Some consumers are already telling you that they want to buy your products. While a great many more consumers would feel the same if they understood what to buy. Supermarkets are inclined to be on your side because you help them sell other products. While mozzarella sales have doubled, supermarkets have also seen their noodle sales double. Consumers in the know are having a great time preparing casseroles and lasagne.

A pound of cheese will more than adequately feed a family of four for one meal -- but how far can a pound of meat go with that same family?

There's an opportunity here. If you can show that American consumer how she can be a better wife and mother by using your products ... if you can show her how she can serve better tasting, more nutritious meals at a lower cost ... if you can show her exciting things to do with plain old noodles ... you'll have made a friend for life!

Let's show her how. Let's give her recipe ideas.
In fact, why not put recipes on your packages or have a recipe hang-tag or have recipes fold out from your label? Any marketing man can see you need "packaged" dairy case promotional programs anyway. Recipes could be a part of that promotion.

Themes could be developed around the recipes ... party hors d'oeuvre recipes ...

family economy recipes ...

gourmet recipes ...

dessert recipes ... or

sandwich recipes.

If you don't think supermarkets are hungry for Italian cheese promotional help, you just ask the buyer at Jewel in Chicago.

This type of effort is essential. Even I have a full-time home economist and test kitchen ... and I don't make Italian cheese. Our people promote food products and food ideas. If we work on recipe ideas certainly you should, too!

Just look at how exciting we made this folder look for Miles Laboratories. Here they're selling flavors industrially yet it isn't dull. It's exciting.

And look at this color page in a brochure for WARF Institute. In no way are they selling to ultimate consumers. They're one of the largest, most highly respected independent testing laboratories in the world. They're selling services to manufacturers. Yet look how exciting they appear.
But ask yourself how many exciting color promotional photos of Italian cheese have you've seen? I think you're just kidding yourselves if you don't come up with exciting food photographs showing Italian cheese at its best to be used in posters. To be used in recipes.

Your recipes could be collected in an attractive recipe book and given away or even sold to consumers. Such a recipe book could be very versatile.

You could place educational ads in consumer magazines or newspapers with a clip-out coupon. Consumers could then send away for this special recipe book.

Or the recipe book could be inserted in consumer magazines ... the kind of booklet that's easily torn out.

You could give them away at supermarkets. You could use them in a number of beautiful promotional campaigns.

How about press releases to newspapers? Newspapers are always eager to get good recipes with well-done photographs and accompanying stories.

Why not regularly send out interesting recipes for dishes using various Italian cheeses. Themes and seasonal considerations could be easily tied with such a newspaper recipe promotion. Your recipe book could even be mentioned as a give-away in the editorial content.

Additionally, newspaper food pages often have new product or consumer information columns where your Italian cheese recipe book could be mentioned as a giveaway.

Well-written feature or news stories could also be prepared for newspapers. Such features could explain the difference among various Italian cheese varieties, their history, or use and popularity.

<table>
<thead>
<tr>
<th>70) Dummy cover of Italian cheese recipe book</th>
<th>71) Dummy of a clip-out coupon ad for recipe book</th>
</tr>
</thead>
<tbody>
<tr>
<td>72) Photo of food section of a newspaper</td>
<td>73) Dummy recipe release. Recipe/photo/copy/recipe book</td>
</tr>
<tr>
<td>74) Photo of Italian cheese varieties</td>
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</tbody>
</table>
Why not bring newspaper and magazine food editors to an Italian cheese factory? Let them taste, touch, and see for themselves the wonderful world of Italian cheese. This could be a great educational experience for these editors. And in turn this education would be passed on to their readers in editorial form with pictures and recipes.

One of the more interesting consumer educational programs that you might do is with professional home economists.

The home economists who not only work with consumers and homemakers ...

but the home economics teachers in high schools.

Another thought. Did you know that over one-half of all U.S. mothers with teenage girls are employed? Over one-half! Because so many mothers are employed, that leaves them precious little time to plan, purchase and prepare family meals.

Of those employed mothers, nearly 22% of their daughters are responsible for planning the family meals.

When it comes to shopping, in about 47% of the cases, the mother selects the cheese. But in 13% of the cases the daughter alone is responsible for selecting the cheese and in 29% of the cases sometimes the daughter and sometimes the mother makes the selection. Clearly, you have a huge consumer market at your feet ... the teenage girl. You might consider specifically tailoring an Italian cheese educational and promotional campaign toward her. These young consumers are now developing their food-purchasing habits. Wouldn't it be great to get at these young consumers now during this impressionable stage?
There are a variety of ways you could influence her buying habits. One way is through her high school home economics teacher.

A complete Italian cheese educational package could be developed for the teacher to use in her classroom.

This could include Italian cheese variety fact sheets, nutritional information, a slide set or film, work sheets, handout materials or recipes and even your Italian cheese recipe book! Educators need these types of materials and would welcome them in their classrooms.

Such educational materials could be promoted through the American Home Economics Association ... at the home economics trade shows and conventions ...

and through the home economics teacher magazines. And I'll guarantee you you'd be surprised at the number of responses you'd get to such an educational package.

Another effective public relations and promotional tool which could be utilized is radio and television. As you probably know, the broadcast media is required to do a certain amount of public service work. Normally this takes the form of promoting Heart Associations, the Red Cross work, announcing Kidney Foundation information, etc.

However, stations are also looking for and utilizing consumer information and tips.
86) Collage of Marschall Dairy cheese promotional materials

In fact, right now the Marschall Division of Miles Laboratories is producing a cheese promotion campaign for June-Dairy Month. Right now, we're preparing public service radio spots, for them to be aired during June. And, developing recipes, writing food stories and feature stories and taking food photographs. All this will go to daily newspapers across the U.S. Why is Marschall doing this? They're vitally concerned and want to help you--the cheesemaker--sell more of your products. But, you could do this sort of promotion, too.

87) Photo inside television studio

Television also offers other broadcast promotional opportunities. Practically every city in the country has a television station which airs a locally-produced consumer-oriented show. These shows often have guests from industry explaining their products and uses as well as doing cooking demonstrations. This might be an ideal way to promote Italian cheese -- by booking guest appearances on these shows of Italian cheese industry spokesmen such as a cheesemaker or a home economist. A well-coordinated 15- or 30-minute segment could be done with many useful consumer information points transmitted to the viewing audience. Your industry spokesman might even have the air time to prepare a simple and economical main dish made with Italian cheese.

