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TABLE OF CONTENTS

PROCEEDINGS

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held in the FORUM BUILDING

of the DANE COUNTY EXPOSITION CENTER

MADISON, WISCONSIN U.S.A.

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The following paper was presented by David M. Barbano, Assistant Professor of Food Science, Cornell University, Ithaca, New York, U.S.A., especially for the 21st Annual Marschall Invitational Italian Cheese Seminar, held in the Forum of the Dane County Exposition Center, Madison, Wisconsin, on September 12 and 13, 1984.

MOZZARELLA CHEESE COMPOSITION, YIELD, AND HOW COMPOSITION CONTROL INFLUENCES PROFITABILITY

By David M. Barbano

ABSTRACT

The federal standard of identity for low moisture part skim mozzarella cheese allows a range of product moisture from 45% to 52% and fat on a dry basis (FDB) from 30% to 45%. The functional characteristics of mozzarella cheese made at the extremes of these composition ranges are very different. In addition, the profitability of manufacturing cheese at different moistures and fat on a dry basis can be very different. In this investigation we first look at the impact of manufacturing low moisture part skim mozzarella at various FDB levels without changing cheese moisture. The examples given in this paper indicate that it is more profitable for the cheese manufacturer to produce higher FDB cheeses within the low moisture part skim mozzarella cheese category, mainly because of the much higher cheese yields obtained at higher FDB. Simple examples of calculations are given which would allow you to substitute in various values for cheese and fat in the cream to do an evaluation that would be more specific for your particular cheese plant. Also, the importance of composition control in maximizing profitability is demonstrated. Casein to fat ratio as a basis of milk standardization would be much better for maintaining composition control at a point that maximizes profitability of the cheese manufacturer.

I. Introduction.

The production of mozzarella cheese for the U.S. market has grown very rapidly over the past two decades. The increase in popularity of pizza has been one of the major factors contributing to the tremendous increase in demand for mozzarella cheese. A very large percentage of the utilization of mozzarella cheese is institutional use primarily in pizza parlors. Several chains of commercial pizza shops represent very large commercial accounts that purchase major quantities of cheese all year long on a contract basis. These chains of pizza parlors strive for consistency in flavor, quality, and appearance of their product offerings. Therefore, the buyers for these large accounts exert a tremendous amount of pressure on the manufacturers of mozzarella cheese to produce a mozzarella cheese that consistently meets their product composition and functionality specifications.

It is very important for both the buyer and the seller of mozzarella cheese to have clear and well defined specifications for product composition and functionality. Once these specifications are clearly defined, it becomes a challenge for the cheese manufacturer to consistently produce cheese that is within the customer's quality specifications. An additional challenge to the cheese manufacturer is to meet the customer's product specifications at a manufacturing cost that is competitive with other cheese manufacturers and at the same time return a reasonable profit to the cheese company.

To achieve the goals of: a) consistently satisfying the customer, b) being price competitive in the market place, and c) making a profit that will sustain the company, it is necessary to have a good management team that can take advantage of new technology and at the same time execute the cheese manufacturing process to obtain consistency, quality, and profitability.

II. Mozzarella Cheese Composition

The federal standards of identity for mozzarella cheese sets a classification system that distinguishes several different types of mozzarella cheese based on the ingredients from which they are manufactured, and most importantly, their finished product composition. The federal composition standards for mozzarella cheese are listed below.

Type of Mozzarella	Moisture	Fat on a Dry Basis (FDB)
Mozzarella	greater than 52% less than 60%	not less than 45%
Low-Moisture Mozzarella	greater than 45% less than 52%	not less than 45%
Part Skim Mozzarella	greater than 52% less than 60%	not less than 30% not greater than 45%
Low-Moisture Part Skim Mozzarella	greater than 45% less than 52%	not less than 30% not greater than 45%

Using low-moisture part skim mozzarella cheese as an example, it can easily be seen that there is a very wide range of product compositions with respect to fat and moisture that all fall into the category of low moisture part skim mozzarella cheese as defined by the federal standards of identity. However, as experienced cheese manufacturers, you know that a low-moisture part skim mozzarella cheese with 47% moisture and 44% FDB is a very different product than a low -moisture part skim mozzarella with a 51% moisture and a 32% FDB. Functionally these two products would perform very differently depending on their intended use.

Because of this wide latitude within the product category of low-moisture part skim mozzarella cheese, it becomes necessary for the cheese manufacturer and the cheese buyer to work together to identify a narrower range of product composition that yields a cheese that has the functional characteristics that will satisfy the customer's needs. This is generally how business is done with large institutional buyers of low-moisture part skim mozzarella.

However, in the retail supermarket sales area there is no clear communication of the customer's needs directly to the cheese manufacturer. Therefore, it is interesting to note the diversity of cheese composition that appears in the supermarket all identified to the consumer as low-moisture part skim mozzarella. The data shown in the next table indicates the compositional differences between different brands of low-moisture part skim mozzarella cheese purchased in supermarkets in New York and Wisconsin.

Composition of Low-Moisture Part Skim Mozzarella Cheese from Retail Supermarkets in New York and Wisconsin.

Source	Moisture	FDB	Protein	Salt
NY - 1	49.8	41.4	24.3	1.34
2	47.1	33.9	29.7	1.61
3	49.6	36.0	26.7	1.12
4	49.3	42.4	23.8	1.07
5	54.7	37.5	22.5	2.33
6	53.1	34.6	24.0	2.09
7	49.8	35.8	26.4	1.69
8	47.8	44.8	23.4	----
9	50.2	35.4	25.5	1.91
10	49.9	35.9	26.2	1.31
11	48.5	41.8	24.0	1.07
12	52.0	40.7	22.8	2.50
13	50.0	35.0	26.2	1.90
14	44.4	48.1	24.1	.98
15	46.1	33.7	29.9	1.80
16	46.6	39.3	26.2	1.10
17	54.1	40.3	20.9	2.24
18	49.0	32.3	28.1	2.29
19	46.3	44.7	24.7	1.33
20	45.5	36.7	28.5	1.80
21	45.8	44.3	24.5	.80
22	55.4	40.9	21.4	1.82
23	47.2	33.1	29.6	1.23
Ave. NY	49.2	38.6	25.4	1.60
WI - 1	46.0	39.8	26.5	1.76
2	45.3	40.0	26.7	2.06
3	45.0	34.3	30.0	1.39
4	46.6	35.8	27.5	1.44
5	50.9	37.2	25.3	1.42
6	45.1	35.3	30.0	1.88
7	49.7	33.8	27.6	.98
8	50.3	30.7	28.7	1.77
9	46.0	40.7	26.6	1.35
10	46.3	41.9	25.2	2.33
11	47.1	31.4	29.4	2.60
Ave. WI	47.1	36.5	27.6	1.72

III. Mozzarella Cheese Yield

Most of the research on cheese yield has been done on Cheddar cheese. Very little published information is available on mozzarella cheese yields or on theoretical cheese yield formulas for mozzarella cheese. To evaluate cheese yield performance in a mozzarella cheese plant, we need a formula for predicting cheese yield based on milk composition.

Some modifications of the VanSlyke cheese yield formula makes it acceptable for use with mozzarella cheese. A modified formula for low-moisture part skim mozzarella cheese is shown below.

$$\text{cheese yield} = \frac{[(\%FR)\ (F) + (C - 0.1)]\ 1.13}{1 - W}$$

Where

%FR = expected fat recovery in the cheese

F = fat content of milk in vat

C = casein content of milk in vat

W = % moisture in the cheese divided by 100

The %FR has been substituted for the traditional .93 that is normally used for Cheddar cheese. This number will be different depending whether you are making cheese at the high FDB or low FDB end of the wide range of acceptable FDB's for low-moisture part skim mozzarella cheese. For a cheese in the middle of the FDB range (i.e. 37.5) an 85% fat recovery may be a good target to be used in the theoretical yield formula.

The other change in the formula is the use of a constant factor of 1.13 instead of 1.09, which is used for Cheddar cheese. This factor is used to take into account the contribution of added salt and non-fat, non-protein, milk solids that contribute to cheese yield. How did I arrive at a 1.13 factor for low-moisture part skim mozzarella cheese? The data shown for the composition of mozzarella cheese on the previous page was used to determine an average factor for all the cheeses analyzed. This was done by determining the amount of non-fat, non-protein, non-salt solids present in each of the cheeses. This amount of other solids (minerals, acids, carbohydrates) plus a fixed target value of 1.7% added salt was used to calculate the constant factor of each of the cheeses. The average value was 1.13.

Therefore, the equation given at the top of this page can be used to evaluate the differences in cheese yield that will result from differences in milk composition.

IV. Selection of Specifications for Cheese Composition

Selection of specifications for cheese composition has to take into account the customer's needs for cheese functionality and characteristics plus the cheese manufacturer's needs to be able to manufacture, package, and market the product at a profit.

One question all mozzarella cheese manufacturers should consider is "Are there any differences in profitability of manufacture of low-moisture part skim mozzarella cheeses of different composition?" To answer this question, we need to evaluate the yields of low-moisture part skim mozzarella of different compositions.

The following group of 3 examples will compare the profitability of making three low-moisture part skim mozzarella cheeses at different fat on a dry basis (FDB). All of the following examples will start with exactly the same composition original 100 lbs of whole milk. Each example will standardize the same whole milk by partial removal of fat by separation. The moisture content will be kept at 49% and the salt content at 1.7% for all cheeses. The price of cheese will be set at $1.31 per pound, the value of fresh cream at $1.80 per pound of fat, and whey cream at $1.60 per pound of fat for all the examples. The calculations are shown so that you can substitute different numbers and recalculate the examples for your own use.

Example 1. - milk standardized to 1.5% fat.

Start with 100 lbs of milk with 3.50% fat, 3.20% protein, and 2.43% casein. Remove 40% fat cream with a separator to obtain milk at 1.5% fat. The table below shows the composition of the original milk and the resulting cream and 1.5% fat milk. In addition it shows the pounds of cream separated and the remaining pounds of milk for cheese making.

	Weight	Fat		Protein		Casein	
	pounds	%	lbs	%	lbs	%	lbs
Stand'zed milk	94.80	1.5	1.42	3.27	3.10	2.48	2.35
Fresh Cream	5.20	40.0	2.08	1.92	.10	1.46	.07
Total Milk	100.00		3.50		3.20		2.43

Cheese yield from 94.80 lbs of standardized milk

$$\frac{[.85(1.5) + (2.48 - 0.1)]\ 1.13}{1-(49/100)} = 8.098 \text{ lbs cheese/cwt}$$

8.098 lbs x (94.8/100) = 7.677 lbs cheese from the 94.8 lbs of standardized milk

Cheese Composition
Moisture - 49.00%
FDB - 30.87% (calculated from the lbs of fat retained)
Salt - 1.70%

Value of cheese and cream from the original 100 lbs of milk

Cheese	-	7.677 lbs	x	$1.31/lb	= $10.056
Cream	-	(5.20 x .40)	x	$1.80/lb of fat	= $ 3.744
Whey Cream	-	.213 lbs fat	x	$1.60/lb of fat	= $ .341

Total Dollars Returned from 100 lbs of milk = $14.141

Example 2. - milk standardized to 2.0% fat.

Start with 100 lbs of milk with 3.5% fat, 3.20% protein, and 2.43% casein as in example 1 except we will skim the milk to a 2.0% fat test instead of 1.5%.

	Weight	Fat		Protein		Casein	
	pounds	%	lbs	%	lbs	%	lbs
Stand'zed milk	96.05	2.0	1.92	3.25	3.12	2.47	2.37
Fresh cream	3.95	40.0	1.58	1.92	.08	1.47	.06
Total milk	100.00		3.50		3.20		2.43

Cheese yield from 96.05 lbs of standardized milk

$$\frac{[.85(2.0) + (2.47 - 0.1)]\ 1.13}{1 - (49/100)} = 9.018 \text{ lbs cheese/cwt}$$

9.018 lbs x (96.05/100) = 8.662 lbs cheese from the 96.05 lbs of standardized milk.

Cheese Composition
Moisture - 49.00%
FDB - 36.96%
Salt - 1.70%

Value of cheese and cream from the original 100 lbs of milk.

Cheese	-	8.662 lbs	x $1.31/lb	= $11.347
Cream	-	(3.95 x .40)	x $1.80/lb of fat	= $ 2.844
Whey Cream	-	0.288 lbs fat	x $1.60/lb of fat	= $ .461
Total Dollars Returned from 100 lbs of milk				= $14.652

Example 3. - milk standardized to 2.5% fat

Start with 100 lbs of milk with 3.5% fat, 3.20% protein, and 2.43% casein.

	Weight	Fat		Protein		Casein	
	pounds	%	lbs	%	lbs	%	lbs
Stand'zed milk	97.32	2.50	2.43	3.24	3.15	2.46	2.39
Fresh cream	2.68	40.00	1.07	1.92	.05	1.46	.04
Total milk	100.00		3.50		3.20		2.43

Cheese yield from 97.32 lbs of 2.5% milk - because of the higher fat content of the milk there may be more loss of fat into the whey, thus we will reduce the theoretical fat recovery in the yield potential formula from .85 to .825 for the 2.5% milk.

$$\frac{[.825(2.5) + (2.46 - 0.1)]\ 1.13}{1 - (49/100)} = 9.799 \text{ lbs cheese/cwt}$$

9.799 lbs x (97.32/100) = 9.536 lbs cheese from the 97.32 lbs of standardized milk.

Cheese Composition

Moisture	-	49.00%
FDB	-	41.27%
Salt	-	1.70%

Value of cheese plus cream from the original 100 lbs of milk.

Cheese	-	9.536 lbs	x $1.31/lb	= $12.492
Cream	-	(2.675 x .40)	x $1.80/lb of fat	= $ 1.926
Whey Cream	-	.3705 lbs fat	x $1.60/lb of fat	= $ .593
Total Dollars Returned from 100 lbs of milk				= $15.011

SUMMARY

The yield of low moisture part skim mozzarella cheese changes significantly as you increase the fat content of the standardized milk used to make this product. The calculations are based on theoretical yields which assume fat recovery in the cheese of 85% for milks at 1.5% and 2.0% fat and 82.5% for milk with 2.5% fat. Both the casein and fat content of the milk will influence the cheese yield. Notice the fact that the casein content of standardized milk will be greater than the original whole milk. For example, two milks with the same fat content but different casein content will give different yields and different finished product FDB.

The FDB of cheese found in the retail market place varies considerably. Commercial samples of low moisture part skim mozzarella ranged in FDB from 30.7% to 44.7%. These same cheese samples ranged from 44.4% to 54.1% moisture. Both moisture content and fat content of cheese will influence the cheese yield and total dollar return from a milk supply. The proper balance of fat and moisture content in the finished product will influence the physical characteristics and flavor. The total dollar return on a starting milk of constant composition will be greater when making cheese from a standardized milk with a higher fat content. This is true because at current prices the fat is worth much more as cheese than fresh cream.

As summarized in the table on the next page, the total income from the same 100 lbs of milk would be $0.87 more per hundred weight with the milk standardized to 2.5% fat versus the milk standardized to 1.5% fat if the moisture content of the finished products are all 49%.

THE KEY FACTOR IS THE QUALITY AND SUITABILITY OF THE CHEESE FOR YOUR CUSTOMER!!

Cheese made from the higher fat milk will have a higher fat on a dry basis and this will influence its physical properties. At current cheese and cream prices it appears that by selling a product that has the highest FDB that your customer will accept, the cheese maker will maximize his return per 100 lbs of milk, if the moisture content of the cheese is held constant. It appears that it may be profitable for a company to look for customers that can use low-moisture part skim mozzarella at the high end of the FDB range. These calculations are intended as an example and you should substitute your own numbers for all parameters to obtain information that applies to your specific situation.

	Fat in Stand'zed Milk	Total Value of Cream + Cheese	Cheese Moisture	Cheese FDB
EXAMPLE 1	1.5%	$14.14	49.00%	30.9%
EXAMPLE 2	2.0%	$14.65	49.00%	37.0%
EXAMPLE 3	2.5%	$15.01	49.00%	41.3%

V. How Does Variability of Cheese Composition Influence Profitability?

Generally, large volume purchasers of low-moisture part skim mozzarella cheese will give the cheese manufacturer product specifications for cheese composition and functionality. Usually these will be specified as acceptable composition ranges for moisture, FDB, salt, and pH. In addition, the customer may have specifications for color, stretch, melt, burning, and fat release.

Moisture and FDB will both have very significant impacts on cheese yield, so let's focus on these characteristics of low-moisture part skim mozzarella cheese. Assume that your customer has given you an acceptable range of moisture of 47.5% to 50.0% and FDB of 35 to 39%. The high end of both the moisture and FDB ranges will give you the highest product yields and maximum profitability. The difficulty is that if you set your production targets at 50.0% moisture and 39% FDB, you will have many vats of cheese that exceed the maximum moisture, FDB, or both and these lots of cheese will be unacceptable to your customer. Therefore, it seems to be common practice to target the middle of the customer's specification range so that the number of lots of cheese outside the acceptable composition range is minimized. The key factor is vat to vat variation in product composition. The more vat to vat variation you have in moisture and fat content, the closer you need to stay to the middle of the specification range with your manufacturing composition targets.

The key to improving profitability is to reduce the vat to vat variation in cheese composition so that your target values can be moved closer to the most profitable cheese composition. The key point is ! FIRST ! reduce the vat to vat variation (usually measured statistically by standard deviation) and then move your target composition closer to the more profitable end of the compositional range. If you do not reduce your vat to vat variability first, you are likely to produce too much cheese that is outside of your customer's specifications and you may risk losing that customer.

How do you improve vat to vat consistency in cheese composition? Consistent cheese making conditions is the first step. Times, coagulants, temperatures, starter culture activity, salting, and cooling are some of the process parameters that need to be defined and executed consistently every day. Many cheese plants do a very good job in this area, yet their cheese composition still varies more than they would like it to.

The next factor to consider controlling is the milk composition from which the cheese is made. You will probably respond to that suggestion by saying that you standardize to the same fat test day after day so you have consistency in milk composition. The consistency in milk composition that I am referring to is in the casein to fat ratio in the milk for cheese manufacture. Additionally it really comes down to the casein to fat ratio of all the ingredients once the cheese vat is full.

Variation in the milk casein to fat ratio will cause variation in both the FDB and the moisture content of the low-moisture part skim mozzarella cheese. Because of differences in specific processing conditions in different cheese plants it is not possible for me to give you specific casein to fat ratios that will result in these specific moistures and FDB's in all cheese factories. Standardizing to a consistent casein to fat ratio by separation of cream from whole milk does not require any additional manufacturing equipment, it just means that you need to determine milk casein content and adjust your fat removal by separation to maintain a constant ratio of casein to fat instead of a constant fat test.

Next, I will give a series of examples that will illustrate the economic value of this approach to controlling cheese composition. Let's assume that we have a customer that has product specifications for moisture content of cheese from 47.5 to 50% and FDB from 35 to 39%. What would be the difference in total end product value if we made cheese at the low end of the ranges, the middle of the ranges, and the high end of the ranges? The information is summarized below.

Cheese Composition

Low end of composition range - 47.5% moisture, 35% FDB.
Middle of composition range - 48.75% moisture, 37% FDB
High end of composition range - 50.0% moisture, 39% FDB.

Assume that all cheese making starts from the same 500,000 lbs of whole milk at 3.50% fat, 3.20% protein, and 2.43% casein. All equipment required for manufacturing the cheese is the same for all product compositions indicated in this example. Cheese price \$1.31 per pound, fresh cream \$1.80 and whey cream \$1.60 per pound of fat. The dollar values of each product have been calculated and are shown below.

Cheese Composition Range	Dollar Value Of			
	Cheese	Fresh Cream	Whey Cream	Total
Low End	52,900	15,750	1,500	\$70,200
Middle	56,550	14,175	1,775	\$72,500
High End	60,200	12,600	2,000	\$74,800

Assume that we target the middle of the composition range and obtain that composition. After looking at the values in the table above we can see that there is more profit at the high end of the composition range. However, our vat to vat variation in cheese composition is large enough that if we targeted half way between the middle and the high end of the composition range we would have too many vats of cheese outside the upper range limits and would risk losing a very good institutional customer.

If we could move our target to half way between the middle and high end of the cheese composition range without having an excessive amount of cheese over the upper limits for moisture and FDB, it would be worth about \$1150.00 per day (\$74,800 - \$72,500 divided by 2) on a whole milk volume of 500,000 lbs of milk per day. If standardizing to a casein to fat ratio instead of a constant milk fat percentage would help us achieve this goal, then it is just a matter of comparing the cost of this approach to milk standardization for low-moisture part skim mozzarella cheese manufacture to the possible long term benefit in improved profitability.

The calculations of yield and dollar value of low-moisture part skim mozzarella cheese at the low and high end of the composition range for the preceding discussion are shown below.

Calculation 1 - Cheese at the low end of the composition range.

Start with 100 lbs of milk with 3.5% fat, 3.20% protein, and 2.43% casein. Remove 40% fat fresh cream with a cream separator to obtain a standardized milk that will yield a finished cheese with 47.5% moisture and 35% FDB.

	Weight Pounds	Fat %	Fat lbs.	Casein %	Casein lbs
Stand'zed Milk	95.63	1.83	1.75	2.47	2.364
Fresh Cream	4.37	40.0	1.75	1.51	.066
Total Milk	100.00		3.50		2.43

Cheese yield from 95.63 lbs of standardized milk from above:

$$\frac{[.85(1.83) + (2.47 - 0.1)]\ 1.13}{1 - (47.5/100)} = 8.449 \text{ lbs cheese/cwt}$$

$$9.018 \text{ lbs} \times (95.63/100) = 8.0799 \text{ lbs cheese from the 95.63 lbs of standardized milk}$$

Cheese Composition
Moisture - 47.50%
FDB - 35.07%

Total Product Value with Cheese made at composition listed above.

