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PROCEEDINGS

23rd Annual Marschall Invitational

ITALIAN CHEESE Seminar

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Marschall Products-Miles Laboratories, Inc.
Madison, Wisconsin

Marschall International Cheese Conferen

PROCEEDINGS

from the

TWENTY THIRD ANNUAL

MARSCHALL

ITALIAN CHEESE SEMINAR

(INCLUDING SPECIALTY CHEESE)

September 16, 17 & 18, 1986

Ths publication has been compiled and distributed as a service to the Italian (and Specialty) cheese industry by Marschall Products, Division of Miles Laboratories, Inc., P.O. Box 592, Madison, Wisconsin 53701.

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The following paper was presented by R.L. Bradley, Jr. Department of Food Science, University of Wisconsin, Madison, WI 53706, at the 23rd Annual Marschall Invitational Italian Cheese Seminar, held in the Forum Building of the Dane County Exposition Center, Madison, Wisconsin, on September 16, 17 and 18, 1986.

CONTROL OF FOULING AND CONTAMINATION OF DAIRY PLANTS

By R. L. Bradley

The removal of soil deposits and bacteria from dairy equipment is a relatively easy proposition. If then, the cleaning of equipment is so easy why does the industry have so much difficulty with post pasteurization contamination in the form of Salmonella, Staphylococcus, Yersinia, and Listeria in finished dairy foods? It is not always the other processor down the road. It could be you! Look carefully at how you clean, sanitize and maintain your entire operation. No segment of the industry is immune from these bacteria any more than a particular segment of the industry having a corner on the contamination market.

The chemical cleaners and sanitizers available to us today are more than adequate to do a satisfactory job of removing fouling and destroying bacteria from all product contact surfaces. It is simply a time-temperature relationship when these chemicals are at manufacturers recommended use levels.

Examine the composition of soil on dairy equipment to solve the cleaning problem.

Lactose - there may be some milk sugar in milk deposits. This sugar is readily soluble in cold water.

Milkfat - in natural state milkfat or butter fat floats in water in an emulsified state. However, if this emulsion is broken, the cleaning problem is compounded. Warm water is the best to rinse away this entity. De-emulsified, as is done with hot water, you have a greasy surface that requires sodium or potassium hydroxide to solubilize it. This is saponified fat, a soap that ultimately can be washed away.

Milk Proteins - one group, the whey proteins, are water soluble and are easily rinsed away with warm water. Don't use hot water because of the fact that you will de-emulsify any fat present but also you will cause the whey proteins to uncoil. They will lose their corkscrew, α-helix, configuration and become increasingly insoluble.

The major portion of milk protein is casein. This entity is naturally denatured in that no amount of physical abuse will change its configuration. It can withstand boiling for 15 minutes with no measurable effect. Casein is naturally a colloidal suspension. It is the protein most subject to precipitation as a result. Warm water is effective to rinse it away as a colloidal suspension. However, cleaning chemicals like polyphosphates are required to remove it when deposited on milk contact surfaces. These chemicals

digest the casein to more soluble proteoses and peptides so that these can be flushed away with water.

Minerals - It makes no difference whether we speak of the minerals in milk or water, calcium and magnesium are the culprits. Calcium phosphate in milk is quite insoluble and readily deposits on warm and hot surfaces. Magnesium salts are much more soluble but still will deposit. Mineral deposits require acids to remove them. Most acid cleaners in this country are organic in nature like gluconic and phosphoric and are effective with the proprietary addition of a compatible wetting agent to aid penetration of the cleaner through the mineral deposit. In Europe because of the use of type 316 stainless nitric acid can be used for cleaning but is not suggested for type 304 stainless.

Thus, two major groups of cleaners exist. One is the alkaline or basic group composed of sodium or potassium hydroxide, polyphosphates, more than likely a chelator to tie up calcium and magnesium in water so it won't interfere and a wetting agent to aid penetration. This could be chlorinated to aid in its protein digesting ability. Alkaline and chlorinated alkaline cleaners are common in every dairy plant. The second group is the acid cleaners. As indicated these are only to remove mineral deposits.

The order of use is rinse warm, wash with chlorinated alkaline cleaner at manufacturer's recommended concentration and temperature (measured at the end of washing), rinse hot and wash with acid at manufacturer's recommended concentration and temperature, rinse hot and air dry.

Simple! Circulate the solutions in a COP tank or in a properly installed and operated CIP system and you have a clean system.

The frosting on the cake comes with the application of the appropriate sanitizer to all product contact surfaces. State and U.S. regulations require that all equipment will be cleaned and sanitized between uses. However, with proper cleaning the need for a sanitizer is obviated technically but it is still required legally.

Chlorine as sodium hypochlorite is the standard. It is a powerful destroyer of bacteria as vegetative cells or spores, yeasts and molds. It is not without criticism since it is corrosive to stainless steel particulary at higher use dilutions. Chlorine solutions of 50-200 ppm are effective and should be circulated immediately before the equipment is to be used. No spent sanitizer solution should be reused.

A much less corrosive chlorine-based sanitizer is dichloroisocyanurate or sodium dichloro-s-triazine trione. It is almost as effective as sodium hypochlorite. In addition as a dry, white powder it is much more stable. Use levels are solutions of 50 to 200 ppm.

Other halogens such as iodine and bromine have little use in dairy plants. The greatest acceptance of iodine is at the farm level.

Quaternary ammonium compounds need attention directed from many viewpoints. Use Level is 200 ppm and this is the no rinse dilution. Concentrations greater

than 200 ppm must be rinsed from any product contact surface obviously negating the effect of the sanitizer. At the no rinse dilution, quats are extremely selective in species of bacteria that it will destroy. It will not destroy effectively E. coli, Staphylococcus aureus and many psychrotrophs, like Pseudomas fluorescens. Further, at a concentration 20 ppm of quaternary ammonium compound, cheese cultures will be slow in acid development. A selective activity such as this should normally condemn a sanitizer to non-use. However, there are circumstances in dairy plants where quats are beneficial. At concentrations above 800 ppm, it can be applied to walls, floors, drains or as a fog at 1200 ppm. Quat has residual properties that make it effective to control microbial species that may collect on these non-product areas.

The last sanitizer that I wish to discuss is called acid anionic. This is an organic acid like phosphoric acid with a wetting agent like alkyl benzene sulfonate (ABS) or sulfonated oleic acid. At use dilution where the ABS oroleate is at 200 ppm the pH is in the range of 3.5 This is a mighty hostile environment for any bacterium. Whether the ABS or sulfonated oleic acid is actually bacteriocidal at 200 ppm or just causes bacteria to float off into the solution, is immaterial. It works well but nowhere near the speed of sodium hypochlorite.

There are two current pieces of information that should be looked at relative to the efficiency of sanitizers and also what might happen in the cheese vat, if these were present in the milk supply.

Slide 1 shows how good these sanitizers are against some bacteria that have or are making banner headlines. These organisms were checked by the AOAC Germicidal and Sanitizer Method. A 99.999% reduction in 30 sec is required to pass.

Sanitizer conc.,	ppm	L. monocytogenes pass/fail 30 sec.	L. monocytogenes pass/fail 60 sec.	S. typhimurium pass/fail 30 sec.	S. typhimurium pass/fail 60 sec.
Acid Anionic (ABS)	200	+	+	+	+
Acid Anionic (oleate)	200	+	+	+	+
Quaternary NH_4 cpd	100	+	+	–	+
	200	+	+	+	+
Iodophor	12.5	+	+	–	–
	25.0	+	+	+	+
Chlorine (HOCl)	100	+	+	+	+
	200	+	+	+	+
Chlorine (organic)	100	+	+	+	+
	200	+	+	+	+

A concentration of 10^7 cells/ml was grown in brain heart infusion broth. One milliliter was the challenge in 99 ml of sanitizer solution with 500 ppm of $CaCO_3$ to create hardness. Data are from Diversey-Wyandotte, Wyandotte, MI.

The next slide illustrates what might happen in the cheese vat if a milk supply were contaminated with a sanitizer. Threshold of inhibition and of flavor is shown in parts per million.

Sanitizer	lab test partial	lab test total	cheese vat partial	cheese vat total	flavor
Acid Anionic (ABS)	60–120	600/200	30–120	600	12
*Peracetic/H_2O_2	0–5	600	0–5	5–35	5
*Quaternary NH_4 cpd	20–30	200	10–20	200	20
Iodophor	75–220	400	15–30	75–200	8
Chlorine (HOCl)	400–1000	1000	35–400	400	50

The flavor threshold was in ppm in cheese at 4 weeks of age. Data are from Dunsmore et al., Journal of Dairy Research 52:287, 1985.

The last type of dairy chemical I would like to deal with is a relatively new item in the manufacturer's display. This is the enzyme cleaner primarily designed for the cleaning of ultrafiltration and reverse osmosis membranes. Primarily these cleaners are used instead of the conventional cleaners because the adhesives among other components in the UF system won't hold up. In my laboratory, Karen Smith has been looking at the efficiency of these cleaners. If you soil a UF membrane with whey by circulating it for 1.5 hours, then concentrate it for 0.5 hours you have a system that has a flux of 75% of the original. If you attempt to clean for periods up to 10 hours to restore flux you will do just that. In regard to what USDA says about flux restoration you have cleaned and that is all that is needed. The unit has restored circulation or flux and if you opened an end it would appear clean. However, if you swabbed the membrane housing after one of these cleaning sessions, you would probably find 10^6 organisms on 8 square inches of surface.

To see just how effective these enzyme cleaners are, we selected 4 of them - 2 liquid and 2 powders and made them to use dilution in skim milk and whey. After intervals of time, the protein content was examined as well as the nonprotein nitrogen. As disintegration of protein occurred, a greater NPN was generated. Then after 24 hours at pH8 and 43°C samples were taken for electrophoresis. These gels provided the most graphical evidence of activity. As can be easily seen in this slide, two were virtually inactive against both skim milk and whey. The active proteolytic enzyme cleaners clotted skim milk in 1-4 hours at use dilution. Further, breakdown of the clot was apparent after storage at room temperature. Improvement in cleaning with these enzyme based systems is a function of time, correct temperature, and pH.

The following paper was presented by Carl Brothersen, Production Supervisor, Marschall Products, Miles Laboratories, Inc., P.O. Box 3490, Logan, Utah 84321, at the 23rd Annual Marschall Invitational Italian Cheese Seminar, held in the FORUM Building of the Dane County Exposition Center, Madison, Wisconsin, on September 16, 17 and 18, 1986.

APPLICATION OF EXTERNAL pH CONTROL IN THE MANUFACTURE OF ITALIAN CHEESE STARTER

by Carl Brothersen

Growing cheese starter under pH control has long been used by culture manufacturers as a means of improving the quality of their cultures. About 10 years ago, workers at Utah State University adapted external pH control technology for use in making cheese starter by cheese manufacturers. Over the past 10 years pH controlled starter has become increasingly popular for the production of Cheddar type cheeses. The reasons so many cheesemakers are turning to pH control are economics, better quality, and greater control over the cheese making process.

These advantages are the result of maintaining a favorable pH throughout the life of the starter. As the starter organisms grow (Figure 1), they ferment lactose into lactic acid. As the buffer capacity of the starter medium is overcome, the pH of the medium begins to drop. Eventually the buildup of acid becomes toxic to organisms. If the organisms remain at these low pH levels for a long period of time, they become damaged. This is the condition cheesemakers refer to as overripe starter.

Figure 2 compares the pH profile of starter grown under external pH control with that of starter grown in conventional media. With external pH control, the organisms grow and develop acid as in conventional media or milk. However, when the pH gets to a certain level a neutralizer is added to raise the pH. The organisms continue to grow and the pH continues to drop, therefore more neutralizer is added. This process continues until all the available lactose is utilized, at which time the pH remains constant and the organisms become dormant. The pH has been kept in the range in which the organisms grow best, and is never allowed to reach a level that will cause injury to the cells.

Since the starter organisms remain healthy, and since more cells per volume of starter are obtained, less starter is needed to produce the same level of acid in the cheese. The cheesemaker saves money because he uses less starter.

It is very time consuming and expensive to have a person stand by the starter tank, determine the pH and add the neutralizer by hand. Also, if this person does not catch the starter at the right time, the pH may drift to a level where acid injury will occur. Therefore pH control instrumentation was developed to automate this process.

External pH control technology has been used successfully in the Cheddar cheese industry for the past 10 years. But the Italian cheese industry has not been as eager to adopt external pH control. The advantages of economics, phage

control and consistency in starter activity and performance, offered by pH control, are just as applicable for the manufacture of Italian type starter, as they are for Cheddar starter. One of the reasons the Italian industry has not adopted pH control is that until now, pH control equipment has not been able to regulate the more complex organisms used in Italian starters.

First generation pH control equipment has very limited capabilities. Generally they consist of an analog system with a single relay to control the addition of neutralizer into the starter. A diagram of what is done is shown in Figure 3. As the starter grows, lactic acid is produced and the pH decreases. When the pH reaches a critical level, the controller relay activates a pump, neutralizer is injected into the starter, and the pH increases. This is repeated until all the available lactose is used up and the pH remains constant. When the pH remains constant, the operator knows that the starter is ready to be cooled and used. The temperature of the starter tank is either controlled by a separate unit, or controlled manually. The tank agitator is left on at all times.

This is acceptable for Cheddar type cheese because these starters consist of S. cremoris or S. lactis cultures which can tolerate the presence of oxygen. However, the continuous stirring of air into the starter is detrimental to the growth of the Lactobacillus organisms used in Italian starters.

The second generation of pH control equipment provides temperature as well as pH control within the same unit. These are generally digital instruments with solid state relays for controlling agitation, temperature, addition of the neutralizer, and the better instruments also have a relay for a pH alarm.

Figure 4 diagrams the control features of these instruments. After the pasteurization process is complete, the instrument can be activated to cool the media to the inoculation temperature. If, during the growth cycle, the starter gets too hot, the instrument cools it back to the acceptable range. These instruments usually do not have a temperature alarm system, however, to warn the operator if the starter gets too hot or too cold. They also do not have the capability of automatically heating the starter if it gets too cold. This is sometimes a problem when growing the thermophilic Italian cultures.

The instrument controls the pH in the same manner as the first instrument. However, the better instruments of this group are able to detect when the pH no longer changes and the starter is finished. At this time they automatically cool the starter. The cooling of the starter after growth maintains the activity of the starter at a higher level and allows the starter to be held for three to four days.

The better instruments also have intermittent agitation. That is, they only stir the starter when neutralizer is being added or when the starter needs to be cooled. The remainder of the time the agitator is off, so the incorporation of oxygen into the media is kept at a minimum. However, these instruments do not control the growth conditions of the starter to regulate the Lactobacillus and Streptococcus organisms.

Some of these instruments also have a pH alarm system. If the pH gets too high or too low, an alarm is activated and the relay controlling the neutralizer is

automatically turned off. This eliminates most problems associated with injecting too much neutralizer and killing the starter. The instrument remains in this alarm condition until the operator corrects the problem.

The special needs of the Italian cheesemaker prompted the development of a third generation of instruments. The entire control process, shown in Figure 5, divided into five sections: pasteurize, cool down, inoculate, growth and autocool.

In the pasteurization segment the instrument brings the media to the proper pasteurization temperature and maintains this temperature for the desired length of time. Safety features are built in so that if the temperature of the media goes outside the prescribed limits, an alarm is activated and the process is suspended until the operator takes whatever corrective action is deemed necessary. Because of shifts in the pH of the media at pasteurization temperatures and the effect of temperature on pH and pH electrodes, pH control is suspended at this time.

When the pasteurization time has elapsed, the instrument automatically cools the media to the proper temperatures for growing the starter organisms. Since many cheese plants have two cooling systems, a well or culinary water system, and a chilled or sweet water system, the instrument selects the water system that will provide the most economical operation for the plant. When the proper temperature is reached, the instrument suspends all operations and waits until the starter tank has been inoculated and the operator activates the instrument's growth mode.

If at any time the pH goes outside the acceptable limits, the pH alarm is activated, and the neutralizer pump is deactivated. The pump stays in this deactivated state until the problem is corrected at which time it resumes operation.

The same is true for the temperature. If the tank gets too hot or too cold, the temperature alarm is activated and all action is suspended until the problem is corrected.

When all the available carbohydrate is utilized, the organisms cease growing, acid production stops, the pH no longer changes and the organisms become dormant. At this time the instrument recognizes that growth is complete, and begins to cool the starter. Again the instrument uses the water source that is more economical. The first water source is used until the cooling rate slows down, then the second source is activated to continue the cooling. When the proper temperature is reached, the water is turned off and additional water is used only if necessary.

Most starters for Italian type cheese contain two different types of organisms, cocci consisting of S. thermophilus and rods consisting of L. bulgaricus or L. helviticus. Figure 6 shows the growth rate of four different strains of S. thermophilis. The horizontal axis is the pH of the growth medium. The vertical axis is the rate of acid production at the growth pH. The rate of acid production is closely related to the growth rate. The rate of growth of these strains is low when the pH of the medium is near 6.5. The rate of growth

is at a maximum at pH values of 5.5 to 6.0. The growth rate is very slow when the pH gets below pH 4.5. These organisms grow ten times faster at pH 5.5 than at pH 4.5.

Figure 7 shows the same acid production rate data for four different strains of L. bulgaricus. These organisms are more acid tolerant. They grow much faster at lower pH values than the cocci. The average growth rate of the coccus and that of the rods is shown in Figure 8. At pH 4.5 the growth rate of the rods is ten times faster than the rate of the cocci. This difference in rate of growth can be used to produce any rod/coccus ratio desired. If the organisms are grown at a low pH, the growth of rods will be favored. If grown at a higher pH the cocci will be favored.

Figure 9 is a photomicrograph of starter grown in Thermolac. The starter contained two defined single strains of cocci and two defined single strains of rods, and was controlled at pH 4.5. There are more rods present than cocci. When these same strains are grown at pH 5.0 (Figure 10), there is a better balance between the rods and cocci. Figure 11 shows the ratio achieved when the pH is controlled at 5.5. A majority of cocci are obtained when the pH is controlled at 6.0 as shown in Figure 12.

Advanced instrumentation can provide additional control of the rod/coccus ratio if growth is controlled in two stages, labeled I and II in Figure 13. During the first stage, the pH is controlled at a lower level, and the temperature at a higher level to favor the production of rods. During this time the cocci are growing, but less rapidly. When the required number of rods is obtained, the instrument shifts to the second growth stage where the higher pH and lower temperature favor the cocci. The rods continue to grow during this segment, but at a much reduced rate. The advantage of using two growth stages is that less time is spent at the low pH levels where the growth rate is slow, thereby reducing the time required to produce the starter. By growing the rods at the lower pH first, when few cocci are present, then raising the pH to grow the cocci, the media is never in a pH range that is harmful to either organism.

Figure 14 is a photomicrograph of starter grown utilizing two growth stages. The starter consists of two defined single strains of cocci and two defined single strains of rods grown in Thermolac. The first growth stage maintained the pH at 5.0 for five hours. The second stage maintained the pH at 5.5 for five hours. The rod/coccus ratio favors the rods and is the same as when the pH is maintained at 5.0 for the entire growth period. However, the time required to grow the starter is reduced by eleven hours.

Figure 15 shows the starter obtained when growth stage I was held at pH 5.2 for five hours and growth stage II at pH 6.0 for the remainder of the time. The ratio of rods to cocci is more balanced and the total incubation time is only ten hours.

The advances in pH instrumentation have provided the tools necessary to more accurately control the rod/coccus ratio of Italian starters. They have allowed the maker of Italian cheeses to take advantage of the benefits of external pH control.

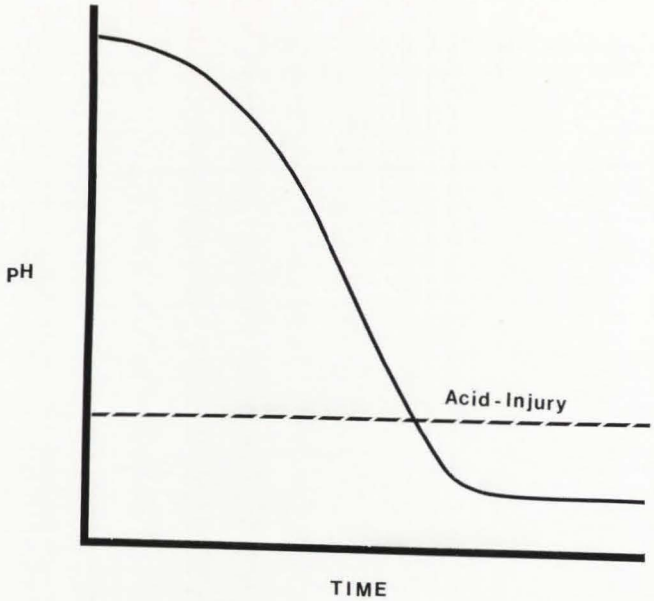


FIGURE 1. TYPICAL GROWTH CURVE OF THERMOPHILIC LACTIC ACID BACTERIA

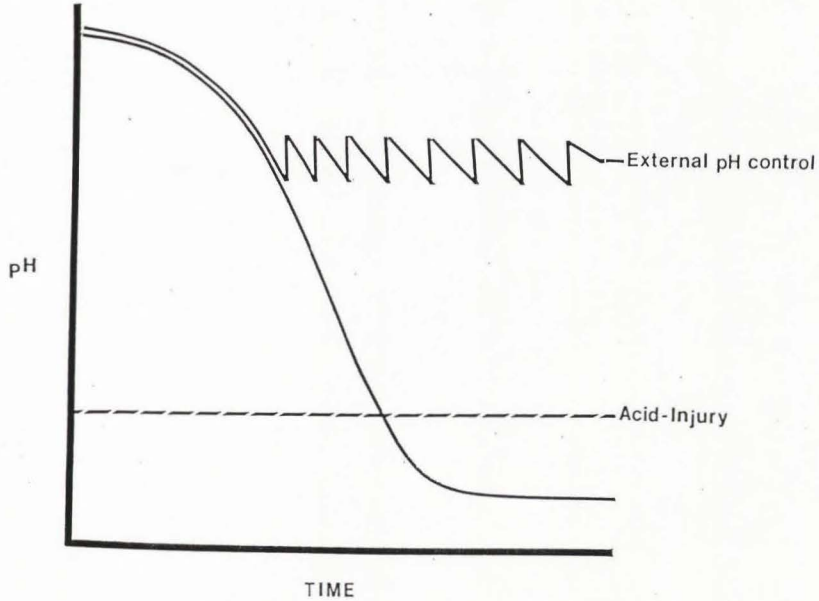


FIGURE 2. TYPICAL pH PROFILE OF EXTERNAL pH CONTROL AND CONVENTIONAL STARTER

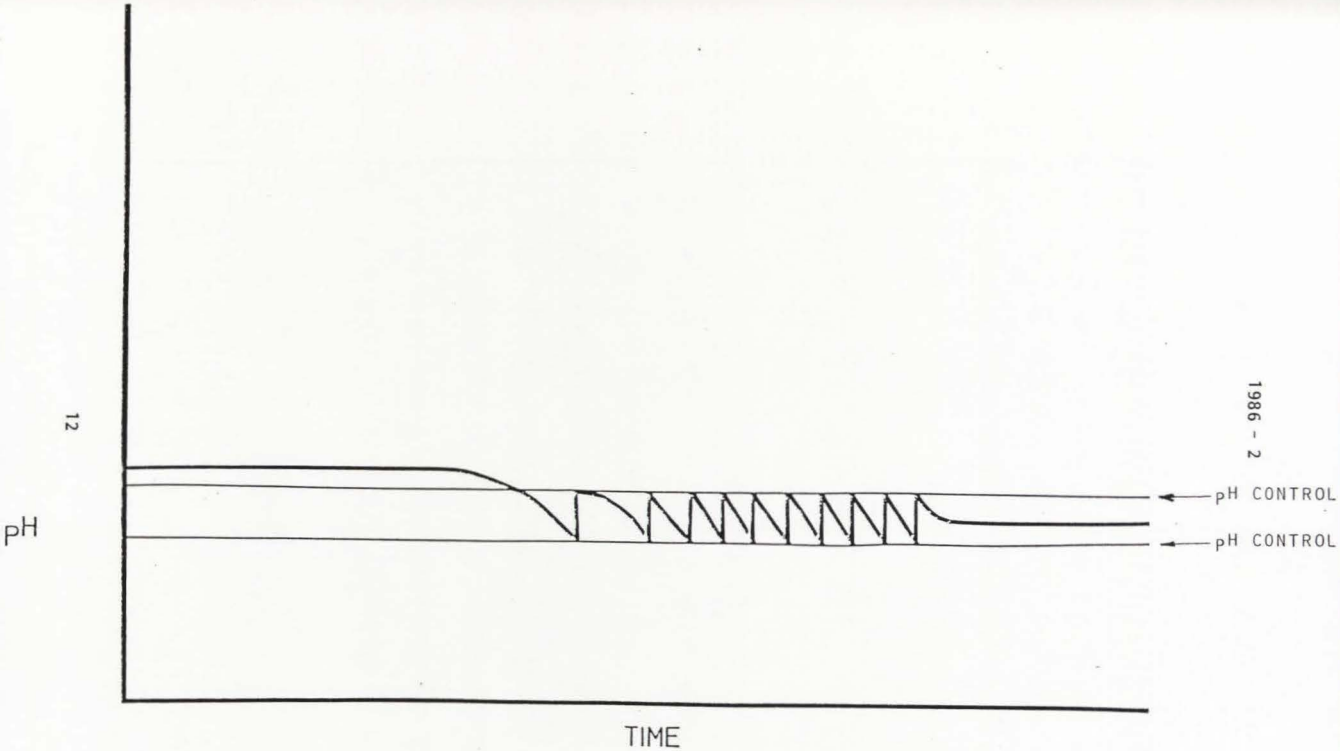


FIGURE 3. CONTROL PARAMETERS OF ORIGINAL INSTRUMENTS

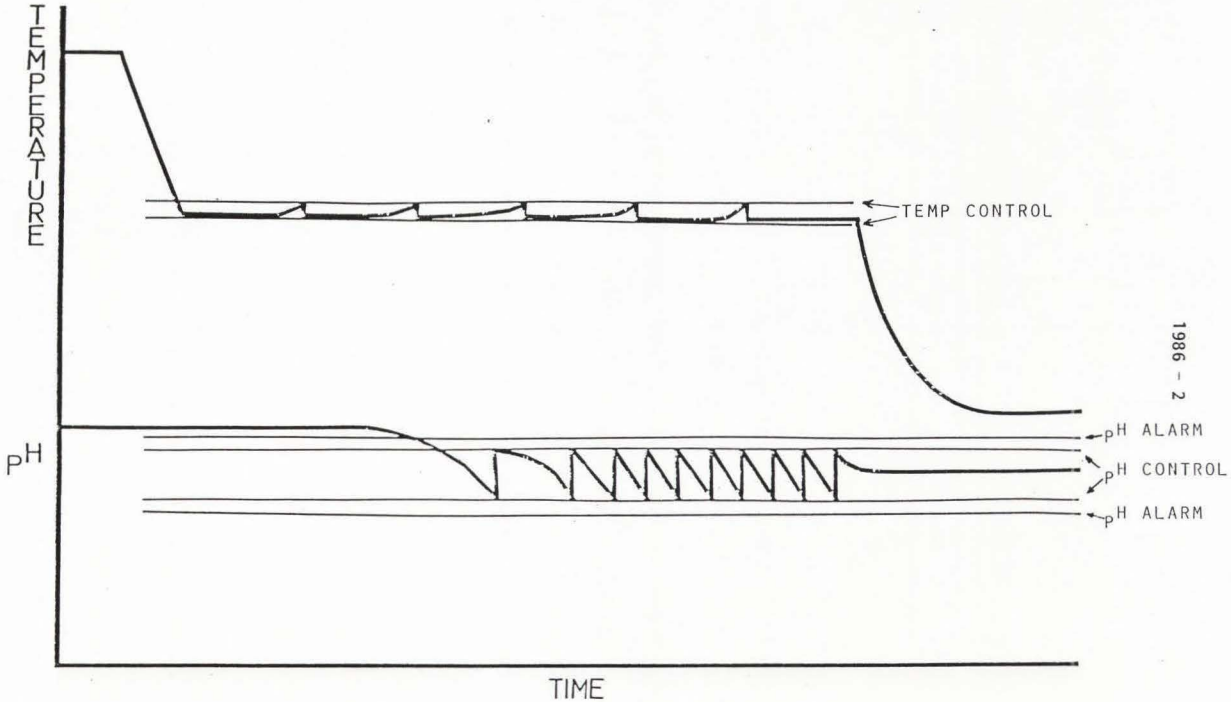


FIGURE 4. CONTROL PARAMETERS OF THE SECOND GENERATION OF pH CONTROL EQUIPMENT.

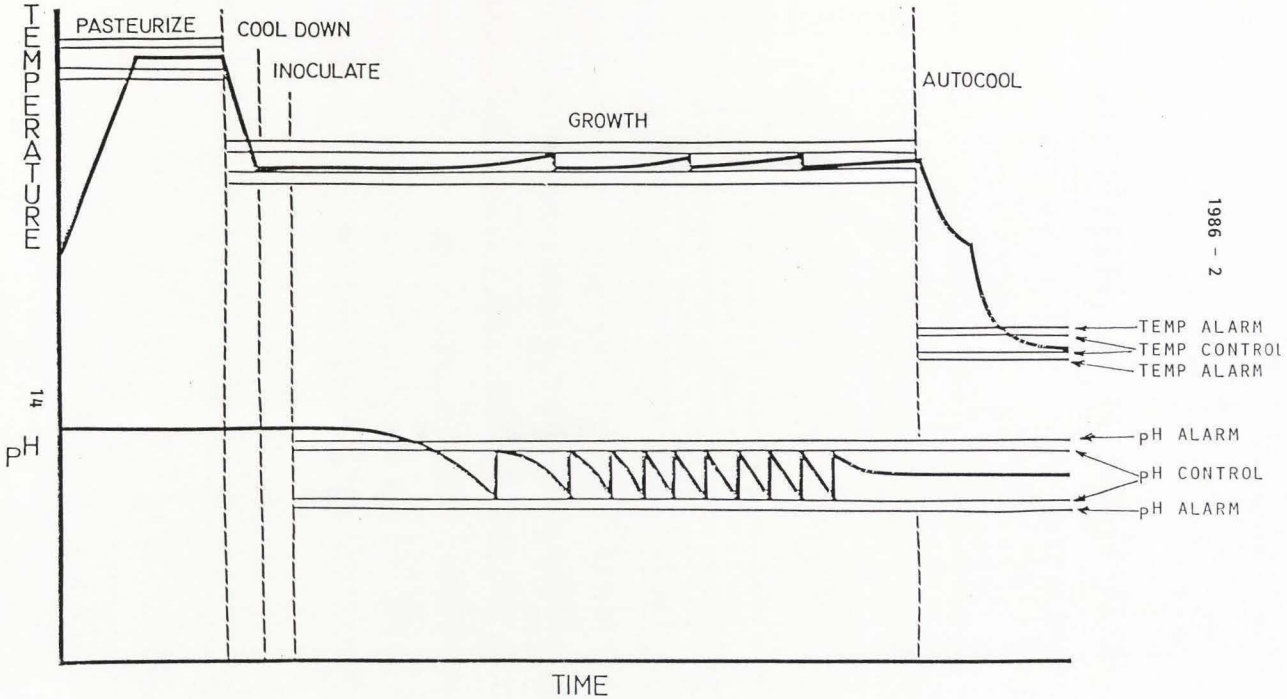


FIGURE 5. CONTROL PARAMETERS OF THE THIRD GENERATION OF pH CONTROL EQUIPMENT.