88) Photo of consumer with cap and gown

The key to all the possible promotion ideas I've mentioned today is education and awareness. All your customers -- whether in the consumer or foodservice market -- are developing enthusiasm about Italian food and the necessary Italian cheese varieties to use.

89) Photo of Italian cheese varieties

To see even greater Italian cheese sales, it's important now to take advantage of this current enthusiasm ... to ride the crest of the wave that's started its swell. If you can produce, whether individually, or collectively, an on-target, colorful, informative and enthusiastic promotional campaign, you will see expanded demand and increased sales.
You are producing now, Italian cheese varieties as fine as anybody in the world. But, when I talk about increasing Italian cheese sales and ask the question, "What Can You Do About It?" ... the answer has to be ... "PLENTY"!
REFERENCES

Belil, Eli S., Research Director of Co-ed magazine, Grocery Store Shopping Habits of the Young Consumer, April, 1974.


Discussions with:

Breeseeman, A. P. Dairy Product Specialist, Wisconsin Department of Agriculture, Madison, Wisconsin.


The following paper was presented by Mr. Howard Chapman, Public Accountant, P.O. Box 14, Plymouth, Wisconsin 53703, especially for the 12th Annual Marshall Invitational Italian Cheese Seminar held at the Dane County Exposition Center, Madison, Wisconsin, on April 29, 1975.

1975 PRACTICAL ACCOUNTING METHODS AND IDEAS FOR ITALIAN CHEESE PLANTS

By Howard Chapman

During the years I've been in the accounting profession, I've often thought I might be asked to talk about my profession and experience. Now, after all these years, this is probably my first and last appearance.

I taught accounting in a private business college in Hickory, North Carolina, from 1946 - 1950. During that time I formed a small accounting service and developed a system simple enough to operate efficiently and yet be readily understandable by a client. The system consisted of a uniform chart of accounts which could be fitted to each client's needs. A journal and ledger for each client completed the arrangement. Monthly income and expense statements and balance sheets were preformed and quickly executed after all entries had been made and posted to the ledger. Time was important in this type of business so the whole operation was kept as modest as possible.

When I returned to Wisconsin in 1951, the system served me well. In a short time a competitor was asking my secretary to explain the method to him.

My first contact with accounting for a cheese factory occurred about six years after I started my practice. I realized the need to make some changes in the ledger function in order to produce the desired results for my client. By elaborating slightly in the chart of accounts, I was able to provide a simple, easy to understand explanation of the relation of cost of sales and expense by percentage to sales. In this manner, the client could readily see the effect of cost upon the figure at the bottom of the income and expense statement.

The average client is primarily interested in the net profit or net loss in the lower right hand corner of the income and expense statement when he should be more concerned with the contributing factors which lead up to the net profit or loss. Such things as inventory control and buying procedures can aid in the reduction of cost and lower the investment in the finished product, thereby assigning more dollars into operating capital.

You know what borrowed money costs these days. It becomes imperative then that you employ techniques which will assist you in controlling your costs. Not only must you consider space and dollars. You must also consider your ability to turn over your working capital. You must systemize any procedure to determine the Economic Order Quantity - the size and frequency of orders, the level of inventory to be maintained, location of the source of supply and availability.

You could find it advisable to enter into long-term purchase agreements with both buyer and source of supply in order to receive a more favorable cost factor. If a buyer will accept a given quantity over a certain period of time, your product can move in a manner which will promote a better turnover of working capital. Control of stock and product point directly to a more efficient factory operation. This means lower overhead costs.
Associated with factory and production costs are those costs which may arise outside the factory. The subject of credit extended and received enters the picture. Overextended accounts receivable may necessitate borrowing money. Careful observance of customers' paying habits and the experience indicated by the account activity should serve as a guide to how much credit can or should be allowed. Also, personal contact follow-up with delinquent accounts can have the desired effect without the anxiety which might occur for fear of becoming antagonistic.

Applying the subject of credit to your own purchasing policies, you can comprehend the importance of a favorable credit rating with regard to your suppliers. In some situations, visible contact may never occur. The only impression a creditor may have of you is what your account indicates. Inattention or delay on your part can cause inconvenience to your suppliers and reduce your prestige. You can't afford to keep your customers in business and neither can your creditors afford to keep you in business. Suppliers cannot finance cheese factories. Putting it all together, the end result becomes more favorable for you and that's what it's all about in the first place.

About four years after I started doing his accounting, one cheese factory client was audited by the Internal Revenue Service. To this day, I don't know whether my system had anything to do with it or not. The auditor didn't say much. However, I still have in my client's file the form he received from Internal Revenue advising no changes were necessary and the tax return had been accepted as filed.

Another cheese factory client was added in 1962. Here was another time when my system had to be altered. No two cheese factories operate in an identical manner. Each must be treated individually. The CPA who had set up the accounting system for this factory had installed the accrual basis. The factory was operated on the cash basis throughout the year, returning to the accrual basis only at income tax time. It became necessary for me to make an explanation at the end of each month about the income and expense items which didn't appear on the books. The operation, although sizeable, had only a few large receivables and payables so I could show the client where he was dollarwise with a minimum of clarification.

I had no knowledge of what had gone on before I started this client's accounting so I received as a slight surprise the notice from the Wisconsin Department of Revenue that, because of an Internal Revenue audit, the state was also going to audit his books. When the state auditor started his examination, I noticed an apparent error on the part of Internal Revenue. Some income had been assessed without regard for the offsetting accrual of liabilities against that income. One item was purchased milk from other than patrons. I knew I was right and I stuck with my assertion. As a result, the state auditor had to reduce certain assessments. It was too late to correct the federal assessment because of statute limitations, but the state assessment was made substantially lower.

Here are two things I learned from tax audits. First, answer questions directly—fully but briefly. Don't ad lib or volunteer. Answer the question—period. Second, if you're right, stay with it. The auditor must then prove you wrong. More often than not, one or two major items verified in this manner can save extensive examination and reduce the length of the audit.