		Per CWT Of Whole Milk	For 5000 CWT's
Cheese	8.0799 lbs/cwt x $1.31 =	$10.58	$52,900
Fresh Cream	1.748 lbs fat x $1.80 =	3.15	15,750
Whey Cream	.1945 lbs fat x $1.60 =	.31	1,550
TOTAL PRODUCT VALUE		$14.04	$70,200

Calculation 2 - Cheese at the high end of the composition range

Start with 100 lbs of milk with 3.5% fat, 3.20% protein, and 2.43% casein. Remove 40% fat fresh cream with a cream separator to obtain a standardized milk that will yield a finished cheese with 50.0% moisture and 39% FDB.

	Weight Pounds	Fat %	Fat lbs	Casein %	Casein lbs
Stand'zed Milk	96.50	2.18	2.10	2.46	2.377
Fresh Cream	3.50	40.0	1.40	1.51	.053
Total Milk	100.00		3.50		2.43

Cheese yield from 96.50 lbs of standardized milk from above:

$$\frac{[.85(2.18) + (2.46 - 0.1)]\ 1.13}{1 - (50.0/100)} = 9.5214 \text{ lbs cheese/cwt}$$

9.5214 lbs x (96.50/100) = 9.1882 lbs cheese from the 96.50 lbs of standardized milk.

Cheese Composition
Moisture - 50.00%
FDB - 38.92%

Total product value with cheese made at composition listed above.

		Per CWT of Whole Milk	For 5000 CWT's
Cheese	9.1882 lbs/cwt x $1.31 =	$12.04	$60,200
Fresh Cream	1.400 lbs fat x $1.80 =	2.52	12,600
Whey Cream	.2507 lbs fat x $1.60 =	.40	2,000
	TOTAL PRODUCT VALUE	$14.96	$74,800

The following paper was presented by M. E. Johnson, Program Coordinator, Walter V. Price Cheese Research Institute, University of Wisconsin, Madison, 1605 Linden Drive, Madison, Wisconsin, 53706, U.S.A., especially for the 21st Annual Marschall Invitational Italian Cheese Seminar, held in the Forum of the Dane County Exposition Center, Madison, Wisconsin, on September 12 and 13, 1984.

METHODS OF STANDARDIZING MILK FOR CHEESEMAKING

By Mark E. Johnson

ABSTRACT

Standardization of milk for cheesemaking requires accurate sampling and analytical techniques. If properly carried out, standardization will achieve the most efficient use of milk constituents and will aid the cheesemaker in obtaining uniform cheese quality and composition throughout the year. Addition of nonfat milk solids may be the most economical method of standardizing milk. Costs of extra labor and time for standardization were not included in the calculations.

Introduction

Milk composition is commonly adjusted to a desired casein to fat ratio (C/F) in order to control the fat-in-dry-matter (FDM) of the cheese. There is a close relation between C/F and FDM although the relationship is not exact and may vary between cheese manufacturing plants. Through daily measurements of the composition of both milk and cheese a C/F can be established to give the desired FDM of the cheese. Once this is done the cheesemaker tries to maintain the same C/F in all cheesemilk. This practice is called standardization.

Why standardize milk for cheesemaking?

1. Establishes the most efficient and profitable proportion of the milk constituents for cheesemaking.
2. Because raw milk is of variable composition, standardization is a useful aid in achieving uniform high cheese quality and composition.
3. Results in cheese which conforms to both legal and individual plant requirements.

Standardizing milk for cheesemaking can be done most efficiently when the following information is known:

1. fat and casein test of milk
2. fat recovery in cheese
3. weight of milk to be standardized
4. weight and composition of cream, if removed, and nonfat milk or skim milk, if added
5. fat-in-dry-matter in the cheese you desire to make.

This information is not only of vital importance to proper standardization procedures but also provides data to show whether the cheesemaker is experiencing difficulty in plant efficiency and what corrections may be necessary.

How to standardize milk for cheesemaking

The first step is to know the composition of the cheese you desire to make. We can calculate the casein-to-fat ratio (C/F) of the milk needed to produce a cheese with a desired fat-in-the-dry-matter (FDM). Although no method can predict accurately the FDM in cheese when milk of known composition is used the best method would be a version of the Van Slyke cheese yield formula.

Equation 1

$$\text{FDM} = \frac{\text{RF (\% Fat in milk)}}{[\text{RF (\% Fat in milk)} + .96 \text{ (\% Casein in milk)}]\text{RS}}$$

FDM = Fat-in-dry-matter of cheese
RF = Retention of milk fat in cheese
RS = Solids not fat, not casein in cheese

Other than the composition of milk the two most important components of this equation are the values used for the retention of fat and solids not fat, not casein in cheese. The latter value is primarily regulated by the amount of sodium chloride in the cheese. The lower the salt level the lower the RS value. The amount of fat retained in the cheese is a function of the amount of fat in the milk and most importantly the cheesemaking practices. This value will be different between plants and reflects different efficiencies and processing conditions. The same rational applies for casein recovery.

Under ideal manufacturing conditions 85% of the milk fat in standardized milk should be recovered and with an assumed salt content of 1.7 the RS value would be 1.13 (Barbano) (1). At least 96% of the casein should be recovered.

Example: What would be the casein to fat ratio (C/F) of milk needed to produce a cheese with a FDM of .43?

Use equation 1 and substitute any value for F. Use .85 for RF and 1.13 for RS. I will use 2% for % Fat in milk. Solve for % Casein.

$$.43 = \frac{.85(2)}{[.85(2) + .96C]\ 1.13}$$

$$C = 1.87 \qquad C/F = \frac{1.87}{2} = .94$$

In order to produce a cheese with a FDM of .43 the C/F of the milk should be .94.

The C/F value can now be used to standardize milk of any composition. It should be emphasized that this value will be different from plant to plant based primarily on fat and casein recovery and amount of salt in the cheese.

Methods of Standardization

All methods of standardization require accurate composition data. The methods I will show are as follows:

1. Remove cream
2. Add nonfat milk solids
3. Add nonfat milk solids and remove cream

I will use milk of known composition; 3.65% fat, 2.46% casein and standardize to a C/F of .94.

Option 1 - Remove Cream

When we remove cream some casein will also be removed and should be taken into account. Since all of the casein will be in the non-fat portion of the milk the following equation can be used to calculate the amount of casein in each pound of cream removed.

Equation 2 $\frac{\%\text{ Casein}}{100-\%\text{fat}} = \frac{2.46}{100-3.65} = .026$ lb casein in every pound of nonfat portion of milk

If we remove 40% cream 60% of that cream will be nonfat milk. Thus .6 X .026 X lbs of 40% cream = lbs casein removed in cream.

Use equation 3 to find the amount of 40% cream to remove in order to obtain a C/F of .94

Equation 3 $\frac{\%\text{ casein} - \text{casein in cream (lb)}}{\%\text{ fat} - \text{fat in cream (lb)}} = .94$

$$\frac{2.46 - (.6)(.026)\left\{\frac{X}{.4}\right\}}{3.65 - X} = .94$$

X = the fat in cream
$\frac{X}{.4}$ = amount of 40% cream to remove

$X = 1.08$ lbs fat to remove $\quad \frac{X}{.4} = 2.70$ lbs 40% cream to remove from 100 lbs. of milk

The % casein and % fat of the standardized milk is now calculated.

Equation 4

$$\frac{\text{casein in milk} - \text{casein removed in cream}}{100 - \text{lbs cream removed}} \times 100 = \frac{2.46 - .04}{100-2.70} \times 100 = 2.49\ \%\text{ casein}$$

Equation 5

$$\frac{\text{fat in milk} - \text{fat removed in cream}}{100 - \text{lbs cream removed}} \times 100 = \frac{3.65 - 1.08}{100-2.70} \times 100 = 2.64\ \%\text{ fat}$$

The cheese yield formula for Mozzarella cheese as proposed by Barbano is used to calculate the potential yield of the standardized milk. I will use 49% as the moisture in the cheese.

Equation 6

$$\frac{[.85\ (2.64) + 2.49 - .1]\ 1.13}{1 - 49/100} = 10.27 \text{ lbs/100 lbs of standardized milk}$$

$$\text{for 97.30 lbs of standardized milk} = 10.27 \times \frac{97.30}{100} = 9.99 \text{ lbs}$$

Value of cheese and cream from 100 lbs of original milk. (3.65% fat 2.46% casein).

Cheese	= 9.99 lbs x $1.31/lb	= 13.09
Cream	= (2.70 X .4) x $1.80/lb of fat	= 1.94
Whey cream	= .38 lbs fat x $1.60/lb of fat	= .61
Total value returned from the original 100 lbs of milk		= 15.64

Whey cream = lbs fat in original milk - lbs fat in cheese and cream

Option 2 - Add nonfat dry milk

Equation 7

X = amount of casein to add, $\frac{X}{.28}$ = lbs of nonfat dry milk

nonfat milk contains 28% casein + 1% fat

$$\frac{X + 2.46}{\frac{.01X}{.28} + 3.65} = .94$$

X = 1.00 lbs casein

$\frac{X}{.28}$ = 3.57 lbs nonfat dry milk to add for 100 lbs of milk

The % casein and % fat of the standardized milk is now calculated.

Equation 8

$$\frac{\text{casein in milk + casein added} \times 100}{100 + \text{lbs nonfat dry milk added}} = \frac{2.46 + 1.00}{100 + 3.57} \times 100 = 3.34\ \%\ \text{casein}$$

Equation 9

$$\frac{\text{fat in milk + fat added in nonfat dry milk}}{100 - \text{lbs nonfat dry milk added}} \times 100 = \frac{3.65 + .036}{100 + 3.57} \times 100 = 3.56\ \%\ \text{fat}$$

Using Equation 6

$$\frac{[.85\ (3.56) + 3.34 - .1]\ 1.13}{1 - 49/100} = 13.88 \text{ lbs/100 lbs standardized milk}$$

$$\text{for 103.57 lbs of standardized milk} = \frac{103.57}{100} \times 13.88 = 14.38 \text{ lbs}$$

Cheese	= 14.38 lbs X \$1.31/lb	=	18.84
Whey cream	= .53 lbs X \$1.60/lb of fat	=	.85
Nonfat dry milk	= 3.57 lbs X \$.92/lb	=	-3.28
Total value returned from 103.57 lbs of standardized milk		=	16.41

Whey cream = 3.65 + .036 - fat in cheese (see equation 9)

Option 3

Add nonfat dry milk and remove cream

Example: Add 1 pound of nonfat dry milk then calculate amount of cream to remove. See equations 2 and 3.

Equation 11

$$\frac{2.46 + \text{casein in nonfat dry milk} - \text{casein in cream}}{3.65 + \text{fat in nonfat dry milk} - \text{fat in cream}} = .94$$

$$\frac{2.46 + .28(1) - (.0281 \times .6)\left\{\frac{X}{.4}\right\}}{3.65 + .01(1) - X} = .94$$

$X =$ .78 lbs fat to remove

$\frac{X}{.4} = 1.95$ lbs 40% cream to remove

The % casein and % fat of the standardized milk is now calculated.

$$\% \text{ Casein} = \frac{2.46 + .28 - .033}{101 - 1.95} \times 100 = 2.73$$

$$\% \text{ fat} = \frac{3.65 + .01 - .78}{101 - 1.95} \times 100 = 2.91$$

Using equation 6

$$\frac{[.85\ (2.91) + 2.73 - .1]\ 1.13}{1 - \frac{49}{100}} = 11.31 \text{ lbs/100 lbs standardized milk}$$

in 99.05 lbs standardized milk $\quad 11.31 \times \frac{99.10}{100} = 11.20$ lbs

Cheese	= 11.20/lbs x \$1.31/lb	=	14.67
Cream	= (1.95 lbs x .4) x \$1.80/lbs of fat	=	1.40
Whey cream	= .42 lbs x \$1.60	=	.67
Nonfat dry milk	= 1 lbs x \$.92/lb	=	-.92
Total value returned from 100 lbs of standardized milk		=	15.82

Whey cream = 3.65 + .01 - .78 - 2.46

Summary

Total value returned from 100 lbs of standardized milk

Removing cream	\$15.64
Adding nonfat dry milk	\$16.41
Combination - adding nonfat milk and removing cream	\$15.82

Adding nonfat dry milk appears to be more profitable than removing cream when standardizing milk for lowfat high moisture mozzarella cheese (FDM .43). However, Olson (2) stated that the addition of nonfat dry milk for the manufacture of Mozzarella cheese may be limited to 1-2%. If 1% nonfat dry milk is added and cream removed the total value returned is still more than removing cream alone. Costs of labor and time for standardization were not included in the calculations.

If properly carried out standardization can be used to achieve uniform cheese quality and composition. Standardization requires accurate sampling and analytical techniques. The results of standardization based on actual cheese composition have to be determined accurately and appropriate changes made. Generally as the level of casein increases the amount of water retained in the cheese will be higher, thus cook temperatures may have to be adjusted.

It should also be apparent from the calculations given that efficiency of fat and protein recovery play a critical role in establishing casein to fat ratios of milk for cheesemaking.

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THE CHANGING ITALIAN CHEESE MARKET

by William C. Sandwick

It is a rare occasion, when one is able to address a group that represents an industry that is setting every record in terms of market growth. Yet, this is exactly the fact in connection with the historic record, the current position and the outlook for the Italian Cheese Industry.

Against this background, my purpose today is to shed light on the reasons for this happy situation; to define the forces behind this growth, both now and in the future; and finally to suggest courses of action that can be taken to assure future success.

Because we believe it is essential in today's world to understand the changes that are taking place, we will cover the following subjects.

1. First, we will show you exactly where we see the Italian cheese industry standing today.

2. Then, we will identify the forces that are impacting on the industry.

3. Next, we will try to look into our crystal ball and tell you what we see lies ahead.

4. And finally, we will suggest some courses of action for consideration in steering a successful and safe course through the mysterious seas of the future.

Let's begin by looking at the dairy industry through the historical record of the recent past.

Slide 1

U.S. Dairy Product Consumption in Million Pounds

Product	1970	1982	% Change
Creamery Butter	898.2	897.1	-0-
American Cheese	1,401.9	2,164.9	+ 54%
Other Cheese	909.1	2,044.6	+125%
Canned Milk	1,213.8	715.4	- 70%
Non-fat Dry Milk	983.7	443.0	-122%
Milk in all Products	109,200	122,432	+ 12%

Dairy industry manufactured foods have grown in sales only 12 percent over the period 1970 to 1983. A closer look at the record reveals two vital facts. First, the phenomenal growth of the cheese market alone has sustained dairy industry sales. Second, the cheese category classified by the USDA as "Other than American Type" clearly indicates a profound shift in U.S. eating habits that is a long range one. We will return to this point later.

Slide 2

Per Capita Consumption By Type of Cheese in Pounds

Cheese	1970	1982	+/-	% Change	
Cheddar	5.9	8.7	+2.8	+ 32%	+ 47%
Italian	2.09	4.89	+2.8	+131%	+135%
Swiss	.90	1.31	+ .41	+ 45%	+46%
Brick	.10	.06	- .04	- 40%	
Muenster	.17	.31	+ .14	+ 80%	+ 82%
Cream	.63	1.14	+ .51	+ 80%	+ 81%
Blue	.14	.16	+ .02	+ 20%	+ 14%
Edam & Gouda	.11	.14	+ .03	+ 30%	+ 27%
Other	.25	.64	.39	+155%	+156%
Process	5.6	7.7	+2.1	+ 31%	+ 37%

Per capita consumption of cheese across the board, also has grown dramatically over the past twelve years. But it is very significant to note that by far the fastest rate of growth has occurred, and is still occurring, in those categories which the industry calls ethnic and speciality cheeses. Per capita consumption of Italian varieties has grown 131% in twelve years and the so-called "other" varieties grew 155%. We are definitely witnessing a trend.

Slide 3

Imported Cheese Growth in Thousand Pounds

Product	1970	1982
American	15,700	17,845
Italian	18,701	13,575
Edam & Gouda	11,799	11,414
Blue Mold	6,829	5,096
Swiss	40,303	82,041
Other	56,754	100,244
Total	150,086	230,216
Non-Quota	10,787	39,127
Grand Total	160,873	269,343

Imported cheese overall grew about 100 million pounds over the past twelve years. However, importation of Italian varieties has declined, while the "other type" category has experienced the most rapid growth.

Slide 4

Cheese Price Trend

Product	% Increase 1982 Over 1967 Base @ 100%
Consumer Price Index	183%
All Food	182%
All Dairy Products	146%
Cheese	43%

A look at the comparison of food pricing in 1982 with the base year 1967, helps us all to understand one important reason why the cheese market has grown so rapidly. While the over-all Consumer Price Index grew 183% over fifteen years and the food price index grew 182%, cheese prices averaged only a forty-three percent increase. It is a fact that margins in the U.S. cheese industry are the lowest in the world.

Having seen how all cheese, as a product category, fits into the overall dairy picture, let's take a look at Italian cheese as its growth relates to the overall cheese market. Starting with Per Capita Consumption.

Slide 5

Per Capita Consumption in Pounds Growth by Cheese Type

	1970	1982	% +/-
Provolone	.23	.47	+100%
Romano	.15	.17	+ 16%
Parmesan	.17	.33	+ 98%
Mozzarella	1.21	3.32	+174%
Ricotta	.25	.48	+ 98%
Other Italian	.08	.12	+ 50%

Per capita consumption of Italian varieties is an accurate reflection of the consumer trend to ethnic eating. From a product standpoint, this is a real growth business in the 1980's--especially when we consider that the market for the lesser known kinds is underdeveloped and we believe will more rapidly develop as this decade progresses. Per capita consumption today of Italian cheese is 4.89 lbs.; double the 1970 consumption level.

Translating Per Capita consumption into pounds, historical production growth figures are an accurate reflection of Per Capita consumption growth. Here are the 1982 pounds of U.S. production.

For the same recent 12 year period, overall Italian cheese production has grown from:

1970	393,668,000 lbs.
to 1975	671,860,000 lbs.
to 1982	1,087,781,000 lbs.

Italian cheese by product type in 1982 reached new highs.

	Type	Year	Production
1.	Mozzarella	1982	763,657,000 lbs.
2.	Ricotta	1982	110,236,000 lbs.
3.	Provolone	1982	106,534,000 lbs.
4.	Parmesan	1982	68,072,000 lbs.
5.	Romano	1982	21,492,000 lbs.
6.	Other	1982	17,790,000 lbs.

To briefly summarize the mass of statistics we threw at you:

We have seen that:

1. Cheese is the only bona fide growth product in the dairy industry.

2. The Italian cheese industry has been, and is the fastest growing segment of the U.S. cheese industry.

3. Italian cheese production growth is being fueled by a phenomenal growth in Per Capita consumption.

4. Mozzarella accounts for three fourths of the total production and has been the fastest growing type.

5. Ricotta is currently the #2 category, but Provolone will grow past it as #2 in this decade.

6. Parmesan sales are growing rapidly in accordance with the growth of popularity of Italian foods using Parmesan as a topping or ingredient.

7. The so-called "other" category is relatively undeveloped.

To complete the picture, let's review two final elements of the current status equation.

Element #1 is the geographic skew - where Italian cheese is made in our country, and the trend in numbers of plants making it.

Reflecting the cheese industry trend, generally, there are fewer plants with higher capacities each year. Also, increased competition and new technology are combining to increase the rate of production. The decline in plant numbers is not precipitous as the following figures show:

1976	191	748,446,000 lbs.
1982	179	1,087,781,000 lbs.

Where are these 179 cheese plants located? Italian cheese manufacturing plants are located in many parts of the U.S. - there are strong concentrations on the East Coast and in California, a state that is rapidly beginning to challenge for the lead in milk and cheese production. But Wisconsin is the leading producer today with 59 plants producing almost 350 million pounds in 1982.

The second element in the current picture equation is pricing and profitability. Upon learning of the historical pricing situation in the cheese industry as a whole, a disinterested outside observer would be tempted to think of it as a highly charitable one. Why? Because margins in the U.S. cheese industry are consistently the lowest in the world. Regardless of any current impact the P.I.C. Program may have tempo-rarily on this situation, the long term outlook is for more of the same.

Regrettable, the U.S. Italian cheese industry is not a noteable exception. Not all Italian cheese producers are profiting from market growth. Our own surveys clearly show trend toward unprofitability among a growing number of them. These same surveys confirm three basic reasons for the trend.

1. Low margins on Mozzarella.

2. High production costs in some operations.

3. Poor or non-existent market strategy.

So, that is the picture of where the Italian cheese industry stands today. On the one hand, it is a glowing picture of continued growth, that bodes well for the future. But on the other hand, not one person in this room would say that market growth alone guarantees the profitable future of his company.

We are living in a time of unimaginable change brought about by explosive break-throughs in the exact sciences and technology. These changes, in turn, are rapidly changing the entire demography and the lifestyle of the U.S. population. For our purposes, it is also changing our eating habits, especially what we eat.

A powerful array of forces are fueling the growth of the Italian cheese industry. As we said, the key to a successful future is:

1. To identify these forces.

2. To understand them and,

3. To act on this knowledge in the right way.

Who would like to stick their neck out and identify the one key force in bringing about the future growth of Italian cheese sales? If you said "The American Consumer," you were right on target. So let's take a look at this consumer of the 80's - who and where they are, and what makes them tick.

Slide 6

Numbers of U.S. Households

1970	63,637,721
1982	83,527,000

The total number of U.S. households over the last twelve years grew by 24% to more than 83 million. So it can correctly be stated that the market universe is much larger in the 1980's than it was at the beginning of the 1970's. It should also be pointed out that the population growth is shifting geographically. California, Texas, and Florida are emerging as leaders while New York, Pennsylvania, Ohio, and Illinois, the traditional leaders, are declining.

Slide 7

Average Size and Age of U.S. Household

	Size	Average Age
1970	3.1	28.1
1982	2.7	30.6
Projected		
1990	2.3	-0-

At the same time, the average size of the U.S. household declined from 3.1 persons to 2.7 persons. Demographers are predicting a further household size decline to about 2.3 persons by the end of the decade. As we also see, the average age went up from 28.1 years in 1970 to 30.6 years in 1982. Here again, the trend is to an older average age in this decade. People are having fewer children and living longer.