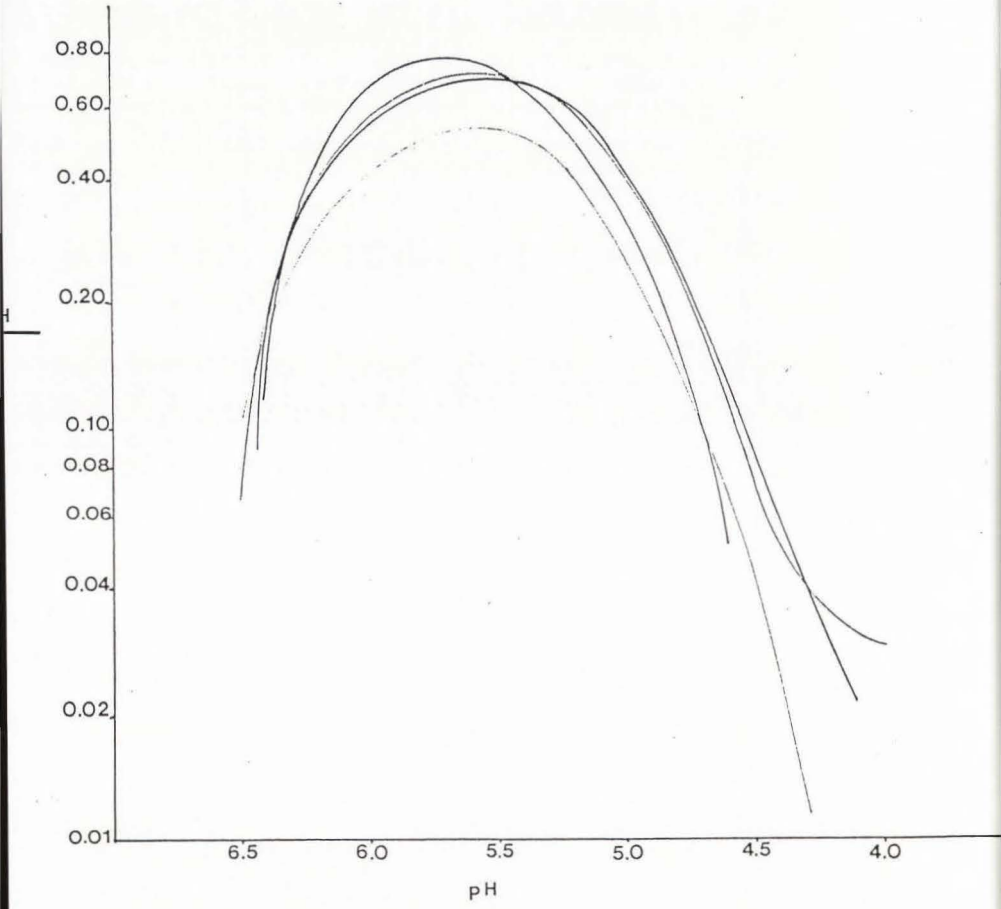


FIGURE 6. EFFECT OF pH ON THE RATE OF ACID PRODUCTION FOR FOUR DEFINED SINGLE STRAINS OF S. THERMOPHILUS

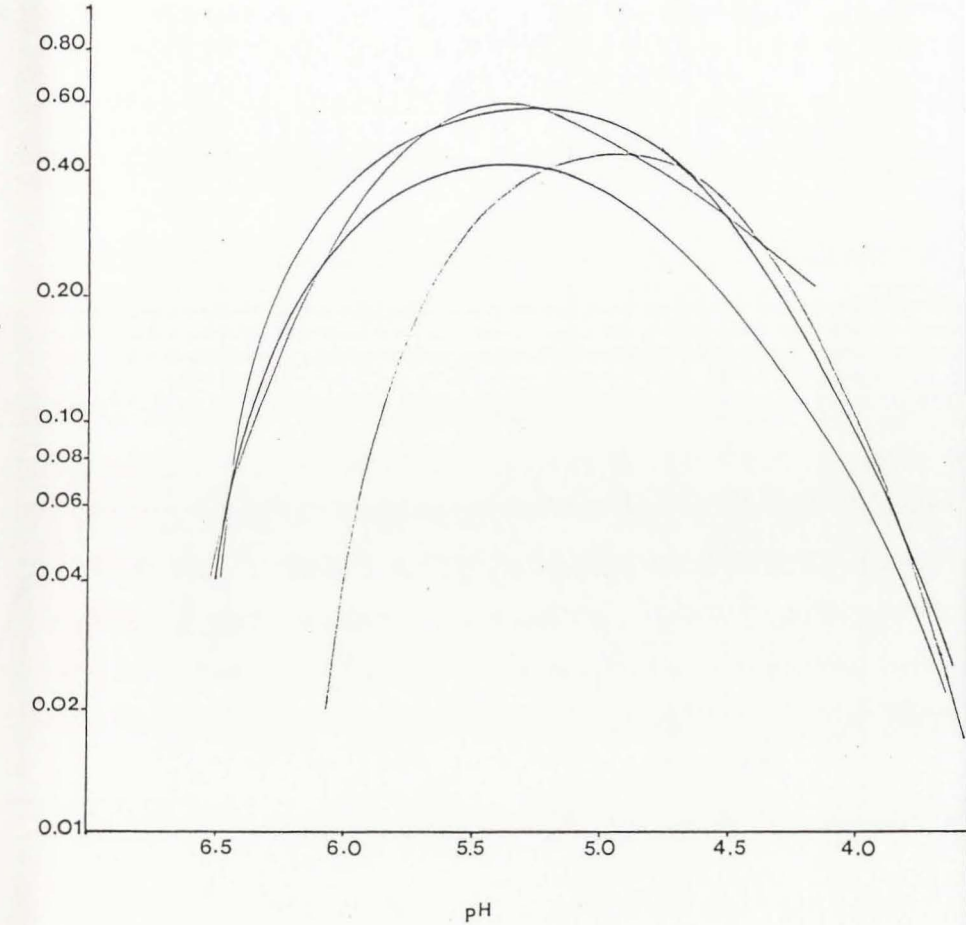


FIGURE 7. EFFECT OF pH ON THE RATE OF ACID PRODUCTION FOR FOUR DEFINED STRAINS OF L. BULGARICUS

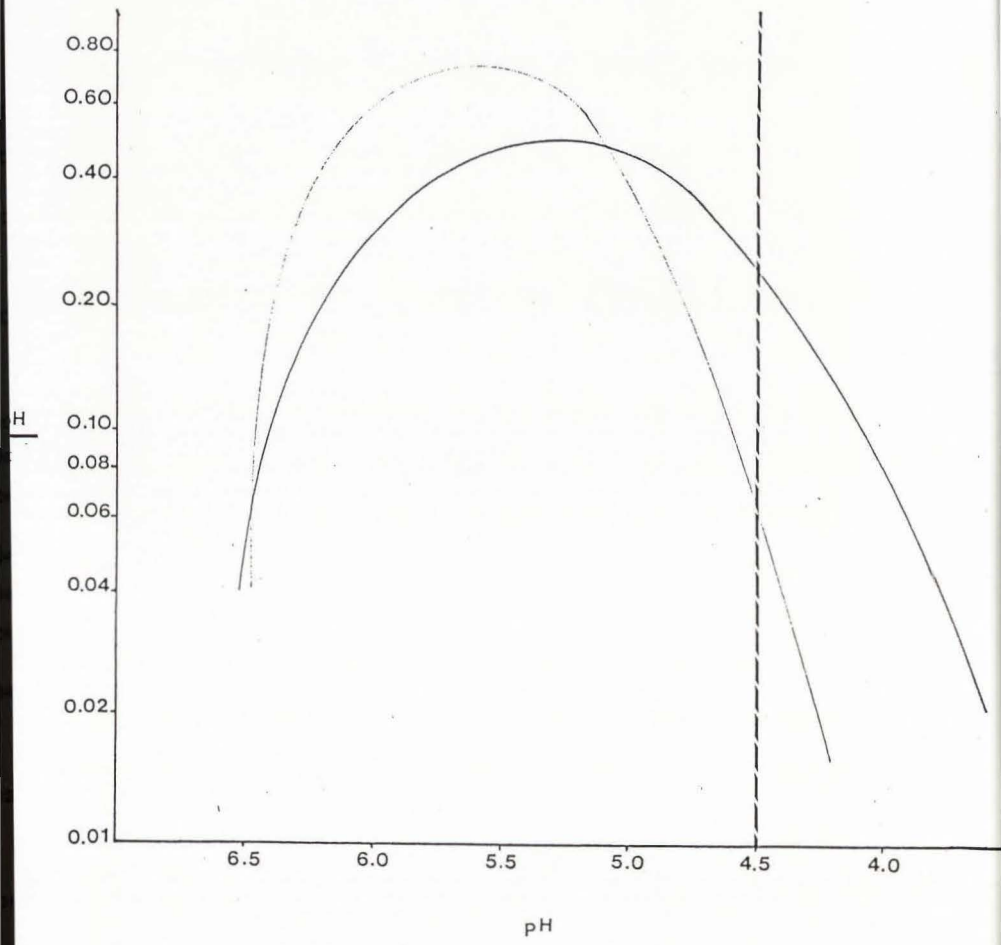


FIGURE 8. EFFECT OF pH ON THE RATE OF ACID PRODUCTION ON S. THERMOPHILUS AND L. BULGARICUS

FIGURE 9. PHOTOMICROGRAPH OF ITALIAN CHEESE STARTER GROWN AT pH 4.5

FIGURE 10. PHOTOMICROGRAPH OF ITALIAN CHEESE STARTER GROWN AT pH 5.0

FIGURE 11. PHOTOTICROGRAPH OF ITALIAN CHEESE STARTER GROWN AT pH 5.5.

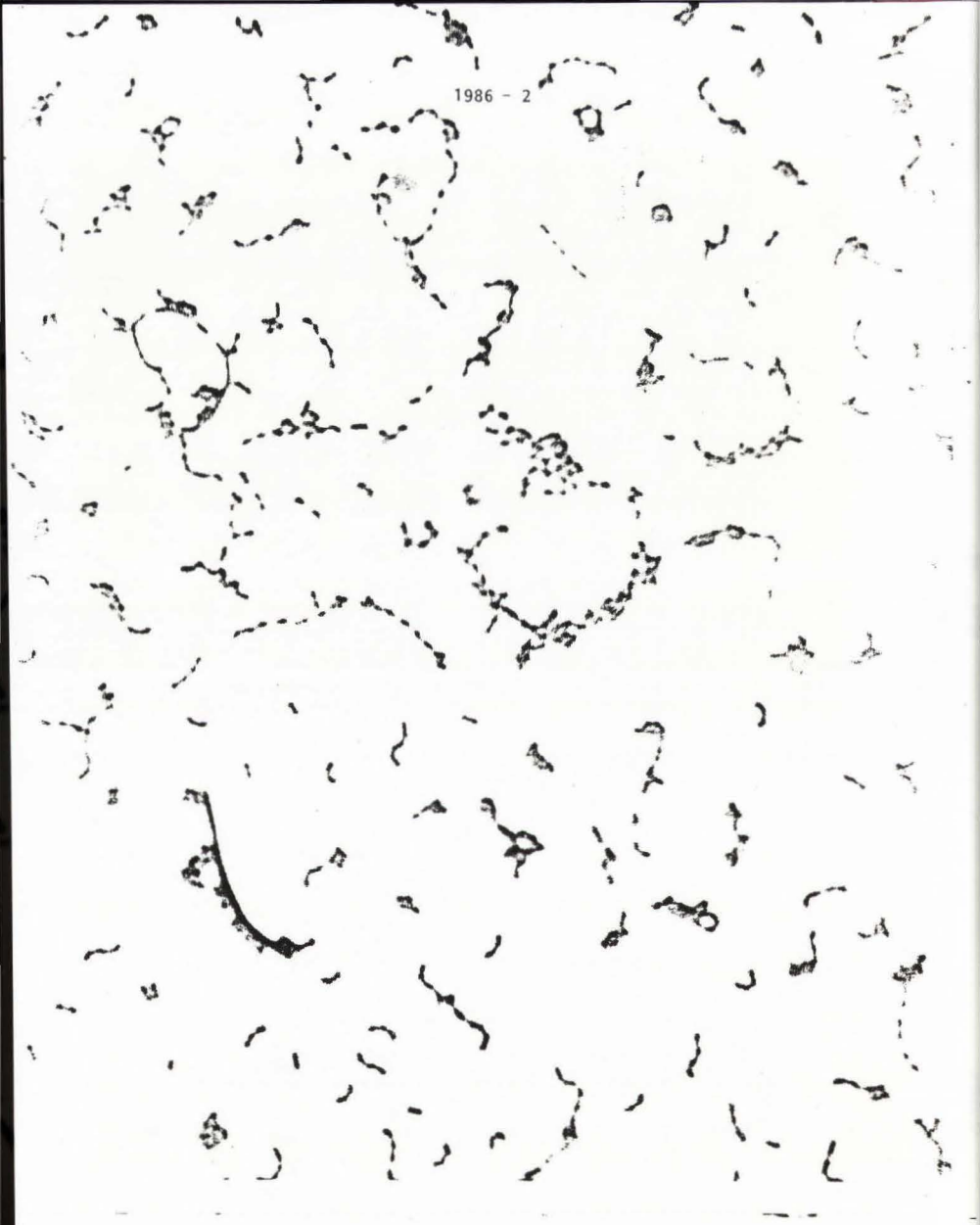


FIGURE 12. PHOTOMICROGRAPH OF ITALIAN CHEESE STARTER GROWN AT pH 6.0.

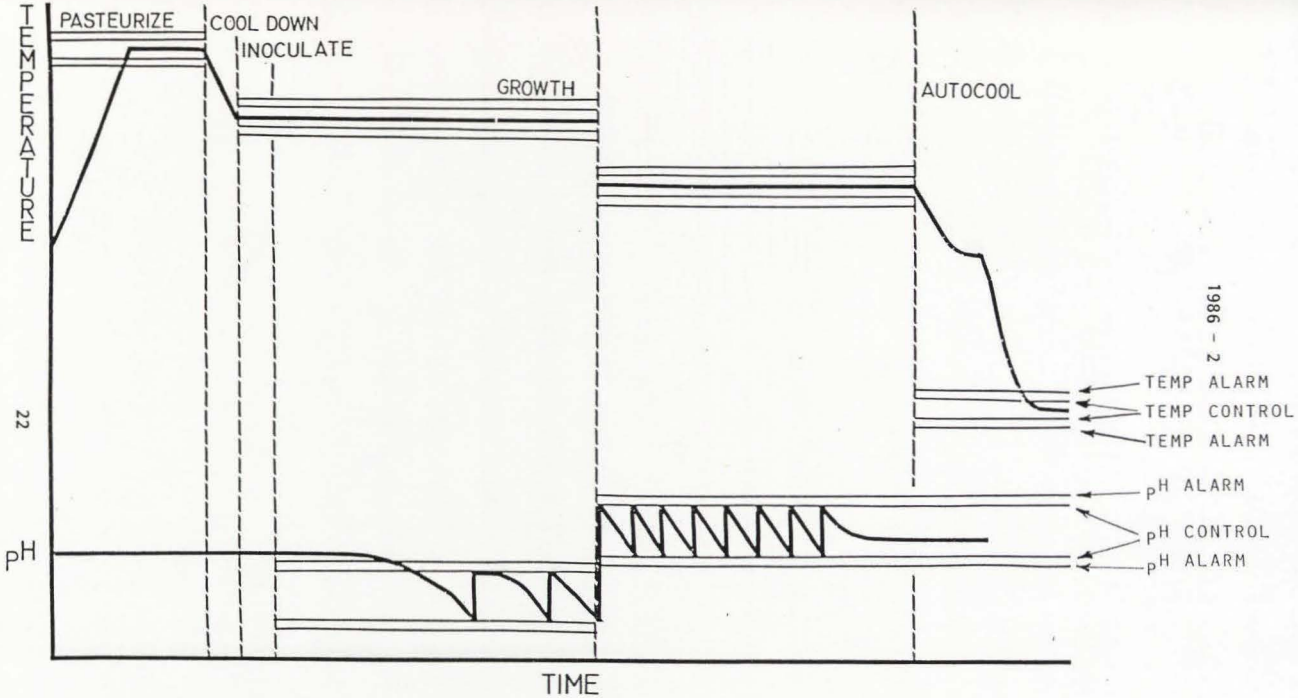


FIGURE 13. CONTROL PARAMETERS WITH 2 STAGE GROWTH CYCLE

FIGURE 14. PHOTOMICROGRAPH OF ITALIAN CHEESE STARTER GROWN AT pH 5.0 FOR FIVE HOURS THEN AT pH 5.5 FOR FIVE HOURS.

FIGURE 15. PHOTOMICROGRAPH OF ITALIAN CHEESE STARTER GROWN AT pH 5.2 FOR FIVE HOURS THEN AT pH 6.0 FOR FOUR HOURS.

The following paper was presented by Martin P. Bender, President, Fluid Air, Inc., 540 Industrial Drive, Naperville, Illinois 60566, at the 23rd Annual Marschall Invitational Italian Cheese Seminar, held at the FORUM Building of the Dane County Exposition Center, Madison, Wisconsin, on September 16, 17 and 18, 1986.

MILLING AND DRYING OF HARD ITALIAN CHEESES

By Martin P. Bender

Abstract

This presentation addresses the technical advances developed over the last few years for producing more uniform, higher quality hard Italian cheeses at considerable cost savings.

The use of modern process equipment coupled with microprocessor controls and automation can produce attractive end results in the competitive effort to keep or improve market share with healthy margins.

Improved profit and a more consistent product. Goals every company wants, but it's like motherhood, apple pie, the flag and the Fourth of July. Nothing new about these. They have been a part of our American way of life. But it can be a reality today if you take advantage of the technology that is available in today's milling and drying equipment to reduce your production costs. In addition, older milling machinery and outdated drying techniques can often result in loss of profit and customers because, unbeknownst to you, the product shipped today is different than that shipped last month.

Do you mill cheese and then dry it with very little thought given to how the milling process affects the drying process? Further, does your milling and drying equipment allow you the flexibility to take into account changes in incoming product? Ungrated Romano or Parmesan can vary significantly in terms of oil content, moisture, color and taste. But do you process it any differently or do you run it through your same old well-proven equipment using the same traditional procedure?

The same type of cheeses from the same supplier usually will have a range of moisture and fat content. When these cheeses are processed through a mill, different particle size distributions result. This change in particle size distribution will also affect the drying. If you can maintain a uniform particle size distribution coming to the dryer, you will be able to do a better job of controlling the drying process.

For example, when a cheese with a high oil and moisture content is milled, it will generally form substantially different particles than a dry or less oily cheese. If this cheese is placed onto a tray or into a fluid bed dryer and dried for the same period of time, the resultant cheese could have a substantially different moisture content and will most likely be quite different in color. This variance is further compounded by the weather. The

different in color. This variance is further compounded by the weather. The cheese will tend to be darker if dried on a hot, muggy day versus drying on a cool, low humidity day.

In addition, the particle size distribution will be different for cheese milled directly out of the cooler versus cheese that is at room temperature (see Figure 1).

PARMESAN CHEESE
PARTICLE SIZE DISTRIBUTION
(% WEIGHT ON SIEVE)

Sieve Size	Cheese at 44°F	Cheese at 74°F
16	25.60	17.69
20	26.72	28.96
30	32.82	42.84
40	12.07	9.38
50	1.56	.84
60	.63	.13
-60	.60	.15

TEST RUN ON FLUID AIR MILL MODEL NUMBER 007
SPEED: 4000 RPM, .113" DIA. HOLE SCREEN

Figure 1

Further, heat is generated during the milling process. While conducting drying tests, we have noticed that the heat of the incoming cheese can affect not only the drying time, but the color of the cheese at the end of the drying cycle. You should always mill you cheese at the same temperature not only to control the particle size but also the resulting dryness and color.

Mills and dryers designed in the Eighties, utilizing today's state-of-the-art electronics, will allow you to compensate for changes in your supplier's product, cheese temperature and weather, particularly if the milling and drying process is considered as one integrated process.

Figure 2

For example, the Fluid Air Mill's (Figure 3) direct connected rotor provides the same mill speed for the same speed setting by eliminating belts. Machines with belts can easily come out of adjustment, and belts wear.

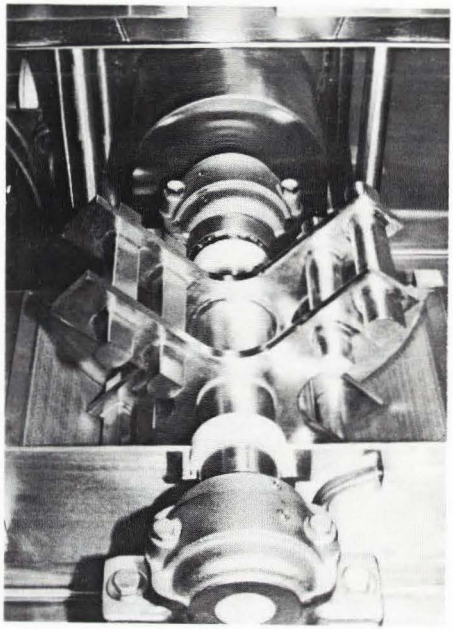


Figure 3

As an aside, note the crack-free construction of this direct connected rotor assembly. This is particularly important with respect to cleaning the mill by eliminating areas where bacteria can grow. The USDA was very impressed with this particular feature of the Fluid Air rotor. Note also the openness of the rotor. This allows the cheese to be impacted and passed on through the rotor assembly as quickly as possible, minimizing heat build-up, another major advantage of Fluid Air's rotor design.

With a direct connected rotor, you can be assured that the machine will always operate at the desired speed. The question now is: "What is the desired speed?" The Fluid Air Mill (Figure 4) pictured here contains a built-in variable frequency drive which allows the machine to run anywhere from 300 to 5400 RPM by simply pushing a button. This allows you the flexibility to vary the machine operating parameters when you find that there are changes in the product that you receive from your supplier.

Figure 4

Look at the difference in these grinds with just a 500 RPM change (Figure 5).

PARMESAN CHEESE
PARTICLE SIZE DISTRIBUTION
(% WEIGHT ON SIEVE)

Sieve Size	3550 RPM	4000 RPM	4500 RPM
16	31.93	17.69	14.00
20	28.62	28.96	21.73
30	34.67	42.84	42.79
40	4.25	9.38	15.66
50	.36	.84	2.72
60	.17	.13	1.88
-60	.10	.15	1.22

TEST RUN ON FLUID AIR MILL MODEL NUMBER 007
CHEESE TEMP.: 74°F, .113" DIA. HOLE SCREEN

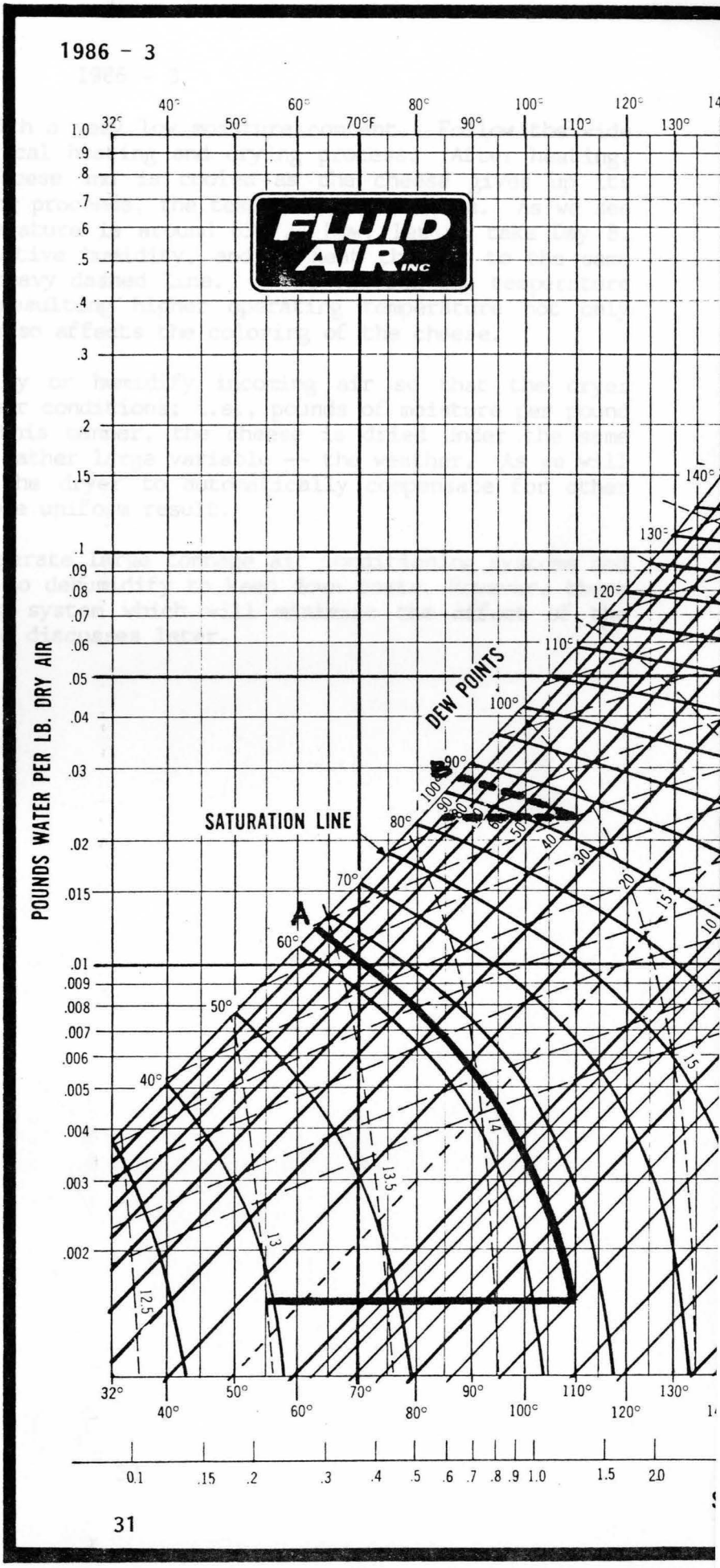
Figure 5

Typically, dryers today, either tray or fluid bed, are operated over a set period of time. The weather conditions will affect how dry the cheese becomes during that period of time. On this typical psychometric chart (Figure 6 on following page), we show a typical drying process that occurs on Day A.

PSYCHROMETRIC CHART

PROPERTIES OF AIR AND VAPOR MIXTURES
FROM 32° TO 600° F

FIGURE 6



FLUID AIR™

540 Industrial Drive,
Naperville, Illinois 60566
312-961-3423

Day A is a nice, spring day with a very low moisture content. Follow the wide solid line. This is the typical heating and drying process. After heating, the air passes through the cheese and is cooled as the cheese gives up its moisture to the air. As drying proceeds, the temperature increases. As we see here, the actual drying temperature is around 63°F. Now, let us take Day B. It's a 85°F day with 90% relative humidity, and we heat the air to the same inlet condition shown by the heavy dashed line. Here you see the temperature only drops to 87°F. The resulting higher operating temperature not only affects the drying time, but also affects the coloring of the cheese.

Ideally, we should dehumidify or humidify incoming air so that the dryer operates with the same inlet air conditions; i.e., pounds of moisture per pound of air, all year long. In this manner, the cheese is dried under the same conditions which eliminates a rather large variable -- the weather. As we will see later, this would allow the dryer to automatically compensate for other drying variables and give a more uniform result.

It is costly to install and operate large tonnage air conditioning systems and most cheese plants choose not to dehumidify to keep down costs. However, there are ways to operate a drying system which will minimize the affect of the weather. These methods will be discusses later.

There are several other big variables that also play an important part in the drying process. Constant air flow is critical to controlling the drying process. Note the large tapered construction of the Fluid Air Dryer (Figure 7). It is designed to minimize pressure drop and to maintain a steady air flow through the unit resulting in an even, fluidized bed of cheese. With the tapered construction, the amount of cheese particles that accumulate on the bag are reduced by lowering the velocity of the air stream passing up through the bag, due to the increased area in the upper portion of the dryer. This is another variable over which you have no control — the moisture content of the incoming cheese. It will substantially affect the outcome of the drying process. Cheese that has a 38% incoming moisture will not be as dry as cheese with an incoming 32% moisture content if the cheese is dried over the same period of time.

Figure 7

If your cheese is overdried, you are selling more cheese and less water. If you consistently sold your cheese 2% drier than it should be, how much profit have you lost during a year by not maintaining the required moisture content?

Utilization of microprocessor controls, shown here on a Fluid Air Dryer (Figure 8), helps to assure that the cheese can be dried at the most optimum conditions. With this type of system, dry bulb temperature and air flow can be regulated and duplicated for every batch. Further, outlet temperature can indicate when the cheese is dry if the cheese is dried under the same weather conditions. Thus, on similar drying days, this system could dry the cheese the correct length of time compensating for any big differences in the initial moisture content of the cheese. This requires that detailed daily records be kept on the weather and dryer operating conditions to determine the correlation between relative humidity, final moisture content of the cheese and final discharge temperature. Different operating programs can then be loaded into the microprocessor for different weather conditions based upon this information.

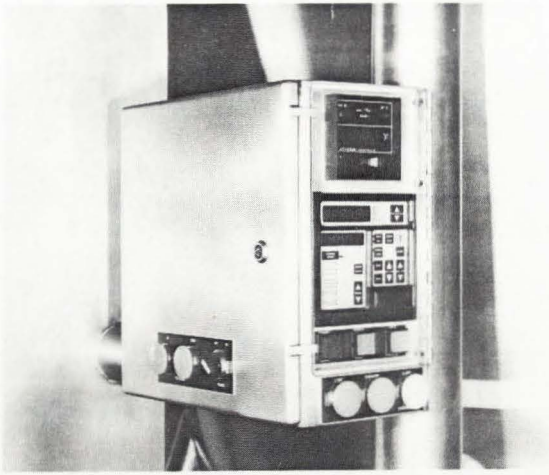


Figure 8

The microprocessor not only controls the operating parameters of the dryer, it also controls all dryer functions, eliminating operator error. The microprocessor is programmed to sequence the dryer through the same start-up, drying, and shut-down process during each batch. This assures you that the cheese sees the same drying conditions with the result being a more uniform output from the unit.

Another major attribute of the microprocessor system is that it can be set up and programmed for drying different products under different weather conditions. A typical program can be stored on a small cartridge (shown in Figure 9) about the size of a cigarette pack. Different programs may be easily dumped into the microprocessor, changing the drying parameters and telling the dryer to proceed through its cycle at different operating conditions. For example, if you find that a particularly oily cheese can be processed at a higher temperature and maintain the same color, you can shorten the drying time using higher temperatures without sacrificing quality.

Figure 9

Thus, it is possible to improve profit margins and product uniformity through the utilization of up-to-date designed milling and drying equipment that gives you the flexibility to change process operating parameters in response to changes in your incoming supplied product. Further, new milling and drying equipment with the latest in construction and electronic controls can provide you the tool with which you can respond to the changing demands of the market through being able to change your product.

The following paper was presented by Carl T. Wolf, President, First World Cheese, Inc., 76 South Orange Avenue, South Orange, New Jersey, 07079, at the 23rd Annual Marschall Invitational Italian Cheese Seminar, held in the FORUM Building of the Dane County Exposition Center, Madison, Wisconsin on September 16, 17, and 18, 1986.

MARKETING SPECIALTY CHEESE IN 1986

By Carl T. Wolf

Consumer tastes and preferences have rapidly changed in the last decade. The market for cheese is no longer a single mass market. The cheese industry has tended to be conservative and production oriented, rather than marketing oriented. Many of the mass marketing principals of the 1960's and 1970's no longer apply. New marketing techniques are being applied to tap demand. Many of these new practices are not necessarily costly and can be accomplished with speed and accuracy, and a new wave of companies are leading the growth in the industry.

Demand for a wider segment of consumer (including cheese) products has increased in the last ten years. This is no fluke; it is a demand that is showing up in many supermarkets, not just in health food stores or trendy restaurants. America's tastes are changing away from one type of mass acceptable product to many products which fit specialized consumer needs. This change in demand is reflective of a society which has large subsegments which are considerably more:

Educated
Nutritionally oriented
Time stressed
More sophisticated in taste
Looking for variety
More mobile and singular

At the same time, a large element of our society is more knowledgeable and value oriented.

Thus, the market has split into three subsegments:

The "old" middle segment
The new upscale segment
The best value or "budget segment"

Marketers who have not positioned themselves to appeal to the new tastes, and continue to sell to the "old" middle, have not grown rapidly. Whereas, marketers positioning to the upscale and budget segments are growing more rapidly. For example in retailing:

Sears.... What segment? What growth?
KMart.... What segment? What growth?

Limited.. What segment? What growth?

In automobiles: Mercedes? AMC-Concord? Honda?