Remember, these auditors are human. They can make errors, too, although not often. However, they don't audit cheese factories every week or every month. Also, they employ the same procedure with a cheese factory as they do with the large manufacturer.
or the corner grocery store. Because of this, I suggest that you, as owners, operators or whatever, re-appraise your accounting structure. Have your accountant gain a better knowledge of how you operate in the cheese business. Together, you can save time and money if you are ever confronted with a similar situation. The successful businessman knows his business and attends to it. Bring your accountant closer.

Something else often becomes apparent in a successful operation. If two people continue to agree, one of them may not be necessary. With this in mind, don't be afraid to listen. Some good ideas have come to me because I kept my mouth closed and listened.

I'd like to remind you of the need and demand, especially now, for good record keeping and professional advice prior to making decisions, in order to avoid circumstances which might prove costly and could be avoided by proper counseling. Among other things, I refer to such items as the sale of assets which can result in recapture of depreciation and investment credit. Correct procedures and accounting methods can mean money in your pocket if you take advantage of them.

The proprietor of a cheese factory is intent upon making good cheese, getting as much for it as he can and using what he gets as efficiently as possible. However, profit can be decreased by additional tax costs of which he may be unaware unless he has the advice of a competent accountant at the proper time.

Each of you, at one time or another, has had some contact with tax forms and instructions. The forms are becoming more complicated and more extravagant each year, regardless of what you may hear to the contrary. The attempts to simplify the returns for the small businessman don't seem to have turned out that way. On today's market you must have specialized help in accounting and tax matters and you should take advantage of an accountant's specialized skills. The intelligent businessman will rely on an established professional. He goes to a lawyer when he needs legal advice. He goes to an accountant when he needs information concerning accounting and taxation. You must rely on the specialist. The amateur once-a-year tax man and the tax service down on the corner are no longer good enough.

The manufacture of Italian cheese in Wisconsin has become a giant. Here is my advice for anyone associated with the manufacture or sale of this commodity. You who operate the smaller factories should seek to establish as efficient production methods as possible to hold down cost. You must also be sure to get a fair price for your product. Your outlet, whether it be wholesaler, distributor or retailer, should help provide it for you. Without you and others like you, they might not be as successful as they are. But they can be the source of some sound advice for you concerning your operation. For instance, I'm in accounting but I'm not above asking opinions of others in an effort to better myself.

To those of you who buy this good Italian cheese, I respectfully request that you consider or reconsider those whose product you buy. The small businessman is not small in his own eyes. You are his bread and butter, yet he is an integral part of your operation, and he must be treated as part of your business.

For the manufacturer, large or small, nothing is gained by looking back. In this age of computers, complex machinery and the like, concentrate on what is ahead for you. Plants must change with the times. Your product is your trademark, an asset which competition cannot destroy regardless of how much it tries. Therefore,
there is great need to seek the assistance of professional people to keep your product that way. Your banker, your lawyer, your accountant, your suppliers, the manufacturers of the fine equipment which produces your cheese - all are members of your team, but they can help only to the extent you allow them to do so. As specialists in their respective fields, they are counselors. Use them as such and make yourself a winning specialist in your own right.
The following paper was presented by Professor K.M. Nilson, Department of Animal Sciences, University of Vermont, Burlington, Vermont 05401 especially for the 12th Annual Marschall Invitational Italian Cheese Seminar, held at the Dane County Exposition Center, Madison, Wisconsin, on April 28 and 29, 1975.

MICROFLORA OF MOZZARELLA CHEESE DURING RIPENING

By Professor K.M. Nilson and Mr. F.A. LaClair

In recent years the United States production of Italian Cheese varieties have increased faster than any other cheese. In 1962 there were only about 160 million pounds produced, whereas in a 9 year period to 1971 production had increased to 450 million pounds. It is estimated that in 1974 over 600 million pounds of Italian cheese was produced in this country. While there are many varieties of Italian cheese, the bulk of the production is Mozzarella.

A search of the literature revealed no information pertaining to the microbiology of this cheese during production and ripening. However, numerous studies have been made on the microflora of Cheddar cheese during its manufacture and ripening. The microbiological phenomenon have been related to many of the natural chemical changes of the cheese. Dr. Marth¹, University of Wisconsin, has reported on the microflora of Parmesan cheese and that more work is needed to relate that work with the chemical changes that take place. He hopes to identify the types of bacteria most responsible for bringing about the desired changes as well as the undesirable changes in the cheese.

There are many reasons why the microflora of Mozzarella cheese have not been studied. The cheese is sold soon after manufacture. It is normally used to cook with rather than eaten as a table cheese, and many times mixed with highly flavored foods and seasonings. The hot water mixing-stretching of the cheese during its production destroys many of the bacteria associated with its manufacture. And finally, Italian cheese popularity in the United States is only in its infancy compared to other varieties.

Procedure

Because of flavor, melting and stretching problems associated with Mozzarella cheese it was felt a knowledge of the bacteria present after manufacture and during the short period of ripening might aid in helping to solve such problems.

Cheese samples were procured from two commercial cheese plants in Vermont. There were four trials, two from cheese manufactured from 2% fat milk and two from cheese manufactured from 3% milk. The cheese in the first trial was manufactured using a single strain of Lactobacillus bulgaricus. In the second trial the cheese was procured from a different commercial cheese plant with the starter manufactured from a mixed strain of L. bulgaricus and Streptococcus thermophilus. The cheese was analyzed to determine bacterial growth of the two major Mozzarella cheese genera, Lactobacillus and Streptococcus. Staphylococci was studied as well as contaminants such as yeasts, molds and coliforms. Sampling and testing were on the day of manufacture, 1, and 2 weeks, 1, 2, 3, 4 and 5 month intervals for trial 1. Trial 2 was terminated after two months ripening.