Slide 8

Household Composition Trend 1970 - 1982

Households w/married couples	+11%
Households w/children	- 2%
Single person household	+65%

Here is what is bringing about this household size change. Over the last twelve years, numbers of households with married couples grew only 11% and numbers of households with children actually declined; but numbers of households with single persons increased a whopping 65%. This is especially significant to cheese purchases and the kinds of cheese purchased as we shall see a little later.

Slide 9

Household Income Trend 1970 - 1982

Income	1970	% of Total	1982	% of Total
Over $15,000	11,203,128	18%	50,240,000	60%
Over $25,000	2,519,021	4%	30,498,000	36%
Over $35,000	-0-	-0-	22,406,000	26%

Although inflation greatly distorts the true picture, the redistribution of wealth over the past twelve years is staggering. There are today over 50 million households with annual incomes over $15,000, and the higher the income, the faster the growth rate. 26% of U.S. households have incomes over $35,000. We believe they will be at least 30% by 1990.

Slide 10

Women in Work Force Trend

1970 - 30,501,807 - 42%
1982 - 47,755,000 - 53%

One reason for this is the rise of the two income household through the rapid increase of women into the work force. Their numbers grew by 44% over the last twelve years to nearly 48 million. So we have witnessed a huge growth in numbers of households, of smaller size, with higher incomes and fewer children but a larger number of household members working.

Slide 11

Higher Education Trend

1970 - 23,367,996
1982 - 42,353,455

And, despite the current criticism of our educational system, we are also witnessing another staggering growth rate in the number of people who are better educated than ever before--nearly 50 million people today have some college education. In general, our population is better educated and better informed than ever before.

The traditional household with a working father, housewife mother and two or three children are a thing of the past. Their numbers today are a small part of the U.S. total. Cheese marketers who continue to appeal to this group are doomed to failure. Instead, let's look at the lifestyle of the new demographic majority of cheese eating households in terms of their eating habits. The old ethnic core groups are drying up and are being replaced by households that are pure American. They are the ones that we have to look at most closely.

It is a documented fact that the smaller the household, the higher the per person expenditure for cheese. In 1982 a household of five people spent 39¢ a week per person for cheese. But a household with one person spent 62¢ a week for cheese that same year. The smaller household also buys more expensive cheese.

In plain everyday language, we are all witnessing the rise of a new kind of U.S. citizen who is more affluent, even in this time of economic stress; more home related; in general, in a 25 to 55 year age bracket; who is better educated and informed than ever before; is tending to move to major cities in the West and the Sun Belt; and, above all, is tending toward gourmet, ethnic and specialty food eating. This market only needs education to keep buying more.

So, what does this new consumer have to do with the Italian cheese industry? Out of this huge consumer group, there are two consumer core groups served by the Italian cheese industry.

1. The Ethnic Italian Community - The largest % lives in the Philadelphia-New York-Boston megalopolis with additional concentrations in Chicago-California-Pittsburgh, Northeast Ohio and Miami. It is a core group that is drying-up at a steady pace. Traditionally, it was served primarily by the Italian deli trade. More recent, the action has moved to supermarkets. This group is also a major customer for bona fide Italian restaurants.

Future concentration of marketing efforts exclusively to this ethnic core group could be disastrous.

The second core group is the one we have already described. They are the future key to Italian cheese sales growth. We call it-

2. The Emerging All-American Consumer Core Group - Condensing everything we have showed you into a few statistics, it looks like this for Italian cheese.

HH Size:	2.7 Persons
Average Wage-Earner per HH:	2
Average Age:	25 - 55 years
HH Size Trend:	Down
HH Income:	$15,000+ Trend: Up
Education:	High School or Better
Location:	SMSA's 500,000+ or more

Summary

This group is into ethnic eating on the basis of a long-term roll, Italian foods top the list and pizza is only the tip of the iceberg. In general, the U.S. Italian cheese industry is not taking advantage of the opportunity this market offers. Instead, it is fighting the battle with Mozzarella as an ingredient cheese, commodity Provolone and Ricotta. It is not presently, developing new entries to develop this huge consumer market, or providing the education it needs to develop more rapidly.

The rise of a huge consumer market for Italian cheese is also fueling a second force that is a key to future success. That force is the changing way that Italian cheese is sold to the U.S. consumer. Here is a look at the distribution of Italian cheese today.

A nine month study we conducted indicates a different and changing distribution picture for Italian cheese than for cheese in general.

Slide 12

Cheese Channels of Distribution

Industrial	16%
Food Service	34%
Retail	50%

For the cheese industry as a whole, product distribution divides up as you see on this slide. 16% through industrial channels; 34% through food service and institutional and 50% through retail.

For Italian cheese, we get a far different picture. Rather than comparing all Italian cheese to the cheese industry norm, we will compare each of the major Italian cheese categories.

Mozzarella	40% Industrial	25% Retail	35% Food Service
Provolone	8% Industrial	35% Retail	57% Food Service
Parmesan	10% Industrial	45% Retail	45% Food Service
Romano	10% Industrial	45% Retail	45% Food Service
Ricotta	10% Industrial	45% Retail	45% Food Service

The high proportion of Italian cheese sales to industrial and food service is due to the hugh U.S. pizza market. Ladies and Gentlemen, that is a lot of eggs to put in one basket. If that market, levels off and begins to decline, or if Italian cheese substitutes and blends grab these markets, watch out. This distribution situation already had a profound impact on the industry because it virtually assures continuing pressure on margins.

Now to summarizewhere we are at this point, we have seen what amounts to a dynamic irony. On the one hand, we are looking at a huge and growing consumer market that is really into Italian eating and wants to know a lot more about it. But on the other hand, we are also looking at an industry concentration on Mozzarella, which in turn, relies primarily on the pizza business for its growth.

We are saying that everything depends on the changing, growing consumer market. And we are also saying that the consumer market is absolutely certain to become more sophisticated in its Italian food eating habits. That does not bode well for the future either of pizza or Mozzarella.

On that basis, future success for everyone in this room is going to depend on what you do in the next five years.

So now, it's crystal ball time. Having stuck our necks out and painted a picture of the current situation, what do we see ahead and what do we do about it?

First, we do not see quite the glowing growth forecasts for Mozzarella that some learned sources are sticking their necks out on. Specifically, here is our projection for market size in 1990 verses 1982 by Italian cheese product category.

Type	1982	1990
Mozzarella	763,657,000 lbs.	850,000,000 lbs.
Provolone	106,534,000 lbs.	182,000,000 lbs.
Parmesan	68,072,000 lbs.	110,000,000 lbs.
Romano	21,492,000 lbs.	23,641,000 lbs.
Ricotta	110,236,000 lbs.	181,890,000 lbs.
Other	17,790,000 lbs.	33,660,000 lbs.

So we are saying that during the rest of this decade we will see:

1. Continued overall industry growth.

2. A slowing of Mozzarella market growth.

3. Provolone, Parmesan, Ricotta, Romano growth at recent and current levels.

4. Accelerated growth of the "other" category.

And finally, we will also see the introduction of whole new families of Italian cheeses.

This brings us to an obligation. Having said what is and what is coming, we also have to suggest what we should do about it. Here, there are four areas to be addressed:

1. The first, is well known to everyone here - persevere with plant modernization and technological advancement to lower production costs.

2. Second, make a consistently high quality product. Today's consumer is more quality conscious than ever before and will become more so as time goes along.

3. Third, consider the possibility of product and distribution diversification. We realize not everyone can do this. Every company is different. Nevertheless, this is an area of survival for some and of added profitability for others. We are saying product innovations are a must.

4. Finally, unless you are exclusively a supplier to other Italian cheese marketers and have no control over your program, give your line an authentic Italian look and gear the support program to consumer education.

Describing what to do is the easy part. How to do it is the hard part. And it is the part that has to be addressed on an individual basis. We'll try to field some of it in answering your questions.

The following paper was presented by Donald L. Wallace, Ph.D., Manager, Quality Assurance and Lab Services, Marschall Products, Miles Laboratories, Inc., P.O. Box 592, Madison, Wisconsin 53701, at the 21st Annual Marschall Invitational Italian Cheese Seminar, held in the FORUM Building of the Dane County Exposition Center, Madison, Wisconsin, on September 12 and 13, 1984.

CHYMOSIN IN PERSPECTIVE

By Donald L. Wallace, Ph.D.

The importance of the chymosin/pepsin ratio of calf rennet to the cheesemaking process continues to be unclear. In order to gain perspective on this issue, the following will be discussed: rennet preparation, content and value; milk clotting; chymosin and pepsin characteristics and action; curd rigidity and yield; cheese quality; chymosin determination; and cloned chymosin.

The chymosin/pepsin ratio in calf rennet has been in the limelight for a few years now and it still is not clear what total significance it has in cheese manufacture. Chymosin certainly has been in vogue but the "jury remains out" on the real importance of it when the entire cheesemaking process is taken into consideration. Perhaps there are certain milk supplies, types of cheeses, processes or types of equipment that tend to make high chymosin/pepsin ratios more important. There may be no one single answer to these questions and I will not be able to provide answers in this presentation but, hopefully, some appropriate perspective can be brought to the subject. This is important so that you do not waste time on something that is of no importance to you. We also believe that it is important for you, the cheesemaker, to be as knowledgeable as possible about the various cheese ingredients so that you can adjust to the changing times in the industry.

To get into this subject, some definitions and background are necessary. Obviously this discussion pertains only to calf rennet and its enzyme makeup; therefore, in this paper the term rennet will mean calf rennet.

As you know, rennet is obtained by aqueous extraction of the fourth stomach of the young milk-fed calf. The extract is concentrated, standardized and packaged. The two proteolytic enzymes in rennet that clot milk are chymosin and bovine pepsin. Unless specialized, expensive fractionation procedures are used, they will both be present in calf rennet. Chymosin is the principle enzyme that coagulates milk and assists milk solids movement through the digestive tract of the young calf. The primary reaction catalyzed by this enzyme is the hydrolysis of Kappa-casein into two products -- para-Kappa-casein and glycomacropeptide -- by cleaving the phe(105)-met (106) bond. Since there are many proteins in casein, you can see that the action of chymosin is very specific at the milk-clotting stage. General proteolysis by chymosin is believed to be relatively low but measureable and clearly present.

Bovine pepsin is a proteolytic enzyme that also clots milk but is less specific than chymosin. However, studies have indicated that bovine pepsin is only slightly less specific than chymosin which probably accounts for the partial success of bovine rennet on the market. This would also suggest that relatively minor variations in rennet pepsin content would be very difficult to reliably demonstrate in cheesemaking. Pepsin has an optimum pH of about 2 whereas chymosin is about pH 5.0 so as cheese milk becomes sweeter due to improved sanitation and milk handling programs, the contribution of pepsin to clotting is eroded. At the pH of milk at setting, however, pepsin activity is more proteolytic than chymosin in relation to its clotting activity. It is not clear whether this difference is significant in relation to the type of set resulting and to cheese yield.

Milk-clotting is believed to take place in two phases -- a first phase involving the enzymatic action on Kappa-casein and a second phase (nonenzymatic) in which the curd is formed in the presence of calcium ions. The impact of chymosin and pepsin on clotting is primarily due to rennet strength or enzyme activity rather than the ratio between these enzymes. It is important to use an amount of rennet that results in proper control of the make procedure.

There are those who maintain that a higher chymosin level results in a higher yield of cheese. It is not clear what, if any, direct relationship there would be between chymosin content and fat losses in the whey -- which is what some plants base their conclusions on. Curd rigidity at cutting long has been shown to influence retention of fat but so many factors influence curd rigidity that it becomes extremely difficult to sort out what factors might be causing variability. The following are some of the items that can cause variation in curd firmness: refrigerated storage of milk, breed of cow, method of milk standardization, acidity, heat treatment, calcium, casein, inorganic salts, fat to solid-not-fat ratio, temperature of set, and rennet strength (1). Operations that cut at a constant time are particularly susceptible to curd firmness variability for obvious reasons. Chapman and Burnett (2) found that objectively measured curd firmness varied three-fold when a fixed time was used for cutting.

Yield studies are difficult to do and require detailed record keeping. For instance, in order to cancel out as many of the variables as possible, one should do these studies over a period of time alternating the rennet source several times using a blind study design and recording all the parameters, including amount of rennet used. Elevated chymosin levels have not stood the test of time yet as to contribution to cheese yield. When the studies are properly done, chances are very good that there will not be a consistent, statistically significant difference in rennet products that are of standard strength and vary 5% in chymosin content (i.e., 85% vs 90%). Additionally, because such small yield differences are involved, the resolution of this issue will probably come from plant experience rather than the research laboratory.

The total amount of chymosin added to cheese milk probably is more important than the ratio of chymosin to bovine pepsin. Since there are about

82 mg of chymosin per 3 oz. of standard strength calf rennet, one can calculate the amount of chymosin being added from the strength and percent chymosin. This approach may allow evaluation of rennet performance on a more sound basis. Again we can see that rennet strength is an important factor that must not be overlooked.

Another important factor is the development of cheese flavor. It would seem that since bovine pepsin is more proteolytic than chymosin, flavor development would be favored by a balance of chymosin and bovine pepsin. We all know that the development of flavor in cheese is a rather complex, poorly understood process. Milk in recent years has continued to improve in quality and the cheese plants are getting larger, more efficient and more sanitary. At the same time, the development of flavor in cheese seems to be slower than ever. Could it be that by pushing milk quality higher and higher, improving plant sanitation to unparalleled levels, and raising chymosin requirements, cheese flavor is changing and a certain price is being paid in the market place? An interesting point to ponder.

Now back to rennet extract for a moment. Many things affect rennet extract composition. One of the primary things is the age of the calf when slaughtered. As the calf gets older and switches from milk-fed to solid feed, the chymosin/pepsin ratio changes from one of high chymosin to one of low chymosin. It is also known that the time of day of slaughter can affect the rennet content as can the handling and storage of the stomachs. Suffice it to say that most of these factors are beyond the control of the rennet manufacturer. Therefore, the rennet obtained is difficult to predict and control from a chymosin standpoint.

The supply of calf stomachs is limited to such an extent that only a small proportion of cheese made today is made from calf rennet -- the remainder being made from microbial rennet. It is a practical reality that the value of rennet will go up considerably if the stomach supply must be further limited to only the very premium stomachs. If the other approach of eliminating pepsin from the extract through processing techniques is taken, the rennet selling prices will further increase because the pepsin clotting strength is being lost and processing costs are being added. In the last couple of years rennet prices have fluctuated widely as the demand for rennet changed. From long experience we know that relatively minor shifts in trends in the calf market and/or the rennet demand rather quickly moves the vel prices up or down significantly.

A brief discussion of the testing for chymosin and pepsin is in order at this point. Testing for chymosin and pepsin content of rennet involves procedures which are not usually done in a cheese plant laboratory. The test most often talked about and used at this time is the International Dairy Federation chromatographic method for the "Determination of Chymosin and Bovine Pepsin Contents". Preparation of buffers, dialysis, column chromatography and clotting strength determinations are used in this test. These are relatively complex procedures from the standpoints of understanding how they work and trouble-shooting procedural problems. Therefore, laboratories that do not have personnel trained in the principles involved in these procedures probably experience difficulties and inconsistent results.

There are two distinct phases to this test -- the chymosin/pepsin separation by chromatography and the determination of the clotting strength of the resulting chymosin and pepsin fractions. In the separation phase, special buffers are prepared at specific concentrations and pH in order for the column chromatography to function properly. The column material (DEAE cellulose) is equilibrated with buffer, loaded into the column, and allowed to pack and equilibrate. At the same time, the rennet sample is carefully put into dialysis tubing and dialyzed against buffer. Dialysis is a means of changing the rennet from a salt solution to a buffer solution so that it can be applied to the column. After the dialyzed rennet is applied to the column, a pump is connected and, using buffers of different salt concentrations, chymosin and pepsin are successively eluted.

These fractions then are tested by the Berridge assay for clotting strength to determine the proportion of each enzyme present in the original rennet sample. This phase of the testing also requires knowledge and experience to reliably perform it because the milk substrate plays such a critical role as do pH, temperature and relative enzyme concentration.

Although results within one laboratory may be quite reproducible, results from different laboratories can show considerable variation -- as much as $\pm$2-3% from the mean. Accordingly, chymosin results should not be viewed with too much expectation for accuracy either within or between laboratories.

Now you may ask what is the optimum chymosin content or what do we recommend it to be? As I indicated earlier, there is no complete answer for that at this point. In certain European countries, chymosin contents are closely regulated and 80% chymosin is considered to be excellent and seems to work best in their soft cheeses. Certainly by comparison, almost all US rennet would be of premium quality. It seems, however, that since some manufacturers believe that higher-than-normal chymosin levels are beneficial, there will be continued interest in this concept. It will be interesting to see what the ultimate answer is on this issue.

Another possibility in this area is the development of cloned calf rennet. Since it will be theoretically possible to produce 100% chymosin, it will be interesting to see how it performs. Many companies are actively involved in the quest for such a product but some considerations and/or cautions are in order. Cloned chymosin can be and has been expressed. However, expensive purification and recovery steps are necessary which will have a large impact on commercialization. The effect of cloned rennet on cheese quality must be evaluated since many enzyme preparations will clot milk but very few yield high quality cheese. Last but certainly not least, regulatory approval of such a product is by no means assured, it depends on the data and the regulatory stance taken on cloned products. It will be most interesting to follow the course of events.

Certainly many questions need yet to be resolved in the chymosin issue. However, most of the issues have been raised and perhaps some perspective has been gained.

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The following paper was presented by Mr. Werner Kofoed Nielsen, President, and Mr. Pedro J. Tortosa, Pasilac Inc., 660 Taft St. N.E., Minneapolis, Minnesota 55413, U.S.A., especially for the 21st Annual Marschall Invitational Italian Cheese Seminar, held in the Forum of the Dane County Exposition Center, Madison, Wisconsin, on September 12 & 13, 1984.

ULTRAFILTRATION

An Accepted Process in the Dairy Industry

By W.K. Nielsen and P.J. Tortosa

ABSTRACT

Ultrafiltration of milk represents the first real innovation in the history of cheese making, offering substantial advantages to both manufacturers and consumers.

Ultrafiltration of whey is an effective means of revaluating the by-products of traditional cheese manufacturing while providing new and valuable sources for food formulations.

The various applications for ultrafiltration in the industry are reviewed with special attention given to the cheeses on the American market.

The results of a recently commissioned plant by Pasilac at Ridgeview Foods Ltd., Whitehall, Wisconsin, complements the information presented in this paper.

INTRODUCTION:

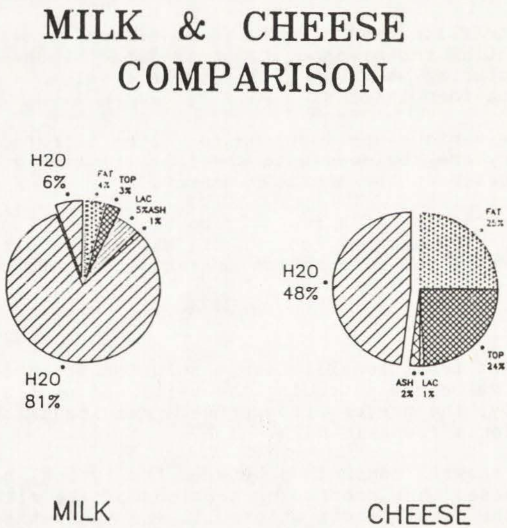
Cheese has traditionally been a solution for preserving the nutritional value and extending the utilization of milk. Unfortunately, the preservation process results in the loss of some of the nutrients found in milk.

Fig. 1 shows a comparison between the typical compositions of milk and cheese. The protruding sections of the milk diagram represents the constituents which will end up in the cheese. The remaining constituents are lost in the form of whey. These losses have a considerable impact on the economics of the processing operation. The potential for reducing loss is of keen interest to the manufacturer.

If, in the effort to increase the yield of the cheese operation, the consumer benefits by greater nutritional value and/or a better price, then the process is certainly of considerable interest.

Let's focus again on the composition of milk and cheese. What are the differences and why do these losses occur? (Fig. 1)

The most obvious difference between milk and cheese is the moisture content. Approximately 93% of the water found in milk must be removed for cheese production. Carbohydrates, vitamins, minerals and any other soluble substances will be included in the water as part of the loss.



(Figure 1)

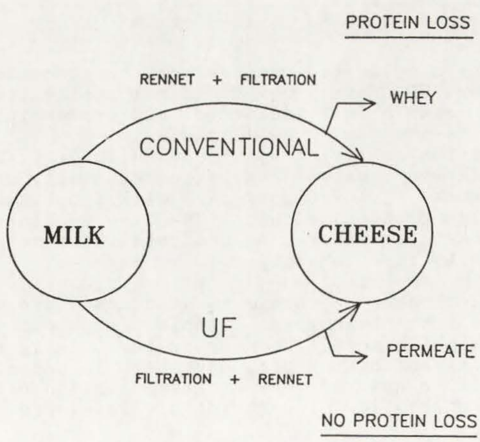
The majority of the non-soluble constituents will remain in the cheese, as well as approximately 7% of the total amount of water, due to the traditional method used to fractionate milk constituents (Fig. 2), which include:

1. BIOCHEMICAL ACTION on the proteins making them insoluble and trapping the fat and water required for cheese, followed by

2. PHYSICAL FILTRATION of the curd (fresh cheese) and removal of the whey.

The filter media traditionally available for processing required increasing the size of the milk particles to be retained, thus introducing the necessity for enzymatic action on the proteins. Once the network of proteins has been created, it will trap the fat globules and some moisture, generating curd particles large enough to be separated by conventional methods. The drawback to this method is that not all the proteins in milk are sensitive to rennet action and about 20% of the protein remains soluble ending up as whey, the by-product.

Looking at cheese production from this standpoint, it becomes obvious that another method by which to fractionate milk constituents and thus retaining more proteins and fat would be highly desirable. This method is, precisely, the contribution of ultrafiltration.