In the cheese industry, we have tended to be production oriented. The philosophy has been to produce large quantities efficiently, turn assets and reduce costs. This is mainly a result of a very efficient system, which profitably produces a product (cheese) whose major cost element, milk, represents from 80-85% of the selling price. The industry looked backwards to save a percent or two, or to turn over assets every five days instead of six. In this changing market, it appears that there is a very real potential in the "budget segment", in larger pack sizes, lowering the percentage milk element in cheese by adding water or substituting oil, or setting up a more direct distribution system to lower wholesale markups since the budget segment of the market is quite large, the industry has effectively entered and marketed its products:

Imitation cheeses
Cheese spreads
Large economy sizes
Generic products

The industry is now turning toward specialty, upscale cheeses which add value and, hence, higher prices to its products. Marketing costs assume a much larger function in the sale of these new products. Some of the most recent successful categories are:

Snack and Convenience: String cheeses
Nutritionally oriented: Low salt/lower cholesterol cheeses
Sophisticated Taste: European style table cheeses, cold pack cheeses

Now the trick is to be successful. How do we get our product to market, and how do we let the consumer know we have a product they need.

We are going to show you a series of steps and procedures, followed in the marketing of specialty cheeses in the 1980's. Think about how it relates to your situation. We will go through one or two actual products, as requested by the audience at the end of this discussion.

Step One:
Isolate your market decision making from your production. The two must mesh later, as you will see. But do not mix the two for now.

Step Two:
Define your product, its market and market size. You must answer the questions as to who am I going to sell the product? What are its attributes? What are its channels of distribution? It does not pay to market a product which will not result in a large enough payoff. If your market potential is only to the gourmet cheese shop customer, it will be hard to sell over $500,000 worth of product. This may be perfectly O.K., but it is better to know about it before you begin.

Step Three:
What is your price? What are your costs? What type of marketing program is required to sell the product?

Step Four:
Do I have a product that really delivers? Can it be made consistently? Is it proprietary?

Step Five:
What are competitive conditions? What will happen in one, two, three years?

Step Six:
Define your criteria for success. In the future, you will have developed this before beginning the exercise.

Now apply a quantitative review of your projections. Develop a budget. Looks good. We're not done.

Step Seven:
Gut feeling, willingness to take risks, speed and ability to cut loss factors. Assuming you have isolated your marketing-decision-making from your production-decision-making, your product needs a SPONSOR - a believer. The smart sponsor will be able to prove that he is in control, can cut his losses and isn't a damn fool.

There are many new firms who are the growing power houses in the industry. All of them started from a marketing base. They all fill a marketing void.

They:

1) Make separate marketing decision from production.

2) Quantify their products as to whether they fill the criteria in the steps above.

3) Are singular in developing cheeses appealing to the value added segment of the market.

4) Test market and improve product quality, packaging, advertising, and product positioning.

5) Live by a risk reward philosophy. They continually rebudget and are not tied to a death by cheese philosophy. They cut their losses.

6) They are fast.

This is how they typically will bring a new product to market:

Independent manufacturer is approached or vice versa in developing or taking an existing product into the market.

Costing/pricing analysis is completed.

Sales projections and marketing budgets completed.

Product quality/uniqueness evaluated.

Consumer research completed as to the products saleability, positioning is undertaken.

Packaging is professionally developed.

A complete marketing campaign is drawn up.

Product and campaign are shown to consumer panels for feed back.

Key decision making - go, no go.

Successful prototypes developed.

Consumer taste tests completed.

Key trade reaction.

Test markets picked.

Campaign formalized.

Initial distribution in test markets. You must get distribution.

Evaluate results.

Go, no-go.

Refine, reformulate.

Enter new markets.

The above process, through the initial test markets, takes from five to seven months. What are the risks? Less, if you have gone through the steps. Less, if you can cut your losses and continually monitor results.

Now the question: If you are a producer, should you do it by yourself? hire a professional? or venture with an independent company?

We have given you a listing of some of the marketing tools available. I hope all of you are ready for our live test. Let's try to follow the procedure for one or two actual or proposed products.

First World Cheese, Inc. became a public company on June 7, 1986. Its units of two shares and one warrant are traded over the counter.

MARKETING TOOLS AVAILABLE

Consumer Research for Taste or Other Concepts
Consumer Focus Groups
SAMI Data
Competitive Pricing Information
Public Relations
Advertising Agency
Package Designer
Package Manufacturer
FDA Approval
Legal Opinion
Industry Statistics
Brochure Design/Sales Literature
Point-of-purchase Design
Newspaper Coupons
Consumer Media-TV, Radio, Magazines, Billboards
Stick-on Labels
Industry Magazines
Mailings to Trade
Premiums to Trade
Pre-packs
Directory of Wholesales, Retailers
Metropolitan Market Information
Demographic Profiles
Laboratory Analysis
UPC Codes #

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NEW PRODUCT EVALUATION - PRELIMINARY REVIEW

Product: _____

Special Characteristics: _____

Appeal to: _____

Channel of Distribution: _____

Total Size of Category: # _____

Size of New Product Category: # _____

Your Market Share _____% $_____

Estimated Price/Sales _____ lb. Total $ _____

Gross Profit _____% _____lb. Total $_____

Competition: _____

_____

Proprietary: _____

Ease & Consistency: _____

Capabilities to handle volume staff & plant: _____

Market Campaign Describe: $ 1._____ 2._____ 3._____

Market Campaign Estimated: $_____

Cost to go to test Market: $_____

Sponsor Available: $_____ Who _____

Risk/Reward: Worst Cost_____ Profit_____

Cost_____ Profit_____

Best Cost_____ Profit_____

Overall Evaluation: _____

_____

More Information Needed: _____

_____

Special Conditions to be Met: _____

_____

The following paper was presented by Mr. Jake Nelles, Nelles Cheese and Equipment, Inc., R.F.D. No. 3, Maquoketa, Iowa 52060, especially for the 23rd Annual Marschall Invitational Italian Cheese Seminar, held in the FORUM Building of the Dane County Exposition Center, Madison, Wisconsin on September 16, 17, and 18, 1986.

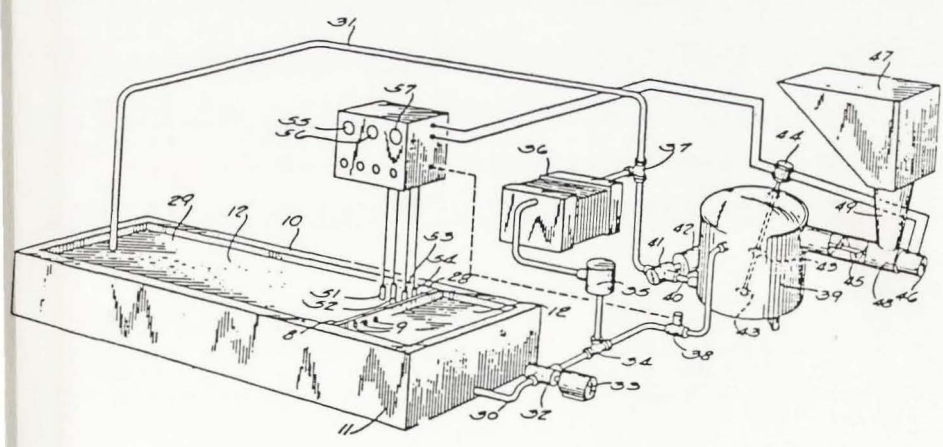
DEEP PIT BRINING

by Jake Nelles

ABSTRACT

A system for cooling and curing pasta filata-type cheese includes a brining pit holding a brine solution into which a number of cheese loaves may be immersed and an adjacent overflow reservoir which receives a portion of the brine solution from the brining pit. A sanitary pump draws the brine from the overflow reservoir through filtering and a heat exchanger to a brine return line which feeds the reconditioned saltwater solution back to the brining pit, thereby effecting a constantly circulated system. A brine mixer connected to the brine return line maintains the desired salinity of the brine.

ORIGINAL NELLES PIT BRINING SYSTEM, PATENT 3,910,174:



Over the last 18 years, our company has been involved in one particular and very important phase in the manufacture of Italian-type cheese, especially Mozzarella. Much progress has been made in cooling and handling of pasta filata-type cheese, but the salting and brining of this type of cheese is still in many cases very neglected. Several methods have been developed and introduced into the industry, some more successful than others.

In general, we feel that the brining is still the most neglected phase, and has not been given the attention and importance it should.

Most plants have grown over the years and produce large quantities of cheese, but have not been able to provide proper brining for the cheese, due to space and building problems. Some methods are still using only approximately 4" depth of any brine space surface; fiberglass, concrete, old cheese vats, etc. To make better use of space, tanks are sometimes doubled up or tripled up. Cheese is put into these tanks and left there without movement. The upper part of the cheese sticks in the air and in many cases, is dry-salted or salt is applied through spray systems.

Undoubtedly some improvements have been made, but in pasta filata production, salting has a double function. The cheese not only is brined, a very important factor is the cooling of the cheese. The heat in Mozzarella has to be removed as quickly as possible to result in a good, firm, non-leaking product. We all know that when cheese lays packed tightly in large areas of brine tanks, the heat is not removed and the upper part of the tank warms up and the salt solution weakens and the cheese stays warm (above 70°), and the bacteria in the cheese is still working. The result is uneven loaves, leaky cheese, woody cheese, soft cheese, and off-color cheese.

In 1974 we presented a new pit brining system method, and introduced it at this seminar. This system was based on large tanks (concrete with fiberglass or stainless steel linings) where brine was constantly circulated through cooling units, brine make-up tanks and ultraviolet purifiers. Cheese was put in stainless steel shelves and submerged into the pit. This system has had the advantage that the cheese would cool very quickly and uniformly since the concentration of brine is the same on top and bottom. It also uses much less space and labor. Many of these systems were installed and the industry has benefitted from them.

Recently we have tremendously improved this system since we eliminated the loading and unloading of the shelves. The shelves are now hydraulically raised and lowered. A large screw pump creates heavy turbulence in the brine around the outside of the tanks and flumes and floats the cheese into the shelves desired for loading and unloading.

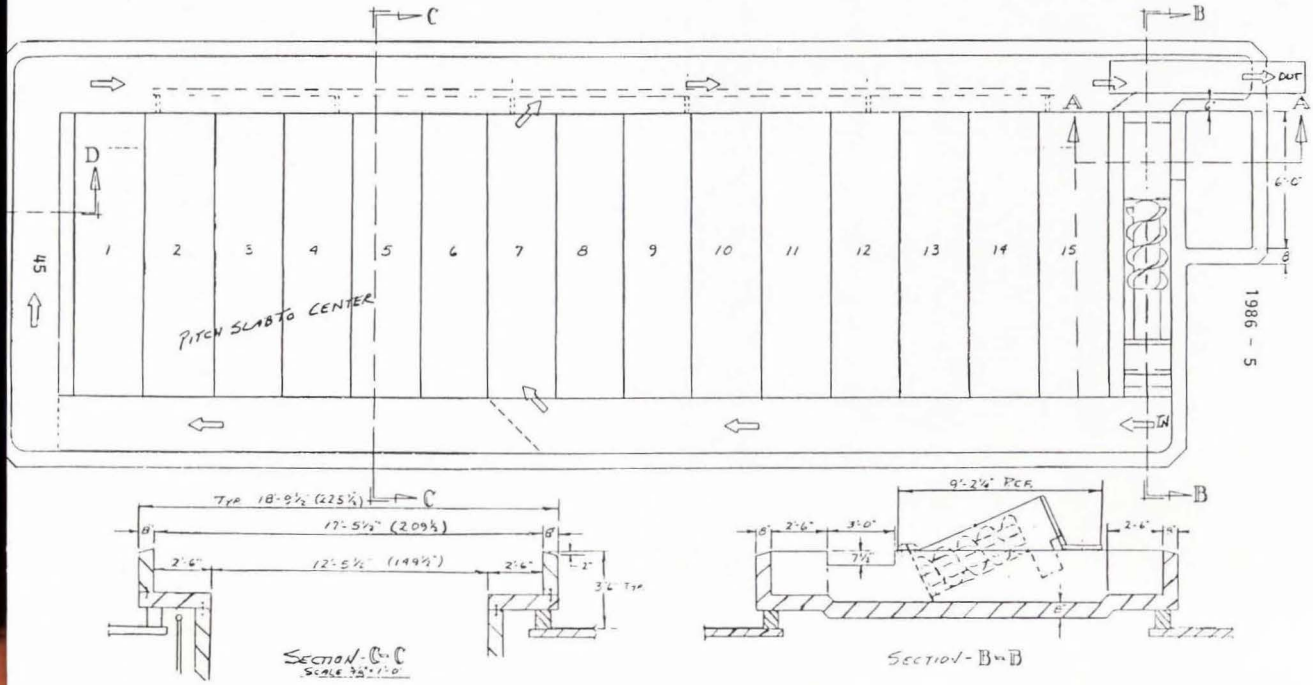
The cooling and purification is similar to the other system. Salt is purchased in bulk and stored in silos, saving 25% of salt usage in one year. No salt is ever on the floor of the pit and the entire solution can be kept extremely clean. The cheese is cooled rapidly, and within an hour even the center of the blocks will reach the desired 50-55°.

One man is able to operate an entire floating brine pit system, handling as

much as 5 tons of cheese per hour, loading and unloading.

Please visit our booth, #99-100-101, to see a video and a scale model of such an installation.

NELLES NEW FLOATING BRINE PIT SYSTEM



1986 - 5

The following paper was presented by Arthur R. Hill, Ph.D., Assistant Professor, Department of Food Science, University of Guelph, Guelph, Ontario, Canada N1G 2W1, at the 23rd Annual Marschall Invitational Italian Cheese Seminar, held in the FORUM Building of the Dane County Exposition Center, Madison, Wisconsin, on September 16, 17 and 18, 1986.

THE MANUFACTURE OF QUESO BLANCO CHEESE

By Arthur R. Hill and Estelle M. Parnell-Clunies

Queso Blanco has been traditionally manufactured in South and Central America by heat-acid precipitation of proteins from milk. The technology of Queso Blanco manufacture as developed for commercial application in Canada is described. Milk or recombined milk is standardized to a protein/fat ratio of 1.2, heated (85°C, 5 min), and acidified to pH 5.3. The amount of citric acid required is calculated from the protein content of the milk. After whey drainage the curd is pressed (one hour), cooled overnight and vacuum packed. The cheese is firm and sliceable with a bland flavor which is compatible with many condiments. Cheese composition is about 52% moisture, 18% fat, 22% protein and 3% lactose. Protein, fat and total solids recoveries are 85-90, 80-90, and 50-55%, respectively. Total cheese yield is about 15% from standardized milk of 3.5% fat and 4.2% protein. Queso Blanco does not melt and can be used to make deep fried snacks. It can be used as an economical substitute for natural cheese in process cheese. It also has potential as an export and foreign aid commodity. The advantages of Queso Blanco over natural cheese are its high yields (due to recovery of whey proteins and high moisture content) and its rapid make procedure (about 2 h from raw milk to finished cheese).

Introduction

Queso Blanco cheese is a broad term describing a group of cheese consumed in South and Central America. It was originally a heat-acid coagulated curd but now includes many varieties produced with rennet. Heat-acid precipitated cheese of India, namely, Paneer and Chhana are similar to traditional Queso Blanco. Queso Blanco type cheese have been reviewed by Torres and Chandan (1981). The objective of this report is to describe the technology of heat-acid precipitated Queso Blanco which has been developed in the Food Service Department, University of Guelph. The reader is also referred to Hill et al., 1982 and Parnell-Clunies et al., 1985a,b and c).

Queso Blanco Manufacture

A detailed make procedure for Queso Blanco is given in Appendix 1. Queso Blanco can be made from whole milk or recombined milk (i.e., reconstituted skim milk and cream), but yields are significantly higher from whole milk. Homogenization greatly improves fat recovery but increases drainage time and produces pasty cheese with poor sliceability. With respect to cheese texture, the optimum ratio of protein/fat in the cheese milk is about 1.2. This implies, for example that milk of 3.5% fat should be standardized with skim milk powder to a protein content of 4.2%. It is desirable to standardize with

skim milk solids rather than by removing cream because the percent recovery of solids increases with the level of solids not fat in the cheese milk. The practical limit of solids not fat, with respect to texture, is 15%. At higher levels of milk solids the resulting cheese is too crumbly. Higher levels of milk solids may be used to obtain greater yields if the cheese is to be used as an ingredient. Queso Blanco can also be made from goat's milk.

After standardization the cheese milk is heated before acidification to pH 5.3. The optimum heat treatment for Queso Blanco manufacture is 85°C for 5 min. Experiments with greater temperatures and holding times indicated no significant increases in yield. Heating at 95°C produced cheese with a noticeable cooked flavor. Heat treatment denatures the whey proteins and promotes their association with themselves and with caseins (mainly κ-casein). Upon acidification the denatured whey proteins co-precipitate with the caseins. This co-precipitation is the chief advantage of Queso Blanco cheese over natural cheese because the whey proteins, which represent 20% of the milk proteins are not recovered by rennet coagulation. The precipitate probably includes flocculated proteins (i.e., loosely bound reversible association products) and aggregates (i.e., irreversible interaction products). There is some reason to suggest that the latter irreversible association of whey proteins with κ-casein accounts for the poor meltability of Queso Blanco (Hill, 1986). It may be possible to improve the meltability of Queso Blanco by modifying the ionic and pH conditions during heat treatment to encourage the whey proteins to flocculate rather than aggregate. This concept is the subject of a current research project in our department. Irreversible association of whey proteins with κ-casein also accounts for the insensitivity of heated milk to rennet coagulation.

After heat treatment the milk is coagulated with a mixture of citric acid and calcium chloride (about 0.34 and 0.025%, respectively, for milk of average composition). Calcium chloride is an optional additive which is included because it slightly improves the recovery of solids. Other acids including acetic, lactic, tartaric or HCl were studied by Chandan et. al. (1979) who recommended the use of citric acid. The optimum pH of Queso Blanco cheese is about 5.3 and the amount to citric acid required to produce cheese of pH 5.3 is related to the solids not fat and to the protein content of the milk. The exact amount can be calculated from the equation given in Appendix 1. The acid must be diluted and added slowly to obtain optimum drainage and cheese texture. Rapid acidification produces small curd particles with little elasticity which are difficult to separate from the whey. The curd and whey are held at T>80°C during and for an additional 10 minutes after acidification to allow the curd to settle and become firm. The whey is then drained off by conventional means. When drainage is complete the curd is hooped, pressed for 60 min. and cooled overnight before vacuum packing. Providing adequate drainage is achieved in the vat, pressing is required only to form the blocks. It would, therefore, be feasible to use a hot packaging system to pack the cheese directly from the vat and produce Queso Blanco with an extended shelf life. It is also possible to heat treat Queso Blanco in boilable pouches. It must be emphasized that Queso Blanco is an uncultured dairy product and any microbial contamination will limit its shelf life. Lactic acid bacteria grow readily because of residual lactose.

The make procedure described in Appendix 1 has been adapted to continuous manufacture of Queso Blanco using the equipment described by Modler (1984) (Figure 1), which was originally designed for continuous manufacture of ricotta cheese. The system has potential for Queso Blanco manufacture but several logistical problems relating to temperature control, holding times and rate of acidification must be solved to produce consistently firm and sliceable cheese. Modler (1984) also reported the manufacture of Queso Blanco with this equipment but did not discuss the texture of the product.

The composition of Queso Blanco produced by the method in Appendix 1 is about 52, 18, 22, and 3% of moisture, fat, protein and lactose, respectively. Considering its fat content (37% dry basis, 18% wet basis) Queso Blanco might be described as low fat. Percent recoveries of total solids, protein and fat from milks of 3.5-4.0% fat (standardized to protein/fat = 1.2) are 50-55%, 85-90% and 80-90%, respectively. Total yield is in the range of 15-16% of milk weight. Fat recoveries in excess of 95% can be achieved from homogenized milk.

Properties and End Use

Queso Blanco is white, firm and bland to slightly acid in flavor. It has good slicing properties with body and texture resembling that of young high moisture Cheddar. Firm body and sliceability are possible in spite of high moisture content because of the high water holding capacity of heat precipitated milk proteins. Probably the most unique property of Queso Blanco is its resistance to melting.

Queso Blanco has potential in North America as a table cheese. A consumer acceptance panel conducted by our department indicated that 70% of the panelists liked plain Queso Blanco. The bland flavor of Queso Blanco also makes it compatible with many condiments. Several other uses for Queso Blanco have been suggested by Chandan and Marin (1978). In our laboratory we produced tasty, golden cheese chips by deep frying slices of Queso Blanco. Queso Blanco readily browns with heat treatment because it contains lactose.

Probably the greatest domestic potential for Queso Blanco cheese is in the manufacture of process cheese and process cheese spreads. It is generally considered that formation and texture of the processed cheese emulsion is dependent on the melting properties of the cheese ingredients employed. However, it spite of its poor meltability, Queso Blanco can be used to produce process cheese with excellent appearance, mouth feel and texture. The only restriction is that homogenization is required to obtain a smooth product. Scanning electron microscopy has confirmed that processed Queso Blanco is similar in ultrastructure to processed Cheddar. It is also possible to extend Queso Blanco with the use of heat precipitated whey proteins in process cheese and cheese spreads.

In addition to domestic utilization, Queso Blanco has potential as an export and foreign aid commodity. For example our department has had correspondence with business interests in Egypt regarding the possible import of Canadian made Queso Blanco. This potential is enhanced by manufacture of Queso Blanco from reconstituted milk. We are currently investigating the feasibility of combining vegetable oils with reconstituted skim milk for Queso Blanco manufacture to further increase its export and foreign aid potential. With

respect to foreign aid, Queso Blanco represents a convenient vehicle to distribute skim milk protein while avoiding the problems of lactose intolerance.

Conclusions

1. Queso Blanco manufacture achieves higher yield and protein recovery than is possible with rennet coagulation.

2. Queso Blanco manufacture is extremely efficient with respect to utilization of labor and equipment because of its high yields per vat and rapid make procedure (about 2h from raw milk to finished cheese).

3. Domestic market potential for Queso Blanco is probably hindered by its poor melting properties. However, melting resistance and the ability to brown with heat offer some unique applications such as deep fried snacks.

4. Queso Blanco represents an economical substitute for natural cheese in the manufacturing of high quality process cheese and process cheese spreads.

5. Queso Blanco and processed Queso Blanco have potential as export and foreign aid commodities.

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Appendix 1. Queso Blanco Manufacture

1. Prepare coagulant solution containing citric acid monohydrate ($HCit.H_2O$) and calcium chloride dihydrate ($CaCl_2.2H_2O$). Weigh $HCit.H_2O$ and dilute to 1.5% with water. Weigh $CaCl_2.2H_2O$ and add to solution of $HCit.H_2O$.

$$\text{Weight } HCit.H_2) = \frac{0.09124 + 0.07075\ (\%\ \text{milk protein}) \times \text{milk weight}}{100}$$

$$\text{Weight } CaCl_2.2H_2O = \frac{\text{Weight } HCit.\ H_2O}{13}$$

2. Weight required salt.

$$\text{Weight salt} = \frac{\%\ \text{milk protein} \times \text{milk weight}}{1{,}000}$$

3. Standardize milk to a P/F of 1.2 using skim milk powder.

4. Heat standardized milk to 85°C and hold for 5 minutes.

5. Slowly pump coagulant solution into vat and agitate slowly. Turn on steam to maintain a high temperature. Hold for 10-15 minutes to allow curd to settle.

6. Open gate and drain whey.

7. Trench and stir curd to allow maximum drainage.

8. Salt curd directly in the vat and mix thoroughly for uniform distribution.

9. Hoop while still hot.

10. Press for 1-2 hours at 20-25 psi pressure.

11. Chill hoops overnight.

12. Vacuum package.

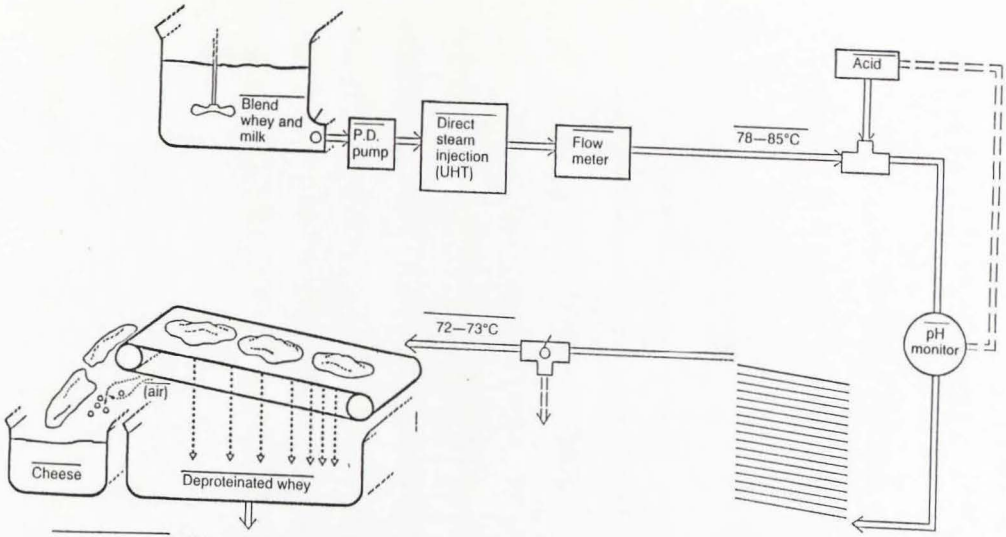

FIGURE 1 CONTINUOUS PROCESS FOR THE PRODUCTION OF RICOTTA AND QUESO BLANCO

(Diagram courtesy of W. Modler, Food Research Institute, Agriculture Canada, Ottawa.)

The following paper was presented by Randall K. Thunell, Ph.D., Culture Development, Marschall Products, Miles Laboratories, Inc., P.O. Box 3490, Logan, Utah 84321, at the 23rd Annual Marschall Invitational Italian Cheese Seminar, held in the FORUM Building of the Dane County Exposition Center, Madison, Wisconsin on September 16, 17, and 18, 1986.

D.S.S. CULTURES AND THERMOLAC MEDIA: APPLICATIONS IN ITALIAN CHEESE MANUFACTURE

By Randall K. Thunell, Ph.D.

The use of Defined-Strain Starter (DSS) cultures in Italian Cheese manufacture is described. Strains can be selected for desirable or unique characteristics. Accurate phage monitoring for each component strain of a multiple blend is possible. The DSS approach eliminates rotations, gives more starter consistency, and exhibits more activity when coupled with Thermolac media and pH-control. DSS cultures grown in Thermolac medium, under pH control, can provide an economical Italian cheese starter system.

The concept of using Defined Strain Starters (DSS) is not a new one. The Cheddar cheese and casein industries have employed single-strain technologies for years. In fact their beginnings go all the way back to 1934 with Dr. Hugh Whitehead, and the New Zealand Dairy Research Institute. Over the ensuing 52 years, much research has been published on mesophilic strain characteristics, and the past seven years have seen the successful application of defined-strain technology Cheddar cheese making in the U.S. (1,2).

But what are defined-strain starters? A defined-strain is a single-strain isolate which has had some of it's various properties characterized. Table 1 lists several rod-coccus strain-properties which can be characterizes. These are not ranked as to order of importance.

Table 1. Some Characterization Traits for Defined-Strain Starters

1. Acid production
2. Phage sensitivity
3. Compatibility
4. Flavor/off-flavors
5. Salt tolerance
6. Proteolysis
7. Freeze-thaw stability
8. Phosphate tolerance
9. Bacteriocin production
10. Type of lactic acid
11. Media preferences
12. Plasmid stability
13. Optimal growth conditions
14. Sugar fermentation profile

The use of defined-strain rod-coccus cultures is novel to the Italian cheese industry. This may be partly due to lower phage occurrence in thermophilic starters, as opposed to mesophilic cultures. In the past, culture rotations have quite successfully side-stepped phage disturbances in rod-coccus cultures. The Italian cheese and yogurt industries, however, are now experiencing explosive growth, which in turn puts increased phage-pressure on starter systems, and requires greater starter reliability and consistency, than ever

before. Rotations may not always be able to withstand this pressure, and still provide consistency. Furthermore, as the number of cultures used in rotation increases, the chances for phage-relationships between cultures also increases.

Figure 1. shows a typical defined-strain starter system. Note that the multiple-strain blend is made up of four strains; two cocci and two rods. The first time these four individual strains are grown together is in the bulk starter tank. Each is added to the bulk tank as a characterized single strain. While this practice might seem peculiar, there is method to this madness, as I'll shortly explain. The multiple-strain blend can be used without rotation, on a continual day-to-day basis, thus giving rise to greater starter consistency. If a component-strain is eventually attacked by phage, the infected strain can be replaced without changing the entire strain blend. This again helps maintain starter consistency.

The individual rod and coccus strains are selected for use by challenging a bank of single, characterized, rods and cocci with whey samples from your plant, which would contain any phages presently active in your plant. Two cocci and two rods are then selected from those strains which are insensitive to phages in your plant.

Even though the incidence of phage infection is lower in rod/coccus cultures, as compared to Cheddar cheese cultures, phages do appear for individual rods and cocci. Of these, the cocci are more widely affected by phage than the rods. Phage testing a mixed-strain (rod/coccus) culture is difficult at best, and only very general observations can be drawn. Defined-strains, on the other hand, allow each component of the culture-blend to be tested for phage, and phage-infection, where present, can be quantified for the individual strain(s) being affected.

Figure 2 describes a simple Phage Inhibition Test which can be run daily in-plant to monitor the individual component-strains of a multiple-blend for phage. We also request that whey samples be sent to us on a regular basis for phage monitoring.

Figure 3 shows a typical external pH-control system. As described in an earlier paper on external pH control, growth parameters can be manipulated to give different rod/coccus ratios.

The concept of growing defined-strain rods and cocci under pH-control was implemented over 2.5 years ago, and has found application in both Swiss and Mozzarella cheese production. In addition to growing rods and cocci together for bulk starter, under pH control, individual tanks of DSS rods and cocci have also been grown. Rod and cocci were then mixed in exact ratios as the cheese milk was inoculated. Up to this point, defined-strain starters have had only limited use in direct-to-vat set of yogurt. If linked with pH-control, yogurt bulk starter may be produced which can drastically reduce incubation periods.

I would venture that the next 2-3 years will bring dramatic changes to Italian cheese starter-systems. Because of their greater consistency and activity, phage-monitoring capabilities, and economics, defined-strain starters linked to

pH-control could become the industry-standard of tomorrow, much the same as they have for the cheddar cheese industry today.

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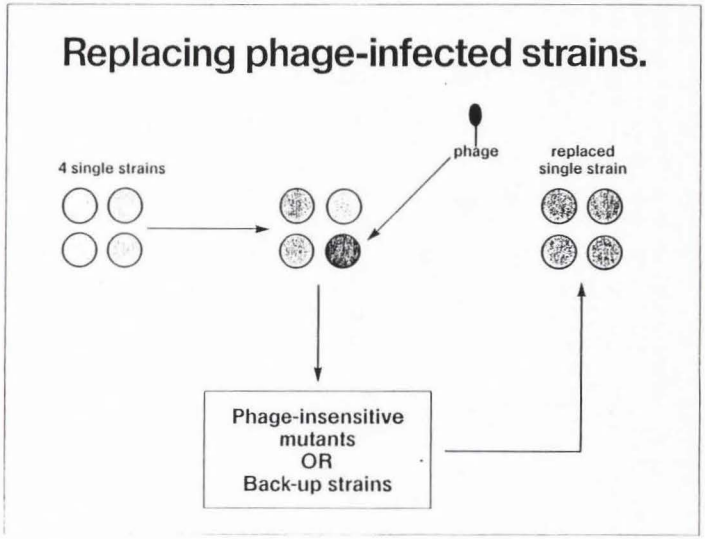
Figure 1.