¹. Marth, Elmer H. Microbiology of Parmesan Cheese Italian Cheese Journal 4: No. 2 page 1.
Results and Discussion

The total number of microorganisms found in Mozzarella cheese are shown in Table 1. The results are an average of four trials for the single strain starter cheese and three trials for the double strain starter cheese. The total microflora in Mozzarella cheese in relationship to cheddar cheese is very low. For the single strain starter cheese (Table 1) total counts were only 380,000 microorganisms per gram of cheese the day of manufacture. After one week of ripening the total count had decreased to about 200,000 per gram of cheese with a steady increase the second and fourth week, reaching over one and one half million. On the second and third month of ripening the total microflora decreased. However, on the fourth and fifth months there was an increase in total microflora.

When the double strain starter was used to manufacture the cheese (Table 1) there was a steady increase in the total microflora from the day of manufacture to one month ripening, with a drastic reduction in the total microflora from about six million per gram of cheese on the first month to only 875,000 on the second month. Some of the reasons for the lower total microflora found in Mozzarella compared to cheddar cheese during ripening are as follows:

Table 1. Total Microflora of Mozzarella Cheese during ripening.

<table>
<thead>
<tr>
<th>Sampling Period</th>
<th>TRIAL #1</th>
<th>TRIAL #2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase</td>
<td>Average 380</td>
<td>Average 1,345</td>
</tr>
<tr>
<td></td>
<td>Range 89-930</td>
<td>Range 20-2,670</td>
</tr>
<tr>
<td>1 Week</td>
<td>217</td>
<td>2,971</td>
</tr>
<tr>
<td>2 Weeks</td>
<td>469</td>
<td>6,541</td>
</tr>
<tr>
<td>1 Month</td>
<td>1,623</td>
<td>6,244</td>
</tr>
<tr>
<td>2 Months</td>
<td>949</td>
<td>875</td>
</tr>
<tr>
<td>3 Months</td>
<td>449</td>
<td>430-1,320</td>
</tr>
<tr>
<td>4 Months</td>
<td>1,520</td>
<td></td>
</tr>
<tr>
<td>5 Months</td>
<td>1,815</td>
<td></td>
</tr>
</tbody>
</table>

TRIAL 1. A single strained *L. bulgaricus* culture was used.

TRIAL 2. A double strain *L. bulgaricus* and *S. thermophilus* was used.

1 - The starter organisms *L. bulgaricus* and *S. thermophilus* both require temperatures of 100 to 115°F for maximum growth. These temperatures are only maintained during the cooking and cheddaring process, which is a short period of time compared to other type cheeses.

2 - In the mixing and stretching process the hot water temperature, ranging from 140 to 185°F, has a drastic affect on the microflora of the cheese.
3 - Temperatures of the cheese after the mixing-stretching process is 120 to 140°F. This high temperature is maintained for an extended period of time.

4 - In the manufacture of most cheeses there is an extended period of time before cooling. With Mozzarella it is normally only a few minutes from molding to cooling.

On Table 2 are found the total Lactobacillus organisms from the day of manufacture through the ripening period. In figure 1 is shown the percent of Lactobacillus to the total microflora during the ripening period. On the day of manufacture the Lactobacillus genus in trial one made up 95% of the total flora, decreased to about 75% after 2 weeks, then increasing to 94% by 30 days with a gradual decrease to 71% on the 4th month of ripening. There was a drastic decrease from the 4th to the 5th month of ripening. In trial two, 98% of the total flora was Lactobacillus up to the 1st month, decreasing to 78% by the 2nd month of ripening.

Table 2. Lactobacillus in Mozzarella Cheese during ripening.

<table>
<thead>
<tr>
<th>Sampling Period</th>
<th>TRIAL #1</th>
<th>TRIAL #2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
<td>Range</td>
</tr>
<tr>
<td>Purchase</td>
<td>358</td>
<td>86-920</td>
</tr>
<tr>
<td>1 Week</td>
<td>160</td>
<td>17-385</td>
</tr>
<tr>
<td>2 Weeks</td>
<td>354</td>
<td>45-740</td>
</tr>
<tr>
<td>1 Month</td>
<td>1,525</td>
<td>184-3,410</td>
</tr>
<tr>
<td>2 Months</td>
<td>879</td>
<td>87-2,720</td>
</tr>
<tr>
<td>3 Months</td>
<td>390</td>
<td>12-1,050</td>
</tr>
<tr>
<td>4 Months</td>
<td>1,080</td>
<td>27-2,660</td>
</tr>
<tr>
<td>5 Months</td>
<td>191</td>
<td>50-300</td>
</tr>
</tbody>
</table>

TRIAL 1. A single strained L. bulgaricus culture was used.

TRIAL 2. A double strain L. bulgaricus and S. thermophilus was used.

Streptococcus organisms appear (Table 3) in trial one after one month ripening, however they appear the first day in trial two. This was probably because trial two cheese was manufactured from starter containing S. thermophilus and L. bulgaricus where as the starter for trial one contained only L. bulgaricus. In both trials there appeared to be a general increase of the streptococcus organism during ripening. Also in Figure 1 is presented the percent of the Streptococcus organism during the ripening period.
Figure 1. Percentage of Micro-organisms in Mozzarella Cheese During Ripening
Table 3. *Streptococcus* in Mozzarella Cheese during ripening.

<table>
<thead>
<tr>
<th>Sampling Period</th>
<th>TRIAL #1</th>
<th>TRIAL #2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
<td>Range</td>
</tr>
<tr>
<td>Purchase</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td>1 Week</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td>2 Weeks</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td>1 Month</td>
<td>4</td>
<td>3-8</td>
</tr>
<tr>
<td>2 Months</td>
<td>6</td>
<td>4-10</td>
</tr>
<tr>
<td>3 Months</td>
<td>18</td>
<td>2-26</td>
</tr>
<tr>
<td>4 Months</td>
<td>425</td>
<td>26-1,040</td>
</tr>
<tr>
<td>5 Months</td>
<td>1,623</td>
<td>252-2,970</td>
</tr>
</tbody>
</table>

**TRIAL 1.** A single strained *L. bulgaricus* culture was used.

**TRIAL 2.** A double strain *L. bulgaricus* and *S. thermophilus* was used.

*Staphylococcus* organism appeared in trial one after one week of ripening and increased slowly, but progressively during the entire ripening period (Table 4.). There total contribution to the total (Figure 1) microflora is minimum. They did not appear in trial two at any time during ripening.