(Figure 2)

Newly developed membranes with a "pore" size small enough to retain protein molecules and fat globules, while allowing smaller molecules such as lactose, minerals and water to pass through, have created a whole new era in cheese production. Basically, the manufacturing process remains the same with the exception of the sequence of operations.

For cheese production by Ultrafiltration (UF), the sequence is, as follows:

1. PHYSICAL FILTRATION through the UF membranes to retain proteins, fat and required moisture.

2. BIOCHEMICAL ACTION on the proteins by rennet and culture to obtain the desired proteolysis and final body, as well as the structure and functionality required by the consumer.

This new approach to cheese manufacturing is nothing more than a simple change in the sequence of unit operations. It is made possible by newly developed fractionating techniques based on the sanitary membranes and modules able to operate at high viscosities. This offers the following advantages:

a) To the manufacturer:
- Increased yield
- Better process control

b) To the consumer:
- Higher nutritional value
- Better price

APPLICATIONS:

Ultrafiltration (UF) of whey:

For reasons of simplicity, urgency and the economics of solving a disposal problem, UF of whey was the first application of membrane fractionation to reach a full industrial and commercial scale.

The whey proteins recovered by UF in the form of Whey Protein Concentrate (WPC) have created a whole new commodity market in the low range of products (35% WPC), as skim milk substitutes. At the other end, the high protein products (75-80% WPC) constitute a sophisticated market of tailor-made products where nutritional value has been replaced by functionality.

A considerable number of cheese manufacturers are using this technique to revaluate their whey. Simple UF systems work well with low protein WPC's while more elaborate systems, designed to cope with more demanding and high WPC's, have been in use since the mid-70's. As a result, a new and very exciting liaison between the dairy and the pharmaceutical industries has developed.

Pasilac has played a substantial and important role in establishing UF as an accepted industrial process in the dairy industry. First, with worldwide recognition of process systems for medium and high WPC's and now with a new approach to cheese making by UF. The result is more than 10 plants producing different types of cheese by UF around the world. Soon, a highly sophisticated Pasilac dairy complex will be put on line in Corona, California, by Express Foods Inc., as a further development of their successful operation in Fairfax, Vermont. Other profitable plants in New Zealand and Europe offer clear examples of the new and exciting horizons open to the dairy industry through ultrafiltration.

Ultrafiltration (UF) of milk:

There are three basic applications for UF of milk:

- Protein standardization
- Preconcentration (1:2)
- Total concentration (1:5 to 1:10)

Protein standardization is a very simple process technique with modest equipment requirements and minimal capital investment. A few of the benefits realized with this process are better organization of the cheese operation and a more uniform final product.

Preconcentration of milk, generally about 1:2, is somewhat more capital intensive, yet can be used for a wide variety of cheeses. This offers a number of solutions for increasing throughput, and the requirement for less floor space. This technique is not yet as common but is sure to become more popular in the marketplace .

Total concentration is the ideal application for UF. It is capital intensive but offers the highest return on investment. This system was first introduced in Denmark in the late 70's and since that time has revolutionized the way cheese is made (feta, for example).

CHEESE AND ULTRAFILTRATION IN AMERICA:

The American market, with its ethnic variety and diversified population, constitutes an important prospect for the new technology in cheese production. Recent developments in ultrafiltration membranes and especially ultrafiltration modules, capable of operating on the conditions posed by highly concentrated retentates (50% T.S.), offers many real solutions to the market. For example, the demands for Latin cheeses such as the Spanish-type queso fresco or queso blanco and the Italian-type ricotta and mozzarella are perfect for UF processing. Fresh cheddar for manufacturing is also being used today for UF cheese production. In addition, monterey jack-types of cheeses will soon be made by the UF process.

During the next five years, we will experience an in-depth restructuring of the dairy industry due to the increased availability of better ultrafiltration systems. The impact of UF will be felt on the farms, at the collection points and milk intake stations, at the cheese production plant where UF has the most to offer, and ultimately for the consumer at the supermarket.

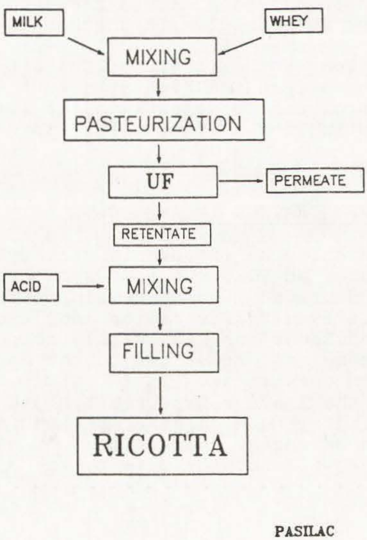
Ultrafiltration retentate powders and fractionized protein and nitrogen compounds will open new doors to the dairy industry in offering interesting links for other food and pharmaceutical applications.

The American spirit, with its foundation in entrepreneurship, is leading the dairy world in accepting ultrafiltration for Italian and Latin cheeses.

The remainder of this paper is a concise review of how some cheeses are actually produced in America using ultrafiltration techniques.

1. Ricotta

Milk is ultrafiltrated with a reduction to 15-20% of its original volume. The retentate is heated and the pH is adjusted for protein flocculation. UF offers several major contributions to the ricotta manufacturer, including an 80% reduction of required heat, a sweet permeate versus an acid whey, and a very smooth final product.



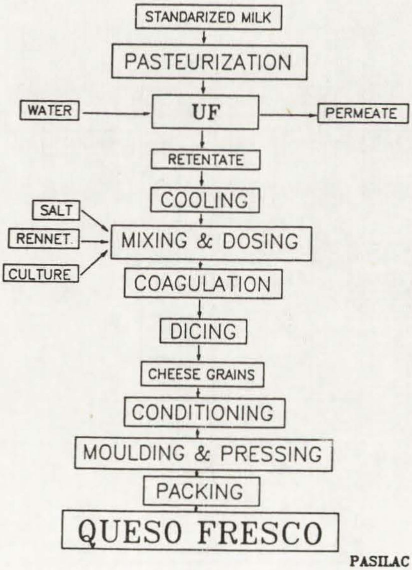
(Figure 3)

2. Queso Fresco

This is a fresh cheese which is non-acid, slightly salty, white and soft with granular structure and a smooth cutting surface. The flavor is fresh, pure, and not acid tasting.

The moisture content of queso fresco is 55%, with a 40% fat content in solids and approximately 2% salt. This fresh cheese has a pH of 6.2.

The process, as illustrated in Fig. 4, consists of ultrafiltering cheese milk which has been previously standardized and pasteurized. The retentate is cooled to the renneting temperature and mixed in-line with rennet and sometimes sodium chloride and culture. Coagulation occurs in a specially designed continuous coagulator. After coagulation, the curd blocks are diced, the grains are conditioned in a permeate bath, and cheese blocks are formed by molding and pressing as in the same manner as conventional methods. Appropriate packing and distribution provide a product with considerably extended shelflife and an increased nutritional value. A typical yield in this operation is 5.5 pounds of milk per pound of cheese.



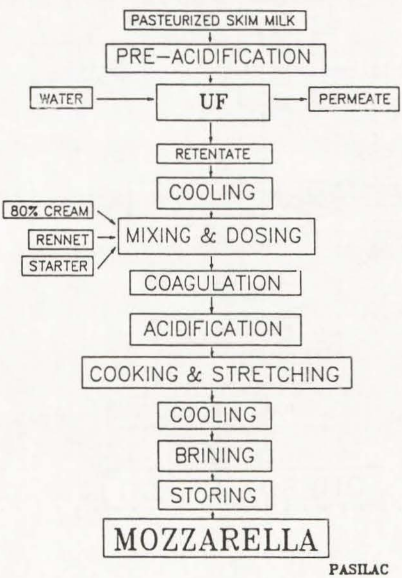
(Figure 4)

3. Mozzarella

In 1983, 862 million pounds of low moisture, part skim mozzarella were produced, accounting for 72% of the total Italian cheese production. This is a dramatic increase of 13% over the previous year.

Low moisture, part skim mozzarella is perhaps the most interesting application for ultrafiltration. Due to the functionality of the product, the process starts with cream separation. The skim milk is pasteurized and pre-acidified prior to the ultrafiltration in order to obtain the correct fractionation of all constituents (Fig. 5). The retentate is then mixed with the highly concentrated cream, culture and rennet. The coagulation takes place in a continuous coagulator specifically designed for this application. The fresh curd enters a continuous acidification unit which then feeds into a conventional cooking and stretching machine. The cheese is then cooled, packed and stored in a traditional manner. A consumption of approximately 8 pounds of milk for each pound of cheese is achieved.

The continuous process with computerized controls, reduced labor requirements, and a highly uniform product are several reasons why ultrafiltration provides such an excellent return on investment.



(Figure 5)

CONCLUSION:

Ultrafiltration has surpassed its first decade in the dairy industry. From its initial steps of low concentrating of soft cheeses to the modern designs of membranes and modules for high concentration, much has been accomplished. Many of the technical problems in materials and designs have been solved. Obsolete standards have been updated in most countries. And today, we can say without a doubt, ultrafiltration is an accepted process and the future of the dairy industry.

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The following paper was presented by Gerry Durnell, Editor of Pizza Today Magazine and Director of the National Association of Pizza Operators, P.O.B. 114, Santa Claus, IN 47579, USA, (812) 544-2608, especially for the 21st Annual Marschall Invitational Italian Cheese Seminar, held in the Forum of the Dane County Exposition Center, Madison, Wisconsin, on September 12 and 13, 1984.

THE FUTURE OF PIZZA

by Gerry Durnell

ABSTRACT

The impact of change and the challenge of the future of pizza have never been more pronounced than today. We have witnessed space age technology and materials incorporated into labor saving pizza production equipment capable of producing more product for less labor and less overhead dollar. In addition, an almost insatiable consumer demand for pizza products and services have created simultaneous and abundant marketing opportunities for the Italian Cheese Industry as well. In order to maximize this potential...to seize this once in a lifetime golden opportunity, it is necessary to understand the dynamic components of the American pizza market, its constants as well as its variables, its constraints as well as its freedoms, its fads versus its trends...because in so doing we can achieve an exact awareness of its potential. It is within this delicate and complex framework that the future of pizza lives and grows. Likewise; so lives and grows the future of Italian cheese in America and the world.

Introduction

Being involved in the pizza business in this decade in America is much like being a part of the "Golden Ages" of former times, a renaissance if you will, when technology and knowledge are at their zenith, blending together to meet the growing demands and appetites for pizza products and services.

Today, pizza is a multi-billion dollar business, the rising star of the 80's...a durable growth industry that is truly a trend rather than a short term fad...a nutritious food product that is affordable and provides an abundant value for the money...a convenient product that if you can't get to it...it will come to you. Best of all, it's taking along the Italian Cheese Industry for participation in an exciting economic future of continued growth and increased product demand.

In order to seize this once-in-a-lifetime golden opportunity of renaissance proportions, it is necessary to understand the dynamic components of the pizza market, its constants as well as its variables...its constraints as well as its freedoms... its fads versus its trends. Because in so doing, we can achieve an exact awareness of its potential. It is within this delicate and complex framework that the future of pizza lives and grows. Likewise, so lives and grows the future of Italian cheese in America and the world. Yes, it's an exciting time to be a part of the pizza business.

Part of the reason for excitement stems from the fact that American pizza has never been more popular. At home, recent Gallop polls place pizza as the favorite take-out food and internationally even the Russian tastes lean toward the satisfying offering of pizza. According to a recent report from Nation's Restaurant News, "In an unusual example of East-West detente, a group of 28 Russian scientists and 115 crewmen from a Soviet research ship were recently treated to 170 pizzas by the 16 American scientists at Dutch Harbor, in Alaska's Aleutian Islands."

Who catered the communists' party? None other than America's biggest corporate pizza maker--Pizza Hut.

It all began when the Soviets decided to cap off a successful, five-week joint ocean-ograph mission with the Americans by treating them to a traditional Russian dinner of pelmeni (a meat pie).

The Americans, wishing to reciprocate, asked their Russian hosts what they'd like to eat. To a man (and woman) they said, "Pizza!"

Pizza Hut president Art Gunther got a call from the U.S. Fish and Wildlife Service, asking whether such a precedent-setting pizza party could be arranged. Gunther couldn't refuse.

Before long, eight pizza-preparers from Pizza Hut's Seattle stores were on their way to Alaska, bringing with them a 1,000 lb. oven, 25 lb. of green peppers, 25 lb. of onions, 100 lb. of cheese, 250 lb. of flour, 15 lb. of mushrooms and 145 lb. of pork, beef, Italian sausage and pepperoni.

The ingredients were used to make Pizza Hut's everything-on-them Super Supremes. Spokesman Mike Jenkins recalls, "They ate every bit of it."

Closer to home, following the Academy Awards presentation this year, Hollywood stars retreated not to the usual posh club settings such as the Brown Derby for refresh-ment and libation, but instead went to a modest pizza spot named Spago's run by gourmet pizza chef Wolfgang Puck. At Spago's you'll find fresh pizza made with buf-falo milk cheese and topped with light seafood toppings such as crab or shrimp and cooked in the intense heat of a wood fired open-hearth oven.

It's a part of a national trend, this flight to quality. Investments are going to the developments that feature upscale menu offerings and an escape from the plastic fast food world. Such offerings as deep dish pizza, stuffed pizza, double decker pizza and in-store, "real ingredient" take-and-bake specialties emerging from super-markets and delis are on the grow.

For the most part, the traditional fast food franchise segment is leveling out, any real growth commensurate with population increases and inflation is going to have to come from increased services such as delivery or catering, different products that run the fad gambit, (quick-in, quick-out) and that, at best, is merely tread-ing water.

Frozen pizza, formerly a product that was better cast aside and the colorful box it came in cooked and eaten, has undergone substantial change. According to a recent Wall Street Journal article on trends in the frozen dinner market, quality frozen dinner sales are rising an estimated 5-7 percent a year with a projection of achieving a $200 million share of the market in a few years. Now it'a a fact of business life, there is a market willing to pay for quality and it provides its own rewards. As Jeff Carpenter, Executive Vice President of Marketing and Sales for Jeno's, Inc. noted in a recent guest editorial in Quick Frozen Foods magazine, "In the past, authentic taste and quality were the reasons for consumers to spend the extra effort and money to get a take-out pizza, but this has changed. Today, the quality and flavor profiles of frozen pizza have improved significantly, especially the premium brands such as Chef Saluto, Tombstone, Tony's, and Jeno's new entry, Colombo's." There is always room for something better, something really new and improved not just a new box or product logo but a genuine change of pace and taste.

After all, pizza is many things to many people...a quick snack after a ball game or movie, affordable and nutritious, gourmet in appeal, or simple fast food fare. Picked up, eaten in, or delivered piping hot to your door, pizza has now become the mainstay favorite of all America. Just the word pizza conjures mental images that represent all the senses replete with an outstanding visual presentation, delicious taste, distinctive aroma and a hot unique texture that crackles under the swift movement of the pizza cutter as it emerges steaming from the oven and underscores our lives in an epicurean manner at milestone intervals in different ways. It is a very personal thing resplendent in variety and flair. In fact, it is this capacity for variety and embodiment of regional flavor that enables the continued growth of pizza.

A significant challenge for the Italian Cheese Industry is to continue its growth pattern associated with the pizza business. In that regard I have three positive action suggestions:

1. Educate the pizza market as to the uniqueness, opportunity for profit and potential increased business the use of Italian cheese offers. A program similar to the successful "real cheese" campaign educated both the buying public and the pizza proprietor. That kind of harmony is mandatory for success.

2. Market Italian Cheese in an upscale manner. Yes, the best costs more but the American consumer is now willing to pay for the best.

3. Participate in the "leading edge" seminars such as the Pizza Think Tank series and NAPO pizza makers upgrade sessions. Involvement is a key component of vital industry information exchange and a head start on correct market planning and strategy.

Obviously, there isn't any magic in these approaches. They all cost time and money but the potential for return is very high and meritorious of your careful consideration. The positioning of risk vs. rewards weighs heavily in favor of becoming more actively involved in the pizza marketing business.

Although much newer on the scene than its fast food competitors of hamburgers, hotdogs or fried chicken, pizza has a unique challenge of maintaining its growth and with superior product flexibility, matching the sometimes fickle demands of a constantly changing demographic profile with an "on target" product time and time again.

To understand that challenge is to understand the population swings taking their place both now and in the future. Dr. Owen Fennema, Past President of the Institute of Food Technologists, Professor of Food Science at the University of Wisconsin, and

1983 member of the Pizza Think Tank team, observed three demographic factors of major importance that will affect the pizza industry: projected changes in age groups as a percent of the total U.S. population, urbanization, and working women.

AGE GROUPS: Pizza is a very age-stratified food commodity that has its greatest popularity in the 4-54 age bracket with pronounced peaks during teenage years, college, and young family development. During the course of Pizza Think Tank '83, significant time was allocated to identify the trends that are currently working in the pizza industry. Who is buying pizza today? Who will buy pizza tomorrow? In a comprehensive article in January's 1983 issue of Food Technology, Dr. Fennema noted the following trends of interest.

1. The U.S. population is predicted to grow to 260 +/- 20 million from the 1980 value of 227 million. Thus, the total requirement for food will increase.

2. The under-5 age group is projected to increase in number and as a percent of population until 1990, after which both values will decline.

3. The 5-13 age group is projected to increase in number but to remain essentially constant as a percent of the population.

4. The 14-17 age group is projected to decline in number and as a percent of the population until 1990, after which both values will increase.

5. The 18-24 age group is projected to decline in number and as a percent of the population.

6. The 25-34 age group is projected to increase in number and as a percent of the population until 1990, after which both values will decline.

7. The 35-44 and 45-54 age groups are projected to increase in number and as a percent of the population. Since individuals in these groups generally possess moderately good incomes, a favorable influence should be observed for restaurant patronage.

8. The 55-64 age group is projected to decline slightly in number and as a percentage of the population until 1990 after which both will increase slightly.

9. The 65-and-over group will increase in number and slightly in percentage. The most rapid increase in this group is projected to occur after the year 2000.

URBANIZATION: By its nature, it increases the distance between areas of food production and areas of food consumption, thereby increasing transport time. Since this is dealt with sufficiently by the pizza industry on an everyday basis at this time, there should not be a significant market impact affecting the pizza industry other than an increase in interurban services such as delivery.

WORKING WOMEN: At this time, more than half of the working age women in the U.S. have careers. The trend is for a continued increase which, in turn, will cause significant increased demands for convenience foods such as pizza and associated delivery services. The result? Both standard fare pizza and gourmet pizza lines will continue to grow and that growth will include pronounced increases of Italian cheese.

As we see, the census numbers paint a picture of opportunity and challenge. There are more people eating out more often and the prime pizza eating market is larger than ever before; that's the opportunity. The challenge is to continue to provide products and services to this segment of the market as it predictably grows while simultaneously serving the segment of the population over 55, a time in life when eating habits do not traditionally include the routine visit to the neighborhood pizza parlor.

Incidentally, the influence of government cannot be overlooked in our review: with the ability to tax, tariff, legislate, regulate, manipulate and yes, sometimes even bureaucratically constipate our business affairs, government looms large as a Jeckyl and Hyde influence...sometimes friend, sometimes foe.

Remember the movie "Network" where the newscaster urged his viewers to run to their windows, throw them open and yell, "I'm mad as hell and I'm not going to take it anymore"? Well, as inappropriate as that may initially seem, it is exactly what must be done.

Informed and aware business people in this country and this room must take the initiative to let their opinions be heard and stand behind their convictions with votes that we either cast or influence in order to establish and maintain a fiscal responsibility in Washington. Let me count for you some of the reasons why "I'm mad as hell and I'm not going to take it anymore":

Whenever a "loafer" or "bum" can make more money dodging work and collecting welfare than the honest people in our pizza shops or cheese enterprises we try to inspire and motivate to work hard and do a better job.

Whenever I see a good business plan calling for new equipment for needed expansion denied funding because the Federal government is draining the availability of money in the marketplace and thereby making expansion capital unaffordable.

There are lots more but let me encourage you to obtain some other facts and opinions. After all, because of the magnitude of the problem, it's easier to dwell on the concept of who's responsible for making the mess than to spend time on cleaning it up. I suggest we discard the idea of Democrat or Republican labels. Remember, we're here to solve the problems, not point the finger of blame. There is not enough time to do both. The basis for our action must be starting fresh and devoting all our energy and action to the solution.

As businessmen in America, whether in pizza or Italian Cheese, we should never let our elected government employees forget who pays their salary and who (through votes) gave them the job in the first place. The situation is like a business turn-around scenario. We are on the board of directors of a company (country) in trouble. We must tightly control expenditures and insure that all employees do their part. If they don't we fire 'em and with no regrets, I might add. Unfortunately, we only get the chance to fire and hire members of Congress and other government entities every two years...but fortunately, this is one of those years. If they are in office now, write them a letter and demand to know where they stand.

If they are not willing to make a commitment, stay with them tenaciously until they do.

If they won't take the responsibility, elect someone who will.

If they are behind the idea of budget correction, support them because they're bound to be receiving fire from the other side and they need all the reassurance and help they can get.

It is an urgent matter and one that merits immediate attention because the potential rewards are worth the involvement. It's a great feeling to be a part of such a dynamic industry. Simply stated without undue ego inflation, we are the best in the world at what we do. Unlike the automotive industry, steel manufacturers, and shoe makers, the United States pizza industry dominates the market. We do pizza better in more configurations, more volume, in more places than any other country in the world. And that is leadership.

Part of that excellence in leadership comes from the simple, yet often overlooked basic fact that most of us enjoy what we do...we like our work...that is so important. I pity the long-faced rush hour traffic crowd, hurrying to a place they don't want to go, accompanied and surrounded by people they don't like, doing work they detest for a pay they consider insignificant and later on in the evening, rushing to a neighborhood tavern to forget the day's activities and numbing the senses for facing the next day...yet more than 80% of the work force in America are not content with what they do. By contrast, there are people in this room that have never worked a day in their life... they were busy...they were productive...but like Thomas Edison, they learned a long time ago, the true riches of the world come when you are doing what you like to do, doing it better than your competitor, and earning money in the process...