Replacing phage-infected strains.
4 single strains
phage
replaced
single strain
Phage-insensitive
mutants
OR
Back-up strains

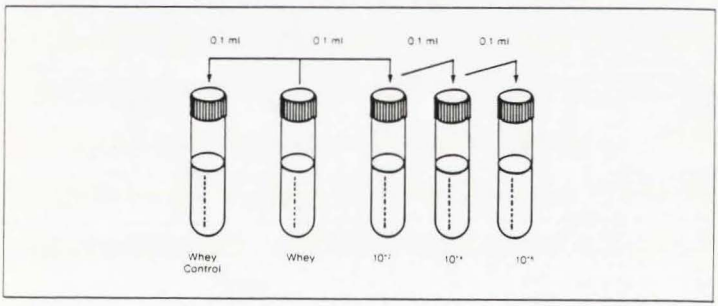
Bromcresol Purple (BCP)-

Phage Inhibition Test

Materials Needed:

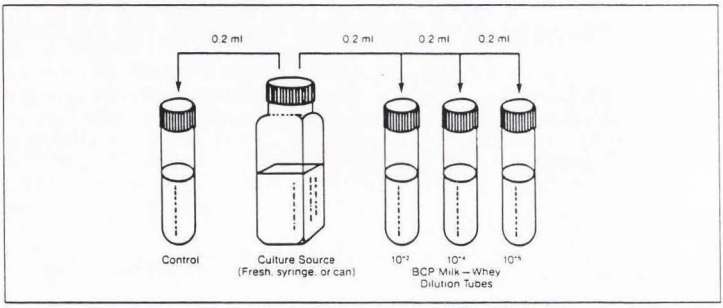
BCP stock solution (1 g/100 ml water)
Test tubes containing 9.9 ml sterile BCP-milk (5 ml BCP stock soln./liter milk)
40–42 C water bath or heating block
1 ml graduated pipettes
Membrane filters (0.45 u)—optional
Disposable syringe—optional
Clinical centrifuge—optional
Whey sample for phage testing
Freshly grown culture, frozen syringe, or frozen can of each strain

Step 1. Add Whey to BCP Milk and Make Dilutions



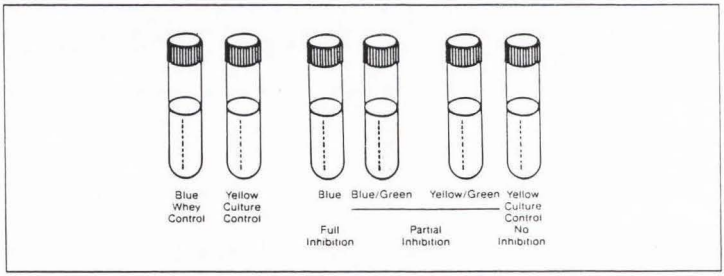
Transfer 0.1 ml of fresh (or filter-sterilized) whey to the first dilution tube (10^{-2}) and mix well. Transfer 0.1 ml from the first to the second dilution tube and mix well. Repeat process for the third dilution tube. (If unfiltered whey is used, a control tube containing BCP milk and whey only, must be prepared. This control tube tests for the presence of active culture in the whey that could mask phage inhibition of a strain.) Whey samples should be refrigerated immediately after collection and held cold until tested for phage.

Step 2. Add Culture to Control and Whey Dilution Tubes



Culture (0.2 ml) is added to whey dilution tubes and to a control tube for each strain. Dilute culture from can 1 ml:9 ml milk before adding 0.2 ml to dilution tubes. The control tube contains only BCP milk and culture. NO whey. The control tube serves to show starter strain inhibition by color comparison with the other tubes.

Step 3. Incubate Tubes and Interpret Results

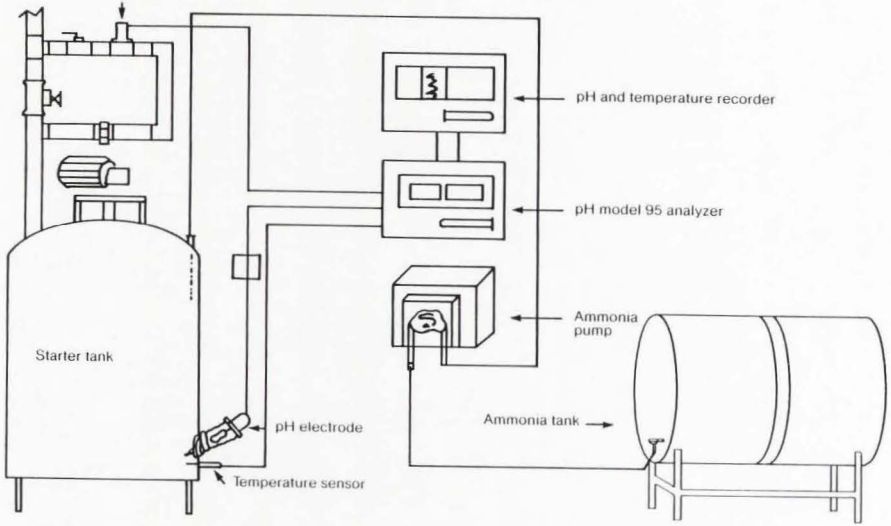


Incubate both control and dilution tubes for 6 hours at **40–42** C. Compare the color of the whey dilution tubes to that of the control tube. Ignore coagulation. An uninhibited culture will produce sufficient acid to turn the BCP dye from blue to yellow. Strains should be removed from the culture blend when full inhibition persists at the 10^{-6} dilution level. The following system should be used to record phage inhibition:

0 = No inhibition at any dilution
1 = Partial inhibition at 10^{-2} dilution
2 = Full inhibition at 10^{-2} dilution
3 = Partial inhibition at 10^{-4}
4 = Full inhibition at 10^{-4} dilution
5 = Partial inhibition at 10^{-6} dilution
6 = Full inhibition at 10^{-6} dilution

Figure 3.

A schematic of pH and temperature control systems for a starter tank.



The following paper was presented by Paul S. Kindstedt, Assistant Professor, Department of Animal Sciences, University of Vermont, Burlington, Vermont 05405, at the 23rd Annual Marschall Invitational Italian Cheese Seminar, held in the FORUM Building of the Dane County Exposition Center, Madison, Wisconsin on September 16, 17, and 18, 1986.

AUTHENTIC DOMESTIC FRENCH CHEESEMAKING - AN EXPERIMENT

By Paul S. Kindstedt, Ph.D.

American companies are showing increasing interest in domestic production of European specialty cheeses. Successful entry into this market requires advanced planning and experimentation. A systematic strategy for developing "old world" cheesemaking expertise and adapting it to the legal and technical realities of American cheesemaking is presented. Recent experiences of a Vermont cheese company that used this strategy to develop an authentic domestic French cheese are discussed.

There is growing interest among American companies to produce what may be termed "authentic old world cheeses", cheeses which perhaps have been made in Europe for hundreds of years using centuries old techniques. The demand for these types of specialty cheeses in the United States has grown dramatically in recent years, creating strong incentive for American companies to tap into this European dominated market. The problem is — how does an American company, which typically thrives on mechanization and automation, acquire old world expertise and make the transition to old world cheesemaking? This paper examines one approach to that problem, an approach taken recently by the Guilford Cheese Company of Guilford, Vermont. This particular account involves authentic French cheesemaking; however, the principles developed below apply to any old world specialty cheese, including Italian varieties.

The Guilford Cheese Company is a small company in southern Vermont which manufactures Brie and Camembert cheeses. In fact, Guilford is one of a very few companies in the United States that produces these French cheeses, and they have gained an excellent reputation in the metropolitan northeast. Nevertheless, Guilford was not wholly satisfied with its cheeses. Their ultimate goal was to produce a truly authentic French cheese, one which would rival the best Brie and Camembert of France. How does a company go about achieving such a lofty objective? Guilford adopted a systematic approach which involved 4 distinct phases.

Phase 1. Acquire first-hand knowledge of authentic old world cheesemaking.

This is critical. Old world specialty cheeses often are extremely complex in character, having been refined through the centuries to their present form. An inexperienced company cannot expect success with such cheeses based on hunches and a few preliminary attempts at cheesemaking. There is no substitute for the experience that has been passed down from generation to generation.

Although acquiring first-hand knowledge presents a formidable challenge to American companies, the challenge is not insurmountable. Several options may be pursued. One option is to establish a business relationship with an experienced European company. This approach was taken by the Guilford Cheese Company. Guilford needed information, training and expertise to achieve their goal of authentic French cheesemaking. At the same time, Fromagerie Renard Gillard, a prestigious century-old French cheese company renowned for its long tradition of award-winning cheeses, was interested in establishing a manufacturing capability in the United States. Good fortune and the efforts of Bernard Horton, a dairy consultant and president of Horton International, Inc., brought these two companies together and they were able to reach an agreement that was mutually acceptable and beneficial.

Another option is to visit the country of origin of the particular cheese and observe old world cheesemakers in action. Small European cheesemakers often are very receptive to foreign visitors who have a genuine interest in cheesemaking. Recently, the owner of a small Pennsylvania cheese company conducted an extended tour of several farmstead cheese operations in Holland. He found the Dutch cheesemakers to be very open and willing to discuss and demonstrate the technical intricacies of producing authentic Gouda cheese. Still another option is to enlist the services of an experienced old world cheesemaker, either temporarily as a consultant or on a more permanent basis. However acquired, first-hand knowledge is priceless and a necessary first step to authentic old world cheesemaking.

Phase 2. Identify legal and technical barriers to domestic old world cheesemaking.

After a company has acquired first-hand knowledge, it should next examine the cheesemaking procedure very carefully. Old world practices were not designed with U.S. regulations and the Food and Drug Administration in mind. Practices which are technically impossible or legally unacceptable in the United States are not uncommon to old world cheesemaking. Such barriers to authentic domestic French cheesemaking were identified initially. The first barrier was the U.S. legal requirement for pasteurization of cheesemilk. The finest Brie and Camembert cheeses in France are made exclusively from raw milk. However, it is illegal in the United States to use raw milk for these cheeses. A second barrier, technical rather than legal in nature, was the milk supply. American dairy farms differ significantly from French farms in management practices. Therefore, there were serious questions as to whether American milk would give a cheese that was comparable in quality and character to an authentic French cheese. Thus, the crucial question facing the Guilford Cheese Company was whether it is possible to make an authentic quality French cheese from pasteurized American milk.

Phase 3. Modify the old world process to meet minimum U.S. requirements and conduct pilot scale cheesemaking.

The objective of this phase is to determine whether authentic quality old world cheese is attainable when manufacturing is modified to satisfy U.S. regulations and conditions. Except for essential modifications, pilot scale cheesemaking should be conducted exactly according to old world practices. For the Guilford

Cheese Company, this meant making cheese from pasteurized American milk using the exact cheesemaking procedure of Fromagerie Renard Gillard. To accomplish this, the following pilot scale experiment was decided upon. A Master and an assistant cheesemaker from Fromagerie Renard Gillard would conduct cheesemaking trials in Vermont. All cheesemaking equipment and materials, including vats, utensils, cheese hoops, cultures and mold spores, would be imported from France. Approximately 700 lbs. of Grande Brie, Petite Brie, Camembert and Coulommiers cheeses would be manufactured over a 5 day period. Ideally, the only difference between experimental cheeses and those made in France would be 1.) the American milk supply and 2.) pasteurization.

An experiment of this scale and complexity proved to be too demanding for the 2 companies to conduct on their own. For this reason, they enlisted the services of the Dairy Products Center at the University of Vermont. A fundamental mission of the Vermont Dairy Products Center is to assist dairy companies in research and development projects that might otherwise be impossible or impractical. The Center provided the infrastructure of equipment, facilities and technical support that permitted the experiment to be conducted, and conducted under controlled conditions which were necessary for meaningful results.

The experiment took place in March of 1986. Cheeses were manufactured in 100 liter vats using a combination lactic acid bacteria -- Geotrichum yeast starter culture. Brevibacterium linens also was included as starter in some vats. Manufacturing was carried out using a fascinating sequence of traditional centuries-old techniques. All cheeses developed a snowy white coat of Penicillium caseicolum mold during ripening. The experiment was declared a qualified success. Although none of the cheeses were perfect, experts from Fromagerie Renard Gillard concluded that, with additional fine tuning, an excellent domestic French cheese, one which is superior to domestic and imported French cheeses presently available in the United States, could indeed be manufactured from pasteurized American milk. As a result, business negotiations between Guilford and Fromagerie Renard Gillard are underway, and construction of new plant facilities in Vermont has begun.

Soon after the experiment was completed, several problems of a regulatory nature surfaced which have yet to be resolved. Even the best laid plans can run awry. For example, experimental cheesemilks were pasteurized at 167°F for 10 seconds, a time-temperature combination that is recognized legally in France and is considered by some to be better suited for French cheesemaking than the American standard of 161°F for 15 seconds. Much to the dismay of the Guilford Cheese Company and Fromagerie Renard Gillard, State regulatory authorities and the Food and Drug Administration have failed to recognize the French standard as an acceptable pasteurization process with little hope of success. The alternative is to pasteurize at 161°F for 15 seconds, the effect of which on cheese quality remains to be seen. This is a good example of the type of legal snare that a company can easily fall into when attempting to adapt old world cheesemaking to the restrictive environment of the new world. As mentioned earlier, it is essential to identify legal barriers early on (i.e during Phase 2).

Phase 4. Systematically modernized the cheesemaking process, if possible. Most companies cannot afford to be satisfied with successful completion of Phase 3. Old world cheesemaking typically is very labor intensive and involves practices which simply do not conform to the economic realities of cheesemaking in America. Thus, further modifications of the old world process may be necessary if the venture is to be economically viable. Unfortunately, with each additional modification comes a tradeoff in cheese quality. Old world cheesemaking practices are the endproduct of centuries of evolution and refinement. What is done is usually done for good reason, and the distinctive character of old world cheeses is soon lost when the idiosyncrasies of traditional cheesemaking are replaced with more efficient and standardized techniques. If changes are necessary, they should be attempted cautiously and systematically, one at a time.

Conclusion

Old world cheesemaking is no easy task and should not be entered into haphazardly. The approach outlined above provides a useful strategy for companies that are truly serious about producing an authentic old world cheese, as opposed to an uninspiring imitation. Of course, it may not be possible to duplicate exactly the complex character of an old world cheese here in American, given the many legal and technical barriers. It may be possible to come close, though, as the Guilford Cheese Company discovered.

The following paper was presented by Dr. David M. Barbano, Associate Professor of Food Science, Cornell University, Ithaca, New York 14853, U.S.A., especially for the 23rd Annual Marschall Invitational Italian Cheese Seminar, held in the Forum Building of the Dane County Exposition Center, Madison, Wisconsin, on September 16, 17 and 18, 1986.

IMPACT OF SEASONAL VARIATION IN MILK COMPOSITION ON MOZZARELLA CHEESE YIELDS AND COMPOSITION

By David M. Barbano, Ph.D.

Seasonal variation in milk composition causes variation in yield and fat on a dry basis of all cheeses. Milk is standardized prior to cheesemaking for part skim Mozzarella and many specialty cheeses. In most cases the cheesemaker standardizes the milk for cheesemaking to a constant fat level all year long. Examples, based on average milk composition in the U.S., are given to illustrate the impact of this common milk standardization practice on seasonal variation in cheese FDB and total dollar value returned to the cheesemaker per hundred weight of milk purchased. Given the assumptions stated in the paper, a low moisture part skim Mozzarella cheese plant currently standardizing to a constant milk fat percentage (500,000 pounds of milk per day — 20 days per month) could increase its total returns on milk purchased by approximately $154,000 per year by standardizing to a constant protein (or casein) to fat ratio.

Bulk milk composition varies seasonally and regionally in the U.S. The milk components that have the greatest impact on cheese yield and cheese composition are milk fat and protein. The objectives of this discussion are: 1) to discuss the seasonal and regional variation in milk composition and its impact on low moisture part skim Mozzarella cheese yield and cheese composition, and 2) to illustrate the economic value of proper control of milk standardization to compensate for these seasonal variations in milk composition during low moisture part skim Mozzarella cheese manufacture.

The average seasonal variations in milk fat and protein in the United States are shown in Figure 1. The average high/low seasonal variation in milk fat is approximately 0.5% and milk protein is approximately 0.2%. Variation in milk composition will cause variation in both cheese yield and cheese composition. There are differences in milk composition from one region of the country to another and these differences are shown in Table 1. Using theoretical cheese yield formula (Figure 2) for Mozzarella cheese (1), potential cheese yields and differences in cheese yield can be determined for different regions of the country. Potential low moisture part skim Mozzarella cheese yields can be calculated at different moisture and fat levels. For the purpose of discussion in this paper we will select two different low moisture part skim Mozzarella cheese compositions. A 51% moisture and approximately 37% fat on a dry basis (FDB) would be made by standardizing milk to approximately 2% fat and a low moisture part skim Mozzarella with 47% moisture and approximately 43% FDB would be made by standardizing milk to approximately 2.7% fat.

It is common practice in many Mozzarella cheese factories to standardize (using a cream separator) to a specific percent fat in the milk for cheese manufacture without any compensation for the variation in protein in the standardized milk. Using this approach to process control (i.e. standardization to a specific fat level) the theoretical cheese yields in each region of the country for each type of low moisture part skim Mozzarella cheese are shown in Tables 2 and 3. The region differences in cheese yield shown in these tables are due to variation in milk protein. The very significant seasonal variations in yield potential in both products are caused by the seasonal variation in milk protein. Typically the cheese yields are low in the summer months and high in the winter months in all regions of the country.

However, in addition to these changes, there are significant changes in cheese composition that occur at the same time. If a plant standardizes to a constant target percent fat in the standardized milk, then the FDB in the cheese will vary seasonally. The expected seasonal variation in FDB under these conditions is given for both cheese compositions in Tables 4 and 5. Seasonal variation in cheese yield shows the normal pattern of high yields in the fall and winter months and low yields in spring and summer (Figure 3). Seasonal variation in cheese FDB shows a pattern opposite that of cheese yield with high FDB's in the summer and low FDB's in the winter when milk for cheesemaking is standardized to a constant fat level (Figure 4). Variation in FDB will result in differences in textural properties of the cheese. On average a cheese plant standardizing to a constant milk fat level will experience about a 2% range from high to low in FDB on a yearly basis in both types of low moisture part skim Mozzarella cheese used in these illustrations.

Let us assume that this is the case in your cheese plant. In addition, let us assume that your current customers are happy with your cheese throughout the year. Therefore, from the customer's point of view the product is acceptable at the maximum FDB in the summer, say the 37.0% for the example where we standardized the milk to 2.0% fat. What if we did a better job of standardizing the milk to a constant protein (or casein) to fat level to maintain a 37% FDB all year long instead of allowing the FDB to vary seasonally? What would be the economic value of doing this type of standardization?

The data in Table 6 illustrates this example with the average milk composition for a U.S. cheese plant and shows the total value of cheese plus fresh and whey cream per hundred weight of whole milk purchased, if we standardize the milk to a constant 2.0% fat all year long (columns at the left in Table 6) versus standardizing to a constant protein (or casein) to fat ratio all year long (columns at the right in Table 6). The data in Table 7 utilizes the yield and FDB information shown in Table 6 and assumes a cheese price of $1.30 per pound and a fresh and whey cream value of $1.70 per pound of fat. If we assume that this cheese plant with average milk composition operated 20 days each month and utilized 500,000 lbs of milk per day, then the gross increase in total revenue to the plant would be $154,000 per year. Increased revenues would be proportionately higher as the plant capacity increases. It can be seen clearly from Table 7 that the value of standardizing to a constant ratio of protein (casein) to fat ratio is greater in the winter months than summer.

Many times of the year the cheese prices and cream prices vary. At times when the value of cream increases and the value of cheese remains the same, it is tempting to reduce the FDB in your cheese to sell more cream at the higher price. The factor many cheesemakers do not properly evaluate in this situation is the decreased cheese yield resulting from the lower FDB in the product and the amount of milk protein (casein) that is sold with the serum phase of the fresh cream. In the example given above with a cheese price of $1.30 per pound, the cream price would have to rise above $2.40 per pound of fat for it to be more profitable to sell the fat as cream instead of cheese.

What are the added cost necessary to accomplish this standardization? First since the plant is already standardizing the fat content of the milk for cheesemaking by separation, there are little if any additional processing equipment costs. In addition, the cheese plant should already have the laboratory facility to test for fat content of the standardized milk. The third part of the system would be testing for protein (or casein). If a plant has no protein testing equipment, this will be an added cost. However, even the most expensive protein testing equipment does not cost half of $154,000 and will last many years. Another cost will be the labor to conduct the protein testing and possibly the improved plant management skills needed to communicate the information to the production area so that changes in the fat milk level can be made during the standardization process to compensate for changes in milk protein levels.

How do you set up a program in your plant to do this standardization to a ratio of protein to fat instead of constant fat percentage? First there are no magic numbers that will tell you that a specific protein (or casein) to fat ratio will give you a specific FDB for your particular product. The ratio to give the same cheese FDB in two different plants may be different. The primary reason for the difference in ratio required from plant-to-plant will be due to the differences in percent fat retention in the cheese caused by differences in processing mechanics and skill of the cheesemakers. However, in any given plant, a protein to fat ratio can be determined by experience through documentation of the relationship between protein (or casein) to fat ratio and FDB under the processing conditions in that plant.

In summary, the concept of protein (or casein) to fat ratio standardization of milk applies to all cheeses for maximization of total dollars returned per hundred weight of milk purchased. One of the most difficult tasks for plant management personnel is to present a proper economic justification for capital expenditure or increased labor cost when they want to introduce a new process or procedure. The same types of examples presented in this paper can be calculated for any type of cheese. This can be done by hand or with the aid of computer software(2).

References

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2. Kerrigan, G.L. 1985. Milk Resource Allocation Decision Support System. Available from the Walter V. Price Cheese Research Institute, 1605 Linden Drive, Madison, WI.

FIGURE 1. U.S. MILK COMPOSITION

AVERAGED ACROSS ALL REGIONS

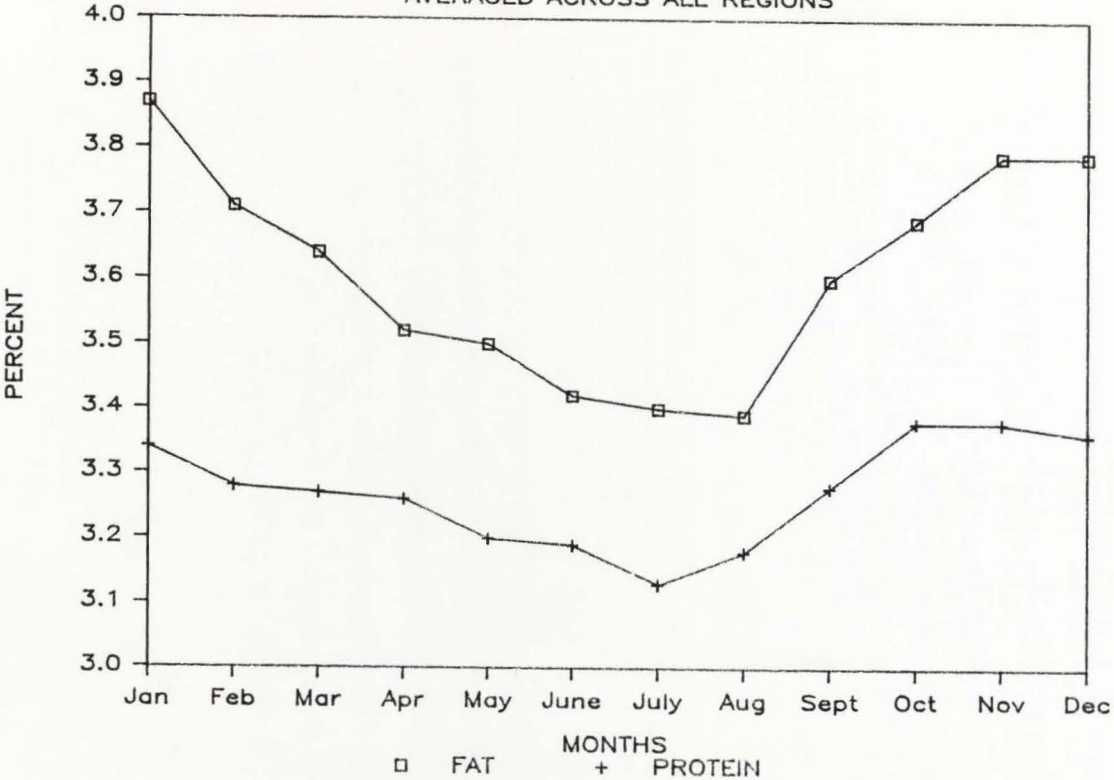

Figure 2. Theoretical Yield Equations for Low Moisture Part Skim Mozzarella Cheese.

The following theoretical cheese yield equations can be used for calculation of low moisture part skim Mozzarella cheese yield. The general equation is as follows:

$$\text{YIELD} = \frac{[.85\ (\%\ \text{Fat in milk}) + (.78\ \text{Protein} - 0.1)]\ 1.13}{[1 - (\%\ \text{moisture in cheese}/100)]}$$

Another version of the same formula uses a casein value instead of a protein value. Use of a casein value should be more accurate, but most labs do not test for protein so they find it more convenient to use the .78 times protein as an estimate of casein.

$$\text{YIELD} = \frac{[.85\ (\%\ \text{Fat in milk}) + (\text{Casein} - 0.1)]\ 1.13}{[1 - (\%\ \text{moisture in cheese}/100)]}$$

The percent fat recovery in the cheese is assumed to be 85%. This may vary from one plant to another. The actual percent fat and percent protein in the standardized milk for cheesemaking and the target final moisture content of the cheese are inserted in the formula to calculate the yield potential of a milk.

To arrive at the yield values displayed in Tables 2 and 3, fat and moisture values were substituted into the general formula as shown below. Casein values used in the calculations were based on the individual average monthly casein tests observed in the full year study (1984) of milk composition at 50 cheese plants in the U.S.

Standardize milk to 2.0% fat and have a final cheese moisture of 51%

$$\text{YIELD} = \frac{[.85\ (2.0) + (\text{Casein} - 0.1)]\ 1.13}{[1 - (51.00/100)]}$$

Standardize milk to 2.7% fat and have a final cheese moisture of 47%.

$$\text{YIELD} = \frac{[.85\ (2.7) + \text{Casein} - 0.1)]\ 1.13}{[1 - (47.00/100)]}$$

FIGURE 3. CHEESE YIELD MOZZARELLA

AVERAGED ACROSS ALL REGIONS

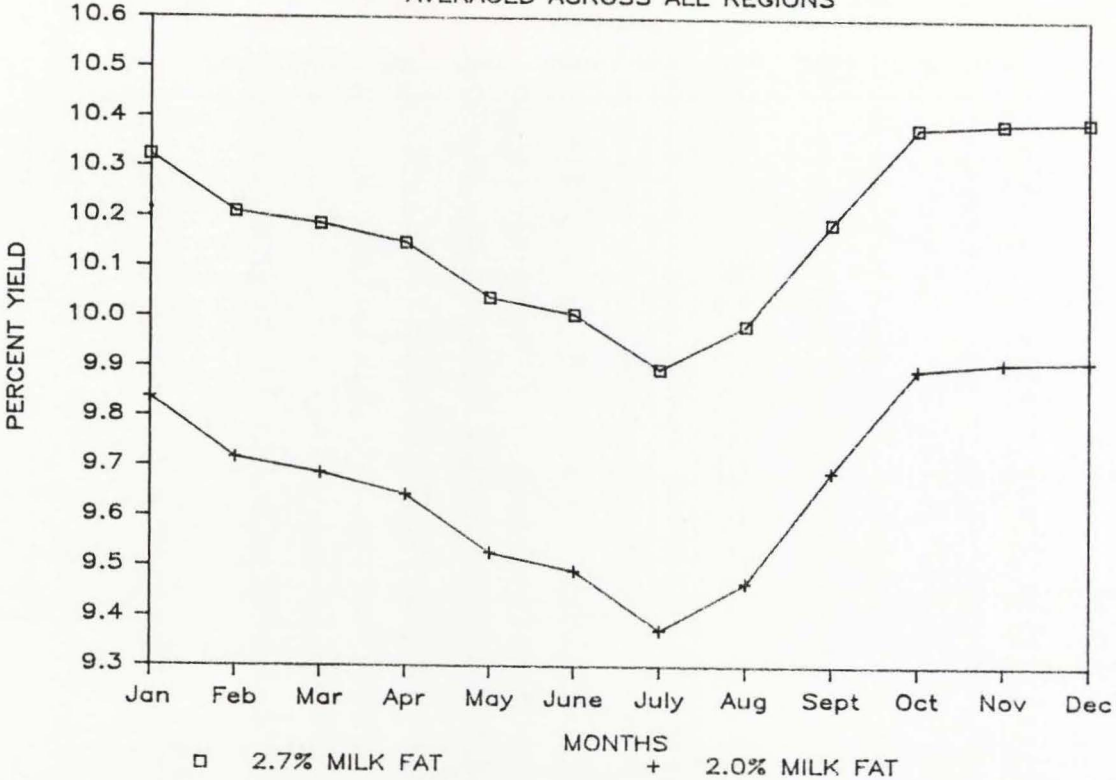

FIGURE 4. CHEESE FAT ON A DRY BASIS

AVERAGED ACROSS ALL REGIONS

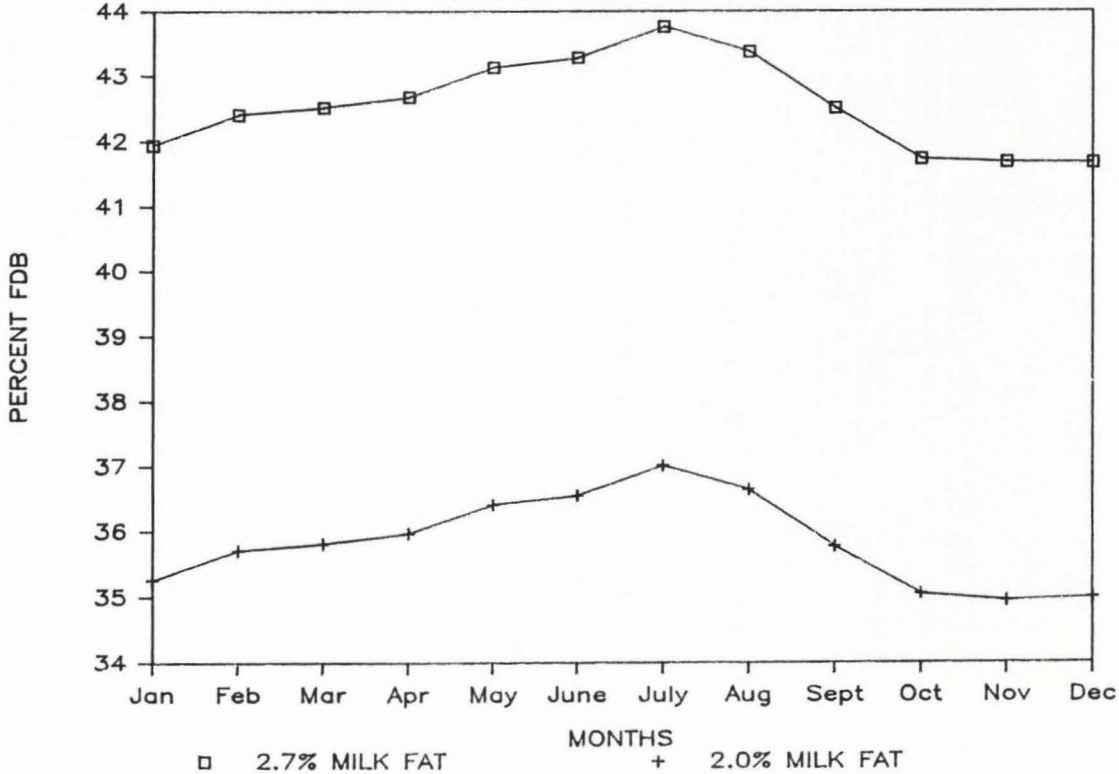

Table 1. Average Milk Fat and Protein in Ten Different Regions of the U.S. in 1984.