Table 4. *Staphylococcus* in Mozzarella Cheese during ripening.

<table>
<thead>
<tr>
<th>Sampling Period</th>
<th>TRIAL #1</th>
<th>TRIAL #2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
<td>Range</td>
</tr>
<tr>
<td>Purchase</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td>1 Week</td>
<td>500</td>
<td>0-1,000</td>
</tr>
<tr>
<td>2 Weeks</td>
<td>750</td>
<td>0-2,000</td>
</tr>
<tr>
<td>1 Month</td>
<td>2,500</td>
<td>1,000-4,000</td>
</tr>
<tr>
<td>2 Months</td>
<td>4,500</td>
<td>0-10,000</td>
</tr>
<tr>
<td>3 Months</td>
<td>5,750</td>
<td>1,000-10,000</td>
</tr>
<tr>
<td>4 Months</td>
<td>6,000</td>
<td>0-20,000</td>
</tr>
<tr>
<td>5 Months</td>
<td>----</td>
<td>----</td>
</tr>
</tbody>
</table>

**TRIAL 1.** A single strained *L. bulgaricus* culture was used.

**TRIAL 2.** A double strain *L. bulgaricus* and *S. thermophilus* was used.
No coliform organisms were found in any cheese samples from either trial. Yeast count in trial one, appeared early with an average count of 22,000 (Table 5.) on the day of manufacture, increased to a maximum of about 114,000 after two weeks, decreasing to 500 after 5 months ripening. Yeasts were negligible in trial two.

Table 5. Yeasts in Mozzarella Cheese during ripening.

<table>
<thead>
<tr>
<th>Sampling Period</th>
<th>TRIAL #1 Average</th>
<th>Range (Thousands)</th>
<th>TRIAL #2 Average</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase</td>
<td>22</td>
<td>2-74</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td>1 Week</td>
<td>56</td>
<td>4-110</td>
<td>0.2</td>
<td>0-0.04</td>
</tr>
<tr>
<td>2 Weeks</td>
<td>114</td>
<td>4-330</td>
<td>0.5</td>
<td>0-1</td>
</tr>
<tr>
<td>1 Month</td>
<td>92</td>
<td>17-180</td>
<td>1.0</td>
<td>0-2</td>
</tr>
<tr>
<td>2 Months</td>
<td>60</td>
<td>10-110</td>
<td>0.5</td>
<td>0-1</td>
</tr>
<tr>
<td>3 Months</td>
<td>36</td>
<td>3-100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Months</td>
<td>8</td>
<td>0-19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Months</td>
<td>0.5</td>
<td>0-2,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TRIAL 1. A single strained *L. bulgaricus* culture was used.

TRIAL 2. A double strain *L. bulgaricus* and *S. thermophilus* was used.
There are two major USDA quality programs available to members of the Italian cheese industry and anyone else involved in manufacturing and marketing dairy products. The first program deals with development of standards and specifications, and the second with inspection and grading services.

The two programs are provided under authority of the Agricultural Marketing Act of 1946 by the Dairy Division of the Agricultural Marketing Service in the U.S. Department of Agriculture (USDA).

Turning first to the standardization program, the Dairy Division is responsible for development, improvement, and interpretation of product quality standards, plant and product specifications, and quality improvement programs for milk and dairy products.

There are U.S. grade standards for 13 dairy products, including butter, nonfat dry milk, dry whole milk, dry buttermilk, dry whey, Cheddar cheese, Swiss cheese, colby cheese, bulk American cheese for manufacturing, Monterey (Jack) cheese and dry casein. So far, however, no U.S. grade standards have been developed for specific varieties of Italian cheeses.

Why does USDA develop federal grade standards for individual dairy products?

Grade standards aid in the marketing of products by providing a common language for trading and a means of measuring quality or value. U.S. grade standards classify the entire range of quality of a product. The standards provide uniformity on a national basis and can assure both the buyer and seller at distant points a fair basis for establishing price. Also, the buyer or user can be sure he will receive the quality of product he has bargained for.

Grade standards are used for many purposes. Let me list a few.

1) To provide basis for trade, as previously mentioned.
2) To provide purchase specification for wholesalers and distributors.
3) To assure quality when purchasing products to be used as an ingredient in processing.
4) To assure quality for restaurants and institutional feeding.
5) To assure quality for government purchases.
6) To provide a benchmark for plant quality assurance programs.
7) To establish loan value for products in storage.
8) To satisfy consumers, many of whom depend on U.S. grade standards when buying foods, in order to obtain the quality that best suits their needs.

Sometimes federal grade standards are confused with definitions and standards of identity. U.S. grade standards are voluntary and establish requirements for quality levels of food products.
On the other hand, Food and Drug Administration (FDA) standards of identity are mandatory. They protect against deception by setting composition requirements which define what a food must consist of to be labeled with a specific name. In addition to the FDA standards of identity for foods, USDA has responsibility for establishing and enforcing standards of identity for federally inspected meat and poultry products, under the Federal Meat Inspection Act and the Poultry Products Inspection Act.

Another responsibility under the standardization program is development of plant specifications. Some of you are familiar with the USDA General Specifications for Dairy Plants Approved for USDA Inspection and Grading Service, which are the basis for the voluntary USDA inspection and grading program. I will discuss the inspection and grading services later on. However, at this time I want to describe the General Specifications and how they are used by many plants as a guide to good manufacturing practices.

The General Specifications set forth detailed requirements for premises, buildings, facilities, equipment and utensils. There are quality specifications for the raw milk supply and requirements for condition of plant and equipment and for sanitary practices. You will be particularly interested in the general section applicable to all plants, the supplements applicable to plants manufacturing and packaging cheese, and the supplements applicable to plants manufacturing, processing and packaging whey, whey products and lactose. Supplemental specifications, which are specific for individual products, also are included for dry milk products, butter, natural cheeses, process cheese, evaporated milk and frozen desserts.

The General Specifications are now being revised. The revision reflects an updating and upgrading of the various requirements due to technological changes that have occurred in equipment, facilities and manufacturing operations. Also, due to the importance of the developing whey industry, supplemental specifications for whey, whey products and lactose have been included. The proposed revision was published in the Federal Register on February 12, 1975, and you are invited to send written comments to the Office of the Hearing Clerk not later than July 1. All comments will be considered by USDA prior to final publication of the revised specifications.