I love my work as I suspect many of you do. I look forward to going there and often neglect to watch the time to go home. I wouldn't have it any other way.

The future of pizza and the Italian Cheese Industry is very bright as attested to by the several examples I have shared with you this morning. It may not be the same in the year 2000 as we know it now. In fact, as one sage observer noted, the only certainty is change. We've seen it happen with numerous examples. Once healthy, profitable industries are now relics of the past with numbered days of even token existence. Look what happened to the railroad industry, the corner drugstore, movie houses, carbon paper, slide rules and roadside diners.

The pizza industry along with Italian Cheese Business is not an island. We too, must stretch and flex, accommodate and modify and, yes, even change if it means survival. And it does. The future is too important to be left to chance. This isn't the sort of task we ask government at any level to do. To paraphrase the famous comic character, Pogo, "we have met the remedy, and it is us."

We have too much of our future, fortune and fortitude on the line to gamble with potential bureaucratic bungling only to have a dead dinosaur, that we formerly knew by the name of pizza dropped on our front lawn with the burden of disposal squarely in our laps (all according to EPA and OSHA standards). That's one funeral none of us wants to attend.

And so it is we look to the future. We make plans, take samples, and continually update the process. We aggressively impact the factors that are within our control and minimize the worry and concern associated with the factors that are not.

The underlying premise of my concept is simple and two-fold. First, the future can and must be explored. Second, the future cannot be predicted exactly or accurately because of the many unknowns. However, by either action or inaction, decision or indecision, and technological discoveries, we are creating our own future. And since we are, we can be in partial control. Additionally, if we are among the first and best informed we will be prepared; because the future, like chance, favors the prepared mind.

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Paper No. 1984- 7

The following paper was presented by Max Wiedemann, Project and Sales Manager, ALPMA Hain & Co. KG, D-8093 Rott/Inn, West Germany, especially for the 21st Annual Marschall Invitational Italian Cheese Seminar, held in the Forum of the Dane County Exposition Center, Madison, Wisconsin, on September 12 and 13, 1984.

CONTINUOUSLY PRODUCED MOZZARELLA BY IMPROVING YIELD AND QUALITY

By Max Wiedemann

ABSTRACT

In 1976 the ALPMA company well-known for cheese packaging machines and cheese equipment introduced a world sensation on the market for equipment. This machine was created to produce cheese curd continuously. Originally designed for Camembert and other fancy European cheeses it was modified also to give advantages in producing continuous Mozzarella and Cottage Cheese curd. Presently it is the only industrial size machinery having the flexibility to make out of a seasonally changing raw material a constant quality by improving the yield.

Introduction

Since cheese production increased substantially in recent years the idea to work continuously for cheese production became more and more important.

Examples were given very early by pasteurizing the milk and for several years it is a fact that butter is produced continuously. The advantages of such a method of production are easy to understand:

less people involved
no changes of batches
less losses
constant quality

Several engineering groups tried to develop a continuous system since 1920, but most of the ideas failed with the fact that milk must be absolutely quiet during coagulation.

But is it really worth an experiment with new equipment after such a long time which was needed to develop a high quality?

Description of the Machine

The answer is the ALPMA-Coagulator.

The Coagulator consists of a long semi-circular vat with flattened end through which a flexible food grade conveyor-belt runs at a very slow and constant speed. Milk is fed in at a controlled rate and in a standardized condition for fat content and pH. The spacing plates come down in sequence and attach themselves to the belt, thus creating a series of individual compartments moving continuously down with the belt.

At the formation of each compartment, rennet and other required components are added. Then each compartment remains entirely still, while moving continuously down with the belt. After the time required for coagulation, the dividing plates are lifted and proceed overhead through their own cleaning system (CIP) to be ready for use again at the start of the belt. In a separate CIP-system the main belt is continuously cleaned as well. Due to an electrostatic curd removal device, a saving of 0.5-1.0% of curd can be reached at this stage.

The curd then runs through the horizontal and vertical cutting knives. The resulting ropes are then cut by a circular knife into uniform cubes. The perfection of this cutting device allows a considerable increase of the yield compared to traditional methods. The important advantages of the uniform cubes can not be calculated in figures as well as the uniform high quality of the curd itself, but a cheese maker can see it at once. After cutting, and in accordance with the cheese manufacturing specification, some syneresis and/or treatment may take place. By means of a special device, stirring, heating and washing can be made in a very gentle manner, in order not to damage even extremely soft curds. Occurring turbulences are stabilized by dividing plates working like a spiral conveyor. These gentle treatments combined with the uniform cutting, lead to a significant yield advantage compared to conventional production systems.

After the cutting or syneresis the curd is discharged from the coagulator down a chute, over a whey drainage cylinder into the following equipment due to the cheese to be made. This can be done by drainage containers like blockforms or drainage systems like belts of another type.

In the case of Mozzarella and also Cottage Cheese, after the knives the machine is equipped with agitators and several dividing worms, which make sure that the curd is flowing downstream continuously. That means that these devices are guaranteeing that no curd is flowing backwards. The agitators are made out of pipes and it is possible to pump hot water through them to bring the energy directly to the curd. By this method it is necessary to heat up the jackets and for technical reasons it is also possible by jets incorporated into the agitators to wash the curd by its own whey or by hot water adjusted in pH or salted water.

Results

To summarize it can be said that the whole equipment is designed to handle the curd soft and gentle. Due to this and the precise way of cutting the curd no fines will be produced. As a result of this the fines in the whey are minimized. Also, in relation to this fat is heavily reduced. Yield increase 3-4% depending on fat content in milk and moisture in final cheese 48%. Some characteristic results are:

Fat in whey:	Less Than 0.3%
Protein in whey:	Less Than 0.7%

The flexibility of the machine is enormous. All parameters can be changed due to the necessity of changing the raw material. Even different types of cheeses can be made on the same machine.

The treatment of the milk is independent of the concentrate to be used. It does not play a roll if high dry matter sheep's milk, cow's milk or ultrafiltrated milk should be handled. The only thing which varies is capacity per hour.

Conclusion

The ALPMA-Coagulator is the ideal machine to make any type of cheese curd continuously on a very gentle and smooth way. For Mozzarella and other Italian cheese types these advantages are especially pointed out because of curd in most ways is after the drainage treated by a cheese-cooking and moulding-machine which works continuously.

The ALPMA-Coagulator is the ideal machine to create a completely continuous line from the curd production till the finished cheese. Due to the continuous way of working, a very uniform and standardized quality will be guaranteed. To date approximately 30 coagulators are installed. (The first one in the United States will be started up in 1985.)

Paper No. 1984-8

The following paper was presented by F. D. Gaibler, Confidential Assistant to the Assistant Secretary for Economics, U.S. Department of Agriculture, 227-E Administration Building, Washington, D.C. 20250, U.S.A., especially for the 21st Annual Marschall Invitational Italian Cheese Seminar, held in the Forum of the Dane County Exposition Center, Madison, Wisconsin on September 12 and 13, 1984.

RECENT CHANGES IN THE DAIRY LEGISLATION AND ITS EFFECT ON THE CHEESE INDUSTRY

By Floyd D. Gaibler

ABSTRACT

Dairy legislation, passed in the Food and Agriculture Act of 1977, established historically high price support levels which set off a chain of events that has created the most serious problem ever encountered by the U.S. dairy industry. Since early 1981, five legislative changes have been made in the dairy title with limited results. The outlook for dairy in the 1980's is continued productivity gains in output per cow. Dairying will likely become more concentrated and specialized. The demand outlook, however, is not as favorable. The demand for cheese is expected to continue to increase though probably at a slower rate of growth. It is in this future setting that dairy policy must be considered. Omnibus farm legislation will again be considered in 1985. The dairy industry, including the cheese sector, will have to make some difficult decisions between now and the consideration of the 1985 Farm Bill.

History of Price Supports

Dairy price supports began in earnest in the Agriculture Act of 1949. It directed the Secretary of Agriculture to set a support price for milk between 75 and 90 percent parity. That foundation is still a part of permanent law.

As you are aware, the support price undergirds the entire price structure for milk sold by farmers to processors. In carrying out the support program, the Commodity Credit Corporation (CCC) offers to buy butter, cheese and nonfat dry milk at announced prices that are designed to maintain the support price to manufacturing grade producers, on average. Thus, the Government's willingness to buy products sets a floor under the price of all milk.

Since 1949, Congress has passed legislation eight times to increase the minimum support price to 80 percent of parity. On four of those occasions the legislation was vetoed. The most recent increase in 1977 to 80 percent of parity has put the industry in a very difficult situation with high government costs and oversupply.

Before 1977, price supports were set annually at the beginning of the marketing year and were effective throughout the marketing year, unless the Secretary of Agriculture chose to raise them. However, the Food and Agriculture Act of 1977 increased the minimum support level to 80 percent of parity, a historically high level and mandated semiannual adjustments in the support price. Moreover, in 1979, these provisions were extended for two additional years.

That legislation set off a chain of events that has created the most serious problem ever encountered by the U.S. dairy industry. First of all, it sent dairy producers an economic signal to produce more milk. More importantly, the high price support level attracted additional production resources into the industry. In early 1980, cow numbers increased for the first time in 30 years and productivity per cow continued to rise. This expansion in dairy production resulted in a tremendous surplus of dairy products at a cost to taxpayers of over $2 billion per year. At the same time, the high level of price support acted to discourage consumption.

While dairy producers responded rationally to the price signals, they were indeed the wrong signals because they ignored the marketplace. The legislation provided for only upward adjustments which bore no relationship to the prevailing economic conditions. Excess production and lower consumption resulted. The surplus problem placed the dairy price support program in jeopardy--where it remains today.

The Recent Past

It seems inconceivable that it would be necessary to make five legislative changes in the dairy title, in just under three years. But, the warning signs were clear and early on the Administration tried to address the issue. We sought and received Congressional approval to eliminate the semi-annual increase that was scheduled for April 1, 1981.

Milk production continued high, demand leveled off and even slumped, surplus inventories kept building and the program costs kept rising. During consideration for the 1981 Farm Bill, the Administration sought flexibility in adjusting the level of price support. We faced strong opposition. In the face of growing surpluses, in late 1981 the Congress passed legislation which established a series of specified annual price support levels tied to a set of triggers that would go into effect beginning in 1982 only if the surpluses declined to stated levels.

The ink was hardly dry before it became obvious that the situation would remain out of control and the provisions in the 1981 Farm Bill would not solve the problem. At the same time, it became clear that without the united support of the dairy industry, the chances of achieving a workable solution would be severly limited.

In March 1982, the Secretary called for a National Dairy Symposium as he felt it was imperative to provide a forum in which the dairy leaders could get together and generate input from the industry. The symposium provided a wide range of ideas but no consensus developed for any one proposal. Nonetheless, it was apparent to everyone that we had little time and could not afford too many more mistakes.

After considerable deliberation the Administration, in May of 1982, offered a proposal to Congress for discretionary authority for the Secretary of Agriculture to establish the price support level as needed to bring milk production under control. At that time, the Secretary promised not to adjust the support level until January, 1983 to allow producers to begin making the necessary cutbacks and still have the benefits of the higher price support. In addition, the Secretary also pledged that the price support level would not be lowered below $12 per hundredweight.

Again, Congress rejected the Administration's proposal. In its place, they passed the dairy assessment plan in the Omnibus Budget Reconciliation Act of 1982. The Administration never supported this plan, knew it would not solve the problem and predicted on the day it passed that the Congress would again be facing the issue in the near future.

Farmer opposition to the legislation was tremendous. The end result was a law that virtually everyone disliked. Yet, the Administration had no choice in the matter as the assessment was the only tool Congress provided the Department that would bring down program costs.

The Department announced plans in December 1982 to implement that first 50-cent per hundredweight assessment. Immediately, lawsuits were filed across the country. Before the month ended, we were legally restrained from collecting the deduction.

In January 1983, the Department again announced plans to implement the assessment in April. At the same time, we asked for comments on a proposal to begin collecting the second 50-cent assessment which was authorized by Congress.

During testimony before the Senate Committee on Agriculture, Nutrition, and Forestry, last April, the Department stated that it would implement the first 50-cent deduction effective April 16. In addition, we stated the necessity for a better policy. However, in the absence of a sufficient resolution by August 1, the Department publicly stated that it would again consider the implementation of the second 50-cent deduction.

After the first assessment was implemented in mid-April, it had become clear that none of the proposals offered before the House and Senate Agriculture Committees were able to receive any unified support. In early May, the Secretary and key Congressional members of the two committees began holding a series of informal meetings to negotiate some form of a "dairy compromise." After several sessions, we were able to reach a tentative agreement on the basic provisions, which for the most part are embodied in the recently passed 1983 Dairy and Tobacco Adjustment Act.

This legislation represents a compromise among all concerned parties. In addition to providing for an initial drop in the price support level to $12.60 per cwt., it also created a new program which will pay dairy farmers for not producing milk. This program philosophically runs counter to the Administration's policy of a free-market agriculture. However, faced with the reality that both Congress and a major portion of the dairy industry continue to reject the

Administration's approach for flexibility in adjusting the price support level and the prospect of continuing current law which would have increased the price support in October 1, 1984, it represented the most feasible means of addressing the surplus problem in the short term.

Future Alternatives for Dairy Policy

The type and level of dairy price supports during the balance of the 1980's and beyond will be dependent on whether dairy policy will rely solely on the price support approach, supply control alternatives, direct payments or assessments or some combination thereof.

It would seem that dairy policy alternatives fall into four general categories: (1) adjustments in price supports; (2) voluntary paid reduction programs; (3) mandatory base plans and; (4) direct payments or assessments.

The current law embodies a combination of three of these approaches. However, it is important to look at each of these alternatives separately and trace through some of their effects.

Adjustments in Price Supports

Prior to 1981, price supports were based on a price standard in terms of parity and were either adjusted by legislation or administratively by the Secretary of Agriculture. Since then the price standard has been stated simply in terms of dollars and cents per hundredweight.

It appears that historically the dairy industry has relied more on the Congress than the Secretary of Agriculture or the marketplace in setting price support levels. If price supports are to be the dominant factor in future Federal dairy programs, they must be effective in that they reflect economic conditions in the dairy industry and the marketplace and that they must be allowed to fluctuate in response to changes in those conditions. The parity concept has become unreliable, ineffective and perhaps counterproductive in terms of reflecting those conditions and relating it in terms of a responsive price support.

Numerous studies have been conducted on various dairy price support alternatives. All have exposed the shortcomings of the parity formula. The parity calculation is based on an index of prices paid by all farmers for inputs and an index of prices received by all farmers relative to the average price of milk over the most recent 10-year period. Both indexes compare current prices with prices in the 1910-14 base period.

The parity standard could be improved by substituting the components and weights in the prices received and prices paid indexes to reflect changes in factors affecting the costs of dairy inputs and the prices received for milk and dairy products, and shifting to a more recent base period. However, this so-called "revised dairy parity" formula is still a purchasing power concept which ignores supply and demand factors affecting milk market conditions and changes in productivity. In addition, input weights would require adjustment over time to reflect the rapid changes due to technology and changing relative prices.

Another alternative discussed has been the use of a cost-of-production standard. While it would overcome some of the limitations of the dairy parity price standard, it still has significant problems. Cost-of-production, if kept current, would reflect changes in both input prices and productivity. However, it does not consider changes in the demand for milk or the impact of changing prices of substitute products.

In addition, production costs vary considerably among farmers. In computing the cost-of-production, what factors should be included? What charge should be made for labor and management? What charge should be made for land? Whose cost should be determined? The average? The least efficient? In the final analysis, I believe cost-of-production will prove to be as flawed as the parity concept. In fact, it may be worse in that it "implies" producers be provided a support to cover costs, hence removing all risks and therefore all opportunity for a producer to achieve a profit.

The recent USDA dairy study of existing and alternative Federal dairy programs indicated that under projected economic conditions for the remainder of the 1980's, the market-clearing prices for milk would be 15-20 percent lower in real terms than the 1983 support level of $13.10/cwt. If those assumptions are correct, it would appear that an adjustment in the price support level of perhaps $2.00 per/cwt. would be necessary to reach the market-clearing level.

Current law, which expires September 30, 1985, allows the Secretary the flexibility to make adjustments in the support price on April 1 and July 1 of 1985 after the termination of the paid diversion program and the 50-cent assessment. Given the level of participation and present supply use projections for 1983/84, it is not inconceivable that projected CCC purchases will exceed the triggers and result in lowering the price support level to $11.60/cwt. by July 1, 1985.

The Department has been directed to submit a report on recommendations for changes in the application of the parity formula to milk to make the formula more consistent with modern production methods with special attention to the cost of producing milk as a result of changes in productivity. I believe it would be instructive to carry the analysis a step further and determine the feasibility of developing a mechanism to establish the support price at some appropriate percentage of past market prices; perhaps the season average price for manufacturing grade milk or the all milk price or a weighted average of the two.

In the absence of any acceptable method or standard for determining the level of dairy price supports, it is possible that the price support level in effect during the consideration of the 1985 Farm Bill may likely be tied to a mechanism based on CCC purchases of dairy products. Price supports would be adjusted on a sliding scale inversely to purchases. Irrespective of the standard used, flexibility must be provided to the Secretary of Agriculture to determine the level of price support in light of changing supply and demand conditions.

Voluntary Paid Diversion Program

Another alternative would involve supply controls which offer producers incentives to restrict production or market less milk, most likely in conjunction with a price support program. The current milk diversion program obviously falls in this category.

The recent experience in implementing this program reveals the complications of the administering and the policing aspects of supply control plans. Bases must be established for each participating producer, contracts must be developed, periodic payments made to producers, certain restrictions enforced in order to assure program effectiveness and penalties sufficient to insure compliance.

The participation in the diversion program was lower than most expected and was the result of several factors. First, while the concept of a paid diversion has been used in some of our other commodity programs, neither the Department nor dairy farmers had any practical experience in this type of program for dairy operations. The complicated nature of the program left many dairy farmers uncertain about entering into a contract for 15 months that locked them into a restrictive production pattern. Even some producers whose current marketing was below their base, and essentially could comply with no change in their operations were reluctant to participate in the program.

Second, it appears that a large number of farmers had increased production over their base to such a level that it would not have been profitable to participate, even at the minimum level. Others who found it profitable to participate were unwilling to participate because they perceived it would involve too much "red tape." In addition, some of these producers were planning to expand their operations and were unwilling to contract to cutback their operation for 15 months and then begin expansion. Finally, new and beginning farmers with no marketing history were not able to participate in the program.

One of the major weaknesses of this type of program is that producers who have gradually reduced production from their base will have to make little or no adjustments to participate in paid diversion programs. In other words, a producer who has not been responsible for the surplus production or who has gradually decreased his contribution to the surplus will be able to comply without actually cutting back from his current production level. In effect, the Treasury is "buying air" which offsets the effectiveness of the program at the expense of other participants and taxpayers.

If dairy producers believe that a paid diversion program would become a permanent part of the dairy price support program there will be pressure to change the base period to reflect the most recent period, particularly when producers outside the program continue to increase production. This, of course, undercuts the effectiveness of such a program.

Another aspect of this type of program concerns whether the incentives or payments to reduce marketing should be partly or wholly self-financing. The current program calls for a payment rate of $10 per cwt. If the necessary reduction in production would have been achieved, the 50-cent per cwt. assessment would have financed only about one-half of the diversion payments. With the limited participation, the assessments are now expected to finance all of the payments, but with less than the necessary reduction to reduce surpluses. If there is a continuation of such a type of program, it appears that some tradeoffs will have to be made between providing a payment that is attractive to producers and a level of assessment that will result in a smaller proportion of the program costs being borne by the taxpayer and better acceptance among the non-farm public.

Finally, if paid diversion programs are to become a permanent part of dairy programs, the issue of a payment limitation will have to be addressed. The Department has been directed to conduct a study on the feasibility of imposing a limitation on the total amount of payments and other assistance a producer may receive during a year.

It is doubtful that the integrity of any future paid diversion program can be protected if unlimited and excessive payments are made to individual producers. Any type of supply control program without some reasonable payment limitation will not likely receive public acceptance or support.

Over the long run, the adoption of bases would result in them taking on a value of their own and create an economic incentive for some producers to buy the right to sell more milk. Thus, it would, over time, reduce the total number of producers, force some of them to operate at less than efficient levels, and, in the end, increase the cost of dairying.

Mandatory Base Plans

Mandatory quotas or bases can limit production and reduce government costs while supporting dairy farm prices. However, resorting to mandatory programs is not without severe drawbacks.

Establishment of quotas or bases results in income being transferred directly from consumers to the quota holders through higher prices for milk. These higher milk prices would be capitalized into the quotas and they would take on value almost immediately.

Rules would have to be established governing any transfer of quotas and entry of new producers into the industry. Otherwise, production costs would be increased for new producers and existing farmers who purchased additional quota. Quotas would freeze existing patterns of resource use and high cost producers would be kept in business at the expense of new, possibly lower cost producers.

Mandatory base plans or quotas require detailed regulation of individual producers and restricts their ability to adjust resource use. The administrative costs of effective quota programs would be substantial. Once in place, quotas or base plans would be almost impossible to terminate because the value capitalized into the quotas would become a vested interest of the quota holders. This has happened in Canada where, due to their base plan, it costs almost $5,000 per cow for the privilege of milking.

Direct Payments or Assessments

Using a direct payment or assessment approach involves either transferring income from the government to producers or vice versa. A direct payment program would be an application of target pricing that we currently have in wheat, feed grains, cotton and rice programs. Payments would be made to farmers when market prices fell below a stated target price.

Producer payments could be made on all milk marketed or some historical level of milk production. Thus, the direct payment approach could be combined with a minimum level of price support program or with supply controls and support prices.

If direct payments were made on current marketings, the costs to the government would be much higher than under the current price support program. When market prices for milk were below the target price, payments would be made to achieve the price support levels. Consumers would be provided dairy products at lower prices resulting in lower consumer expenditures than if market prices were maintained at support prices.