Region	Identification	Yearly Average Percent Fat	Protein
1	Deep South	3.39	3.26
2	Western States	3.71	3.33
3	NB, IA, KS, MO	3.6	3.31
4	ND, SD, Western MN	3.57	3.26
5	Eastern MN	3.68	3.29
6	South WI, IL, OH	3.63	3.25
7	Northeast WI	3.68	3.27
8	Northwest WI	3.72	3.29
9	South NY, PA, VA	3.56	3.22
10	North NY, New England	3.57	3.21
Simple Average All Regions		3.61	3.27

Data from the calendar year 1984 (Barbano & Olson)

Table 2. Theoretical Mozzarella Cheese Yield (lbs/cwt) - Moisture 51%; FDB 34 to 37%
2.0% Milk Fat in Standardized Milk

Region	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Average
1	9.78	9.74	9.60	9.57	9.39	9.35	9.24	9.42	9.57	9.76	9.82	9.81	9.59
2	9.92	9.97	9.76	9.73	9.62	9.59	9.52	9.60	9.78	10.08	10.05	10.05	9.81
3	10.04	9.76	9.81	9.72	9.55	9.42	9.33	9.51	9.71	9.92	10.03	10.04	9.74
4	9.79	9.62	9.66	9.57	9.49	9.44	9.39	9.46	9.76	9.87	9.97	9.95	9.66
5	9.85	9.75	9.74	9.66	9.57	9.51	9.42	9.49	9.80	9.98	10.00	10.01	9.73
6	9.77	9.66	9.68	9.60	9.51	9.48	9.28	9.43	9.72	9.93	9.86	9.93	9.65
7	9.87	9.78	9.71	9.63	9.58	9.61	9.44	9.52	9.72	9.94	9.90	9.93	9.72
8	9.91	9.76	9.70	9.77	9.61	9.66	9.47	9.55	9.77	10.01	9.94	9.93	9.76
9	9.71	9.53	9.64	9.64	9.48	9.39	9.31	9.35	9.53	9.74	9.82	9.81	9.58
10	9.75	9.59	9.56	9.55	9.47	9.46	9.33	9.35	9.55	9.74	9.72	9.69	9.56
Average	9.84	9.72	9.69	9.64	9.53	9.49	9.37	9.47	9.69	9.90	9.91	9.92	9.68
Minimum	9.71	9.53	9.56	9.55	9.39	9.35	9.24	9.35	9.53	9.74	9.72	9.69	9.56
Maximum	10.04	9.97	9.81	9.77	9.62	9.66	9.52	9.60	9.80	10.08	10.05	10.05	9.81

Based on actual milk fat and casein data from the year 1984 (Barbano & Olson)

Table 3. Theoretical Mozzarella Cheese Yield (lbs/cwt) - Moisture 47%; FDB 41 to 45%
2.7% Milk Fat in Standardized Milk

Region	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Average
1	10.27	10.23	10.11	10.08	9.91	9.88	9.77	9.94	10.07	10.25	10.30	10.30	10.09
2	10.40	10.45	10.25	10.22	10.12	10.09	10.03	10.11	10.27	10.55	10.52	10.51	10.29
3	10.51	10.25	10.30	10.22	10.06	9.94	9.85	10.02	10.21	10.40	10.50	10.51	10.23
4	10.28	10.12	10.16	10.08	10.01	9.96	9.92	9.97	10.25	10.36	10.44	10.43	10.17
5	10.33	10.24	10.24	10.16	10.08	10.03	9.94	10.01	10.29	10.46	10.47	10.48	10.23
6	10.26	10.16	10.18	10.11	10.03	10.00	9.82	9.95	10.22	10.41	10.34	10.41	10.16
7	10.35	10.27	10.21	10.14	10.09	10.11	9.96	10.03	10.22	10.42	10.38	10.41	10.22
8	10.39	10.25	10.20	10.27	10.11	10.16	9.99	10.06	10.26	10.48	10.42	10.41	10.25
9	10.21	10.04	10.14	10.14	10.00	9.92	9.84	9.88	10.04	10.23	10.31	10.30	10.09
10	10.24	10.09	10.07	10.06	9.98	9.97	9.85	9.88	10.06	10.24	10.22	10.18	10.07
Average	10.32	10.21	10.19	10.15	10.04	10.01	9.90	9.99	10.19	10.38	10.39	10.39	10.18
Minimum	10.21	10.04	10.07	10.06	9.91	9.88	9.77	9.88	10.04	10.23	10.22	10.18	10.07
Maximum	10.51	10.45	10.30	10.27	10.12	10.16	10.03	10.11	10.29	10.55	10.52	10.51	10.29

Based on actual milk fat and casein data from the year 1984 (Barbano & Olson)

Table 4. Expected Variation in Percent Fat on a Dry Basis (moisture 51%)
Standardizing to a Constant 2.0% Milk Fat for Cheesemaking

Region	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Average
1	35.49	35.62	36.12	36.27	36.95	37.10	37.55	36.84	36.27	35.55	35.34	35.37	36.21
2	34.97	34.78	35.54	35.67	36.06	36.19	36.45	36.14	35.49	34.41	34.51	34.54	35.40
3	34.55	35.54	35.36	35.68	36.32	36.82	37.20	36.50	35.72	34.96	34.58	34.55	35.65
4	35.45	36.06	35.93	36.24	36.54	36.77	36.94	36.69	35.56	35.14	34.18	34.87	35.86
5	35.23	35.59	35.60	35.90	36.25	36.47	36.83	36.55	35.40	34.75	34.69	34.65	35.66
6	35.51	35.91	35.83	36.12	36.47	36.59	37.37	36.79	35.69	34.93	35.19	34.94	35.95
7	35.15	35.46	35.71	36.06	36.20	36.11	36.76	36.43	35.68	34.90	35.04	34.92	35.70
8	35.00	35.56	35.77	35.50	36.10	35.90	36.62	36.33	35.51	34.66	34.89	34.93	35.56
9	35.73	36.40	36.00	35.98	36.59	36.93	37.26	37.11	36.04	35.63	35.33	35.37	36.20
10	35.58	36.19	36.27	36.32	36.65	36.69	37.20	37.10	36.32	35.60	35.70	35.82	36.29
Average	35.27	35.71	35.81	35.97	36.41	36.56	37.02	36.65	35.77	35.05	34.95	35.00	35.85
Minimum	34.55	34.78	35.36	35.50	36.06	35.90	36.45	36.14	35.40	34.41	34.18	34.54	35.40
Maximum	35.73	36.40	36.27	36.32	36.95	37.10	37.55	37.11	36.32	35.63	35.70	35.82	36.29

Based on actual milk fat and casein data from the year 1984 (Barbano & Olson)

Table 5. Expected Variation in Percent Fat on a Dry Basis (moisture 47%)
Standardizing to a Constant 2.7% Milk Fat for Cheesemaking

Region	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Average
1	42.18	42.31	42.83	42.98	43.68	43.84	44.30	43.57	42.98	42.24	42.02	42.05	42.92
2	41.64	41.44	42.23	42.36	42.77	42.90	43.17	42.85	42.18	41.05	41.15	41.19	42.08
3	41.19	42.23	42.04	42.37	43.04	43.55	43.95	43.22	42.42	41.63	41.23	41.20	42.34
4	42.14	42.77	42.63	42.96	43.27	43.50	43.67	43.42	42.25	41.81	41.46	41.53	42.62
5	41.91	42.28	42.29	42.60	42.96	43.19	43.57	43.27	42.08	41.41	41.35	41.31	42.35
6	42.20	42.61	42.53	42.83	43.19	43.31	44.12	43.52	42.38	41.59	41.86	41.60	42.65
7	41.83	42.15	42.41	42.72	42.92	42.82	43.49	43.15	42.37	41.56	41.71	41.59	42.39
8	41.66	42.25	42.46	42.18	42.81	42.60	43.35	43.05	42.19	41.31	41.55	41.60	42.25
9	42.42	43.11	42.70	42.69	43.31	43.67	44.00	43.84	43.12	42.33	42.01	42.05	42.94
10	42.27	42.90	42.99	43.04	43.38	43.41	43.94	43.84	43.04	42.29	42.39	42.52	43.00
Average	41.94	42.41	42.51	42.67	43.13	43.28	43.76	43.37	42.50	41.72	41.67	41.66	42.55
Minimum	41.19	41.44	42.04	42.18	42.77	42.60	43.17	42.85	42.08	41.05	41.15	41.19	42.08
Maximum	42.42	43.11	42.99	43.04	43.68	43.84	44.30	43.84	43.12	42.33	42.39	42.52	43.00

Based on actual milk fat and casein data from the year 1984 (Barbano & Olson)

Table 6. Yield Comparison of Constant Percent Fat Standardization Versus Constant FBD Standardization

	Mozzarella - 51% Moisture Constant 2.0% Standardization		Mozzarella - 51% Moisture Constant 37% FDB		
Month	Yield	percent FDB	Yield	percent FDB	Extra lbs cheese per cwt
Jan	9.84	35.27	10.11	37.00	0.27
Feb	9.72	35.71	9.92	37.00	0.20
Mar	9.69	35.81	9.87	37.00	0.18
Apr	9.64	35.97	9.80	37.00	0.16
May	9.53	36.41	9.62	37.00	0.09
June	9.49	36.56	9.56	37.00	0.07
July	9.37	37.00	9.37	37.00	.00
Aug	9.47	36.65	9.52	37.00	0.05
Sept	9.69	35.77	9.88	37.00	0.19
Oct	9.90	35.05	10.21	37.00	0.31
Nov	9.91	34.95	10.23	37.00	0.32
Dec	9.92	35.00	10.23	37.00	0.31
Average	9.68	35.85	9.86	37.00	0.18

Table 7. Gross Revenue Comparison of Milk Standardization to a Contsant Fat Versus Standardization of a Constant FDB in the Cheese.

Month	Total Value of Cheese plus Cream in dollars per cwt of milk: Standardize to 2% milk fat	Total Value of Cheese plus Cream in dollars per cwt of milk: Standardize to 37% FDB	Difference in dollars returned to the plant: dollars per cwt milk	Difference in dollars returned to the plant: dollars per day
Jan	$15.99	$16.19	+.20	$1000
Feb	$15.60	$15.75	+.15	$ 750
Mar	$15.47	$15.60	+.13	$ 650
Apr	$15.17	$15.29	+.12	$ 600
May	$14.97	$15.03	+.06	$ 300
June	$14.82	$14.87	+.05	$ 250
July	$14.65	$14.65	.00	$ 0
Aug	$14.75	$14.79	+.04	$ 200
Sept	$15.32	$15.45	+.13	$ 650
Oct	$15.71	$15.93	+.22	$1100
Nov	$15.86	$16.08	+.22	$1100
Dec	$15.86	$16.08	+.22	$1100

Based on the average variation in milk composition in the U.S. in 1984, cheese price of $1.30 per pound and a cream price of $1.70 per pound of fat.

If a plant processed 500,000 lbs of milk per day 20 days per month for one year it would realize a gross increase in dollar revenues of $154,000.

The following paper was presented by James F. Shell, Market Manager-Food & Dairy, Koch Membrane Systems, 850 Main St., Wilmington, MA 01887, at the 23rd Annual Marschall Invitational Italian Cheese Seminar, held in the FORUM Building of the Dane County Exposition Center, Madison, Wisconsin, on September 16, 17 and 18, 1986.

ULTRAFILTRATION IN CHEESE MAKING

By James F. Shell

Abstract

Conventional vs Ultrafiltered methods for making cheese are discussed. Many factors effect the final cheese process adopted such as existing capacity requirements, percent building and equipment available, and market trends of the cheese being manufactured. Emphasis is put on the ultrafiltration process and the advantage it has over existing conventional methods.

Interest continues for ultrafiltration of milk prior to and as part of the cheese making process. There are many major dairy companies in the United States who have or are installing processes for cheese-base and cheese using ultrafiltration as part of the process. I would like to examine today some of the reasons for present and anticipated success of ultrafiltration for cheese and how UF fits into certain cheese processes.

(See Figure 1) First let's review a standard, conventional cheese process one may find in the dairy today. Of course this diagram is somewhat simplified; however, basically all cheese processes consist of the dairy clarifying, pasteurizing and standardizing the milk prior to being pumped to a cheese vat. In the vat the milk is held at ideal temperature for starter growth. The rennet is added to the vat of milk. After the coagulum is formed it is usually cut with various knives, the heating or cooking of the curd then takes place with the whey being drained off and the curd washed. Further processing depends on the variety of cheese being made. Due to the many factors involved, the process can be lengthy and the results difficult to control. Of course, whey is produced which carries with it some of the fat if the cheese is made with milk containing fat, but more importantly the whey proteins which reduces the yield of the cheese being produced per pound of milk used. Also, whey proteins are a very nutritious portion of the milk.

The process of cheesemaking with an ultrafilter allows for concentration and incorporation of whey proteins along with the normal casein and fat components of cheese. The process also allows for the selective removal of lactose and calcium. This concentration of whey protein and standardization of other components has made the ultrafiltration process a highly respected tool of the modern cheese maker.

To understand the advantage of whey protein incorporation into the cheese process, (figure 9) shows the theoretical yield increases of an ultrafiltered cheese. In the conventional process, cheese made from normal whole milk has the potential of protein loss of 0.61% from an original 100/lbs. of milk. With

the ultrafiltration process yield, increases of 23.1% are possible when looking at protein levels alone. When accounting for fat and protein, the yield increases are on the order of 9.8%.

(See Figure 2) There are numerous processes for utilizing an ultrafilter in cheesemaking. The first and perhaps easiest method is the manufacture of cheese using conventional cheese making techniques. Whey from the conventional process is concentrated by ultrafiltration to produce a 35 to 70% whey protein concentrate that is added back to the cheese to enhance the protein content. Cottage cheese, quark, and other soft cheese are some examples of where this technique may be used.

A second process is the ultrafiltration of cultured milk directly after acidification. The membrane acts in the syneresis step, concentrating protein and fat to the final total solids content of the product. Since whey proteins are now incorporated into the total protein compliment, the yields of product per pound of milk increase significantly. This technique is particularly suited for soft, ripened and unripened cheese made from a range of skim milk to 12% fat-fortified milk. Advantages of the product are an improvement over texture and consistency as well as being a continuous method well suited for automated production.

The last two ultrafiltration processes involve concentrating the cheese milk prior to culturing. For high moisture cheese, the ultrafiltered cheese milk ranging from 30 to 45% total solids is cultured and renneted with no subsequent whey drainage step. In this case only the ultrafiltration permeate is lost in the process with all proteins and fat incorporated into the cheese. This results in the highest possible cheese yield. If a syneresis step is included in the process for the production of hard cheeses, some whey must by expelled by the cheese curd. Although some protein can be lost in this step, the volume of whey removed is a small fraction of what is found in a conventional cheese process and major cheese yield increases are still realized. This last process is the basis of the successful cheddar process perfected by the CSIRO group in Australia.

(See Figure 3) During ultrafiltration of milk for cheese, the milk is usually concentrated from 2 to 7 times normal solids concentration. Many factors need to be examined at the dairy prior to choosing how far to concentrate the milk. In the 1 to 3X concentration range the conventional cheese making methods can be slightly modified and standard equipment can be used. In this range, part of the whey proteins are recovered, a modest increase in yield is accomplished and plant capacity can be increased with a low capital expenditure for equipment. Also, existing cheese making technology applies to the process, making it easier for the plant to adopt. However, to maximize yield per pound of milk the 5 to 7X concentrations are required. Using the ultrafilter in this way requires alternate make procedures and specially designed equipment. There are many plus factors to be recognized such as maximizing yield, less whey to handle, reduced rennet required, and ability to be in control of the total process.

Some cheese presently being made via ultrafiltration procedures include Feta,

Ricotta, Mozzarella, Brie, Cheddar, Quark, Cream, and some cheese base for processed cheese.

I will review a few of the simplified processes for some typical cheeses with the understanding that specific processes for each of these cheese types vary according to the process requirements of the individual dairy. For ricotta cheese production, the cheese milk is clarified, standardized, pasteurized, and then acidified to pH 5.9. The milk is held at 39-46°F for one hour during which time calcium is solubilized and released from the casein micelle. The pre-acidified milk is then heated to 130°F, the ideal ultrafiltration process temperature, and concentrated to a 3.5X volumetric concentration factor. The total solids of the final product is 29%. The concentrated milk is then heated to 194°F for denaturation of the whey proteins in a scrape surface or tubular heated exchanger. The product is allowed to settle for development of curd structure and then cooled, salted, and packaged.

(See Figure 5) The next cheese to be discussed which can be made by ultrafiltration is Brie cheese, in which case the milk is pasteurized, then cooled to 93°F, standardized for protein to fat ratio of 1:1.45. Preacidification is accomplished with lactic acid culture to pH of 6-6.2. The milk is then ultrafiltered at 120°F to 3-4X concentration to produce a total solids of 30-34% with a fat of about 14.5%. Salt can be added at this point, the product is put in containers with rennet being added to the containers, and the product is ripened to a pH of 5-5.2. The surface mold is then added and the product is matured to 4-6 weeks prior to final packaging.

(See Figure 6) Another cheese that's more important in the United States, is cheddar. The CSIRO process, which was developed in Australia, takes the whole milk which is pasteurized and standardized, and cooled to a temperature of 125°F. The milk is concentrated to approximately 5x to obtain a retentate of approximately 40% total solids. The retentate is then cooled to the culturing temperature where the culture is added.

The concentrate is ripened to a pH of 6.4 before rennet is added at a concentration of about 1/5 of normal. Coagulation is done in a semi-continuous coagulation tube specially designed for the process. The coagulum is cut into 5-15 mm cubes and dropped into a series of syneresis drums for expulsion of the remaining whey. The syneresis drum design is specific for minimizing mechanical forces on the curd to prevent excessive fat and protein loss. During syneresis the curd is heated to 100°F and subjected to an increasing amount to mechanical force over the 60 minute cook period. The volume of whey drained from the system is about 10% of that found in conventional process with a whey protein complement of about 35%. The remaining portion of the process involves a traditional cheddaring operation either in a continuous or batch mode. This patented process has the advantage of cheese yield increases on the order of 8-10%, consistent product quality, and continuous production techniques.

(See Figure 7) The last ultrafiltered cheese product to be discussed today is Quark for which the market seems to be growing in the U.S. and Canada. The milk, skim milk in this case, is pasteurized and held for protein denaturation, then cooled to approximately 72-75°F. The lactic acid culture is added along

with rennet for a 16 hour set. The curd is then cut and the ultrafiltration process is used to concentrate the cultured product to approximately 3.2 volumetric concentration. The cheese off the ultrafilter is the final product, although additional cream, fruit, or fruit purees may be added prior to packaging.

(See Figure 8) To give a better understanding of the yield for the Quark process, the conventional method yields approximately 21.3 lbs. of cheese for each 100 lbs. of milk used. Using a heat denaturation method prior to the standard conventional procedures, an increase of approximately 1.4 lbs. of cheese can be seen per 100 lbs. of milk used. Again, using the conventional method but ultrafiltering the whey and adding the protein concentrate back into the curd produced by the conventional method, the increase can be up to 26.3 lbs. per 100 lbs. of milk. And then finally with the use of cultured milk ultrafiltration the final cheese yield can be increased up to 29.4 lbs. of cheese for 100 lbs. of milk. In other words, an increase of 8.1 lbs. of cheese can be realized allowing for quick payoff of capital investment.

(See Figure 9) We would be somewhat remiss if we did not discuss some of the characteristic properties of cheese made using ultrafiltration. For the pre-cheese the buffering capacity, the lactose concentration and total solids can be closely controlled, and the permeate is a high quality lactose. In the coagulum, the rennet requirements are reduced, the cheese produced per vat is increased, the firmness of the curd is increased due to the retention of the whey proteins, and special handling is required for the coagulation and cutting of the coagulum. The curd is firmer and it is more susceptible to damage by excessive shear. Refusion of the curd can occur which would prevent syneresis. There is no whey cushion for the curd and the release of whey is greatly reduced. But then finally in the final cheese product, there are four factors that are effected by the whey proteins. One is the flavor, secondly the aging quality of the cheese, thirdly the texture and firmness of the finished product, and lastly the nutritional qualities of the cheese.

We can not finalize this discussion without at least giving some attention to ultrafiltration at the farm level. Of course, much work has been done by Dr. Zall at Cornell University. A very small ultrafilter is being used at the farm to preconcentrate the milk 2-4X which reduces the amount of liquid which must be shipped to the processing plant. It also produces a high quality permeate with lactose, ash, and non-protein nitrogen which can be fed directly back to the cow. The retenate which is shipped to the cheese processor can then go through the conventional make procedures or use additional ultrafiltration and processes previously described for the final cheese make process. Per the initial work completed, ultrafiltration at the farm level is economically feasible, especially in herds of larger sizes. This presents a new and exciting frontier that will require further investigation.

(See Figure 11) In summary, the major benefits of ultrafiltration for the cheese industry are increased product yield due to retention of the whey proteins and virtually no fat loss. The protein can be standardized and the lactose controlled for better consistency of end product. The process allows for new types of cheese to be developed. Ultrafiltration helps make the cheese making process semi-continuous and in some cases continuous; therefore, giving

better process control. Economically the UF process is energy efficient and simple to operate thus lowering labor costs.

(See Figure 12) Of course we must always work with the regulatory authorities. At present time the ultrafiltration process for cheese making is better handled on a case by case basis by the FDA in Washington. As per the presentation given at the Dairy Forum earlier this year in Florida, two of the major items they are concerned with is the standards of identity which does allow for alternative make process for cheese giving flexibility for the technique use. And secondly with the physical and chemical properties of the finished product which must be the same as conventionally made cheese. We feel the most important item concerning the regulatory issue is that of communication as it is important that the equipment supplier and the cheese company communicates with the proper regulatory official so that it can be discussed what make procedure is going to be used, how it may effect the end product, and what flexibility the process may have so that the physical and chemical properties of the final cheese product can be controlled on a consistent basis.

Ultrafiltration for cheese making is a process of the present and future. We at Koch would be happy to discuss any existing or possible new processes with you. I appreciate your attentiveness and if there are any questions I will answer them at this time.

SIMPLIFIED CHEESE PRODUCTION

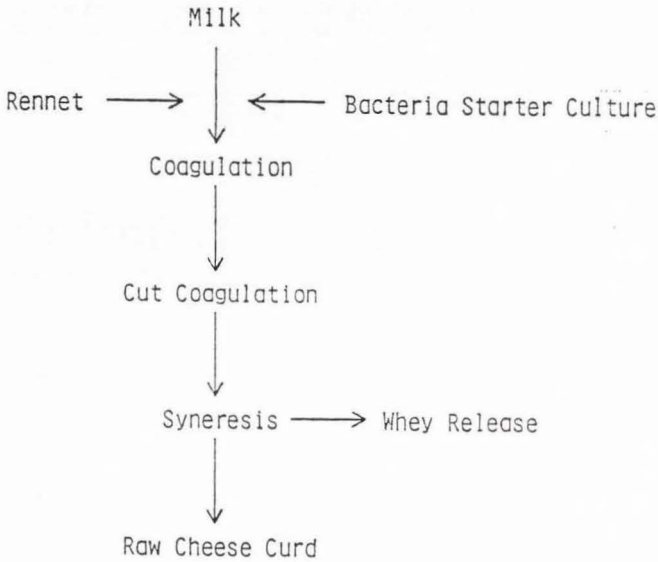

FIGURE 1

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CHEESEMAKING WITH ULTRAFILTRATION

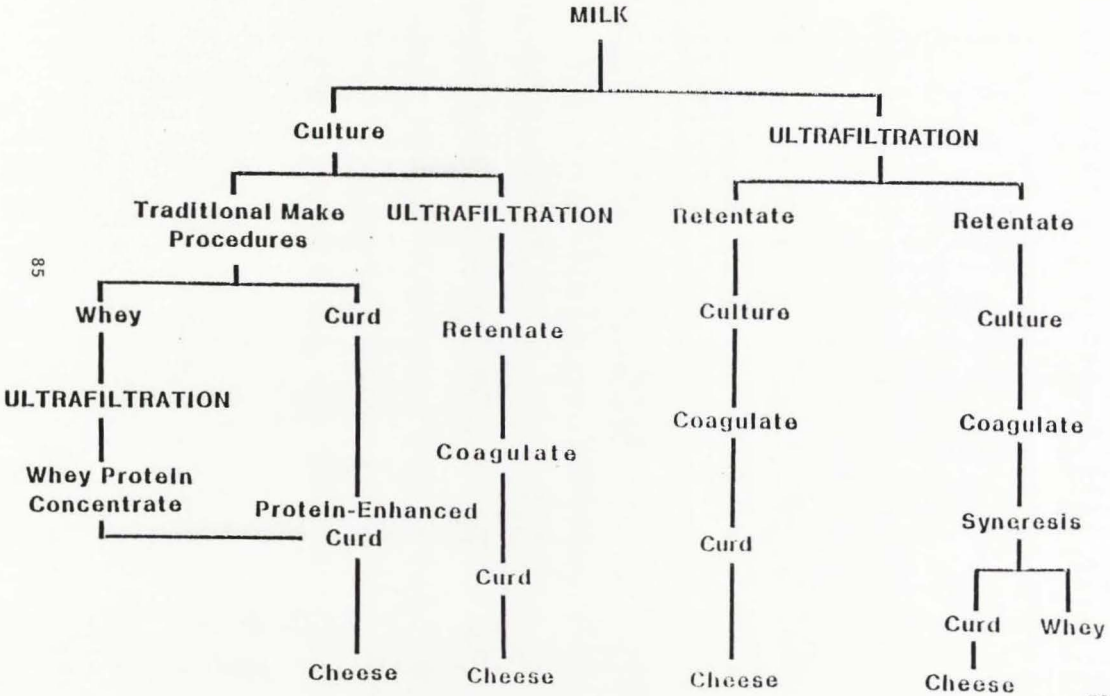

FIGURE 2

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ULTRAFILTRATION CHEESEMAKING TECHNIQUES

Milk — **Milk Concentrate**

1X 2X 3X 4X 5X 6X 7X

Traditional Make Procedures	Special Make Procedures
Traditional Equipment	Special Equipment
Partial Whey Drainage	Minimal or No Whey Drainage
Modest Yield Increase	Reduced Rennet Levels
Lowest Capital Investment	Greatest Standardization Control
	Highest Yield Increase
	Allows for Reconstitution and Substitution Methods

FIGURE 3

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RICOTTA CHEESE PRODUCTION

Whole Milk	Pasteurize
Preacidification	Preacidify with Acetic Acid pH 5.9 1.0 hour 4–8°C
Heat Exchanger	55°C
ULTRAFILTER	Concentrate to 3.5X 29% Total Solids
Heat Exchanger	Heat Denature Whey Proteins 90°C
Set/Cool	5–8°C
Salt/Package	

FIGURE 4

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ULTRAFILTRATION METHOD FOR BRIE CHEESE

Whole Milk	Pasteurize Cool to 93°F Standardize Protein:Fat 1:1.45
PreCulture	Preacidify with lactic acid Culture 0.8%' pH 6.0–6.2
Ultrafilter (Permeate)	Process at 120°F 3–4X
Retentate	Total solids 30–34% Fat 14.5% Add salt 1.5%
Containers	Add rennet to containers
Ripen	Ripen to pH 5.0–5.2 12 hours
Surface Mold	Add surface mold
Maturing	4–6 weeks 55°F
Brie	Pack

FIGURE 5

ULTRAFILTRATION PROCESS FOR CHEDDAR CHEESE

(CSIRO Process)

Whole Milk	Pasteurize Standardize
↓	
ULTRAFILTRATION	Temperature: 125°F Diafilter at 3X Concentrate to 5X
↓	
Retentate	40% Total Solids 1.5% Lactose 48% Fat 52% SNF Cool to culture temperature
↓	
Culture	Add S. cremoris Ripen to pH 6.4
↓	
Rennet	0.5% Calf Rennet (1:5)
↓	
Coagulate	10 minute continuous or batch coagulation
↓	
Cut Coagulum	120–220% of coagulation time 5–15 mm cubes Minimize minimize mechanical forces
↓	
Agitate and Cook	Agitate immediately, increasing force Cook to 100°F 60 minutes
↓	
Drain Curd	Whey Drainage -- 10% of normal pH 5.6
↓	
Cheddar	Traditional cheddaring methods

FIGURE 6

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DIRECT CULTURED MILK ULTRAFILTRATION QUARK

Skim Milk	Pasteurize
↓	
Heat and Hold	Protein Denaturation 95°C, 5 min
↓	
Cool	22–24° C
↓	
Preacidification	Lactic Acid Culture 0.8%
↓	
Coagulation	Rennet Set 16 hours
↓	
Cut Curd	pH 4.6
↓	
ULTRAFILTRATION	3.2X 18% Total Solids
↙ ↘	
Quark 18% Total Solids / Permeate 6.0% Total Solids	
↘	
Quark Cooler	10°C
↓	
Mix	Cream, Fruit Purees
↓	
Package	

FIGURE 7

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QUARK PRODUCTION METHODS

	Cheese Yield kg Cheese / 100 kg Milk
Conventional Method	21.3
Heat Denaturation Method	22.7
Whey Protein Concentrate Addition	26.3
Direct Cultured Skim Milk Ultrafiltration	29.4

FIGURE 8

CHARACTERISTIC PROPERTIES OF ULTRAFILTERED CHEESE

UF Precheese

Buffering capacity controlled
Lactose concentration controlled
Total solids controlled
Permeate is high quality lactose

Coagulum

Rennet addition reduced
Vat capacity increased
Firmness increased due to whey proteins
Special handling required for coagulation and cutting

Curd and Whey

Firmer curd
Susceptable to damage by excessive shear
Refusion of curd can occur -- prevents syneresis
No "Whey cushion" effect for curd
Whey release dramatically reduced

Cheese

Whey proteins influence flavor
Whey proteins age differently
Whey proteins affect texture and firmness
Whey proteins increase nutritional benefits

FIGURE 9

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CHEESEMAKING WITH ULTRAFILTRATION

THEORETICAL YIELD INCREASE

100.0 kg Milk
- 2.6% Casein (2.6 kg)
- 0.6% Whey Protein (0.6 kg)
- 0.2% NPN
- 4.8% Lactose
- 0.7% Ash
- 3.5% Fat

Conventional Process		Ultrafiltration Process	% Yield Increase
2.6 kg	True Protein	3.2 kg	23.1 %
6.1 kg	Fat + True Protein	6.7 kg	9.8 %
0.6 kg	Protein loss	0.0 kg	

FIGURE 10

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Abcor

BENEFITS OF ULTRAFILTRATION IN THE CHEESE INDUSTRY

- Increased Product Yield
- Standardization Of Protein
- Control of Lactose and Ash
- New Cheese Types Possible
- Low Energy Concentration Method
- Continuous Process
- Reduced Labor Costs
- High Quality Permeate

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FIGURE 11

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ULTRAFILTRATION AND CHEESEMAKING:

FDA REGULATORY ISSUE

- **Standards of Identity:**
  - Alternative Make Procedure Clause Allows Flexibility
- **Physical and Chemical Properties:**
  - Physical=Organoleptic Properties
  - Chemical=Nutritional Properties
- **Milk Source:**
  - Cows Milk -- Allows for Standardization of Fat and Skim Milk Addition
- **Cheese Addititives:**
  - Must Follow Standards of Identity
- **Communication:**
  - Communicate with Regulatory Officials

FIGURE 12

The following paper was presented by Dr. Antonio Maggi, Technologist, sole director of ALICO srl — Company for consulting and technical assistance in the cheese industry -- Via Villa Eleonora, 6-27100 PAVIA, ITALY at the 23rd Annual Marschall Invitational Italian Cheese Seminar, held in the Forum Building of the Dane County Exposition Center, Madison, Wisconsin, on September 16, 17 and 18, 1986.

THE TREATMENT AND DISTRIBUTION OF AIR: ITS ESSENTIAL IMPORTANCE IN RIPENING AND WEIGHT LOSS IN "PASTA FILATA" CHEESE

By Dr. Antonio Maggi

Abstract

To be described are the fundamental parameters of the technology of the production by slow ripening of Pasta Filata cheese like provolone, and the defects that can arise during the process. To be compared are the values of weight loss in normal ripening and one in which the distribution, temperature and humidity of the air are controlled by a central computer which sets, modifies and records all the values directly from an operative station. The advantages, in addition to a decrease in weight loss and under the appearance of a decrease in mould, of an improvement in the uniformity of the rind, and the disappearance of defects in the rind. The adaptability of this technology also for other cheeses of medium-slow ripening.

Cheeses called "pasta filata" have in common the particular technology, based on the property of casein of letting itself go stringy under the particular conditions of temperature and acidity. The pasta is "ripe" at the stringing when the metamorphic phenomenon carried by the lactic acid on the calcium phospho-caseinate is ended. The pasta strings when the phospho-caseinate has eliminated parts of the combined calcium. In other words, it is a process of demineralization of the curd.

Pasta Filata cheeses can be divided in two big groups. Those so called "fresh" that are for immediate consumption like mozzarella, fior di latte, pizza cheese etc; and those of medium-slow ripening, the most important and well know being provolone.

It is just regarding the ripening of Pasta Filata cheeses that we will speak.