Another USDA specification which should be of interest to you from the standpoint of milk procurement and manufacture of cheese is the Requirements for Milk for Manufacturing Purposes and its Production and Processing, Recommended for State Adoption. The Recommended Requirements are for State adoption and enforcement, and, when adopted, will promote uniformity in the State dairy laws and regulations, as well as national uniformity in the sanitary manner in which manufacturing-grade milk is produced and processed. The Recommended Requirements include standards for milk quality, farm facilities and manufacturing plants.

In reviewing the substance and enforcement of State laws and regulations for manufacturing milk, we find a lack of coordinated effort and organization among the States. Requirements for quality of manufacturing milk, farm conditions and plant practices vary considerably among the States. Some States have requirements equal to or better than those recommended by USDA. Some States only partially meet the requirements, and some States have few or no requirements for manufacturing-grade milk.

Since 1972, when the Recommended Requirements for manufacturing milk were updated and revised, USDA has worked with States in updating and improving their laws and regulations. We have met with State officials, legislators and industry groups to explain the Recommended Requirements and their application, and assisted some States
in drafting legislation for adoption of the requirements. Also, we have worked with State officials to develop plans to implement regular inspections of all producers and manufacturing plants.

We believe it is essential that there be uniform State dairy laws and regulations and enforcement across State lines to assure a safe and wholesome milk supply, high quality manufactured dairy products and fair competition for the dairy farmer and manufacturing plants. A uniform program would permit reciprocity among the States when the milk from producers and manufactured dairy products are shipped across State lines. The program would help assure producers fair competition with other producers shipping to a neighboring plant, or producers in other States supplying milk for manufactured dairy products which will compete in the marketplace. Also, adoption of the USDA Recommended Requirements by all States would greatly strengthen the dairy industry's position for stricter controls on dairy product imports. The present argument that imported dairy products should meet the same requirements for production and quality as domestic milk and dairy products lacks substance because of the deficiencies in some State requirements for domestic dairy products.

Let us now turn to USDA's inspection and grading program.

The responsibilities under this program are to inspect plants and equipment for condition and sanitation; to sample, inspect and grade dairy products; to check products for condition; and to assist plants in quality control and improvement.

The services under the inspection and grading program are provided on a voluntary basis, and USDA charges a fee to cover the cost of the services. Various types of services are available. For discussion purposes, the inspection and grading program can be divided into four separate services:

1) Inspection and grading of dairy products
2) Laboratory analysis
3) Plant surveys
4) Resident grading and quality control service

The inspection and grading service is available to anyone who has a financial interest in a product — for example, a manufacturer, packer, processor, distributor, wholesale buyer, or retailer. The service may cover any quantity of product from a few pounds to truck lots and carlots.

Official certificates are issued to describe the inspection service performed. Products may be inspected or graded for quality to determine compliance with a U. S. grade standard, a contract specification or a buyers' specification. Lots of product also may be inspected for condition of product or packaging.

Another grading and inspection service is the labeling of consumer packages with the U. S. grade of the product. This service has been very successfully used in the retail marketing of butter for many years, and in more recent years is also used on Cheddar cheese, instant nonfat dry milk and cottage cheese. If necessary to help prove a point, official grading certificates are acceptable as prima facie evidence in court cases.

The second service under USDA's grading and inspection program is laboratory analysis. A well-equipped and staffed Dairy Division laboratory in Chicago supports inspection, grading and standardization activities. The laboratory is widely used by the dairy
industry for tests required in connection with sales of dry milk, butter and cheese under the Dairy Price Support Program, government purchases of eggs and meat products for the school lunch program, and corn-soy milk and whey soy drink mix for Public Law 480 distribution to needy people overseas. The laboratory performs a great variety of analytical and quality control tests, including chemical and microbiological tests required to determine the quality and condition of dairy and related food products for compliance with U.S. grade standards, and purchase specifications. Because of the expertise of the laboratory staff, the laboratory also fills an industry need as a reference laboratory when plants want to submit samples for checks on the accuracy of their plant laboratory. These services are available to any applicant, and fees are charged for the services rendered.

The third service is the plant survey program. This service provides an unbiased inspection and appraisal of a dairy plant. The inspection is based on the General Specifications for Approved Dairy Plants and includes a detailed inspection of a plant's premises, building and facilities, equipment, processing techniques, sanitary practices and the quality of the milk supply. The USDA inspector provides a written report of the inspection and discusses details of the survey with management. Plant approval is required as a basis for eligibility for inspection and grading of the plant's products. The General Specifications require two inspections per year, except that four inspections are required for dry milk and other dried milk products. Plants approved under this program are listed in the quarterly publication, Dairy Plants Surveyed and Approved for USDA Grading Service. This publication lists the name and address of the plant and the products which are eligible for grading service, or in other cases the processing or packaging operations are listed which meet USDA requirements for facilities and sanitation. Presently about 1,100 plants are listed in this publication. It is available upon request without charge. Many dairy and food distributors, processors and manufacturers use the list as a source of supply for dairy products.

The fourth service is resident grading and quality control. This service provides a full-time USDA inspector stationed at a dairy plant. The inspector is proficient in all aspects of the program - inspection and grading of products, laboratory analysis, plant inspection and quality control. The plant provides a properly equipped laboratory and then complete inspection and grading services can be performed on the spot on a daily basis. Resident inspection service can help reduce the need for large storage facilities and large inventories, because there is no waiting for results as there is when samples are shipped for testing to the dairy laboratory in Chicago. Also, the resident inspector can be very helpful to plant management in assisting in the plant's quality control program. Under this program, continuing checks are made on the quality of incoming raw milk, ingredients, supplies, condition of equipment and sanitary practices. In-process checks are made for processing controls, and the finished products are checked for quality and composition. This program helps management to consistently make high quality products which will meet the requirements of discriminating users.

This has been a brief resume of USDA programs available to your industry. In summary, U.S. grade standards may be developed, upon request, for any of the varieties of Italian cheeses. Such standards could be useful to the producer, distributor and user.