Direct payments based on some historical priority of output would result in the same kinds of problems with supply controls in establishing and administering bases. In addition, payments would do little to stabilize market prices and production.

Assessments were an integral part of the 1982 legislation. Their intent was to help pay for the growing program costs and return some of the assessment to producers who froze or reduced milk production. The concept was retained in the current legislation to help offset the cost of the diversion payments.

However, the assessments have proven to be extremely unpopular with farmers. But self-financing concepts have become more prevalent in commodity programs. For example, the tobacco program operates under a no-net-cost concept where producers contribute fees to a fund in order to cover any government loans on surplus tobacco that farmer-owned cooperatives cannot repay.

Summary

The dairy industry, as well as the other agricultural sectors, will have to make some hard decisions concerning farm policy and programs, particularly between now and the consideration of the 1985 Farm Bill.

Productivity gains in output per cow are expected throughout the eighties. Genetic advances such as embryo transplants and hormone treatment are already on the horizon. Further improvements in production technology and management will also contribute to increased production.

Average herd size is expected to continue to increase as dairy farms become more specialized in milk production and less diversified in the production of feed and other commodities. In addition, dairying will probably become more concentrated in existing dairy areas which are well suited for milk production.

The demand outlook for the eighties is not as favorable. Fluid milk could continue to lose market share to competing beverages. While growth in fluid milk consumption will occur in some regions of the country, total growth in fluid milk sales may not keep up with population growth.

The projected demand for dairy products is mixed. The demand for cheese is expected to continue to increase, though probably a slower rate of growth. Sales of butter will likely remain stable while nonfat dry milk sales is expected to endure further declines. In general, per capita consumption of dairy products may only grow marginally during the eighties.

It is in this future setting that dairy policy must be considered. The dairy diversion program and an increase in commercial use is expected to contribute to a decline in milk production of 1-3 percent of 1983/84. However, surpluses will remain, likely through 1984-85. Based on current trends projected CCC purchases will be above the trigger levels in current law, potentially lowering the support price from $12.60 per cwt. to $11.60 per cwt. by July, 1985.

That potential situation could provide the starting point for determining the type of dairy program formulated for the rest of the decade. If the historic price support and purchase program is to be retained, there must be increased flexibility in making adjustments in the price support level. In the absence of any changes of the price standard, price supports may be tied to some mechanism based on the level of CCC purchases.

An extension or variation of the current paid diversion program is another alternative that may be considered. However, the lukewarm response of farmers to this type of program may preclude it as a viable alternative. In addition, a paid diversion program for dairy, like other commodity programs, are not particularly effective unless supplies are only marginally out of line with demand. Like the current program, slippage will occur resulting in some government outlays being made with no effective reduction in production.

A continuation of a paid diversion program will institutionalize the use of bases. There would be pressure to continually shift the base period as participants as well as producers outside the program will want to expand and increase production, or "race for base".

The bases would take on a value and create an economic incentive for some producers to buy the right to sell more milk. Over time, it will reduce the total number of producers, force some to operate below efficient levels, and in the end increase the cost of dairying.

Given that the dairy industry produces only for a domestic market and the problems that we have encountered with base plans and allotments with other crops, it is legitimate to ask if this is good public policy.

Once bases are adopted into law, it is probably only a matter of time before they are made mandatory. This would only exacerbate the problems for new and beginning producers as it would be extremely difficult to start or expand dairy operations. Detailed regulation would be required and administrative costs would be substantial. Consumers would be forced to pay higher prices for milk.

More importantly, mandatory controls freeze production and dairy operations would become increasingly inefficient over time. With projections of even higher productivity and only a marginal increase in demand for milk and milk products over the rest of the decade, it would be irresponsible to enact a program that would further dampen demand and create gross inefficiencies in an industry that is becoming more productive and specialized.

Direct payments in the form of deficiency payments result in tremendous government costs. In addition, they would do little to stabilize prices or output and would result in the same disadvantages in establishing and administering bases with supply control plans.

Assessments on milk production currently in effect have not been well accepted by dairy producers, either as a way to discourage production or to help offset the costs of diversion payments. However, if some form of supply management is to be continued, it seems inevitable that assessments will likely be a part of a support program.

Whatever policy is adopted, it is imperative that the dairy industry become united behind a single approach that is responsive to economic conditions and offers the flexibility to respond to changes in those conditions. I would urge that you become more involved in the debate not just on dairy policy, but all farm policy and programs. This is truly a watershed period for agriculture. We must take advantage of this time to formulate effective and responsive farm policy. That is the challenge that is before us all.

Thank you.

Paper No. 1984-9

The following paper was presented by Mr. L.F. Buss, Laboratory Products Manager, Nelson-Jameson Inc., 2400 E. Fifth Street, Marshfield, Wisconsin, 54449, U.S.A. especially for the 21st Annual Marschall Invitational Italian Cheese Seminar, held in the Forum of the Dane County Exposition Center, Madison, Wisconsin on September 12 and 13, 1984.

MODIFICATIONS IN DYE-BINDING CHEMISTRY FOR VERY ACCURATE AND SELECTIVE MEASUREMENT OF "EFFECTIVE" PROTEIN

By: Lynn F. Buss

ABSTRACT

Development of a dye system using "Acid Orange-12" resolved several problems inherent in earlier dye-binding procedures, including; dependence of dye-binding capacity on protein concentration, poor resolution due to insufficient slope of absorbence vs. protein concentration, effect of temperature, variable assays of commercial dyes and lack of standardized procedures and equipment for various protein categories. Several applications of modified dye-binding procedures have been demonstrated by research. Monitoring cheese ripening, assaying rennet activity, screening for proteolytic organisms, testing for mastitis, protein accountability, predicating cheese yield, and determination of nutritional quality of protein following severe processing conditions, were mentioned. The Acid Orange-12 System provides a practical and accurate way to employ these research applications in the industrial laboratory setting.

Introduction

Since 1925, investigations have been carried out into the quantitative aspects of the binding of dyes to proteins (16). In 1944, Fraenkel-Conrad and Cooper, showed that in a buffer at pH 2.2 the acid dye, Orange G combined stoichiometrically with basic groups of proteins (9). Germans Schober and Hetzel, showed the suitability of Amido Black 10B for determination of protein in milk and noted conditions necessary to obtain reliable results (16). That same year, 1956, Udy, doing parallel studies, showed the suitability of Orange G for protein testing of milk (18). By 1958 the use of dye-binding to test patron milk for private industry had become well established. That year 147,000 samples were tested for protein by the League of Cooperative Dairies, the Netherlands. The number of tests had risen to 1,160,000 in 1960 with 30% of the results used for payment (16). In 1966, Ashworth compared a new dye system; Acid Orange-12, developed by Udy in 1959, with Orange G (4). AOAC accepted the Udy method in 1967 with final action status in 1969. Successful collaboratives had been performed using pasteurized fluid milk, cream and ice cream, chocolate drinks, dry or reconstituted nonfat dry milk, and cultured buttermilk (18). Also, in 1967 a modified procedure using Acid Orange-12 dye was approved by the American Association of Cereal Chemists for application in cereal grains, oil seeds, legumes, forages, and animal and dairy products (18,22).

It is the purpose of this paper to discuss the current status of the Udy system described in AOAC and AACC, in the context of comparisons with earlier generations of dye-binding procedures. Advantages of using the dye-binding method compared to other types of testing will be mentioned.

Mechanism of Dye-Binding:

In order to appreciate changes occurring in the evolution of dye-binding, a brief discussion of the mechanism of binding dye to protein is in order. The basic principles of the test have not changed since described in 1944 by Fraenkel-Conrad and Cooper (18). An insoluble precipitate forms rapidly as acid dyes are combined with proteins in an acidified buffer solution. Both Orange G and Amido Black dye systems are acidified using citric acid with a sodium phosphate buffer (16, 1). At a pH of 2.2 complete dissociation of basic protein groups is approached without any molecular breakdown (9). The positively charged proteins take on the character of large cations. Anionic dye molecules then react with these cations, forming an insoluble protein-dye complex (13). The reaction appears to be stoichiometrically between the acid groups of the dye and the basic groups of the protein (4). Figure I illustrates the respective binding sites for Amido Black and Orange G. Binding sites for a peptide composed of lysine, histidine, and arginine are shown in Figure 2 (9,10). Note that both Amido Black and Orange G are disulfonic acids and, therefore, have the same binding groups. Lysine, histidine, and arginine are bound to the dyes by the basic epsilon amino, imidazol and quanidinium groups respectively. (23) Therefore, the amount of dye bound by a protein is directly related to the presence of these three amino acids (17).

Upon removal of the precipitate by filtration or centrifugation, remaining Orange G or Amido Black is measured at .480μ and .615μ respectively. Because, absorbance for these dyes is consistent with Beer's Law for portions normally used, the concentration of the remaining dye may be easily determined (9).

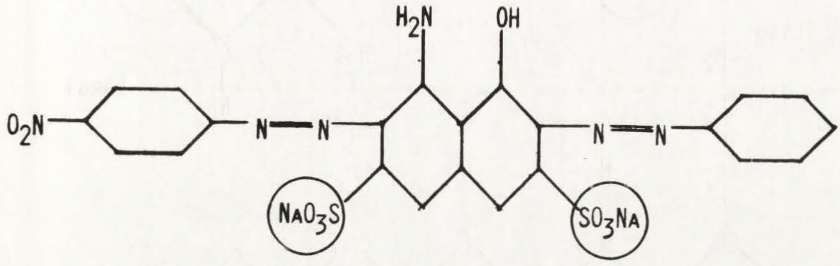
Each unit weight of protein binds and precipitates a constant amount of dye, due to the stoichiometrically reaction. The ratio of dye to protein is called the dye-binding capacity (5). This dye protein relationship must be determined using standard samples of known protein content. Protein in an unknown sample may then be found by multiplying the milligrams of dye bound by the reciprocal of the dye-binding capacity (4).

Calibration of a dye-binding system applies only to the type of samples and procedures used in the calibration and only within a specified range of protein contents. Besides the nature of the protein mixture; dye concentration, protein to dye ratio, reaction time, temperature, and measurement accuracy must be controlled (18). Different protein fractions of milk vary in their capacity to bind dye. Whey proteins bind more dye per unit weight than casein. Dialyzable nitrogen compounds ("non-protein nitrogen") bind none of the dye (1). Therefore, dairy products containing a high proportion of milk protein fractions other than casein require special standardization curves. For example, albumins and globulins bind about 1.38 times the amount of Orange G dye bound by an equivalent weight of casein. (2). Ingredients must also be considered. Chocolate proteins bind dye but not to the same extent as milk protein (4). Protein undergoing a severe heat treatment during processing may acquire a unique dye-binding capacity (18).

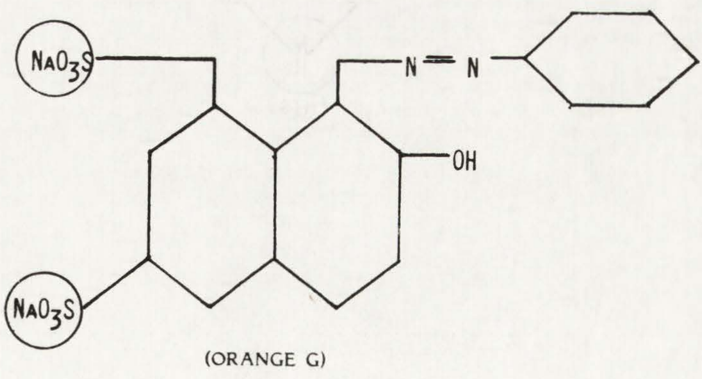
Finally, a calibration procedure must include accurate standardization of the dye. The optical density for zero protein must be constant (9).

Modifications Required in Early Dye Systems:

In spite of the precautions listed in the previous section, the accuracy of the early forms was somewhat inconsistent (1).



(AMIDO BLACK)



(ORANGE G)

Figure 1: Binding sites of Amido Black and Orange G (19).

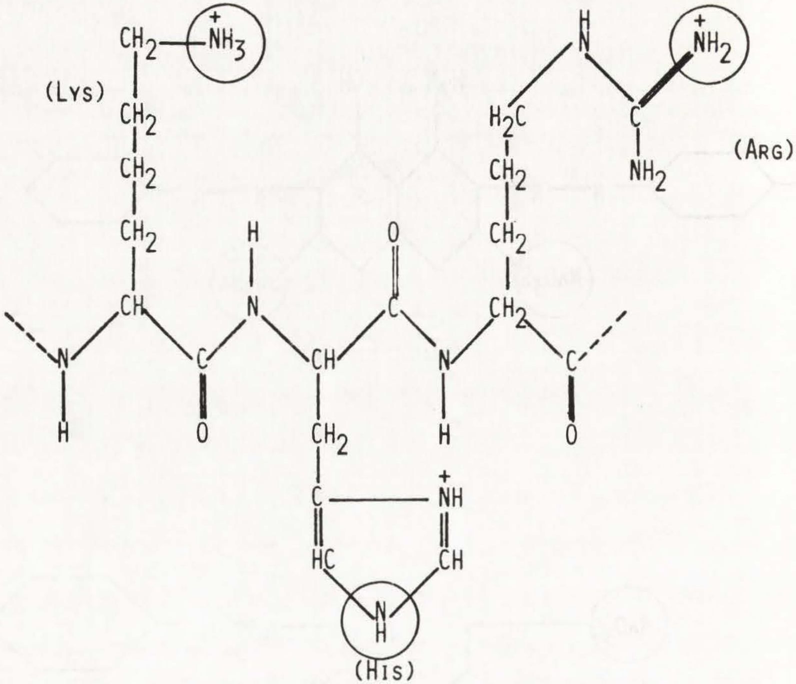


Figure 2: Binding sites of arginine, histidine, and lysine (10).

The difficulty with improving accuracy appeared to be primarily due to four problems: purity of commercial dyes; large effects on dye concentration of multiple chemical equilibria at high and low protein ratios (5); poor resolution of dye to protein calibrations; lack of testing parameters, procedures and equipment for best results with a specific product.

Standardizing dye-binding procedures was difficult due to variation in pure dye content of commercial dyes (5). Orange G as purchased in 1962 varied in dye content from 87 to 98% (3). The average assay of Amido Black was found to be between 80-86% (5). Dyes having a low purity required a special calibration, for each batch. Impurities reacted with protein but had a lower absorption coefficient for the wavelength used to measure optical density (9).

Deviations from established dye-binding capacities were noted at extreme dye-protein ratios. As indicated in Figures 3 and 4, dye-binding capacity for Amido Black was considerably dependent on free dye and protein concentrations. For both Amido Black and Orange G, dye-binding values went up when the amount of protein dropped, where the ratio of dye to protein was small, a marked decrease in the dye binding capacity appeared (5).

Although Amido Black reacts in the same molar ratio as Orange G, it gives a much more sensitive indication of protein content. This may be attributed to a higher molar optical density for this compound. The result is a much steeper curve of optical density against protein (9). Consequently, Amido Black was found to be three times as accurate as Orange G in detecting subtle differences in dye-binding capacities between similar products, given a narrow range of dye:protein ratios (9).

In 1957 Ashworth and Seals noted variation in the amount of dye bound per unit weight by the different milk proteins (1). Since then numerous catagories of protein have been defined for dairy products (1,2,3,4,13,14,16,17,18,20). Accuracy of testing in terms of Kjeldahl protein was not possible, however, until calibrations were developed for each of these "new" types of protein or mixtures thereof. Similarly refinements in equipment had to be made before this method was to be practical for testing the large number of various samples generated by modern dairies (9,19).

Use of Acid Orange-12 With Standardized Testing Procedures:

Ashworth, 1966, compared a new dye, developed by Udy, with Orange G. The dye was called Acid Orange-12, and differed from Orange G in three major aspects. Each molecule of dye had only one sulfonic acid protein binding group, (Figure 5). The absorbance of the chemical was significantly greater than that of Orange G. The acidic buffer, which carried the dye utilized glacial acetic instead of citric acid (4). His results indicated several advantages of this system over the two most popular commercial dyes. The product was available in a commercially pure form for use as a primary color standard. This preparation was then repurified by Udy to a constant assay (4). The dye-binding capacity of "Udy's dye" was very stable compared to that of Orange G, over a wide range of free dye concentrations. This comparison is illustrated in Figure 6, where the relative stability of Acid Orange-12 is shown (5). The contribution of acetic acid in stabilizing the Acid Orange-12/phosphate buffer system is indicated in Table 1 (22). Phosphate buffer was replaced by Udy in 1974 with an oxalate buffering system. This alternate ingredient was approved by AOAC in 1975. The stability of the currently used dye system is shown in Table 2. Variation of dye-binding capacity at equilibrium dye concentrations between .6 and .8 mg/ml are negligible (23). Because of the single functional group per molecule, the sensitivity of Acid Orange-12 was found to be twice that of Orange G.

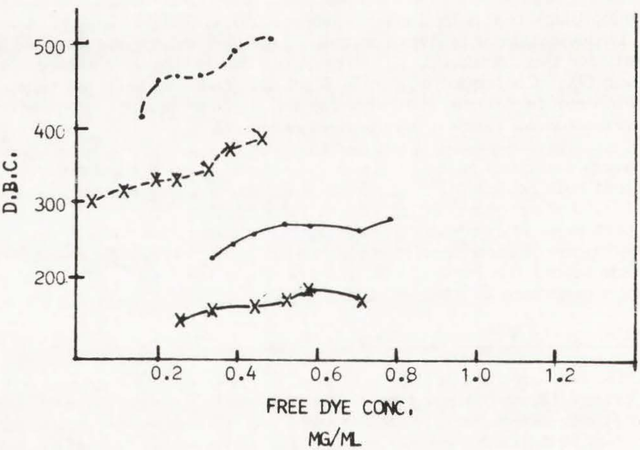


Figure 3: Dye binding capacity of Amido Black and Orange G plotted against concentration of free dye (5).

· ____________ α casein

x ____________ whole casein

---------------- Amido Black

____________ Orange G

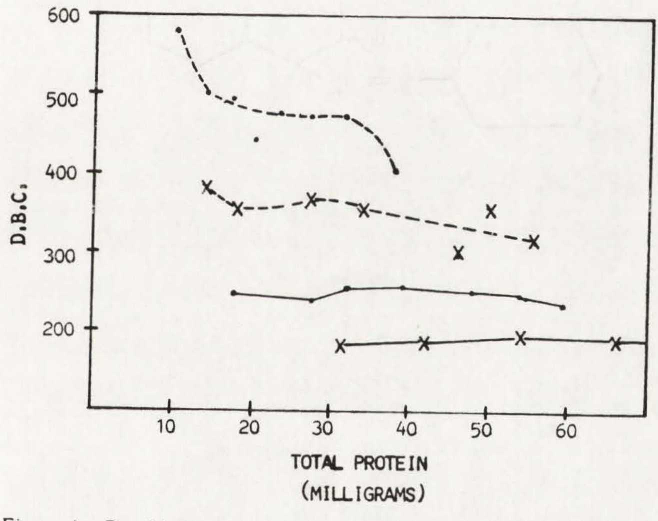


Figure 4: Dye binding capacity of Amido Black and Orange G against milligrams of total protein (5).

· ____________ α casein

x ____________ whole casein

---------------- Amido Black

____________ Orange G

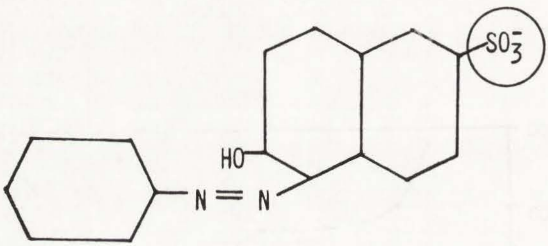


Figure 5: Binding group of Acid Orange 12 (23).

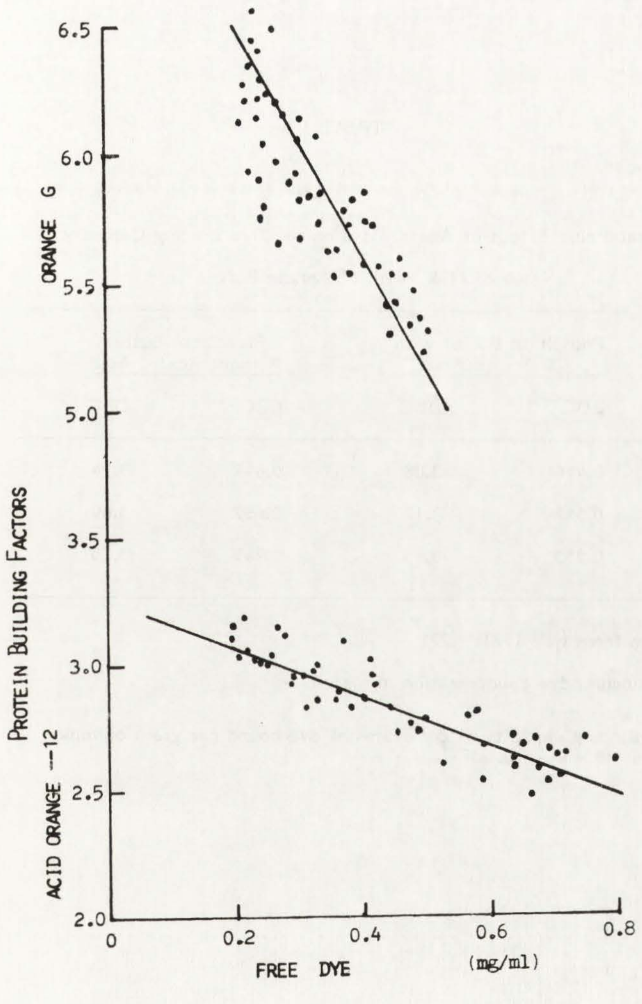


Figure 6: Protein Binding Factors, (1/DBC), for Orange G and Acid Orange 12 plotted againt mg/ml free dye concentration (4).