Our intervention will be extremely essential and practical, as we are technical experts that have lived for years in the daily production of these cheeses. We will leave the chemical and organoleptic characteristics of cheese and will take into account two fundamental aspects for the success of provolone: the technological and the ripening aspect.

The production technology passes through these fundamental stages:

Milk quality

The study of lactic flora and its eventual corrections is of utmost importance. Knowledge of the percentage of curved and rod-like forms is determined for:

Utilization of suitable starters
The enrichment of whey-graft and/or selected types suitably isolated and utilized in industrial production is the best guarantee for attaining the desired product and above all for producing always steadily.

The rennet
Fundamental for flavor: the choice is dependent on what we must produce.

The technology
Which starters to use, in what dose, how to coagulate, which type of rennet to use, the breaking of the curd, etc. are essential parts of the production technology that cannot be standardized but adapted depending on the product that is to be obtained and on the type of milk at disposal. Only a great experience can give this possibility of "personalizing" the production depending on the market requirement.

The ripening of the curd
It is achieved on heated benches left for a period of about 4.5 hours before being strung out. During this time it is turned over 2-3 times. The pH of the pasta passes from 6.13 to 4.90 at the end of ripening. The ripening benches are in the dairy, therefore the optimum ripening temperature (45°C) is hardly ever kept constant. In process are further tests of a technology that, by keeping constant the ripening temperature, allows us to ripen the curd only in 3 hours with a time saving of 1.5 hours.

The stringing and moulding
The use of machines for stringing and moulding, that have been tested for many years, is the best guarantee that the final phase of production is achieved in the best way.

The salting
The time period varies depending on the weight — generally one day each kilo of weight of the mould.

The drying
After salting, the cheese is moved to a so-called drying room where the temperature and humidity must be kept constant for a certain period. The values of temperature and humidity are variable depending on the size of the cheese and the technology of the various factories. The value of the utilized temperature varies from 23-24°C to 28-29°C and the humidity from 50% to 60%. On account of the above it appears that it is extremely important at this stage to use installations that, by using a centralized computer, can control the temperature and humidity according to our will. It is exactly in this phase that the cheese starts to lose weight and to ripen.

Changes of temperature and humidity can be harmful to the outcome of the cheese. During the drying phase some technologies for the first 6 hours, for example, suggest to set the temperature at 30°C and then to pass to 10°C for 12 hours. It is very important that drying is carried out in such a way that the dehydration of the cheese is attained gradually, namely that the ventilation is interrupted to allow the rehydration of the superficial layers at the detriment of those internally.

This is to avoid rind defects and therefore the installation to be used must be controlled by the cheese itself.

As cheeses are different in weight and diameter, the installation has to be studied and "personalized" depending on the production of the company. Also the mould-proofing treatment (see slides) gives an interesting contribution for decreasing the weight loss.

Ripening

The cheese will stay for about 4 months. The temperature will be around 13°-14°C and the humidity at 80-85%.

After the drying this is the second phase of basic importance due to weight loss and arising of rind defects and moulds in an undesired and abnormal way.

Storage

If cheese is not sold after ripening, it is necessary to initiate the storage phase that, practically, is a slow ripening. The cheese is to be kept at low temperature (6°C) and humidity of around 80-85%. It is advisable to have static ceiling evaporators that allow the cooling without using the ventilation. In this way also weight loss is reduced.

Tests and results obtained

The objective was to verify if the air distribution and treatment (temperature and humidity) handled in a modern way where nothing is left to chance, could give, under the same quality conditions, improvements in weight loss, uniformity of rind, saving in time and personnel when brushing the cheese at the end of ripening.

The TRAVAGLINI s.n.c. (Via dei Lavoratori 50- 20092 Cinisello B. (Milano) telex 340537 TRAVMI) has designed and developed with us equipment having the following characteristics:

It controls the air during drying, ripening and seasoning of the cheese by using the "Computer System SSC 84" which is based on a microprocessor for setting and controlling the drying, seasoning and storage cycles of cheese in real time.

This system has been directly connected to the air-conditioning equipment of the same company. Practically, we have noticed that the "SSC 84 System" has brought the following advantages: a sharp reduction of electromechanical control components, as relays, timers, etc.; a great simplicity and speed during maintenance checks; lower running costs since the control logic is physically separated from the power plant and all controls are transmitted only with 4 wires; the possibility of conversing with the central computer, thus allowing to set, modify and record all phases of drying, ripening and storage.

The installation is controlled by the humidity produced by the product.

New systems of ventilation in which the air distribution is obtained through two lateral ducts on the ceiling. A motorized damper changes the air flow into the two inlet ducts producing a vertical air current constantly moving inside

the room. The air recovery is achieved by means of ducts hanging from the ceiling with adjustable suction. The above system offers an absolute liberty of operation and consequently high sanitation in a completely free room.

Higher energy saving since a heat-recovery system takes energy from the hot gas produced in the cooling system. In this way, in addition to almost eliminating the hot water, there is a considerable saving in cold water for the condensation cycle of the cooling group.

The tests performed over a year have been carried out on production of 30 kilos of provolone. They have been examined in the three phases of drying, ripening and storage, half in the usual way and half with TRAVAGLINI installation. The results obtained on all samples with the new installation were:

1) Reduction of weight loss around 3%.
2) Absence of cracking, cuts or splits on the rind.
3) Sharp reduction of mould, and, therefore, saving in time and personnel when brushing at the end of ripening.
4) Uniformity of the rind.
5) No organoleptic variation of the product.
6) The combined mould-proofing and conditioning treatment, besides the non-brushing of the product, also eliminates the scraping for removing the cracks and the pitting, which is caused by the cheese acarus producing craters of approximately 2 cm. depth. Consequently, this process does not further decrease the weight.

On the basis of these results, there are tests in process on other types of cheese of medium-slow ripening like parmesan, fontina and ewe's-milk cheese. Then why not utilize this technology that is very adaptable to other cheese of medium-slow ripening.

The following paper was presented by Ms. Nancy J. Muller, Product Manager of Cheese Packaging, Cryovac Division of W.R. Grace & Co., Duncan, S.C. 29334, at the 23rd Annual Marschall Invitational Italian Cheese Seminar, held in the Forum Building of the Dane County Exposition Center, Madison, Wisconsin, on September 16, 17 and 18, 1986.

TODAY'S CHEESE PACKAGING EFFICIENCIES AND FLEXIBILITIES

By Nancy J. Muller

ABSTRACT

A brief review of changing consumer attitudes and eating habits sets the tone for emerging trends in cheese buying patterns of both food service distributors and retailers. Specific examples of new cheese product categories are cited, as a means of illustrating the evolution of packaging efficiencies and flexibilities in response to the needs of a changing marketplace. Hermetic heat sealed closures have dramatically enhanced package integrity. Additional marketing options have expanded through improvements in package print capabilities, as well as through the addition of other new technology features. Our future promises the means of improving production efficiencies still further, without sacrificing the flexibility to handle a varied product range. Still, we cannot be exclusively reliant upon equipment and materials to bring about these enhancements. People resources continually need upgrading to match the sophistication of growing demands upon the production environment.

When asked to speak to you, all I could think of at the time was the uncertainty facing the cheese industry. The Government had just put into place the dairy herd buy-out program, and questions were already arising about its effect on milk availability and prices. And while Italian cheeses have witnessed spectacular growth in demand, rumblings continue about consumer dietary health concerns, competition by supermarkets against fast food pizza outlets, and the importance of product presentation in the self service retail dairy case.

Lots of messages. Lots of mixed messages. But lots of opportunities in a rapidly changing marketplace.

How is this multi-faceted marketplace affecting your business? How do you respond to the ever-increasing needs of your customer base? Let's look a little deeper into a changing set of demands.

Food service operators need a consistently high quality product delivered in packaging materials sufficient to withstand the rigors of a complex and lengthening distribution chain. It is not unusual for a box of mozzarella cheese to remain in inventory for weeks along the way to its final destination, changing hands two to three times in the process. The product has to speak for itself — be your company spokesman — as fewer opportunities exist for a sales

contact and face-to-face communication with that Mom & Pop pizzeria. Package integrity is a key part of that communication process.

The food service industry is also searching for ideas that might lead them to increased sales, possibly with a new and different menu concept for their customers and a more efficient means of filling an order. Food service operators are avidly seeking new ideas to give them competitive edge in getting their customers through the door of their restaurants. Bulk packaged grated cheese is a perfect example of delivering product in a different form in order to provide speedier, less complicated preparation.

Retailers, more than ever before, are looking for excitement and variety in the cheese they put in their dairy cases. They are catering to an increasingly fragmented consumer audience filled with creative cooks, price-conscious shoppers, health fanatics, young singles, and working mothers.

We've all read about how little time today's supermarket shopper has to make a very complicated set of buying decisions. With some 360 items in the typical retail dairy case, the shopper (according to recent research published by Dr. Oesterle of Purdue University) has to see and make a decision about six items every second. And this thought process has to take place while walking past the average 50 feet of case display. This assumes of course that baby has not thrown the egg carton on the floor, that six-year-old Johnny hasn't disappeared, and that the neighbor from next door hasn't stopped to chat.

Does packaging have to catch the shopper's attention? You bet it does. The job of selling from a self service display case must be done at the point of purchase — with product quality and consistency to reinforce the value to the consumer and make her a repeat buyer. Implicit in the success that a product enjoys is its functionality in the consumer's eyes — its ability to meet a set of perceived needs.

Elsewhere in the retail industry, superstores are utilizing space in every conceivable way to woo all of these different kinds of consumers and to keep them coming back. We're therefore living in the decade of boutiques — for flowers, crusty bread, wines, nuts and candies, and specialty cheeses. The supermarket industry has adopted Bloomingdale's strategy of almost forcing shoppers to buy their way out of the store. But think about it — these boutiques, if executed properly, attack all of our senses by letting us touch, taste, see, smell, and hear the product and its story. Understandably, many buying decisions are based on factors like entertainment and emotionality. We want to bring the excitement into our homes.

Today's food shoppers are, however, more sophisticated and suspicious than ever. Although they might not know where the retail cuts of cheese were packaged, they'll still inspect them to ensure seals are complete and that there has been no contamination or tampering. And because there is such a range of dates coded onto cheese, purchases are made more by sight, — does the surface look dried out or cracked? is it really fresh? — than by intellect. In recent consumer focus groups, we, at Cryovac have learned that code dates on cheese are distrusted because they are often so far into the future that they lack meaning. In a recent consumer attitude study commissioned by SUPERMARKET

BUSINESS 71.3% of the respondents indicated that packaging information about new products is second in importance only to the product's appearance. They want realistic, comprehensible information based on their beliefs and values. Some of us may be impressed by extended shelf life, yet some consumers may think something "good" until December of next year is an inert junk food filled with empty calories.

All of you know that the traditional dairy case is changing to meet those new consumer values. Expect to see more branded, prepackaged "specialty" cheeses appearing there — both imported and domestic varieties. Why? It's quite simple. The dairy case continues to be the primary point of cheese purchases. In an effort to be differentiated from commodity cheese, these branded items will tend to be exact weights and have exotic but tasteful labeling. They will also differ by shape. We'll see more wedges and heels. As a result, demands for more flexible cheese packaging characteristics will increase. Fortunately, the packaging industry has not been standing still but has been refining and expanding upon its offerings.

Positioned against the need to fill their stores with variety and options is the sharp reality that retail store managers must generate profits. So the battle for shelf space must also consider turnover, product costs, and product loss due to spoilage. What has occurred as a result? The number of dairy product choices for the shopper has increased as retailers have searched for the right mix to increase volume and maximize profits. Just remember that the consumer ultimately determines the coefficients in the equation, however. Time and time again, researchers have concluded that consumers must feel a need for a new product before choosing it.

Before leaving the retail supermarket story, random, weight "commodity chunks" of cheeses deserve the spotlight. Expect to see opportunities for them to upgrade their image with higher quality, glossier, and better fitting packaging materials. The retail dairy case is changing, and it's becoming a more exciting place for consumers to shop.

With all of these factors and influences as a backdrop, let me now talk about today's cheese packaging efficiencies and flexibilities.

Further processing of Italian cheeses prompted the need for strong, hermetically-sealed closures and the elimination of the metal clip in packaging. Clips assured only 85% accuracy in closure integrity. This had a direct bearing on the guarantees for product shelf life which you could give to your customers. Vacuum shrink bags were already ideal for the natural shapes of Italian cheeses. So what we needed were machines — equipment to withstand the rigors of salt build-up and to deliver efficiencies to justify the capital investment. Cryovac first introduced its family of 8300 heat-seal vacuumizing machines in 1979. Just recently we introduced the 8600/8610 series of second generation models with improvements in areas such as speed, product transfer, and bag tail cut-off.

Shrinkable materials such as barrier bags offered by us, Viskase, and the American Can packaging group, not only shrink evenly on all sides of the package — particularly critical with printed packaging — but place factory

seals on either the ends or sides of the package depending on how the retail "face" is to be displayed. Hence, for bollas, scarmorze, cylinders and virtually all shapes a great deal of flexibility exists.

Higher speeds and better labor efficiencies have been twin driving forces behind much of the packaging equipment innovations introduced to the cheese industry. With new mechanical drives, horizontal form-fill-seal Hayssen machines can now deliver output averaging 100-120 packages per minute, depending on the package size. Machine efficiency is outstanding. Residual oxygen levels in packages analyzed off line consistently register less than one percent.

Thermoforming equipment has also evolved with speed as an objective, continually building flexibility into its repertoire of tooling designs. Ten years ago, Koch-Multivac commercialized a variable film advance system to enhance registering printed material and change of package size. Computer diagnostics are becoming common; some even by remote control over telephone lines. Every company involved in this type of packaging has been active in improving what's offered to you. Laminate packaging options today include steam shrink — a system of utilizing heat in the sealing die for improved product conformity, a valuable marketing tool for "natural" shapes.

For shredded cheese — a major growth segment already at 30% of all mozzarella sold -- we have automatic sealing to keep up with package filling rates. Horizontal as well as vertical form fill seal options exist.

In the context of branded cheese products, I feel obligated to speak about printing options. There are at least four significant evolutions worthy of comment. (1) Process print on flexible, shrinkable plastic materials has appeared on the scene. This has, in recent years, opened new merchandising as well as economically sound avenues for labeling retail product. (2) The use of "screens" in combination with flexographic printing has allowed us to produce images in more than six colors at a fraction of the historical cost. (3) Ink adhesion on plastic materials has been improved in the last decade through the introduction of corona treatment and other special surface treating methods. (4) Photopolymer plates have both improved registration and drastically reduced the cost of changing labels. Computer-aided design assisted equipment utilized by packaging material suppliers, coupled with the consistency of the Pantone matching system, has also improved the final product. I'm talking about the kind of print capabilities which sell the product from the case on day one and resell it repeatedly thereafter. The consumer is not the only party to remember either — consistent print bar coding for in-store scanning at check-out is a must. This is becoming particularly critical for specialty cheeses.

At this juncture you're probably thinking that you would have much preferred to hear about the advent of new cheese packaging efficiencies and flexibilities than the historical evolution of such. As so you should if you're here to reflect upon possible investment options you might face in becoming a more profitable and aggressive enterprise.

First of all, you can expect from your suppliers an improvement in your packaging yields and efficiencies. By this I mean:

(1) Autoloading and automatic unassisted indexing systems (including a slicing function);

(2) Robotics incorporated in the loading operation;

(3) Use of microprocessors, not only for in-plant inventory and record-keeping, but the tracking of packaging quality as well as focusing of the machine on accommodating product size and shape; and

(4) Automated packoff and palletizing — Europe has already made major strides in this area.

Expect and demand more flexibility in packing systems as a whole. Materials as well as equipment will be developed and further modified to become even more forgiving of each other. Can you imagine — a world of marriages without divorce? Equipment and materials for cheese are finding it together. We'll soon have gas flushing options on vacuumizing equipment: (1) for Emmenthal, gassing cheeses; as well as (2) for a variety of products moving across the same machine. This kind of flexibility will be critical to the converter supplying multiple product offerings to maintain its corporate growth. You'll see families of equipment and materials purposely designed to join in symbiotic, hermetic union.

New sealing mechanisms, such as ultrasound, will emerge commercially within the next several years — aimed at both improving upon seal integrity and the aesthetics of seal closure. Sloppiness and excessive materials in retail packaging — particularly for specialty cheeses — should not and will not be tolerated.

Finally, expect packaging materials themselves to consist of thinner, higher strength films. Over the coming decade, we will enjoy the use of "smarter" formulations, too — those specifically designed to match both oxygen and carbon dioxide transmission requirements.

In closing, allow me to state emphatically that changes in cheese packaging over the past twenty years are but a dawning of new tools to evolve for us in the years ahead. We must acknowledge and prepare for the impact of a changing world on our people. Product innovation, product integrity — and therefore consumer acceptance, corporate competitiveness and profitability — are all ultimately dependent upon the people creating them. Human resources continue to be our single most critical factor determining success or failure, good or poor quality, and company growth or stagnation. Neither robotics nor microprocessors can substitute for this assurance. Training and conscientious upgrading of managerial talent and a skilled workforce are essential to your prosperity in future years.

A chapter is closing. It has in fact been one of great accomplishment in packaging efficiencies and flexibilities. But our future together promises still more variety, excitement, and challenge both in the marketplace and happily in packaging systems as well. We're joint authors of that book — one filled with messages and lots of opportunities.

The following paper was presented by Jeff Giffin, Procurement Manager, N. Dorman and Company, 105 Third Street, Monroe, Wisconsin 53566, at the 23rd Annual Marschall Invitational Italian Cheese Seminar, held in the Forum Building of the Dane County Exposition Center, Madison, Wisconsin, on September 16, 17 and 18, 1986.

CHEESE IMPORTS - AN OVERVIEW OF THEIR IMPACT ON THE DOMESTIC CHEESE INDUSTRY

By Jeff Giffin

Abstract

The importation of cheese products into the United States is a controversial subject due to the continuing over supply of milk and declining milk prices. In order to understand the impact cheese imports have on the domestic cheese industry, the following is discussed. Fluid milk sales, cheese sales in the U.S. and the world, history of dairying in the U.S., sales and marketing trends in the future, licensing and import regulations, and speculation as to the impact imported varieties have on the United States cheese industry.

The surplus production of cheese in the United States certainly is a main topic of discussion in many dairy industry meetings, congressional hearings, and government budget sessions that have taken place recently. Quite frankly, the American dairy farmer has done an outstanding job of producing enormous quantities of milk which is more than enough for all fluid needs and consumer cheese needs.

The large increases in milk production have unfortunately been coupled with a continual decline in fluid milk consumption. As the graph on the overhead shows, fluid milk consumption is approximately 80% of 1964 total consumption. (See Table A)

Fortunately, cheese consumption in the United States has been a steady bright spot for the overall milk industry. Currently, consumption of cheese in the United States is over double the total cheese consumption in 1964.

The increase in consumption of cheese products has, in a large measure, compensated for the sales decline of fluid milk products. Without this major shift from fluid milk sales to cheese sales, our milk supplies would be even more burdensome.

Therefore, it seems that overall the major growth area for milk utilization for the future is in the cheese production area.

In order to expand upon this growth area, a small deviation into the background of cheese production in the United States is necessary.

Milk production in the United States was initiated by the arrival of the colonists from Europe. Prior to the 1600's the production of milk, and therefore cheese, was not part of the native American Indian culture.

The early immigrants brought over their dairy equipment, dairy cattle, and their expertise in cheese making. In addition, these immigrants brought over butter and cheese provisions, which were staples in their diet.

The dairy industry in the United States was an immigrant industry and continued importation of cattle eventually led to the building of large herds in the east coast area of continental United States prior to 1850.

Up until 1850, virtually all of the cheese manufactured in the United States was of the cheddar variety. This was primarily due to the lack of expertise for the manufacture of other cheeses.

The manufacture of foreign type cheese did not start in the United States and really did not become of any significant importance until the early 1900's. (See Table B)

Reduced to simple terms, the growth rate of foreign variety cheeses experienced a 143-fold increase from 1910 to 1985 compared to American varieties' ten-fold increase.

Obviously, the production, marketing and exposure to the consumer of different cheese varieties had a profound and an extremely favorable impact on the domestic cheese industry.

Another background area for our domestic cheese industry is to observe per capita consumption patterns. (See Table C)

As the table illustrates, per capita consumption of cheeses increased from 7.5 pounds per capita in 1953 to 22.1 pounds per capita in 1985. This increase in per capita consumption is quite large and represents an approximate 300 percent increase.

The substantial increase in per capita consumption and the large increase experienced by foreign varieties as compared to American varieties, leads one to the conclusion that the major consumer market for today is one of a variety of cheeses. The consumer of today wants to experience a wide range of specialty cheeses with varying tastes and attributes.

Clearly if one looks at the cheese consumption patterns of Europeans, one acquires a small sense for the potential of the domestic industry. There cheese is consumed at breakfast, at dinner, as a dessert, for entertaining and, of course, as a substantial protein source in cooked dishes. (See Table D)

If one also compares the European uses for cheese and their per capita consumption pattern (which currently ranges up to 46 pounds per person in certain areas) to the United States consumption pattern, the potential for large increases in cheese consumption in the United States looks very promising. In addition, if we look at the consumption trends of the past and

predict future trends, we can see what potential growth for the cheese industry in the United States exists.

During the 1970's, cheese sales were increasing at approximately 5 percent annually. In the early 1980's sales of cheese products did not attain this 5 percent growth rate, but instead, were 4.5 percent annually. Clearly, this annual sales growth is not extremely exciting, but at least it does show growth and leaves us with a good base for future sales gains.

But what are the future trends for cheese consumption?

According to sources with Business Trends Analysts, annual consumption per capita should reach more than double the 1985 rate to approximately 50 pounds per person by the 1990's. Another source also suggesting new, exciting growth in the cheese industry is the FIND/SVP research firm which predicts annual sales increases of cheese products of 12 percent annually by the 1990's.

Obviously, if sales increases of 12 percent per annum coupled with 50 pounds of annual cheese consumption per capita is achieved, the future of the cheese industry looks very bright indeed. To capitalize on this growth potential, we must be prepared for the consumer preferences of the 1980's and 1990's.

As of late, there is an increasing consumer awareness of the varieties of tastes and functions that cheese can serve. Cheese consumers have become adventuresome as they seek out new varieties with different attributes and uses. Some of these new cheese varieties' popularity is influenced by U.S. tourism abroad. Frequently, tourists will visit France or Italy or other European countries and experience new uses for cheese and new cheese varieties. Upon return to the U.S., many times these travelers will attempt to purchase these same cheeses that were so pleasing while abroad. If a retailer is successful in providing the cheese or a very similar cheese to this discriminating consumer, a new variety is introduced in another household.

In addition, American consumers are becoming quite aware of the ability of cheese to be an integral part of any party or social gathering. Certainly a cheese tray with many varieties of cheese can be more than just a food source. This simple appetizer can stimulate conversation and bring many compliments to the host and is especially popular today in conjunction with wine.

There also is the growing trend of the American consumer towards a "grazing" food selection lifestyle, which quite frankly can be very helpful to the domestic cheese industry. Certainly cheese should be able to capitalize nicely on this growing market by presenting small attractively packaged, quality cheese products for the satisfaction of the grazing appetite. A wide variety of imported and specialty cheeses should find a growing niche in this market area.

One other area where cheese has a high potential for future sales growth, is in the health food area. The continual stress of the needs of both men and women for additional calcium intake certainly should be helpful to the cheese industry. Couple this need with the development of lower fat, lower sodium varieties, and cheese offers many attributes desired by the consumer of today.

Certainly, this market advantage for cheese has not been utilized to any great extent in the past, but looks to be a large potential growth area for the 1980's and 1990's.

It is important to note, though, that today's consumer, while being introduced to many varieties of cheese, has become more and more discriminating as far as quality is concerned. Certainly, the industry must police itself and not allow poor quality products to enter the market place. The potential harm to the individual source of supply and to the industry as a whole cannot be underestimated and certainly is understood by all in this room. We all have felt the effects of the much publicized product recall actions and sickness that have resulted from dairy products in the recent past.

So, overall, it seems that opportunity for continued growth of per capita consumption of cheese is more than just possible. Frankly, it seems that opportunity abounds in this area.

With the future presenting many opportunities for cheese sales growth, what role do imported products play in the domestic cheese industry? In order to assess their impact, a short review of our current import license system is necessary.

Most dairy products are subject to quotas established by the President under authority of the amended Agriculture Adjustment Act. The purpose of the quotas is to prevent the imported cheese products from affecting the U.S.D.A.'s milk price support program. The quota program limits the imports of cheese products (with the exception of soft ripened varieties and cheese not made from cow's milk) by the use of a licensing system.

On all cheeses subject to quota prior to January 1, 1980, the license allocations are primarily given to "historical" licenses. In simple terms, historical licenses are granted to persons who were actually in the business of importing cheeses during the representative period chosen for a particular quota.

Due to the Trade Agreement Act of 1979 and the Presidential Proclamation of 1979, imported cheese allocations were increased and the products covered by the quotas were increased so that now the majority of all cheeses imported into the United States are covered by import quotas. These cheeses were not previously under quota primarily due to their high prices as compared to domestic markets. The new quotas are allocated so that no more than 50 percent are given to new "historical" licenses and at least 50 percent or more of the remainder are allocated in the form of "supplementary" licenses on a first-come, first-serve basis.

So in an overview, there are three types of licenses available for importation of cheese products.

Historical licenses which are allocated to persons who were engaged in a product's importation during the product's base period utilized for quota derivation.

Nonhistorical licenses (available for those items listed in Appendix One of the Import Regulations) are available to persons operating importing or cheese manufacturing businesses. To be eligible, a firm must show proof of importation of at least two shipments of cheese totaling 10,000 pounds or show proof of the manufacture of at least 100,000 pounds of cheese in a U.S.D.A. approved cheese plant.

To establish an importation record, a potential candidate for a nonhistorical license can import non-quota cheeses such as Stilton, Roquefort, goat or sheep milk cheese, or soft ripened cheeses such as Camembert or Brie (or even Cheddar from Canada - if aged over nine months, because this product, while upon quota, does not require a license for importation.

Supplementary licenses are available to persons who meet the same criteria as nonhistorical licenses, have historical eligibility under Appendix Two for the country the supplementary license is requested for or if the license is endorsed in writing by the government of the supplying country as a "preferred" importer and must also meet either of the previously mentioned requirements for supplementary license.

Due to the strong demand for certain imported cheese varieties, the allocation of quantities of product is done on a first-come, first-serve basis and cannot be guaranteed. Further, certain quota cheeses may have all quantities utilized by previous years' nonhistorical licenses and, therefore, it is quite possible that there will not be any additional quantities of cheese for supplementary license holders.

At this point in time, the total quantity of imported cheeses (under quota) allowed into the United States is 240 million pounds. The only additions to this importation ceiling are soft ripened cheeses and cheeses not made from cow's milk. This ceiling on quota imports was placed in 1980 and has put an effective barrier on cheese import volumes while domestic production and consumption has increased in the United States. Couple the importation limits with strong consumer overall cheese demand, strong consumer demand for a variety of cheeses, and certainly a market niche exists for domestically produced specialty cheeses to compliment imported varieties which have developed market shares.

In addition, the decline of the overall prices for domestic cheese products have allowed much competition between imported cheese varieties and domestically produced varieties. This price competitiveness and the growth of sizable markets for imported cheese has led to more than a handful of domestic producers entry into production of foreign type cheeses.

To date, we have seen the production and large scale introduction of domestically produced soft ripened cheeses into the United States markets. This area looks to be a growing area for today's consumer as tastes are cultivated for these specialty products. Certainly the impact of the widely publicized listeria problems have not done the overall industry or the soft ripened industry any good, but implementation of mandatory regulatory holds on imported product until certification of the product being listeria free has put shelf life constraints on imported products. Due to the time necessary for the

testing of soft ripened cheeses for listeria, the domestic production of soft ripened cheeses looks to be even more promising in the future.

Another cheese imported into the United States which recently has initiated production in the United States on a much larger scale than in the past, is 60 percent cream Havarti. Certainly the impact of imports on the domestic cheese industry can be seen in these two growing industries, which have developed market shares and now are being produced in the U.S.

If we look quite quickly at a few other imported cheeses, we can see that these cheeses have done an exceptional job of promoting brand awareness and have created a ready market for their products. Product names such as Jarlsberg Swiss, Holland Gouda, Danish Havarti, Port Salut, Blue Cheese and Roquefort, Switzerland Swiss, Austrian Swiss, and others have all done an exceptional job of promoting, selling and delivering quality cheeses to the United States market place. Frankly, the American consumer has come to expect quality from many of these imported products and continued satisfaction undoubtedly leads to more experimentation, and purchase of domestically produced varieties is the result.

The continued growth of these cheese varieties and the continual growth of domestically produced alternative varieties are exciting opportunities for the domestic cheese industry.

The imported cheese industry has sent the United States market a wide array of quality products for distribution and consumption. The introduction of these products have led the American consumer to experiment and enjoy many different varieties of cheese. Overall consumption of cheese products are enjoying continual steady growth due to the placement on the U.S. market of a wide array of cheese products. Certainly, the impact of imported cheeses on the United States market has been very beneficial for domestic cheese producers. The growth of imported cheese varieties has contributed to the overall growth of the cheese consumption pattern in the United States.

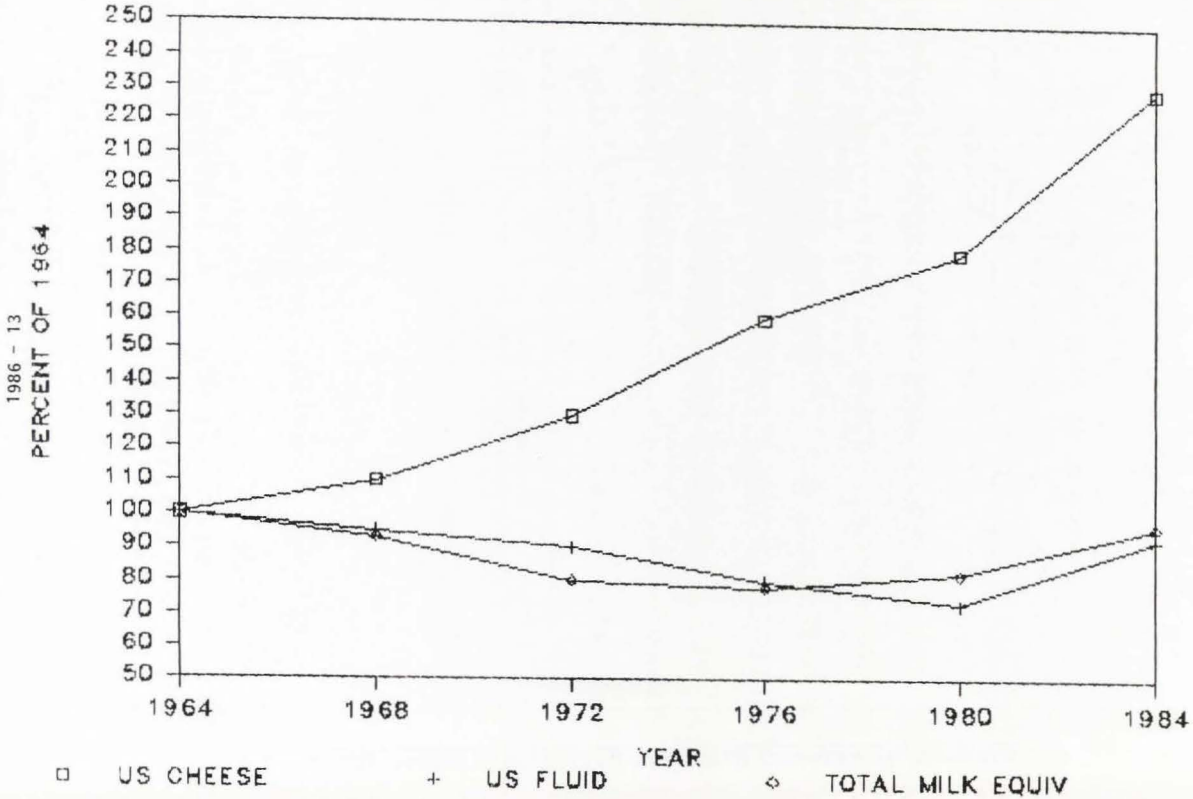
Currently, over 40 percent of our entire United States cheese production is devoted to the production of foreign cheese varieties. The continued importation of a variety of cheeses is quite beneficial and continues to provide market opportunities to observe first-hand what products are received well by the American consumer. As in the past when sales of specific varieties of foreign cheeses reach appreciable volumes, domestic production of these varieties typically result.