The General Specifications set forth detailed requirements for plant equipment, raw material and sanitary practices. You may use these specifications as a guide to good manufacturing practices.
You may request inspection and grading on lots of cheese, and official certificates will be issued to assure compliance with buyers' specifications or a purchase contract.

Laboratory analyses on dairy and food products are available to assure compliance with product specifications, or as a check on the accuracy of your plant laboratory.

You may have your plant inspected to obtain an unbiased appraisal of the plant's premises, building and facilities, equipment, processing techniques, sanitary practices and quality of the milk supply. The inspection report can be very helpful in the operation of your plant.

The resident grading and quality control service can provide all these services on a continuing basis.

We believe USDA standards, specifications and inspection and grading programs can be useful in the production and marketing of Italian cheeses. More detailed information about these services is available upon request from the U. S. Department of Agriculture, Dairy Division, AMS, Washington, D. C. 20250.
Measurement of titratable acidity of milk and whey is a commonly used and relatively accurate method of estimating acidity development during cheese making. Although methods for pH measurement have been available for some time, wide-scale commercial usage of this technique in the cheese industry has occurred only recently. Use of this method will increase in the future with greater utilization of mechanized and continuous cheese making processes.

Principles of pH measurement.

pH is a measurement of the concentration (more accurately-activity) of hydrogen ions in a solution. Compounds called acids release hydrogen ions into a solvent like water, whereas other compounds called bases combine with the hydrogen ions. The amount or concentration of hydrogen ions in most foods is very small. For example, one liter (approximately 1.1 quarts) of milk at pH 7.0 contains one ten-millionth of a mole of hydrogen ions. A mole is a unit quantity used in chemistry. To simplify the expression of the concentration of hydrogen ions, a numbering system (pH values) was developed. In this system, pH is defined as the logarithm of the reciprocal of hydrogen ion concentration or as the negative logarithm of hydrogen ion concentration.

As indicated earlier, milk at pH 7.0 contains one ten-millionth (0.0000001) of mole of hydrogen ions which is shown in the following formula:

\[ pH = \log \frac{1}{0.0000001} = 7.0 \]

If an acid was added to the milk to lower the pH to 6.0, the milk would contain one one-millionth (0.00001) of a mole of hydrogen ions as shown in the following formula:

\[ pH = \log \frac{1}{0.000001} = 6.0 \]

The above examples illustrate two points about pH measurement:

1. As a solution becomes more acidic, its pH decreases.

2. For every one unit change in pH, there is a tenfold change in hydrogen ion concentration.

In dilute solutions, pH values are expressed in a range between 0 and 14. This range is based on the extent of release of hydrogen ions by water. A solution is said to be neutral if it has a pH of 7.0. Acidic solutions have pH values below 7.0; alkaline or basic solutions have pH values above 7.0.
pH measurement.

The pH of liquids or solids is measured with special electronic circuitry and glass or quinhydrone electrode systems. Glass electrodes are used most commonly in the dairy industry but the quinhydrone system may be more useful for measuring pH of cheese, especially those varieties with low moisture contents.

Glass electrode system.

A pH meter equipped with a glass electrode consists of this electrode, a reference (calomel) electrode and an electronic potentiometer to measure the electrical potential between the two electrodes. The glass electrode consists of a glass stem with a tip of thin pH sensitive glass. The glass stem contains an electrode and a solution containing a specific concentration of hydrogen ions. The pH of a solution is measured from the electrical potential caused by differences in hydrogen ion concentration on the two sides of the special glass tip of the electrode.

Use of glass electrode pH meter.

A pH meter is a delicate instrument and will not be accurate if it is not maintained or used properly. Always follow the manufacturer's instructions in using and maintaining the instrument.

Certain general procedures can be recommended as follows:

1. Do not allow the glass electrode to dry out. Keep it immersed in distilled water, or a buffer if recommended by the manufacturer.

2. The meter should be allowed to warm up and brought into electrical balance according to manufacturer's instructions.

3. The pH meter should be standardized with two standard buffer solutions. Their pH values should be above and below the pH values of solutions (unknowns) to be measured. The temperature of the buffers should be within 2°C of the temperature of the unknown.

4. The electrodes should be rinsed with distilled water after being immersed in buffers or test solutions. Blot the water from the electrode with tissues but do not wipe the electrode since this may create static electricity on the electrode.

Quinhydrone electrode meter.

The quinhydrone system consists of a potentiometer, gold electrode and a reference (calomel) electrode. A sufficient amount of crystals of quinhydrone are mixed with cheese to give the cheese a gray color. The cheese is packed in a tube and the gold electrode inserted in the cheese so that the gold tip is completely surrounded by cheese. The tube is then placed in a saturated solution of potassium chloride; the reference electrode is also placed in this solution. The electrical potential is read on the potentiometer 90 seconds after mixing the cheese and quinhydrone. The potential reading is converted to pH using a chart.
Maintenance of meters.

Lack of maintenance of pH meters is undoubtedly the greatest source of error in their use in cheese plants. The electronic circuitry of meters should be checked routinely according to manufacturer's instructions.

A buildup milk protein and fat on the glass electrode is probably the most common problem with this system. The film will cause a sluggish response by the meter and erratic readings. This film can be removed by soaking the electrode for 2 hours in a mixture of part of concentrated hydrochloric acid and five parts of water. The acid solution should cover the tip and lower portion of the electrode stem. Then soak the treated electrode in distilled water for 24 hours. It may be helpful to place the electrode in a pH 7.0 buffer for an additional 24 hours prior to use. It may be necessary to repeat the above process. The reference electrode can also be fouled by milk protein and fat.

Titratable acidity.

The titratable acidity of milk or other liquids is determined by adding a sodium hydroxide solution (sometimes called base or alkali) to raise the pH of the milk to about 8.3. An acid-base indicator, phenolphthalein, is used to estimate the endpoint pH of 8.3. The strength of the sodium hydroxide solution (0.1 normal) and amount of milk (9 grams) are chosen to allow conversion of the milliliters of base, required for titration, to percentage of lactic acid in the sample. One milliliter of base equals 0.1% lactic acid. There is no real basis for expressing titratable acidity as lactic acid since there is practically no lactic acid in fresh milk. This system of expressing acidity is not followed in Europe which can cause confusion in comparing cheese making processes.