TABLE I

Stabilizing Effect of Acetic Acid on the Dye Binding Capacity Value of Milk[a] with Phosphate Buffer

Phosphate Buffer with 6% Acetic Acid		Phosphate Buffer Without Acetic Acid	
EDC[c]	DBC[d]	EDC	DBC
0.446	3.08	0.642	3.54
0.547	3.12	0.692	3.64
0.955	3.15	0.749	3.70

[a]Taken from Udy 1971. (22)

[b]Equilibrium dye concentration in mg/ml.

[c]Dye-Binding capacity as decigrams of dye bound per gram of milk protein (%N x 6.38).

TABLE 2

Stabilizing Effect of Acetic Acid on the Dye Binding Capacity

Value of Milk with Oxalic Acid Buffer[a]

Oxalic Acid Buffer with 6% Acetic Acid		Oxalic Acid Buffer without Acetic Acid	
EDC	DBC	EDC	DBC
0.400	3.29	0.400	3.69
0.500	3.32	0.500	3.82
0.600	3.34	0.600	3.94
0.700	3.34	0.700	4.07
0.800	3.35	0.800	4.20

[a]Reference 21.

Following the development of a credible dye system, Udy refined and standardized other components of the dye binding test. Today's reagents and accessories are the culmination of this effort and include the following innovations: three standardized dye concentrates for use in a three point calibration and product testing, (Slide 1), precalibrated dispensing apparatus to ensure uniform delivery of prescribed amounts of dye and sample (Slide 2), non-absorbent filters for insertion into dispensing bottles for rapid separation of supernatant from precipitated protein (Slide 3), a spectrophotometer with flow through cuvet and .480μ filter, which utilizes a microprocessor for conversion of absorbance values to percent protein or logarithmic scale for special calibrations (Slide 4) and tables giving calibration settings and sample size reflecting the various dye-binding capacities and protein contents of various products (Slide 5).

Applications of Selectively Measuring "Effective" Protein:

The unique mechanism of dye-binding, compared to other indirect forms of protein measurement, has made it a useful tool in the selective measurement of "effective" protein. Acid Orange-12 binds to the amino acids, arginine, histidine, and lysine. The molecules must be contained in peptide units of 5 amino acids or more, for binding to occur. As the length of a protein molecule decreases through hydrolysis by enzymatic action or as binding sites along the molecule become unavailable due to chemical reactions during severe processing conditions, changes in dye-binding capacity, proportional to the loss of the protein's functional properties, occur. These chemical changes, which take place during storage and handling of milk and various other dairy ingredients, reduce the effectiveness of proteins for both nutritional and manufacturing applications. Arginine and lysine are considered "essential" amino acids (12). When bound to reducing sugars by the Maillard reaction, these are no longer available to humans or livestock for synthesizing protein (10). Because the two amino acids then become "limiting" in a diet (12), the entire protein quality of a food is reduced. The yield of cheese, and other types of dairy products is directly proportional to the quantity of intact protein molecules in raw materials used. As protein molecules deteriorate so does cheese yield with a concomitant increase in protein nitrogen lost to whey or other by-products. Therefore, by utilizing its selective properties, dye-binding may be used as a reliable assay of the potential effectiveness of various proteins in nutritional and manufacturing applications.

In 1979 Kroger and Weaver used the principles above and demonstrated the advantages of dye-binding over amino acid analysis for the objective monitoring of cheese ripening during the first three months of storage for cheddar cheese (14).

Changes in absorbance occur as rennet proteolyses casein, (13) making dye-binding a simple assay of enzyme activity. The method has also been developed as a screening test for proteolytic micro-organisms responsible for digestion of milk proteins. This method was shown to be much simpler than amino acid assays and give a better indication of the fraction of protein hydrolyzed (13).

Rowland determined the average nitrogen distribution in normal milk to be 78.5% casein: 9.2% albumin: 3.3% globulin: 4% proteose-peptone: and 5% non-protein nitrogen. Milk from cows having mastitis tended to be low in the special milk constituents casein and lactose, and high in albumin, globulin, proteoses, and salts when the respective proportions were compared to normal milk. The greatest increase was in the globulin portion, which increased to several times its normal relative concentration (17).

The economic consequence of casein displacement by serum protein in mastitic milk is, of course, a decrease in yield. This characteristic of mastitic milk may be measured either indirectly using somatic cell counts or directly by measuring the casein:total

Protein ratio of producer milk. Dye-binding provides an inexpensive, accurate, and fast alternative to the Kjeldahl method used by Rowland to determine this ratio. (15).

The versatility of the dye-binding method for protein determination is shown by the development of suitable modifications of the test for a variety of uses within the food industry. This diversity of application would permit a plant to account for protein from every source at every stage in the manufacturing process, similar to programs now in place for butterfat.

Tests of comparable versatility, Kofranyi (13), Kjeldahl etc. have not been modified successfully to meet the increased testing load required for production laboratories. Several advantages of the dye method compared to the Macro Kjeldahl and steam distillation procedures were mentioned in the literature. These include: speed (even semi-solid materials are tested in less than one fifth the time); much lower cost per sample; elimination of handling strong acids or alkalies; and the comparative simplicity of the test allowing it to be used routinely. (20).

When calibrated against the Kjeldahl procedure, for a given material, dye-binding proved to be an accurate substitute. Using 104 samples of milk from individual cows, Treece and Gilmore reported a standard error of estimate of .05% protein or a correlation of .98 between the two procedures (20).

Conclusion:

In conclusion, this paper has shown that dye-binding has progressed from a curiosity to a valuable tool available to the food industry. The extent of this value can only be determined by measuring the cost of protein presently lost or damaged due to current breeding, handling, processing, and distribution practices. Research using the dye-binding system has demonstrated many ways to measure this lost protein. Now it is industry's turn to realize the potential this system provides before, during, and after the manufacturing process.

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Paper No. 1984-10

The following paper was presented by Angelo A. Mongiello, Sr., President of American Pioneer Corporation, 820 - 62nd Street, Brooklyn, New York, 11220 U.S.A., especially for the 21st Annual Marschall Invitational Italian Cheese Seminar, held in the Forum of the Dane County Exposition Center, Madison, Wisconsin, on September 12 & 13, 1984.

"1984 STATE OF THE ARTS FOR SALTING AND COOLING PASTA FILATA CHEESE"

by Angelo Mongiello, Sr.

ABSTRACT

For many years Food Science Professors, Manufacturing Cheese Companies and Equipment Manufacturers have tried to design systems and methods which would make, cool and salt cheese more efficiently and economically. American Pioneer Corporation, back in 1974 and then again in 1979, offered to the industry a homogeneous in-line one hour salting system. Proven lab test reports were offered at that time to confirm the results of this system. But due to the skepticism of our industry and the fact that the concept was considered a "fairy tale" companies were not willing to investigate and/or invest to implement this system. Now in 1984 American Pioneer Corporation is back to you offering to you, the industry, a less costly 2 1/2 hour in-line patented mechanical cooling and salting system which is the new state of the arts for cooling and salting of pasta filata.

Introduction

Current cooling processing consists of several methods including four compartment trays immersed in 40° cold sweet water tanks by hand or conveyor, another is putting automatic molding forms through a cooler shed, that is showered with 15° solutions, another is a tremendously expensive automatic cooling system using stainless steel trays, requiring large areas of floor space to accomodate the system, plus another method is a patented system extruding a rectangular ribbon, guillotined by length, leaving both ends unsealed with open veins to bleed out fat, contaminating brine. None of these methods solve both the cooling and salting problems at the same time.

Still another innovation has come to pass that people are using a "molding machine" combined with a rotary table that supposedly cools these cheese blocks to maintain their shape in the brine tanks. If you plug the block with a thermometer and watch the reading, you will begin to understand the cost of refrigeration. Today it costs a lot to exchange BTU's when done correctly--it costs twice as much when done incorrectly. It should be apparent that this system cannot be of help to you, whatsoever, in salting cheese.

The present salting processes being used today are the traditional overnight brine tank system and the latest innovation is using a small machine with a hopper and a small screw to feed granular salt into the recirculating tank of the cook water, cooking the curd to be made into mozzarella before molding. This attempt to salt mozzarella to speed up the salting time of the block in the brine tank and still trying to obtain a passable and acceptable product for the trade is all done to try to shorten the salting process down to eight or ten hours instead of overnight. These methods have been used exclusively. Many other methods have been tried and/or used--and found totally unsatisfactory--becoming costly blunders.

NOW we offer you a chance for greater production, less use of plant floor space and a better quality of cheese no matter what your standards or production requirements, that's right, all the way up to 10,000 lbs. per hour.

We offer you a mechanical way to salt cheese--the right way and that's the natural way and we have a bonus for you--we also threw in the cooling of the cheese blocks. All this in 2 1/2 hours cooled to 40°F, fully salted 1.7% ready to be packaged and refrigerated thereafter.

Conclusion

Is the industry ready for a change in the current methods used for cooling and salting cheese? We believe that NOW YOU ARE.

Available to you now is our patented M-20 Mechanical 2 1/2 Hour Cooling and Salting System. Your having it will reduce your labor cost, cut down your cycle time, give you back valuable floor space in your plant, plus increase your productivity per hour. The summary of all this does one and only one thing, increase your percentage of profit per each pound of cheese you produce.

We are presently working with several cheese companies regarding the availability of our engineering services, technical knowledge, cutting and cooling equipment plus our patented cooling and salting system to work in conjunction with their operations.

Regardless of the size of the products you are manufacturing, from 8 oz. to 20 lb. slicing blocks, our patented M-20 Mechanical 2 1/2 Hour System can be applied--perhaps also to your present equipment eliminating the cost of you having to buy new equipment. If this is the case, your only cost is for the conversion plus the right to use our patented system.

We have the system and we know that it works and when you see the stainless steel molds and samples that they produce, you will definitely agree that this is a practical and economical way of cooling and salting cheese. SEE ALL THIS TODAY AT OUR BOOTH #61/62. Another plus is that our patent covers a multitude of designs and produces a distinctive product that can be easily identified in the market place.

Paper No. 1984-11

The following paper was presented by Jerry Dryer, Publisher, The National Dairy News, P.O. Box 951, Madison, Wisconsin, 53701, U.S.A., especially for the 21st Annual Marschall Invitational Italian Cheese Seminar, held in the Forum of the Dane County Exposition Center, Madison, Wisconsin, on September 12 & 13, 1984.

IS IT PIZZA PIE IN THE SKY?

By Jerry Dryer

ABSTRACT

Italian cheese sales have been the envy of dairy marketers for years. Is the hope of future sizeable, profitable sales increases just a "pie in the sky" dream or is it possible?

With a quality milk supply (priced right), new plant technology and an awareness of the new marketplace, profitable and increased sales are waiting for Italian cheesemakers and marketers.

Sales increases in the Italian cheese industry--especially mozzarella--have been the envy of other dairy product marketers for many years. In fact, the envy of many other food marketers.

You all know the numbers. The pounds of product sold last year was four times greater than 20 years ago--a 400% increase. Mozzarella has been the big winner but other Italian types'--provolone, romano, parmesan and ricotta--sales have doubled in just 10 years. These numbers aren't pie in the sky; they are not "an illusion of future benefits and blessings which will never be realized." These are piping hot facts, served up with a crust, tomato sauce, various meats and vegetables and Italian cheese.

The pizza pie has been your secret weapon. It has sold a lot of cheese for the Italian cheese industry.

But I'm getting ahead of myself. I hear you muttering under your breath: "sales are pretty good but margins are real thin."

"Yes, sales are good and they'd be better, but I can't get enough milk."

"I've got plenty of milk, but yields are real low. I can't make any money."

"There's always somebody out there that will undercut my price."

After listening to all those complaints for the past 15 years I begin to wonder why so many of you have doubled and tripled your plant capacity and built new plants to enter the Italian business.

I'm either addressing a room full of eternal optimists or the world's largest gathering of intelligent risk takers. I prefer to believe you're the latter.

There's plenty of room for intelligent risk takers. But some days it also takes a good dose of optimism.

I know. Like many of you, I'm an owner/operator. Sometimes day-to-day operations and day-to-day problems make it almost impossible to look at where we are going over the long pull.

So I dedicated several hours to thinking about and talking to people about the Italian cheese industry. My prospective is from outside of, but close to the industry. A prospective that also encompasses the total dairy industry. Hopefully, the many segments of this nation's dairy industry can learn from one another. And, I think my outside prospective can offer some stimulation. I would like to share several thoughts that take us from the farm, through the plant and to the consumer.

Thought #1: <u>Put as much distance between you and the government as possible.</u>

We've watched industry after industry face and struggle with deregulation over the past several years.

Now this administration has started deregulating the dairy industry, i.e. price supports. And it is irreversible.

I don't care if you think the Democrats are going to be elected to every seat in Congress and to the White House this fall. One fact remains: the dairy price support program as we have known it is going the route of the dinosaur.

The government dictated price for milk will continue to decline and will seldom, if ever, set the market price of milk once the 1985 farm bill becomes law.

Plant and farm inspections--more government regulation--are getting fewer and further between. Especially if you're regulating yourself and doing a good job.

Standards of identity are getting an overhaul. They served and protected the industry very well for many years but are now potentially an albatross around our necks. Standards of identity--like the Great Wall of China--have protected us. But they have also imprisoned us.

Now in the most recent efforts at change, commenting on the proposed "general standard of identity for certain other cheeses," Bob Anderson on behalf of the National Cheese Institute "stressed the need for a general standard... which would encourage and support the development of new cheese varieties."

"Let the marketplace provide the signals based on the broad guidelines encompassed in a new concept for a general cheese standard," Anderson explained.

The Italian cheese industry and, in particular, the American Producers of Italian Type Cheese Association and the Wisconsin Cheese Makers Association are to be applauded for throwing out mozzarella grading proposals offered up by USDA several years ago. Your responsibility is to make what your customers want, not what some government grade defines as desirable.

The Italian cheese industry has been fighting with its customers over regulations concerning the labeling of frozen, prepared "pizzas" that contain imitation product. It all started almost 20 years ago and we still don't have any regulations.

Don't get me wrong. I think you have made an excellent argument for the clear labeling of products. I think you are absolutely correct. My point is: the government may not be the best source for a solution. More about this issue later.

No. We don't want to throw the baby out with the bath water. Some regulation is needed and necessary. And the excess regulation that exists today will be slow to die. But as John Naisbitt, author of Megatrends, says "Yesterday is over."

To succeed you need to be in front of the parade, not in back gingerly avoiding the residue of the cavalry troop that preceded you.

Thought #2: Profits and losses begin with your raw material costs--the price you pay for milk and you can do something about that.

To control your primary production cost--the price you pay for milk--you need to take charge. Remember, the price support program is yesterday.

Use product yield pricing so you get what you're paying for. Pay your producers an incentive and they'll supply you with the quality of milk you need. I think they'll even adjust production seasonally so that you get the milk you need in May and the milk you need in November. And while you're getting those seasonal production wrinkles ironed out of your own milk supply from your own milk producers, I don't see any problem with trading a few loads of milk with your neighbor. Does the cheddar cheese plant down the road need milk when you're a little long on it? Do you need milk when they're a little long on it?

With the changes that have already happened in the dairy price support program, we're going to lose some farmers and we're going to lose some cheese plants. The farmers and cheesemakers still in business a year or two from now are going to be even leaner and even meaner business people.

Farmers will respond to your price incentives. They'll deliver the kind of milk you want, when you want it.

Ask people that have been buying milk on a product yield basis. There is more protein in the milk they're buying today then a year ago. Producers still selling to them have improved the quality and protein content of the milk they are producing. And other milk producers with higher quality milk have been attracted to their plants.

Thought #3: Make your plant as efficient and profitable as possible by squeezing every marketable pound of product possible out of every pound of milk you buy.

Preconcentration of milk is the current hot topic. The technology needed to produce cheese from milk concentrated to the consistency of toothpaste is now available. It started in Europe, spread to Canada and now we have a plant in Whitehall, WI.

If you think you are having problems with plant margins now, just wait. These plants will be selling 12 or 13 pounds of cheese for every one hundredweight they send through their new plant. Their finished product hasn't been christened cheese by the F.D.A., but it will get the government's blessing.

Even if it doesn't get to wear a mozzarella cheese label, it can wear a "Mothers Pizza Cheese" label and that's good enough for many of your customers making frozen prepared foods.

Instead of complaining about these innovators we ought to be thanking them for breaking new ground here in the U.S. Let me explain.

First of all, time is on your side. Correct me if I'm wrong, but existing ultrafiltration capacity for mozzarella is only about a million pounds of milk a day. With a 12-pound yield, that means those plants will be producing a very small percentage of last year's total output. It's going to take some time to get the government's blessing for the product. And they are going to make some mistakes which you can learn about without putting a major dent in your checkbook or your bottom line.

Additionally, there is some other technology available that may be as good or better. How about preconcentration with an evaporator instead of ultrafiltration. It costs less to get started and it also improved yields. Ask the cheddar cheesemakers that are using it right now.

How about capturing some of the solids from your whey and recycling them through the vat. I know it's illegal now, but the law can be changed.

How about retrieving all of the other valuables in your whey--like Tolibia's proposed ethanol plant. And don't shortchange the booming market for the proteins and lactose in whey.

And what about the quality of your product. Maybe you're better off with your current equipment. Just lubricate it with some brain power and make a product so good your customer won't have much choice but to buy from you.

For too long, the mozzarella business has been much more price competitive than quality competitive. Look at provolone makers. They are selling 50% more on a per capita basis then they were just seven years ago--ricotta, plus 32%; parmesan, plus 17%. That's per capita and there are more per capitas born every day. Those are nice sales gains.

Thought #4: <u>Quality and perceived value are more important than price in the eyes of today's consumer.</u>

Quality, a high-quality reputation. That's what I think is selling provolone and ricotta and parmesan. They look great in the deli and quality overshadows price.

Perceived value. String cheese is a good example. It's convenient. It's fun to eat. It's (low fat) healthy. It's high priced. Eight to $16 a pound at retail. But your customers think it's worth it. Certainly, it costs more to produce it and market it, but I'll bet the product is generating a far better margin per pound than the 5- and 20-pound loaves headed for pizza.

Psychologists and marketing specialists and consultants and pollsters and newscasters and lots of other people that haven't pushed a shopping cart down the grocery store aisle for a long time agree: our society is not homogeneous. It is segmented. It is subsegmented. And the subsegments are divided several more times.

But by the time all of these authorities tell you all about these various segments, they've forgotten to tell you how to sell your product; and by the time you get around to selling your product to all these different segments, the segments have changed.

You can sell enough product at enough profit if you just remember two things. There are customers shopping for PRICE, and there are customers shopping for QUALITY.

Stephen Arbeit of D'Arcy McManus put it well this summer when he spoke in Amsterdam. Spinning off the Megatrends theme of high-tech/high-touch, Arbeit used this example. The traditional supermarket is losing business in two directions. One side of the aisle is high-tech/low cost: no frills warehouse stores and generics. On the other side, high-touch/high quality: delicatessens, gourmet and health food stores.

We're surrounded by pizzerias that will sell us a 14- or 16-inch pie for under $10. Maybe we should turn some of our attention toward Los Angeles. That's where they sell a 12-inch caviar and smoked salmon pizza for $18.

George Lazarus, a business writer for the Chicago Tribune, recently pointed out some great potential: "The frozen pizza market has a bad case of indigestion. Business for most makers of frozen pizza is sluggish if not flat. The business has been victimized by erratic pricing and inadequate advertising and promotion."

"With all the price cutting, consumers suspect there has been a further reduction in quality and this feeling has adversely affected sales," Lazarus concluded.

I think Lazarus has pointed the way: develop a high quality frozen pizza (no imitations--cheese, meat extenders, etc.) and put some advertising and promotion dollars into the project. There are nearly 200 companies making and marketing frozen pizza products. Sales are flat, but market share is changing hands. Firms using "real" cheese and other top quality ingredients are selling more and gaining share. Team up with customers like this, help them promote quality and worry less about federal labeling regs.

Let's go back and take another look at Lazarus's contention that price cutting has customers suspecting further reductions in quality. Here is an opportunity to be a price maker instead of a price taker. We can take a lesson from the ice cream business and teach it to the pizza industry.

The cost of ingredients--milk and sugar--kept going up; and to hold retail prices, ice cream makers kept chipping away at the quality of their product. They added less cream and more air. Results: they didn't even hold on to the market they had, let alone gain any new market or margins.

Then a flash of brilliance. How about good old fashioned high-fat ice cream And that flash of brilliance is only a few years old. Yet in 1983, the International Association of Ice Cream Manufacturers says that 17% to 20% of the total market for ice cream was premium and super-premium product. The high quality stuff. In fact, they say by 1990 thirty percent of the ice cream sold in this country will be of premium or super-premium quality.

How about premium and super-premium pizza? Or frozen lasagna? Or a host of other products that need "real" cheese, so they have a higher perceived value.

Here's a rapidly emerging high-value market--the deli and the cheese shop within a supermarket.

Remember Stephan Arbeit's traditional supermarket? It's losing business two ways. Supers aren't taking that standing still. They are adding delis and cheese shops. Today, over half of this nation's supermarkets have a service deli.

And what's the new item being added by most? Fresh pizza. High quality pizza. High priced pizza. Ready to take home and pop in the oven.

Four out of every ten delis now offer fresh pizza. That's one out of every five supermarkets in the U.S.

How do you sell deli items? You use the oldest sales technique in the books--"Try it, you'll like it." That's right. Three-quarters of those delis use sampling. Are you and/or your broker helping those delis sample your cheese?

The past is prologue. The Italian cheese industry's outstanding sales record of the past is <u>not</u> pie in the sky. There is a great and growing market for your high quality products.

SUMMARY:

<u>Thought #1</u>: Put as much distance between you and the government as possible.

<u>Thought #2</u>: Profits and losses begin with your raw material costs--the price you pay for milk and you can do something about that.

<u>Thought #3</u>: Make your plant as efficient and profitable as possible by squeezing every marketable pound of product possible out of every pound of milk you buy.

<u>Thought #4</u>: Quality and perceived value are more important than price in the eyes of today's consumer.