Foreign type cheeses have achieved great success in the United States. The continued importation, distribution, and subsequent domestic manufacture of foreign varieties has in the past and will in the future, be a large growth area for our industry. The challenge of the 80's and 90's is to be responsive to our consumers and provide the quality and variety of products desired. If we do this, the future of our industry looks bright indeed.

(Table A)

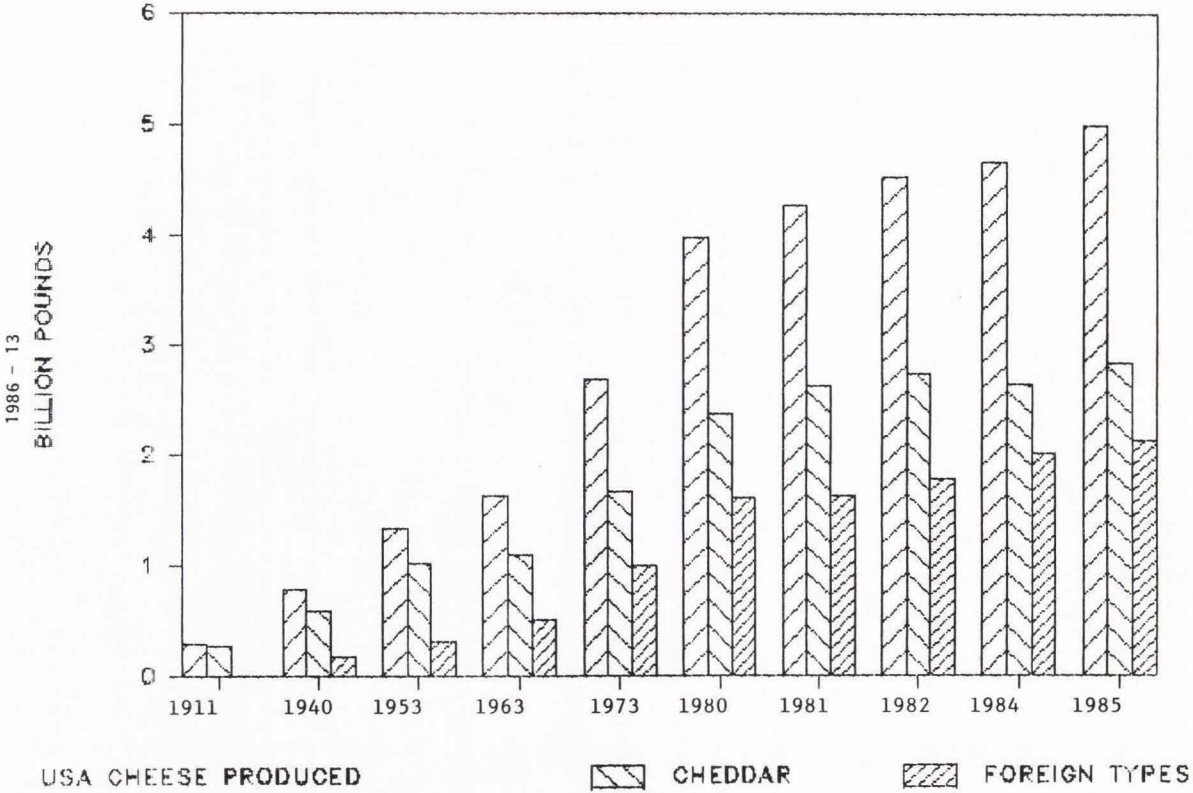
RISING CHEESE CONSUMPTION

OFFSETS FLUID MILK SALES DECLINE



(Table B)

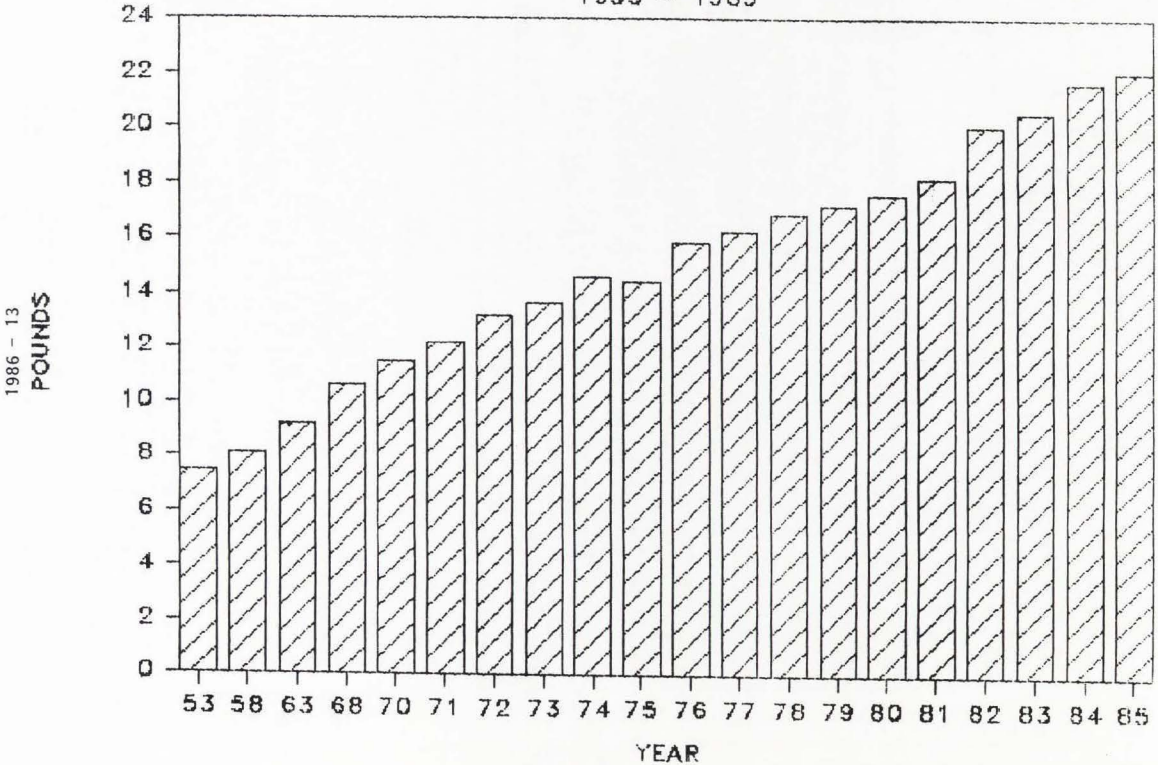
U.S. CHEESE PRODUCTION-FOREIGN VARIETIES COMPARED TO AMERICAN



(Table C)

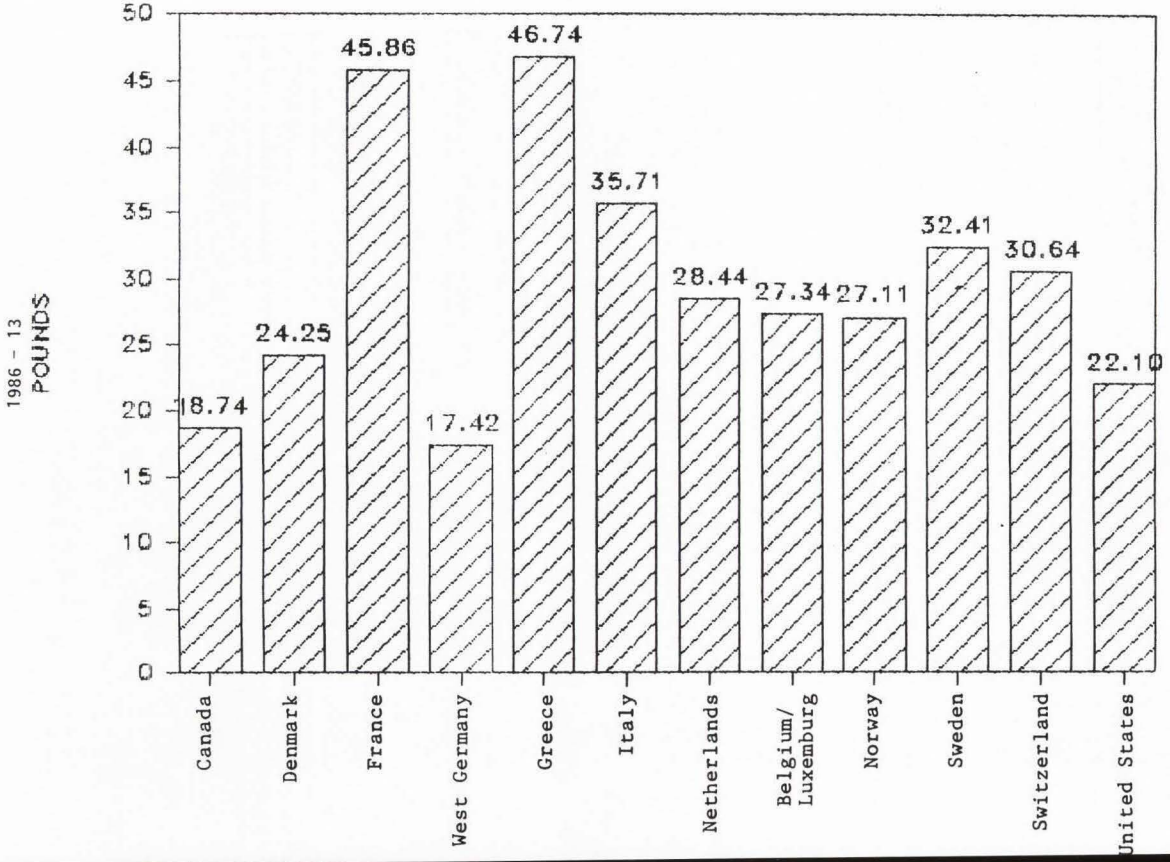
US PER CAPITA CHEESE CONSUMPTION

1953 - 1985



SELECTED WORLD PER CAPITA CHEESE CONSUMPTION

(Table D)



The following paper was presented by Michel Sponcet, Manager Development and Technical Services, Marschall Products, Miles Laboratories, Epernon, France at the 23rd Annual Marschall Invitational Italian Cheese Seminar, held in the Forum Building of the Dane County Exposition Center, Madison, Wisconsin, on September 16, 17 and 18, 1986.

MANUFACTURE OF CAMEMBERT AND SIMILAR CHEESES

By Michel Sponcet

Soft cheese represents 36% of the French cheese productions (1.1 million tons). The following will be discussed: the traditional method of Camembert production, the new methods in soft cheese production, the current practice in France, the Starters for pates molles productions.

The production of pate molle cheese is so extensive that I will concentrate on the general problems associated with its technology.

The most famous pate molle cheese is Camembert, a name closely linked with that of Marie Harel, who was a farmer's wife at the end of the eighteenth century in a small village called Camembert. As she was born in the village where Brie cheese was already produced, she probably produced cheese in the molds normally used to produce the traditional local cheese. Thus began Camembert.

Cheeses which are produced under the name of pates molles are listed in Figure 1. The differences are primarily due to the presence or absence of Penicillium spp on the surface and also by the nature of the cutting. The main characteristics are given in Figure 2. Over the last 20 years, in order to solve the problem of over-acidification, French cheesemakers have developed Pates solubilisees -- or stabilized pastes. Pates molles cheese is the main cheese type in France. It represents 36% of French cheese production (Figure 3).

Pates molles cheese contains about 50 to 56% moisture, with almost no minerals. The calcium present in the curd comes from the retained whey. The fat content is generally 45 to 50% of dry matter and the curd is a composite curd obtained by both rennet and lactic acid bacterial action.

Method of Production

The traditional process is as follows: After standardization of the fat content the raw milk is heated to 28 to 32°C. Checking a titratable acidity (.2-.3% LA). Generally the normal values are 30°C .25% LA. The cheese milk is held in vats containing about 100 liters. Rennet extract is added to the ratio of 15-20 ml per 100 (traditional rennet at 520 mg of Chymosin corresponding to half of the American single strength rennet). The setting time is about 15 minutes. As there is no temperature regulation of the vats, the room temperature is about 25°C. When the curd reaches the right firmness (about 45 minutes - 1 hour), the forms are carefully filled with a ladle.

The filling of molds requires between 1.5 and 3 hours. The cheesemaker does not break the curd as the expulsion of whey would be too fast and the final cheese too dry. The curd stays in the forms for a few hours and the room temperature is increased to 28-29°C. The first turn is made after 6 to 7 hours; the second after 10 to 15 hours. The starter is working during this stage. (Acidification curve of the whey is shown in Figures 5, 6, and 7.)

The next morning the cheeses are taken out of the molds. The room temperature is decreased to 18-20°C and the penicillium spores are sprayed on the surface.

To salt the cheeses, two systems can be used:

(1) Traditional method of dry salting with one single light application on the top and bottom.
(2) Modern method of brining in stainless steel racks at 13°C. At the end, the salt concentration must be about 2 to 2.5%.

The curing is carried out in ripening rooms with good air circulation, temperature at 13-15°C, and humidity at 90% relative humidity. After 5 to 6 days, the penicillium mold appears and the cheeses must be turned to allow even mold development. After about 12 days, the cheeses are completely covered by mold. At this stage the cheeses can be packed. Figures 8 and 9 demonstrate the modification of the flora which takes place during the curing of Camembert.

There are other organisms on the surface in addition to Penicillium Camembert, with micrococci and yeast being particularly important. Inside, lactic streptococci are the main population.

In general, pates molles can be described as a mixed curd cheese obtained by the action of the rennet and the lactic acid bacteria, with the latter's action being more important. The curd is consequently much more fragile as compared to a rennet curd cheese such as Cheddar.

During curing, there is neutralization of the acidity produced by the lactic acid bacteria after whey drawing by the mold's yeast, micrococci and Brevibacterium. These groups of micro-organisms are essentially responsible for the finished taste and flavor of the cheese. The lactic acid bacteria have only prepared the proper bioenvironment during the first steps of the process.

A good cheese results from achieving the correct balance between these different groups of micro-organisms.

We can observe in the case of the traditional soft cheese some evolution:

(1) Increase of the renneting temperature explained by the relative decrease of the milk quality (less Nitrogenous components refrigerated milk) and,
(2) the research of better yield by reducing the losses in the wheys coming from the mechanization of the process.

New Methods in Soft Cheese Production

After this short description of the traditional process, I propose to discuss the evolution and development of new approaches in two aspects of soft cheese production: mechanization, and the use of the starters. In fact, these two aspects are developing at the same time and are influencing changes in one another.

The first is the mechanization of the process. This tendency has been imposed on cheesemakers for reasons of economy, but the evolution has been slow. Pate molle production has been the last to be mechanized due to the high fragility of the curd.

We can easily detect two tendencies. The first and oldest is the maintaining of the classical method and yet modifying the molding procedure and the expulsion of the whey. In this case, the process after the end of the coagulation step can be completely automated today.

The movements developing from the traditional cheese process can be divided into two areas.

One is to use the requisite quantity of milk to produce one cheese and repeat each operation a great number of times.

The second is to treat the whole milk volume as a unit until molding. By 1982, practical experience indicates that this is the preferred option.

This development breaks with the traditional process. It uses the scientific understanding of coagulation and syneresis to obtain a continuous process.

To illustrate this, I will describe the more common processes which are currently in use in France.

Current Practices in France

The first system is to process the milk in quantities sufficient for one batch of cheese. This is done in "micro bassines", which move on a conveyor for each step of the process: renneting, milk filling, coagulation, and cutting. Molding is achieved by overturning the "micro bassines" above the molding blocks. Expulsion of whey is achieved in the classical manner. The advantages of this system (Hugonnet, France; Guterman, Germany) are to improve the yield by decreasing the average weight of the cheese by 10% and to reduce the manpower requirement. Old in the conception, they have disappeared.

The second system is to process large quantities of milk. Examples of this are the Burton Corblin and Alpma systems.

In the Corblin process, the milk is clotted in hemispherical stainless steel vats, which sit on frames. There is a special set of tools for cutting the coagulum and drawing off the whey.

The vats are divided into compartments either by fixed partition or by means of a trolley carrying one set of partitions for all the vats, moving along overhead. The trolley can be completely mechanized. The partitioning is determined according to manufacturing needs and can fill one or two molding

blocks. The molding is done by a spout situated above the molding blocks, the shape of which is especially designed to avoid breaking the curd. The process is repeated by lifting the partitions one after the other as the molding blocks advance. The partition sealing ensures retention of the whey and the curds in each compartment. Whey expulsion is achieved by the traditional process with all the operations to stack, overturn, transfer, unstack, etc., now being automated. At present in France, 40% of the pates molles are produced with this system.

In the second system, developed by Alpma, the operating sequences can be summarized as follows. The plant consists of a semi-circular, trough-shaped conveyor belt with mixing, coagulation, cutting and syneresis zones. After rennet and starter have been added to the warmed milk, the whole is introduced into the mixing zone. By inserting spacing plates, the milk agitation ceases. Coagulation takes place in the milk which is absolutely free of vibration but slowly moving with the trough-shaped conveyor belt.

The spacing plates are removed prior to the cutting of the coagulum. A short-time electrostatic charge prevents the curd from clinging to the spacing plates. Built-in fully automatic cutting devices slice the coagulum into exact uniform curd cubes. During syneresis, the curd can be optionally moved once or twice, or it can be left completely. The finished cheese curd is discharged continuously and gently from the belt.

In France, one new procedure based on ultrafiltration was developed during the 70's by Maubois, Mocquot and Vassal from INRA.

A general description of the MMV process is as follows. Non-fat milk is ultrafiltered to reach, in the case of pates molles, a concentration of total protein of 17-19% instead of 3-3.2% in the raw milk. This ultrafiltered milk is heated at 30-32°C.

Cream is added as a function of the desired fat content in the final product. The resulting blend is inoculated with 2% of starter. Ripening continues until the pH falls to about 6.1.

Spores of Penicillium caseicolium and standard rennet are added. This "prefromage" is put into the molds. The coagulation appears in 7 to 10 minutes after rennetting. The firmness of the curd increases very rapidly. Generally, after 30 minutes the cheeses are taken out of the molds and put into bottomless molds where they remain for 14-16 hours. After that the process follows normal procedures.

The advantages given by the authors for this process are as follows:

(a) Increase in yield by the presence of soluble proteins and caseinomacropeptide in the retentate. Suppression of fat losses in whey.

(b) Reduction of the quantity of rennet used.

(c) Reduction in the size of the equipment and services.

We have seen the automation at the level of the cheese making in the vat, but all the operations - from the molding to the cure room - have been mechanized as well. Using a stacker enables the stacking of the trays one by one at a great rate (5 seconds per tray). The turns which were made by hand in the past are now made with automatic over turner. A transfer conveyor on chaining tables realizes the automatic conveyance of the stacks from a collector conveyor to the chaining tables which are also mechanized with chains. At all the steps, the whey is recovered in a special chainer. At the end, there is a chain unstacker to unstack tray by tray and to send the pieces to the molder.

In the last year, a new patented machine has been proposed to the cheesemakers to transfer the curd in the mold as by hand with a ladle. It is a kind of robot which takes the curd in the vat by mechanical ladles and transfers it into each mold.

Its major advantages are to reproduce exactly the molding with ladle but at a great rate (20 ladles every 10 seconds); to reduce the formation of fines, consequently, to increase the yield; and to mechanize the production of traditional French Camembert which must be molded by ladling.

Starters for Pates Molles Production

Before pasteurization in cheesemaking, the lactic acid bacteria needs to originate from the natural flora of the milk - with all its variations.

In traditional pates molles cheese, the starter used in France is a mixed culture containing Streptococcus lactis, Streptococcus cremores, Streptococcus diacetylactis and/or Leuconostoc cremoris. Their principal characteristics are to produce lactic acid at a rate corresponding to whey expulsion; to produce some gas and aroma; and, to initiate enzymatic action during curing. For acidification, I can summarize the characteristics required compared to the starter used in the Cheddar production. If we compare the production of lactic acid by using the Marschall activity test, a satisfactory starter for pates molles cheese reaches only .6-.7% LA. This is the main difference.

Another difference, the consequence of strain composition, is the production of gas and aroma. While their proteolytic activity is not unimportant, it is secondary compared with the action of the molds and other micro-organisms, which are present in the soft cheeses being considered.

In the production of a pressed cheese such as Cheddar, some new theories on the composition of the starters have emerged in the last 10 years. This applies especially to the New Zealand, Australian and more recently, the American systems of using single strains or a blend of single strains which are monitored for phage.

In France, until now such systems were never important in starter production for soft cheese. Another development has taken place; with the traditional process we get cheeses like Camembert, Brie, Carre de l'Est with low pH after salting and strong taste after curing. As consumers increasingly prefer cheese with a mild taste, soft cheeses have developed over the past 20 years called stabilized paste cheese, to answer this need. These products in general have the characteristics of the pates molles in terms of dry matter, size and

general aspect, but their pH after salting is much higher and their shelf-life is also longer.

This can also be obtained by the use of thermophilic strains. Initially, one part of the mesophilic starter was replaced by Streptococcus thermophilus and it became dominant as the starter; now some pates molles are produced only with Streptococcus thermophilus. At the same time, setting temperatures have been increased and the effect of the rennet is reinforced. Consequently, the curd is less fragile and easier to handle. Thus, the yield is increased, particularly in mechanized processes. This trend is also evident in pates molles cheese with a high fat content.

Another new approach is the direct inoculation of the milk. This is possible at two levels: prematuration of milk at low temperature; or, ripening in the cheese vat.

For prematuration there is no problem. One can of Marschall Superstart is used in 10,000-15,000 liters of milk, dependent on the time, temperature or pH relationship required.

For direct inoculation of the cheese vat in the case of the traditional pates molles, the procedure has not yet been fully developed, due to two contradictory factors. With the direct inoculation system, the bacteria must produce a lot of acid in a short time. On the other hand, for pates molles, the lactic acid bacteria must produce acid over a long period at a medium rate. In fact, we need to find bacteria which are able to produce lactic acid at a fast rate when they are inoculated and thereafter to produce the same lactic acid but at a slower rate. Probably microbiologists will be able to solve this problem in the near future.

In the case of thermophilic cultures, the problem is less complicated and is now almost solved. I know of successful trials on a large scale and this kind of method will be in use very soon.

I want to mention briefly the evolution of coagulants in the soft cheese area. Microbial coagulants, especially the second generation extracted from Mucor miehei, obtain the same result as the traditional rennet. For reasons of economy, some pates molles producers have moved from animal rennet to microbial coagulants with no loss of product quality.

Conclusion

All developments in the procedure involving rennet, starters and the process itself have resulted from economic pressure on the cheese industry. By examples quoted, I have tried to describe how I believe the soft cheese industry has been able to improve the quality of its final products.

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FIGURE 1 PATES MOLLES CHEESES

PRODUCTION METHOD	SURFACE WITH MOULDS	WASHED SURFACE NO MOULDS
SPONTANEOUS DRAWING OF WHEY	CAMEMBERT COULOMMIERS BRIE CHAOURCE NEUFCHATEL ST-MARCELLIN GOAT CHEESES	EPOISSE LANGRES
ACCELERATED DRAWING OF WHEY BY CUTTING	CARRE DE L'EST	GEROMME LIVAROT MAROILLES MUNSTER PONT L'EVEQUE VACHERIN

FIGURE 2 PATES MOLLES CARACTERISTICS

CHEESES	DRY MATTER	FAT % OF DM	FORM	WEIGHT	DIAMETER
BRIE	NLT 44	>40	FLAT CYLINDER	2.4-2.8 K	32-38cm
CAMEMBERT	NLT 110g/P	NLT 40	FLAT CYLINDER	250g	10.5-11 cm
CHAOURCE	NLT 40	NLT 50	FLAT CYLINDER	180g	11-11.5cm
NEUFCHATEL	NTL 40	NLT 45	-----	100-200g	-----
ST MARCELLIN	NLT 40	NLT 40	CYLINDRICAL	NLT 80g	7cm
LIVAROT	NLT 230g/P	NLT 45	CYLINDER	-----	12cm
MAROILLES	NLT360g/P	NLT 45	SQUARE	-----	12.5-13 cm
MUNSTER	NLT 44	NLT 45	FLAT CYLINDER	NLT 450g	13-19cm
PONT L'EVEQUE	NLT140g/P	NLT 45	SQUARE	-----	10.5-11.5c

NLT : not less than

FIGURE 3 FRENCH SOFT CHEESE PRODUCTION (TONS)

	1977	1980(1)	1983	1984	1985
TOTAL PATES MOLLES	335527	384289	383727	408188	411585
% TOTAL CHEESES	35	36	36	36	36
CAMEMBERT AND SIMILAR	218220	184011	180957	184336	--
BRIE AND SIMILAR	32324	41824	59941	73887	--
CARRE DE L'EST AND SIMILAR	21005	8052	6421	6317	--
OTHER	42190	122548	136409	143638	--

Sources: SCEES

(1)New statistical system

IGURE 4 COMPARISON OF PRODUCTION METHODS

	CAMEMBERT old fashion	CAMEMBERT modern technology	SOLUBILIZED PASTES
REPARATION F MILK AY -1	RAW MILK REFRIGERETED PREMATURATION 15-20H 11-14°C / CaC12 0.1-0.2% STARTER FAT STANDARDISATION 28 G/Liter	THERMISATION 64-65°C FAT STANDARDISATION 28g/Liter PREMATURATION 15-20H 0.2-0.5% STARTER 8-14°C / CaC12	THERMISATION FAT STANDARDISATION PREMATURATION 15-20H 0.2% STARTER 12-14°C
ATURATION	TO REACH: TA .23-.28%LA TEMPERATURE 32-34°C POSSIBLE ADDITION OF 0.1 TO 1% STARTER	PASTEURISATION 72°C +1.5-2% STARTER TEMP:33-36°C-CaCL2 15-90MnTO REACH pH 6.1-6.35 TA .19-.25%LA	PASTEURISATION 72°C 2%THERMOPHILIC ST. 35-38°C 30-40Mn
DAGULATION INGLE ENNET	7-10mL/100L COAG.TIME 6-8 Mn TOTAL COAG.TIME 30-45 Mn	9-11mL/100L COAG TIME 7-8Mn TOTAL COAG TIME 30-45Mn	10-13 ml/100L COAG TIME 8-10 Mn TOTAL COAG TIME 30-45Mn
UTTING	NONE	Small or important according to type	Yes
ARTICULES IZE	NONE	CUBES 2.5Cm	CUBES 1.5Cm
TIRRING OTAL TIME	NONE ---	Small 30-40Mn	According to type 45Mn
OULDING	WITH LADLE 2 STEPS	Multi block moulds	Multi-block moulds
RAINAGE	2 TURNS OVER 16HOURS 26°-29°C WHEY TA 1.10-1.15%LA pH CURD 4.6-4.8	Some hours at 28°C Cooling to 20°C 3 TURNS .5-3-9H TA:3H,.3%-6H,.6% TA:9H,.9%-END 1.15	5 TURNS -28°C Cooling to20°C pH 5.0-5.4
ALTING	DRY	DRY OR BRINE	BRINE
RING 1	INOCULATION WITH PENICILLIUM CAMEMBERTI DRYING FOR 2 DAYS RELAT.HUMIDITY 80-85%	INOCULATION WITH PENICILLIUM CAMEMBERTI DRYING FOR 1 DAY RELAT.HUMUDITY 85% pH 4.7-4.9	INOCULATION WITH PENICILLIUM CAMEMBERTI
3	8-10°C 5-6 WEEKS REGULAR TURNING	12-13°C 8-9 DAYS PACKAGING	11-13°C 8-9 DAYS PACKAGING

Fig 5 pH EVOLUTION

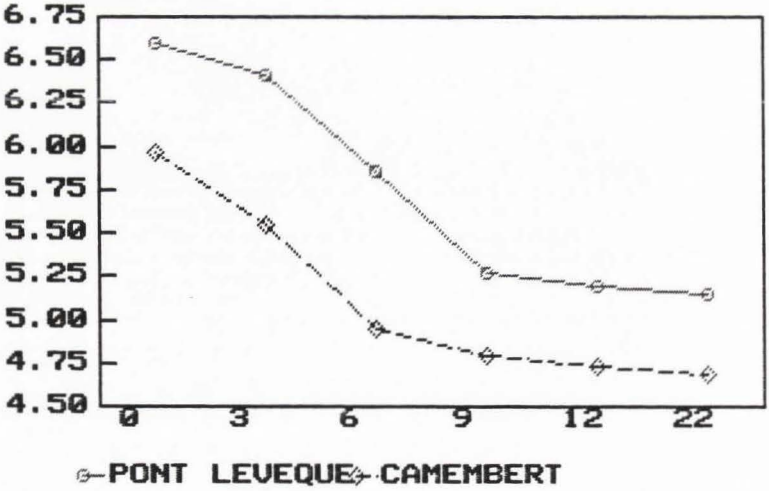


Fig 6 WHEY ACIDIFICATION-DRAINAGE

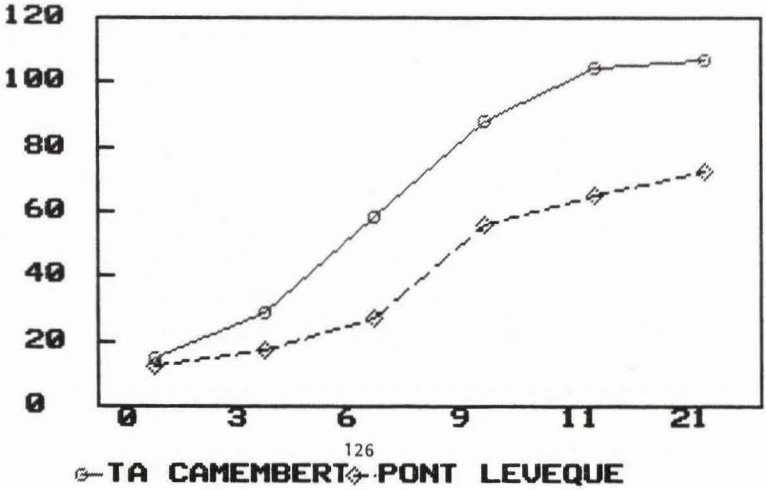


Fig 7 DRY MATTER EVOLUTION

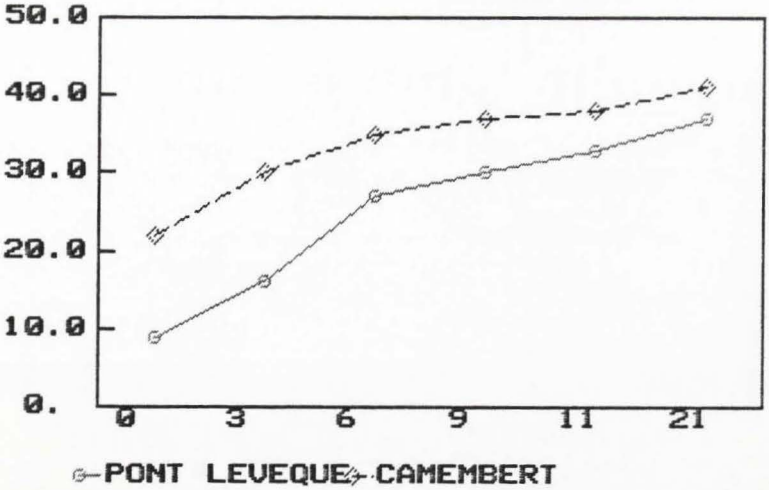
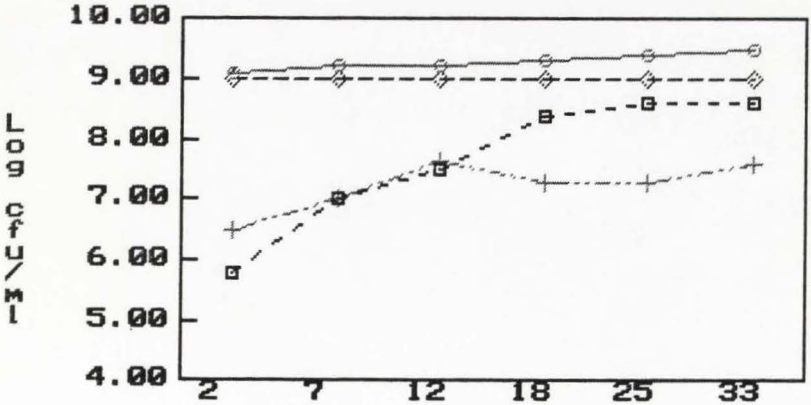
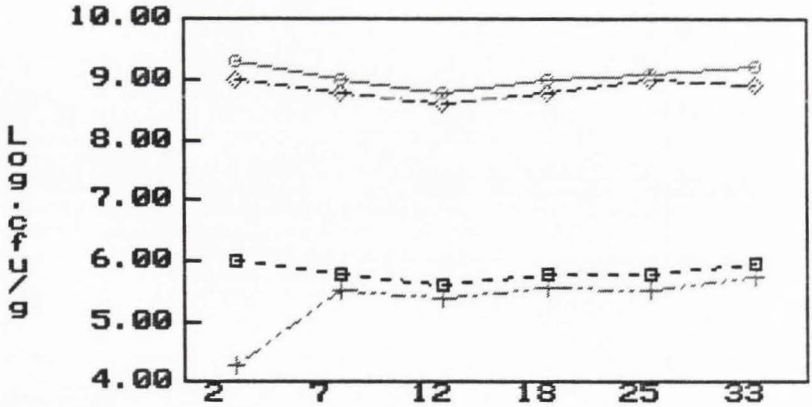


Fig 8 MICROFLORA ON SURFACE



from Lenoir 1962

Fig 9 INSIDE MICROFLORA



T.COUN ACID.B MICRO. YEASTS
from Lenoir 1962

Fig 10 MICROBIAL DEVELOPMENT IN CAMEMBERT

TECHNICAL STEPS	MICROORGANISMS	OBSERVATIONS/PHENOMENONS
STORAGE MILK pH 6.6-6.8	MICROCOCCI	SMALL PROTEOLYSIS
PROCESS ACIDIFICATION DRAINAGE	LACTIC ACID BACTERIA	TO pH 4.6-4.8 + LACTATE
SALTING		
CURING	YEASTS/OIDIUM	SMALL DESACIDIFICATION INCREASE pH IN SURFACE 1 DAY AT 14-15°C DRYING IN SURFACE MOISTURE 80-85%
INOCULATION CURING ROOM 10-12 DAYS	PENICILLIUM CAMEMBERTI MICROCOCCI BACTERIUM LINENS MUCOR	T°:12-13°C MOISTURE 90-95% GOOD AERETION GROWTH OF PENICILLIUM pH INCREASES TO 6.5-6.7 PINK PIGMENTATION INCREASES pH DEFECT "POIL DE CHAT" BLACK COLOR FAVORIZED BY HIGH pH-HIGH MOISTURE HIGH RELATIVE HUMIDITY
PACKAGING STORAGE SALE		T°:4°C pH 5.5-6.0 AFTER 20 DAYS

The following paper was presented by Ricardo J. Alvarez, Ph.D., Director, Corporate Quality Assurance, Pizza Hut, Inc., Pepsi Co., 9111 E. Douglas, Wichita, Kansas, 67202, at the 23rd Annual Marschall Invitational Italian Cheese Seminar, held in the Forum Building of the Dane County Exposition Center, Madison, Wisconsin, on September 16, 17 and 18, 1986.