Whereas pH is a measure of "free" hydrogen ions, titratable acidity is a measurement of any constituent that will react with and neutralize the sodium hydroxide. There are a number of components in milk that will combine with the base in addition to the small amount of acids that might be present. These constituents which constitute the solids-not-fat portion of milk include the proteins, phosphates, citrates and carbon dioxide. Proteins and phosphates contribute to the greatest extent with carbon dioxide also playing a fairly significant role in influencing titratable acidity. The direct effect of the concentration of these milk constituents is illustrated in Table 1.

Table 1

Relation of Milk Composition to Acidity (1).

<table>
<thead>
<tr>
<th>Fat in Milk</th>
<th>Solids-in Not-Fat in Milk</th>
<th>Titratable Acidities of Milk</th>
<th>Titratable Acidities of Whey</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Fresh</td>
<td>Setting</td>
</tr>
<tr>
<td>3.0</td>
<td>8.3</td>
<td>.15</td>
<td>.155</td>
</tr>
<tr>
<td>3.5</td>
<td>8.54</td>
<td>.16</td>
<td>.165</td>
</tr>
<tr>
<td>4.0</td>
<td>8.73</td>
<td>.17</td>
<td>.175</td>
</tr>
<tr>
<td>4.5</td>
<td>8.8</td>
<td>.18</td>
<td>.185</td>
</tr>
</tbody>
</table>

aJust before the whey is drawn.
The titratable acidities of the various milks vary directly with the concentration of solids-not-fat.

The effects shown in Table 1 have some implications in cheese manufacture. Slight compensations would have to be made in acidity levels desired at various stages of cheese making if the milk solids concentrations varied widely, or if the milk was pre-concentrated or if the milk was fortified with solids-not-fat. The effect of higher concentrations of solids carries over to the whey as shown in Table 1. Slightly higher acidities must be attained to reach equivalent pH values in curd and whey from the high-solids milk.

**Acidity changes during cheese making.**

Acidity development during cheese making depends upon the activity of the lactic starter which is added to the milk and is then trapped in the curd. As shown in Table 2, the pH of the milk and curd decrease fairly uniformly during cheese making.

### Table 2

<table>
<thead>
<tr>
<th>Cheese Making Operation</th>
<th>Time</th>
<th>Titratable Acidity</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Add Starter</td>
<td>8:15</td>
<td>.16</td>
<td>6.6</td>
</tr>
<tr>
<td>Add Rennet</td>
<td>9:00</td>
<td>.17</td>
<td>6.55</td>
</tr>
<tr>
<td>Coagulation</td>
<td>9:12</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Cut Curd</td>
<td>9:30</td>
<td>.10</td>
<td>--</td>
</tr>
<tr>
<td>Steam on</td>
<td>9:45</td>
<td>.10</td>
<td>--</td>
</tr>
<tr>
<td>Steam off</td>
<td>10:15</td>
<td>.11</td>
<td>6.4</td>
</tr>
<tr>
<td>Drain whey</td>
<td>11:00</td>
<td>.13</td>
<td>6.2</td>
</tr>
<tr>
<td>End dipping</td>
<td>11:30</td>
<td>.15</td>
<td>6.0</td>
</tr>
<tr>
<td>Pack</td>
<td>11:45</td>
<td>.17</td>
<td>5.9</td>
</tr>
<tr>
<td>Pile 2 high</td>
<td>12:30</td>
<td>.25</td>
<td>5.7</td>
</tr>
<tr>
<td>Pile 3 high</td>
<td>1:00</td>
<td>.32</td>
<td>5.5</td>
</tr>
<tr>
<td>Mill</td>
<td>1:30</td>
<td>.45</td>
<td>5.45</td>
</tr>
</tbody>
</table>

Titratable acidities exhibit a more erratic pattern (Table 2). Acid produced by the starter raises the titratable acidity of the milk slightly before rennet is added. Subsequently, the curd is cut and acidity measurements are made of the whey.
The dramatic decrease in acidity of whey immediately after cutting the curd as compared to milk is caused by removal of some of the base-combining constituents of the milk. Casein and some of the phosphates, which are titrated in milk, are trapped in the curd and would not be titrated in the whey. As shown in Table 2, the titratable acidity increases uniformly from the point of cutting up to the time that the whey is drained from the curd. Consequently, this measurement can be used as an indicator of acidity development.

The relationship between acidity and pH values becomes erratic during the period from settling the curd to the end of draining (Table 2). The pH of the curd decreases fairly uniformly during this time and reflects production of acid by the starter. The titratable acidity of whey increases rapidly from the point of settling curd through the initial stages of "cheddaring" the curd. This is caused by several factors. Firstly, the extent of dilution of acid, produced in the curd by starter, by the whey in the vat affects titratable acidity. Acid diffusing from the curd into a full vat of whey, prior to draining, will be diluted so that the acidity of the whey will not be affected greatly. Once this large volume of whey is removed, acid diffusing from the curd is diluted only by the small volume of whey draining from the curd and will have a greater effect on the acidity of this whey. Secondly, the ability of constituents in whey to neutralize or buffer acid being produced also affects the relationship between pH of curd and titratable acidity of whey. The buffering capacity of milk constituents increases as the pH of milk is lowered from 6.6 to 5.6. Thus the maximum buffering occurs during early stages of cheddaring. This would cause the titratable acidity of milk to increase without causing proportional changes in pH.

After whey drainage, and initial stages of cheddaring, the titratable acidity of the whey again shows a uniform increase up to the point of milling. Care should be taken to obtain a sample of whey which runs directly from the draining curd. Whey caught in puddles between slabs of curd or on the deck of the vat will not reflect the true acidity of the curd.

Summary.

Acidity development during cheese making can be measured either by pH or titratable acidity. Measurement of pH reflects the "true" acidity of milk or curd. Titratable acidity measures acids that are produced but is also affected by other milk constituents. The effect of milks solids has to be compensated for in using titration method. Properties of cheese curd are related to and are affected directly by the pH of the curd.

REFERENCE