EXPECTATIONS OF ITALIAN CHEESE IN THE PIZZA INDUSTRY

By Ricardo J. Alvarez, Ph.D.

Abstract

The success of pizza has been a major factor in the growth and popularity of Italian cheese. The per capital consumption of Italian cheese is now in excess of six pounds. Consumption of mozzarella cheese increased 12.9% to 1,045MM pounds over the year (1985). Pizza chains have high quality expectations of their cheeses in order to provide their customer a pizza or pizza product with the desired functional properties. Various cheese processing, packaging and handling variables can affect the desired end product in the cooked pizza pie. Pizza chains impose strict specifications (chemical, microbiological, physical, after cook, packaging, shipping) to the Italian cheese suppliers. The quality expectations are many and strict. The functional goals are specific. However, the reward is continued pizza segment growth and the assurance of a high quality, value added Italian cheese that results in continued customer satisfaction.

Introduction

U.S. cheese manufacturers had another good year in 1985, as they watched sales increase 5.5% to $10.7 billion over the year. Per capita consumption of both imported and domestic cheese increased to 24 pounds and is expected to total 25.4 pounds during 1986. Italian cheese continues to grow in popularity with per capita consumption now in excess of six pounds. Sales of mozzarella cheese have more than doubled in the past eight years. Consumption of mozzarella cheese increased 12.9% to 1,045MM pounds over the year (1985).

Cheese Consumption Changes

Table 1 illustrates the tremendous growth in per capita consumption of Italian cheeses. In 1960, per capita consumption of all Italian varieties combined amounted to only 1.00 pound per capita. In 1984, the corresponding number had increased to 5.82 pounds. Mozzarella is the variety that most influenced this increase as it moved from 0.40 pound in 1960, to 4.06 pounds in 1984, for an increase of 915 percent.

Table 1
PER CAPITA CIVILIAN CONSUMPTION OF ITALIAN CHEESES

Year	Mozzarella	Provolone	Ricotta	Parmesan	Romano	Other	Total
	Pounds						
1960	.40	.16	.14	.12	.15	.03	1.00
1965	.71	.17	.18	.15	.16	.03	1.40
1970	1.21	.23	.25	.17	.15	.08	2.09
1975	2.14	.28	.38	.17	.23	.07	3.27
1980	3.05	.42	.47	.28	.15	.10	4.47
1981	3.01	.45	.50	.31	.14	.09	4.50
1982	3.32	.47	.48	.33	.17.	.12	4.89
1983	3.71	.50	.54	.33	.16	.09	5.33
1984	4.06	.55	.58	.36	.18	.09	5.82

Source: U.S.D.A.

Table 2 is a summary that shows the per capita consumption of American, Italian, and other varieties. Of these three groups, American varieties have increased on a per-capita basis by 123 percent. Other varieties have increased by 90 percent. However, the top performer has been Italian cheeses, recording an impressive 582 percent increase.

Table 2
PER CAPITA CIVILIAN CONSUMPTION OF SELECTED CHEESE VARIETIES

Year	American	Italian	Other Varieties	Total
1960	5.40	1.00	2.03	8.3
1965	6.10	1.40	2.14	9.6
1970	7.10	2.09	2.31	11.5
1975	8.20	3.27	2.86	14.3
1980	9.68	4.47	3.48	17.6
1981	10.28	4.50	3.58	18.4
1982	11.49	4.89	3.76	20.1
1983	11.61	5.33	3.68	20.6
1984	12.02	5.82	3.86	21.7

Source: U.S.D.A.

Business Trends

The increase in the popularity of pizza has been and continues to be a major driving force in the growth of the Italian cheese industry. The fresh pizza industry has been led to its present position of prominence by a number of pizza chains. Table 3 shows the top ten pizza chains in the United States.

Table 3
TOP TEN PIZZA CHAINS

Chain
Pizza Hut
Domino's
Godfather's
Pizza Inn
Little Caesars
Round Table
Shakey's
Show Biz
Mr. Gatti's
Ken's

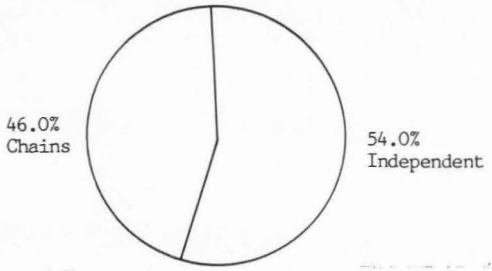
In addition to these chains, there continues to be a large number of small independent pizza operations who cater to their neighborhood and community

clientele. A breakout of how the fresh pizza market is shared between chains and independents is shown in Figure 1.

Figure 1
SLICING UP THE TOTAL PIZZA MARKET

TOTAL PIZZA MARKET: $9,100,000,000

TOTAL PIZZA CHAIN SALES: $4,186,000,000



Source: Nation's Restaurant News

Analyzing the mozzarella production trends by business segment (Table 4) we can observe that the restaurant business segment contributed to the largest increase in pounds and share when compared with the supermarket and others. However, the total growth of mozzarella use has been equal in the pizza chains and independent segments.

Table 4
MOZZARELLA PRODUCTION TREND: BUSINESS SEGMENT ANALYSIS

Business Segment	52 Week Pound Volume Ending: 02/01/85	01/31/86	% +/-	52 Week Pound Share Ending: 02/01/85	01/31/86	+/-
Frozen Pizza & Entrees	60.1mm	63.9mm	+ 5.0%	6.5%	6.1%	-.4
Consumer Packaged	127.2	140.1	+ 9.1	13.8	13.4	-.4
Frozen Appetizers	1.5	2.9	+48.2	.2	.3	+.1
Total Supermarkets	188.9	206.9	+ 8.7%	20.5	19.8	-.7
Pizza Chains (46%)	297.0	337.8	+11.9	32.1	32.3	+.2
Pizza Independents (54%)	349.0	396.5	+12.0	37.7	38.0	+.3
Total Restaurants	646.0	734.3	+12.0%	69.8	70.3	+.5
Government Purchases	34.0	36.9	+14.1	3.7	3.5	-.2
All Other Applications	56.5	66.7	+15.3	6.0	6.4	+.4
Total Productions	925.4mm	1044.8mm	+11.5%	100.0%	100.0%	—

- Pizza Restaurants showing almost 14% real growth and stable share position.
- "All Other" segment (primarily extruded applications) has grown dramatically, both in volume and share.
- Supermarket segments have maintained share and are growing at slightly less than the Category's rate.

The production statistics and customer consumption trends continue to increase. However, in order to maintain the loyalty of the customer, pizza chains will need to continue offering value added, high quality menu selections. New products and rigid quality assurance systems must be continually added and upgraded to maintain the customer's high expectations.

Mozzarella Cheese Quality Expectations:

Because of the growing trend and consumption of mozzarella cheese in the pizza industry, the quality expectations of this Italian cheese will thus be discussed in more detail. Pizza Hut, Inc., the leader in the pizza industry, uses a combination of part skim mozzarella cheese and low moisture mozzarella cheese. Because of the success of this cheese in our products and its

acceptance by our customer, it is the envy of Pizza Hut competitors. The general quality expectations of this combination, hereafter referred to as Mozzarella cheese, will be covered in more detail. We must understand that every pizza chain has different expectations of their cheese. Also, proprietary information becomes part of the specification of the particular cheese. Pizza Hut has very stringent and rigid requirements. Yet, the general quality requirements are probably similar among other major pizza chains. The recent popularity of the pizza home delivery segment of the pizza industry could create additional expectations for mozzarella cheese.

Regulatory Issues

Mozzarella cheese supplied to pizza chains must conform to the definition and standards of identity prescribed in the Code of Federal Regulations (CFR), Title 21, Paragraphs 133.155, 133.156, 133.157 and 133.158. Mozzarella cheese is the food prepared from milk pasteurized in accordance to CFR requirements. Specifically authorized ingredients, in addition to pasteurized milk, include harmless lactic acid producing bacterial starter cultures, suitable milk-clotting enzymes, calcium chloride (low moisture cheese), acetic acid, safe, suitable and approved antimycotics and salt. Pizza Hut specifies the type of antimycotic and it's method of application.

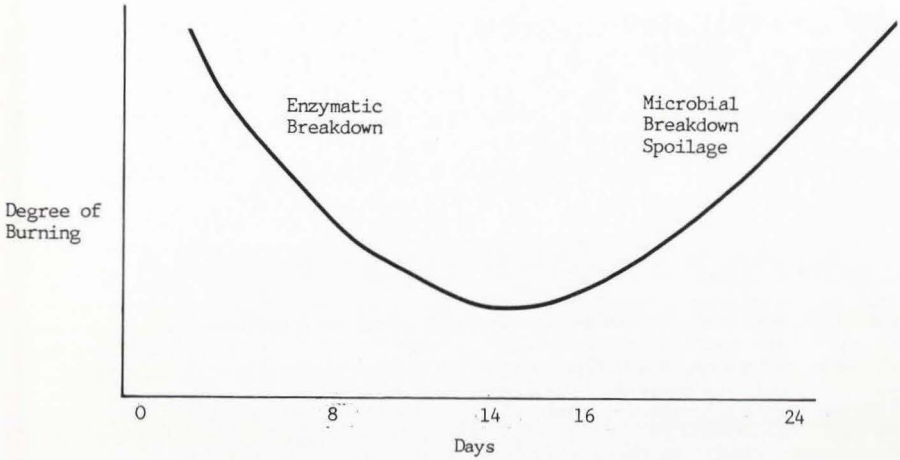
The labeling of the mozzarella cheese must also comply with all appropriate regulations.

Variables That Play a Role in the Quality of Mozzarella Cheese in a Pizza

Various factors in the processing distribution and handling of the mozzarella cheese can affect the desired properties a pizza chain want in it's product for the customers. Some of these factors include:

a) Milk Quality: % milkfat; lactose content; casein quality; whey protein content; enzymes presence and activity; mineral content; bacterial count, somatic cell count; presence of sulfa drugs or antibiotics; rancidity or off odor and flavors;
b) Pasteurization process; good manufacturing practices (GMP) and Hazard Analysis Critical Control Point (HACCP) system;
c) Bacterial starter cultures;
d) Temperature of bacterial activity;
e) Addition of clotting enzymes;
f) Degree of acidity;
g) Time and temperature of cooking;
h) Completeness of whey drainage;
i) Inactivation of natural and microbial enzymes;
j) Ca Cl_2 levels (low moisture mozzarella cheese); antimycotic levels;
k) Aging;
   •An important role in the degree of cheese burning on the pizza, see Figure II. (Each cheese will age slightly different)

FIGURE II: EFFECT OF AGING ON CHEESE BURNING



m) Packaging;
n) Storage;
o) Shipping;
p) Handling at restaurant level;
q) Thawing/refrigeration/temperature controls;
r) Distribution in the pizza;
s) Type of oven; temperature of cooking;
t) Time of pizza service

Mozzarella Cheese Specification:

The mozzarella cheese suppliers will have to manufacture an Italian cheese that meets the desired needs of the specific pizza chain. Each pizza chain will have different expectation for the quality for their cheese. The following will include some general properties Pizza Hut expects in the mozzarella cheese supplied by the various vendors. However, details cannot be provided due to proprietary restrictions.

A) Before cook quality measures:
   1) Chemical:
      - moisture;
      - fat wet basis;
      - salt;
      - pH.
   2) Microbiological:
      - Coliform;
      - Escherichia coli;
      - Coagulase positive Staphylococcus;
      - Salmonella;
      - Clostridium perfringens;
      - Yeast;
      - Molds.
   3) Physical: (properly stored sample).
      - Color;
      - Extraneous matter;
      - Aroma;
      - Flavor;
      - Texture;
      - Size of shred (screen and bulk density);
      - Length of aging;
      - Handling after storage;

B) After cook quality measures:
   - Flavor
   - Color/appearance
   - Blister size
   - Blister coverage
   - Blister color
   - Stretch
   - Melt

Mozzarella cheese quality is evaluated routinely by both the vendor and the Quality Assurance Group of Pizza Hut. Both analytical and cooking results are shared and frequent meetings and vendor plant audits are performed in order to maintain open communications, discuss quality issues and expectations and assure high consistent quality.

Pizza Hut also has specific packaging and code dating requirements and are included in the specification. In addition, pallet size and configuration are also given to the vendors. Rigid and specific temperature controls are imposed on all vendors during the entire "life" of the cheese product.

Summary

Pizza Hut with 4,845 units is the leader (46%) of the chain pizza market. In order to maintain and improve our leadership position, high quality, value added products will be provided to our loyal customers. Quality leadership is only maintained through the continuous monitoring of all the products supplied to the entire system.

The expectations of Italian cheese (mozzarella) are high. Very rigid specifications are imposed on the finished product. In addition, demands are made at every processing step, starting with the raw ingredients.

The continuous growth of Italian cheese and the pizza category will depend on continued consumer acceptance. Cheese quality will be an important factor in the success of a pizza chain. Pizza Hut will maintain it's leadership by only providing the finest quality cheese in our pizzas. The expectations are high, but the reward is continuous growth and customer satisfaction.

Acknowledgements:
The author would like to express sincere gratitude for the assistance provided by Rick Bartz, Leprino Foods, Teresa Anderson, Pizza Hut, Erin Cyphert, Pizza Hut, and Dr. Max Abbott, Pizza Hut.

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The following paper was presented by John C. Bruhn, Ph.D., Extension Food Technologist, Department of Food Science & Technology/Cooperative Extension, University of California, Davis, California 95616, at the 23rd Annual Marschall Invitational Italian Cheese Seminar, held in the FORUM Building of the Dane County Exposition Center, Madison, Wisconsin, on September 16, 17 and 18, 1986.

MICROBIOLOGICAL AND CHEMICAL CHARACTERISTICS OF SOME HISPANIC CHEESES

By John C. Bruhn, Ph.D.

Abstract

Hispanic cheeses are a growing market in the west. These renneted-cheeses are characterized as having a high pH, high moisture content, high salt content and a mixed contaminating microflora. The cheeses have a large potential market and need to be more carefully characterized bacteriologically and chemically in order to develop cheeses of maximum quality and shelf-life.

The fresh, country-style cheeses, or quesos, with the traditional characteristics of cheeses made on the Mexican ranchero, and in other Latin countries, are making their way into the Western food stores, alongside jack, cheddar, and other favorites. These hispanic cheeses are produced primarily in California, and in particular in Southern California, although some hispanic-style cheeses are produced in Texas and other states with large Hispanic populations.

In California there are currently nine companies producing these white cheeses. These hispanic cheeses constitute a 14,570,000 pound market in California. It is a market to watch for continued growth as new populations from Mexico, Central and South American countries continue to establish themselves in the United States. This category has grown some 60% in the past three years and is expected to grow an amazing 45% in the next three.

There are two basic types of hispanic cheeses: fresh and cooked. Both start with cow's milk, whole, part-skim, or all skim. The curds are generally formed using microbial or calf rennet; occasionally a small amount of starter is employed, but not often since too much acid formation will change the curd characteristic. The fresh, hispanic cheese curds should be dry and crumbly and the manufacturers wish to avoid the "acid curds" characteristics of jack cheeses. Make procedures for a few cheese varieties are:

Panela

Pasteurized milk at 80°F is added to the vat
Rennet and salt are added; sometimes culture
Set time, one to two hours
Cut curd
Cook at 108°F
Dip curd into plastic bucket; allow drainage
Package.

Queso Fresco

Similar to panela, except the curds are milled prior to packaging, giving a more solid, but crumbly texture.

Mexicano

Add pasteurized milk to vat; heat to about 98°F
Add culture, set
Cut curd
After draining the curd, it is stacked several times for whey removal and acid development
Curd is milled
After first milling, the milled curd is stacked once again. This curd is placed in cheese cloth
The next day this curd is cut and run through a sieve until it comes out like spaghetti
Salt is added. Then it is placed in a second machine where it is groomed further and salt should be mixed in
A third unit extrudes it for packaging.

There are many styles of hispanic cheeses, each reflecting different countries of origin and differences in opinion by cheesemakers on the desired sensory properties - taste (salty, mild; and texture, usually crumbly). California state standards for these cheeses are general: for panela, queso blanco, queso fresco, and flavored hispanic cheeses (e.g., jalapeno), the maximum percent moisture is 55 percent irrespective of whether the cheese is manufactured from skim, part skim or whole milk. Minimum percent fat in dry matter is 30, except for cheeses made from skim milk, in which case it should be less than 30.

Our interest in these cheeses stemmed from concerns on the susceptibility of the cheeses to microbial growth and in particular, various pathogens, including Listeria. The literature has few references to these cheeses, and in particular those made with little or no culture.

Work by Arispe and Westhoff (1984) and Torres and Chandan (1981) point out the lack of information about these cheeses.

Our current work is to survey the microbiological and chemical qualities of the hispanic cheeses at retail (R in the tables) and at the place of manufacture (P in the tables). For retail sampling, students and I have gone to local markets throughout the state and purchased samples "as is", and placed them under refrigerated storage until analyzed in the lab, usually within 24 hours. Whenever possible, we would try to buy two samples of each type so that we could analyze one immediately, and one at its stated retail pull date.

We also have been collecting samples from the manufacturer, returning them to Davis under refrigeration for immediate analysis. Sufficient samples are being collected from the manufacturer so that portions of a retail lot can be held and analyzed at the stated retail pull date. From these microbiological data we hope to establish 1) if the retail pull dates are valid, considering the sometimes less than optimum handling of these cheeses at retail, and 2) the degree of variations in the selected chemical and bacteriological properties of the cheeses collected at the point of manufacture. Since this project is an

ongoing one, this paper should be received as a progress report, rather than a final report.

All the chemical and bacteriological tests were conducted according to methods published in the current edition of Standard Methods, or the official methods published by the AOAC.

Table 1 shows the first results on over 60 hispanic cheeses analyzed in our lab, including both "factory fresh" (P) and retail (R). You can note the very wide range in both the bacteriological counts and in selected chemical parameters. Clearly, some of these cheeses would not be legal under California regulations for various bacteriological and chemical parameters. The highest salt concentration, 5.2%, reflects the concentration expected in a cotija cheese, which is characterized as dry and salty and used to grate, or crumble, on foods, like Parmesan; however, some do eat it directly. Likewise the 40.7% moisture is typical for cotija.

Table 1
BACTERIOLOGICAL AND CHEMICAL RESULTS FOR HISPANIC CHEESES

Variable	Minimum	Maximum	Median
Coliform	0	7.2×10^7	1.9×10^3
Enteric	50	5.4×10^7	1.4×10^4
Total	1.1×10^3	1.5×10^8	7.1×10^6
Yeast/mold	5.2	4.6×10^5	9.5×10^2
% Salt	1.0	5.2	2.15
% Acid	.01	.86	.17
% Moisture	40.70	72.8	54.3
pH	5.1	6.31	5.69

Very little titratable acidity is evident in these cheeses which reflects the predominant use of rennet as a coagulant. In some instances, I am sure, the higher acidities are due to growth of contamination bacteria, and in some instances the loss of moisture from ranchero and cotija cheese during aging.

Tables 2-5 give some specific bacteriological and chemical finding for various styles. These reflect results from samples collected from retail and the plant.

Table 2 shows the bacteriological and chemical results for panela, a fresh curd cheese. The average salt concentrations in the samples do reflect

manufacturing differences, with Brand A having the highest (2.4%) and Brand D the lowest (1.2%). The pH values, also reflect a range depending on manufacturer. Moisture contents are all legal, not exceeding the State of California maximum of 55%. The bacteriological picture reflects no particular pattern, except that manufacturer D's samples to date show an excellent profile for samples collected at the plant. Plant samples for manufacturer C., however, are uniformly high, except for the yeast and mold. Note, too, that some of the retail samples were phosphatase positive. State of California inspection insures that the milk used to make these cheeses was pasteurized and all equipment was functioning properly. Work by Dr. Tom Richardson of the University of California has shown that without exception, the phosphatase test cannot be used to determine if a hispanic cheese has been made from pasteurized milk or not, since there are contaminating bacteria which produce a heat-sensitive phosphatase, in contradiction to the previous scientific literature. With the total high counts encountered with samples from manufacturers A and B, it is not unexpected that some samples came out "phosphatase positive."

The results for fresco, a milled-curd fresh cheese, are shown in Table 3. These samples show less variation in the average salt concentration, but greater range in the percent moisture. With two manufacturers, the average percent moisture for the lots examined was illegally high. Average pH values ranged from 5.7 to 6.5. Bacteriological counts were high for all manufacturers, except D. Again, one sample of cheese from manufacturer B gave a positive phosphatase test, probably due to a heat sensitive phosphatase-producing species of bacteria.

Table 2
BACTERIOLOGICAL AND CHEMICAL RESULTS FOR BRANDS OF PANELA CHEESE*

Brand	Coli	Enteric	Total	Yeast/mold	Salt	Acid	Moist	Source	pH
	count/ml				%				
A**	1.2×10^4	2×10^4	2×10^7	850	2.4	0.02	54.5	R	
B**	2.0×10^7	3×10^7	5×10^7	666	1.4	0.10	53.1	P/R	6.18
C	1.6×10^7	1×10^7	3×10^7	33	1.8	0.08	52.4	P	6.0
D	110	1×10^3	2×10^7	0	1.2	0.08	53.3	P	6.54

* Values shown in table are mean values.
**Two samples from A brand and one sample from B brand gave a positive phosphatase.

Table 3
BACTERIOLOGICAL AND CHEMICAL RESULTS FOR BRANDS OF FRESCO CHEESE*

Brand	Coli	Enteric	Total	Yeast/mold	Salt	Acid	Moist	Source	pH
	count/ml				%				
A	—	—	—	--	1.7	0.37	59.5	R	—
B**	$1.2x10^6$	$1x10^7$	$6x10^7$	$7x10^3$	1.9	0.14	57.3	P/R	6.05
C	$1.6x10^7$	$3x10^6$	$2x10^7$	$3x10^2$	2.0	0.17	52.8	P	5.72
D	160	$2x10^3$	$8x10^5$	0	2.1	0.07	52.5	P	6.51

* Values shown in table are mean values.
**One cheese sample gave a positive phosphatase result.

Ranchero cheese is usually produced from a milled curd and can be similar to fresco, estilo casero and quesito. Like panela it starts with drained curds. The curds are ground, kneaded and pressed into round or square forms. The texture is a bit like farmers cheese. The results (Table 4) indicate that between the two manufacturers, there are some differences in the salt and moisture content which give these cheeses distinct sensory properties. Even being factory fresh did not improve the bacteriological profile of the samples.

Table 4
BACTERIOLOGICAL AND CHEMICAL RESULTS FOR TWO BRANDS OF RANCHERO CHEESE*

Brand	Coli	Enteric	Total	Yeast/mold	Salt	Acid	Moist	Source	pH
	count/ml				%				
A	$5x10^3$	$1x10^4$	$6x10^7$	$4x10^3$	2.1	0.22	59.6	P	5.43
B	$5x10^3$	$3x10^4$	$4x10^7$	$5x10^5$	2.6	0.05	52.7	P	—

* Values shown in table are mean values.
**One sample from Brand A and one from Brand B gave positive phosphatase results.

Cotija cheese (Table 5) is a much drier cheese, and each manufacturer used a slightly different make procedure. These samples were 60 days old when sampled. The high total plate count probably reflects the effects of added culture.

Table 5.
BACTERIOLOGICAL AND CHEMICAL RESULTS FOR TWO BRANDS OF COTIJA CHEESE*

Brand	Coli	Enteric	Total	Yeast/mold	Salt	Acid	Moist	Source	pH
	count/ml				%				
A	510	$1x10^3$	$7x10^7$	$2x10^3$	5.1	0.34	41.5	R	—
B	$8x10^3$	$1x10^4$	$2x10^5$	0	4.0	0.51	44.2	P	4.94

* Values shown in table are mean values.

The next four tables (6 to 9) reflect the changes that occur when factory-fresh samples are stored at 7°C, a temperature not uncommon in many retail dairy cases. Multiple samples of the same lot of cheese were collected and a portion sampled at the beginning of storage and at the retail pull.

Table 6 details the effects of storage on enchilado cheese. As would be expected, the chemical parameters remained the same during the 60 day storage period. The bacteriological characteristics changed little.

Table 6
EFFECTS OF STORAGE ON ENCHILADO CHEESE

Time	Coli	Enteric	Total	Yeast/mold	Salt	Acid	Moist	pH
Days	count/ml				%			
0	$6.0x10^2$	$4\ x10^2$	$1.8x10^6$	$8.2x10^3$	2.3	0.34	49.1	—
60*	$2.3x10^3$	$2.4x10^4$	$3.9x10^6$	$2\ x10^3$	2.2	0.48	49.5	5.60

*Pull time

When Fresco cheeses were held, the storage picture was about the same (Table 7). The counts were uniformly high, even shortly after manufacture (within 48 hours). A second manufacturer's fresco cheese was held for 39 days (Table 8). The coliform and enteric counts increased with storage; yeast and molds and plate count remained about the same. This manufacturer used less salt in the cheese, and the moisture content was illegally high.

Table 7
EFFECTS OF STORAGE ON FRESCO CHEESE

Time	Coli	Enteric	Total	Yeast/mold	Salt	Acid	Moisture
Days*	count/ml				%		
0	6.0×10^7	6×10^6	1.9×10^7	1.0×10^3	2.2	0.15	54.2
39	3×10^6	6.7×10^6	5.8×10^7	$<1 \times 10^2$	2.2	0.20	54.4

*Pull time

Table 9 shows the findings for cuajada cheese, a fresh-milled curd cheese, often shaped in ovals. Over the 21 days of storage, all counts increased, except for the yeast and mold counts. Initial counts were acceptable. This cheese had a salt concentration similar to what one finds in the majority of milled-curd cheeses. The ending pH was high (6.3).

Table 8
EFFECTS OF STORAGE ON FRESCO CHEESE

Time	Coli	Enteric	Total	Yeast/mold	Salt	Acid	Moist	pH
Days	count/ml				%			
0	8.6×10^2	5×10^3	7.1×10^6	$<10^2$	1.7	0.07	57.2	—
0	5.2×10^3	8.6×10^3	1.5×10^6	1.5×10^6	1.7	0.07	57.7	—
39*	4.5×10^6	8.3×10^7	1.8×10^8	5×10^2	1.6	0.14	59.0	5.99
39*	4×10^6	4.4×10^7	8.5×10^7	5×10^2	1.7	0.13	57.9	6.03

*Pull time

Table 9
EFFECTS OF STORAGE ON CUAJADA CHEESE

Time	Coli	Enteric	Total	Yeast/mold	Salt	Acid	Moist	pH
Days	count/ml				%			
	8.0×10^2	2.6×10^4	2.6×10^4	$<10^2$	1.5	0.06	55.0	—
0	1.4×10^2	1.1×10^4	1.2×10^3	$<10^2$	1.6	0.07	54.9	—
21*	6.3×10^7	7.6×10^7	1.3×10^8	4×10^2	1.5	0.09	53.5	6.35

*Pull time

Ranchero cheese was held for 42 days and those finds are reported in Table 10. These samples started out at relatively high counts and the counts remained constant throughout the storage period. There were no changes in the chemical parameters, as expected.

Table 10
EFFECTS OF STORAGE ON RANCHERO CHEESE

Time	Coli	Enteric	Total	Yeast/mold	Salt	Acid	Moist
Days*	count/ml				%		
	2.0×10^4	1.5×10^4	5.4×10^5	2.2×10^3	2.2	0.19	56.2
0	8.1×10^3	7.4×10^3	3.5×10^5	2.0×10^2	2.1	0.17	55.7
	1.9×10^3	1.7×10^3	1.4×10^5	1.0×10^2	2.0	0.17	55.8
13	4.7×10^3	1.7×10^4	2.7×10^7	3.8×10^4	2.1	0.01	55.8
20	10	30	4.9×10^6	$<1 \times 10^2$	2.2	0.18	55.6
31	2.0×10^4	1.2×10^4	5.3×10^7	$<1 \times 10^2$	2.1	0.26	57.9
34	1.9×10^3	3.0×10^3	5.6×10^7	1.0×10^2	2.2	0.23	56.2
	3.8×10^2	2.5×10^4	8.0×10^7	3.2×10^2	2.1	0.24	55.6
42*	4.0×10^2	1.3×10^4	9.8×10^7	2.0×10^2	2.1	0.27	56.3
	5.6×10^2	2.8×10^4	7.0×10^7	1.0×10^2	2.2	0.25	55.4

*Pull date

Lastly, the type of microflora encountered in the "high count" cheeses when the individual colonies on the plate are picked and identified are extremely varied. There is clearly no dominance of one type, but as a colleague described it, "a microbial zoo".

The preliminary results reported here point to the need for careful manufacturing procedures to insure that the cheeses conform to State standards on moisture. Further more efforts will need to be expended to help those manufacturers with producing cheese of low initial bacteriological counts. Lastly, it is our preliminary conclusion, based on these and other limited data, that manufacturers are placing too long of a pull date (ranging up to 60 days) for these fresh, rather perishable cheeses.

References

1. Torres, Normanella and R.C. Chandan. 1981. Latin American white cheese - a review. J. Dairy Sci 64:552-557.

2. Arispe, Ivelio and Dennis Westhoff. 1984. Manufacture and quality of Venezuelan white cheese. J. of Food Sci 49:1005-1010.