The following paper was presented by Dr. Frank V. Kosikowski, Professor of Food Science, Cornell University, Ithaca, New York, 14853, U.S.A., especially for the 21st Annual Marschall Invitational Italian Cheese Seminar, held in the Forum of the Dane County Exposition Center, Madison, Wisconsin, on September 12 and 13, 1984.

Advances in Mozzarella and Ricotta Cheese Technology

By Dr. Frank V. Kosikowski

ABSTRACT

Significant advances in domestic Mozzarella and Ricotta cheese technology were evolved through the hard work and ingenuity of early Italian immigrants and their children. Improved keeping quality and greater safety of cheese and more efficient labor saving cheesemaking processes resulted.

More recently radical new concepts of cheesemaking which significantly increased yield, improved manufacturing techniques and maintained quality, have emerged. A new plant for producing Mozzarella cheese employing French MMV precheese principles with highly concentrated ultrafiltration retentates has gone into production. Another major advance is the LCR concept of cheesemaking, utilizing low concentrated retentates ultrafiltered on the farm or at the dairy plant, for Mozzarella, Ricotta and other cheese.

Introduction

Italian cheeses came to America early, perhaps accompanying Christopher Columbus to this continent on his first voyage of discovery. The cheeses undoubtedly were hard types, Romano, Provolone, and Asiago, to withstand the long journey.

It was not until the early 1900's in the United States that an infant, domestic hard type Italian cheese industry, struggling to survive, was conceived. However, the Great Depression of the 1930's drove many Italian cheese manufacturers on the East Coast out of business, and when they returned soft cheese production was favored involving Mozzarella and whole milk Ricotta made from cow's milk. Small family-run pizza parlors and Italian restaurants were proliferating just before and during World War II. Dining out became popular at this time, because many women were now working in defense plants. This pattern was repeated in Central and West Coast areas.

RICOTTA CHEESE

Ricotta, or recooked, cheese in the United States originally was largely made from the whey of Mozzarella cheese to which a small amount of milk was added for substance. It was acidified and coagulated at high temperatures, approximately 195°F, and then the curd was molded and dried on shelves giving a product which found a major outlet as a supplement for grating cheese. Presently, however, whole milk and part skim milk Ricotta of approximately 76% moisture is widely used. This cheese made from milk coagulated at approximately 176°F, displays a soft, smooth texture and a mildly sweet, nutty flavor. It is used in a wide variety of Italian dishes such as Ravioli, Manicotti, and Lasagna. In Corsica, France, a staple food of the island is Broccio, a slightly pressed Ricotta cheese made from whole sheep's milk.

The United States has experienced advances in Ricotta cheese manufacture of which several are cited here; improved keeping quality, use of acid whey powder coagulants, and new technologies.

Improved Keeping Quality

In early domestic whole milk Ricotta cheesemaking, the predominant primary container was a 3 lb. perforated tin. It was filled with hot curd and, drained in production rooms, then topped with additional curd and covered with parchment paper held in place by rubber bands. In this form it was purchased directly by consumers or, if held at the plant, was emptied from the tins into open hoppers of packaging machines to produce consumer size packets. Many of these small sealed plastic containers during storage or transport would pop their caps and the keeping quality of the cheese often was minimal. Why should this happen then to such a nice cheese which was initially practically sterile having been filled hot at 175°F directly from a kettle? The primary causes were post manufacturing contamination and inadequate cooling. Microbe laden water vapor circulating in production rooms settled on the exposed surfaces of the draining curd containers. During the long cooling period yeasts and molds and coliform bacteria grew to large numbers, and spoilage was inevitable.

Presently, most manufacturers of Ricotta cheese cool the cheese rapidly to below 5°C after mechanical removal from kettles, and consumer packaged them quickly in closed lines and filler systems. In some operations the cheese is packaged hot. As a result of these advances the keeping quality during marketing has been extended many days.

Acid Whey Powder as a Coagulant

Acid whey powder was suggested as a milk coagulant for Ricotta cheese in 1967 (10). Although not used by all manufacturers, many have found it advantageous to replace traditional coagulants, starter or vinegar, with acid whey powder. It can be added to large vats or silos of milk to establish an optimum pH 5.9 for stable operations. Also, acid whey powder dramatically increases cheese yield because it introduces additional protein, and the curd matrix has a better entrapment potential for whey proteins. The cheese assumes a very smooth texture and rich flavor. Optimal levels of acid whey powder at pH 4.6 are 2.25 to 2.50% by weight of the milk.

New Technologies

Ultrafiltration of milk and its selective concentration represent one of the most promising new technologies for whole milk Ricotta manufacture. In fact, New York State, aware of the potential behind such new technology, recently held a public hearing on permitting molecular membranes for Ricotta cheesemaking.

In the forefront of ultrafiltration developments is the new Alfa-Laval continuous Ricotta cheese maker utilizing MMV principles awaiting some adventuresome cheese manufacturer interested in conducting trials. It consists of an ultrafiltration unit coupled to a swept-surface heater capable of raising the retentate temperature to 180°F, followed by coagulation during agitation. The MMV precheese concept utilized continuously gives higher than normal yields. Cheese packaged hot in pilot plant trials of this new process (16) displayed qualities of traditional whole milk Ricotta with enhanced keeping quality.

Using an alternative concept, involving low concentrated retentates between 1.5:1 and 2:1 total protein, whole milk Ricotta cheese of excellent quality has been produced (12). Some advantages perceived from this mini-research are that more cheese can be made per unit of milk mixture, less acid whey powder as a coagulant is required per kilogram cheese obtained and increased solids in whey lead to improved drying efficiency.

For Ricotta cheese made from 80% whey and 20% milk, or some similar combination, a new method involving continuous coagulation of curd in plastic tubing immersed in hot water was recently developed in Canada by Modler (20).

MOZZARELLA CHEESE

Mozzarella cheese and its manufacture have spread throughout the world, for example to India and France. In Italy it is commonly made from cow's milk but throughout the Naples area some cheese is derived from the milk of the water buffalo. This milk, always white, gives the most sought after Mozzarella cheese.

The early domestic Mozzarella cheese of the United States was made from raw milk. As such it displayed a fine sheen, smooth texture and excellent stretching qualities, but often a rancid flavor.

Traditional Mozzarella cheese at its best is soft, white with a juicy, creamy appearance and a bland slightly acid flavor. Another cheese, originally called Pizza, also was produced along with traditional Mozzarella. Its lower moisture gave a harder body and made it easier to slice in pizza restaurants.

In the mid 1900's Pizza cheese was legally changed to low moisture Mozzarella which has become the predominant type among the 1.2 billion pounds of Italian cheese produced in the United States last year.

Some major advances in the Mozzarella cheese industry include: change over from raw to pasteurized milk, controlled acidification, and new technologies.

Conversion of Raw to Pasteurized Milk Technology

Despite the possibility of creating public health problems, there were some economic and technical advantages to using raw milk for Mozzarella cheese. Energy and capital expenditure savings were possible and, more importantly, the high bacterial counts of the raw milk permitted an active natural lactic acid fermentation leading to excellent texture.

Much of the raw milk curd was partly acid ripened in 40 lb. bundles at the plant and then shipped under ice to Lattichini, or milk stores, in urban centers such as New York City. At these specialized stores, a number of which still remain, the curd was fully acid ripened in a warm room and the cheese, on demand, was stretched and molded in hot water for the customer on the spot. However, it was discovered that despite exposure to hot water during stretching and molding the Mozzarella cheese showed a positive alkaline phosphatase reaction indicating underpasteurization. As a result the soft Italian cheese industry converted entirely to pasteurized milk about 1952. Pasteurized milk, however, produced a Mozzarella cheese without a stretch, but research soon corrected this fault through judicious selection and use of starter cultures. The result was a more uniform cheese, finer flavor and improved keeping quality. This advance played a critical positive role in the wide public acceptance of Mozzarella cheese.

Controlled Acidification

The optimum pH for stretching curd for Mozzarella cheese varies from 5.7 to 5.2 depending upon mode of acidification. Rapid advances have been made in acidification processes. For example, starters were developed explicitly for Mozzarella cheese. These included mesophilic lactic acid streptococci, *S. lactis* or *S. cremoris*, and the enterococci, *S. durans*, all cultured at 90°F. *S. durans* grows slowly below 75°F and in the lengthy cooling of curd, this characteristic prevented over-ripening which causes soft, mushy cheese centers. For low moisture Mozzarella cheeses, thermophilic bacteria, *S. thermophilus* and *L. bulgaricus*, are cultured at 113-116°F. Because thermophilic starters grow rapidly in the vat, and during ripening, the process including stretching is completed in a few hours.

Our knowledge of starter applications were accompanied by advances in the direct acidification of milk using food grade acids such as acetic, phosphoric and citric. Direct acidification of milk for cheesemaking, historically, was practiced in other countries for a number of centuries using available acids. Important research on direct acidification of Mozzarella cheese, conducted at the University of Wisconsin (3, 14, 22), refined the early concept and led to more knowledge of individual acid behavior and pH optima. As a result, modern effective direct acidification production methods have evolved for Mozzarella cheese.

New Technology

The characteristic step in the early manufacture of Mozzarella cheese was hand stretching of hot curd. Cut portions from a bundle of acid ripened curd were placed in a tub of hot water and stirred by a hand paddle until the curd temperature was 135°F. Then, the curd was removed, pulled and molded manually to the form and size desired. It was cooled, brined and wrapped in parchment paper. Later, hand working was replaced by taffy pulling machines.

Advances continued with the introduction of highly mechanized, large capacity mixer-cookers and molding machines described by Nilson (21). These machines produced a smooth, uniform product at a high rate. Mechanical brining and automatic vacuum and gas packaging followed.

Modern advances, however, have not eliminated all cheese quality problems. Examples include development of a uniform browning defect throughout the cheese, now under investigation by Olson (23), burnt and discolored cheese particles on pizza crusts during heating and the appearance of large brownish areas occurring between the film of the sealed package and cheese. Burnt discolored cheese particles on pizza apparently are associated directly with higher than normal lactose levels. This defect was reproduced simply by making Mozzarella cheese from condensed whole milks containing increasing levels of lactose. The cause of these isolated brown areas in packaged cheese is unknown but Masters (15) isolated yeasts and a brownish-grey mold from the discolored areas.

Research on ultrafiltration of milk for Mozzarella cheese at the pilot plant level has indicated a great future potential for advancing its technology. Covacevich and Kosikowski (5) in 1978 reported that acceptable Mozzarella cheese could be made using the MMV-precheese concept if certain modifications were introduced. Further development of this early research was undertaken by individual industrial membrane manufacturers. In continuing studies at Cornell University by Fernandez and Kosikowski (6) direct acidified Mozzarella cheeses using acetic acid were made from UF whole milk retentates concentrated between 1.4:1 and 2:1 total protein. These cheeses had better quality and higher yield efficiencies than controls. Later the same Mozzarella cheeses, partly supplemented with 5:1 whole milk retentate, were converted in a cooking kettle to acceptable pasteurized, processed Mozzarella cheese. (7)

A recent interesting application of ultrafiltration to milk was reported by Kosikowski and Jimenez-Flores (13). They found that pharmaceutical antibiotics like penicillin G, present in contaminated milks, can be removed completely and with ease by a simple ultrafiltration-wash treatment to give non-detectable antibiotic levels using an official assay method. This technique, potentially useful for salvaging tanker and silo milks contaminated with antibiotics, awaits field trials.

Ultrafiltration Advances in Domestic Cheesemaking

Application of ultrafiltration and its retentates to cheesemaking (4, 9, 18, 19) has led to confusion as to the concept upon which it is based. Two important concepts are now used and a third, combining elements of the first two, is emerging. The first two include (A) the MMV-precheese concept dependent upon highly concentrated UF milk retentates, and (B) direct ultrafiltration, or retentate supplementation of milk, based on modest increases total protein levels between 1:1 to 2:1. Both are dealt with in detail in the 20th Annual Proceedings of this seminar (11, 12). For future clarity, concept (B) is named LCR, or low concentrated retentate method. Results and requirements of concepts A and B are compared below.

MMV	LCR
Very high yield increase	Modest or no yield increase
Improved cheesemaking efficiency	Improved cheesemaking efficiency
Traditional cheesemaking eliminated	Traditional cheesemaking retained
Cheese composition quality changed	Cheese composition quality unchanged
Reduced rennet requirement	Reduced rennet requirement
Retentates concentrated 5:1 to 7:1	Retentates concentrated 1:1 to 2:1

New Developments

Movement in the United States toward ultrafiltration for cheesemaking, including Mozzarella, is becoming apparent. Plans for building a new plant in Arizona designed to produce UF milk retentate material for making pasteurized processed cheese are underway. Elsewhere, new plants for producing Mozzarella cheese by the MMV-precheese concept with modifications are in operation. Ridgeview Foods, Ltd. at Whitehall, Wisconsin started operations with Pasilac equipment on June 25, 1984, thus, making it the first plant in the United States to produce cheese commercially by ultrafiltration.

Regulatory Official and Milk Producer Attitudes

Views of regulatory officials are being closely followed on the use of molecular membranes for cheesemaking. At present more information on the compositional and quality differences would be helpful. Cheeses produced by the MMV-precheese concept display the same gross composition as traditional cheese but differ qualitatively because of total retention of whey proteins and higher than normal retention of calcium and phosphorus (5). MMV cheeses generally should have a higher nutritional quality than traditional cheeses. Mozzarella cheese made by the LCR concept using UF retentates essentially shows quantitative and qualitative compositions similar to traditional cheese. However, some LCR cheeses, such as Mozzarella, may have improved nutrient qualities because of modest increases in protein, and apparently, calcium and phosphorous. Glover (8) reported that 59-98% of the B-complex vitamins were retained in 2:1 UF retentates. But, as vitamins are largely removed with whey in traditional cheesemaking, the significance of these results by Glover is yet to be appraised.

Cheesemaking by ultrafiltration generally increases efficiency of manufacture, yield and nutrition of cheeses and aids in whey utilization. For these reasons food regulatory officials might be expected to adopt a favorable view when sufficient supporting scientific data are presented to them.

Milk producers should accept the new ultrafiltration technology because envisioned lower costs for producing cheeses of improved nutritional value will permit keener competition against imitation cheeses. Directly, or indirectly, the farmer will benefit, particularly when ultrafiltration moves to the farm.

Ultrafiltration of Milk on the Farm

Ultrafiltration-thermization of milk on the farm was first conceived by Prof. J.L. Maubois, Director of the INRA Laboratory of Dairy Technology Research, Rennes, France (1, 2, 16). Beside originating this concept he also was the pioneer in conducting many basic scientific trials of ultrafiltration-thermization of milk on the farm for approximately the past 5 years, starting about 1979. In these trials he designed a unique in-line simple refractometer for monitoring concentration levels of UF retentate and acquired countless data on the quality of milk retentates, efficiencies of processing, and the composition, yield and quality of retentate cheeses. Studies reported in 1981 by Bernard, Maubois and Tareck (2) showed that bacterial quality of milk retentate produced on farms was improved by ultrafiltration-thermization. For example, psychrotrophic bacteria averaged 12,000 per ml in raw milk but were reduced to 3,500 in retentates. Unfortunately, Professor Maubois' research has been published largely in French and, as such, is known in this country to only a few active in the field. In the United States, Slack et al (24, 25) at the University of Wisconsin confirmed the practicality of ultrafiltering milk on the farm for use in Cheddar cheese plants with benefits discernable to the milk producer of 100 cow dairy farms. These benefits escalated rapidly for producers of 1,000 cow dairy farms.

It was my privilege to have recently visited Brittany, France, where ultrafiltration-thermization is being conducted on farms as developed by Maubois. At one French farm, twice-daily the raw milk from a herd of 40 or more cows is ultrafiltered to 2:1 total protein concentration and the chilled retentate collected every three days and blended with retentates from other farms for transportation to large cheese factories. The Alfa-Laval UF farm unit was completely automated for operation and sanitizing. At the cheese plant a number of the retentate cheeses appraised were considered of more than satisfactory quality.

Ultrafiltration on the farm is no longer looked at simply as a basic or applied research project as carried out on French farms. It is considered a technically successful routine milk house or parlor practice, well accepted by the milk producer.

Future

Developments in high technology cheesemaking involving ultrafiltration and application of metal membranes are moving rapidly and this advance could revolutionize our milk collection practices and cheese industries, including Italian. Fortunate are we to be participants in some of these developments and observers of the passing scene.

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SOFT BODY MOZZARELLA

By Jeffrey J. Ryan

ABSTRACT

Lactobacillus counts were run on three Mozzarella cheese samples exhibiting a soft body defect and two normal bodied samples. Soft bodied cheeses contained high numbers of contaminant or non-starter lactobacilli. No lactobacilli were detected in the normal bodied cheeses. Using standard biochemical identification tests, Lactobacillus isolates were tentatively identified as L casei, L. fermentum, L. lactis and L. helveticus. All isolates were proteolytic. Additionally, several were psychrotrophic and thermoduric. Inoculation of cheesemilk with certain Lactobacillus isolates prior to Mozzarella manufacture by direct acidification resulted in cheese with a soft body defect. The presence of significant numbers of non-starter lactobacilli in milk or cheese could be a cause of soft body defects in Mozzarella cheese.

Introduction

Soft body is a defect of Mozzarella cheese that is recognized as a problem throughout the Italian cheese industry. Cheeses having this defect exhibit a soft, pasty body, are difficult to slice or grate, and may have undesirable melting characteristics. Several different variables may contribute to the occurrence of this defect. Along the lines of milk processing, excessive heat treatment of milk may cause soft body defects and a reduction in product yield. Poor starter cultures due to bacteriophage problems or an improper rod to coccus ratio may cause soft body defects. When the lactobacilli or rods are in excess, early acid production is slow and excess moisture is retained in the curd. Additionally, the rod is proteolytic in nature and can cause excess protein breakdown leading to soft body defects. Type and amount of coagulant may have an effect on cheese body as can cooking temperatures and brine salting. Contamination of the cheese with proteolytic psychrotrophs may cause the soft body defect.

One area that has recently received attention is the role of non-starter lactobacilli in the development of soft body defects in Mozzarella cheese. Hull, Roberts and Mayes (2) in Australia have observed high numbers of non-starter lactobacilli in soft-bodied Mozzarella cheese samples. Fermentation patterns of the non-starter lactobacilli indicated that the organisms resembled Lactobacillus casei. Cheeses containing this organism at levels of 10,000 or more per gram of cheese had a soft body defect. Potential sources of this contaminant were investigated. The authors observed that the non-starter lactobacilli could be isolated in low numbers from producer milk and milk powder but not from starter cultures or coagulant. Additionally, several important characteristics of the organism were noted. The organism was thermoduric, could grow at temperatures as low as $6^{o}C$ and could grow in milk containing 5% NaCl.

As a follow up to the Australian study, the objective of our research has been to determine if non-starter lactobacilli could be a contributing factor to soft body defects observed in Mozzarella cheese produced in the U.S.

Methods

Four Mozzarella cheese samples were obtained directly from an Italian cheese manufacturer. All cheeses were manufactured using a direct acidification method and were within normal moisture limits. Two of the samples were judged by the manufacturer to have a soft body defect, while the remaining two were normal bodied. A fifth sample, which also exhibited the soft body defect was obtained through retail channels.

Preparation of the cheese samples for lactobacilli enumeration was done by aseptically transferring 11 g of cheese into a sterile blender to which 99 ml of diluent containing sodium citrate was added. Following blending for 3 minutes, the mixture was further diluted than plated on LBS isolation agar. LBS agar is a selective medium used for the enumeration of lactobacilli. Plates were transferred to a Gas Pack anaerobic unit and incubated at $37^{o}C$ for 48 hours.

Isolated colonies in LBS agar were picked and streaked a minimum of 3 times on MRS agar. Pure cultures of the organisms were then transferred to MRS broth and maintained in that medium with bimonthly transfers. Fermentation patterns of the isolates were determined by a micro-titre plate technique (3). Tentative identification of the organisms was accomplished using a computerized culture identification program (1).

Pasteurization resistance of several isolates was determined by heat treating ($63.8^{o}C$/30 min) a 10 ml sample of stationary phase cells. Plate counts on LBS, MRS and SPC agars were made before and after heat treatment. Ability to grow at refrigeration temperatures was determined by streaking the isolates on MRS agar plates and incubating at 7.2°C for 2 weeks. Proteolytic potential was determined by streaking the organisms on SPC agar amended with 10% sterile skim milk.

Mozzarella cheese was manufactured using a direct acidification technique (4). One lot of milk standardized to 2% fat was used in all cheese making trials. In each trial, 7.8 kg of milk were acidified with lactic acid to pH 5.6 at 7.2°C. Following acidification, 100 ml of a 24 hr Lactobacillus culture were added to the milk. The milk was then warmed to 35°C and rennet added at a rate of 1.0 ml per 4.54 kg milk. Within 5 minutes, the coagulum was cut. Following a 10 minute healing period, the curd was cooked at 35°C for 50 minutes. Drained, matted curd was broken into small pieces and stretched in 70°C water containing 3% NaCl. Rectangular boxes which were submerged in ice water were used for molding and cooling. Following brine salting, cheeses were packaged in Cryovac bags and stored at 7.2°C. A control cheese was manufactured as described above except that no Lactobacillus culture was added to the milk.

Results

Lactobacillus counts on cheeses which were judged to have the soft body defect ranged from 150,000 to 250,000 per ml. Since these cheeses were manufactured by a direct acidification method, the organisms were considered cheese contaminants or non-starter lactobacilli. No lactobacilli were detected in the normal bodied cheeses. Although only a limited number of cheeses have been examined thus far, these results concur with previous findings (2) in which cheeses containing 10,000 or more non-starter lactobacilli had a soft body.

Of the 12 Lactobacillus isolates studied, standard biochemical identification tests indicated that seven of the isolates were _Lactobacillus casei_, three were _L. fermentum_, one _L. lactis_ and one _L. helveticus_. Following several transfers, the _L. helveticus_ would not grow and was lost. These organisms are commonly found in milk products and dairy environments. Two isolates each of _L. fermentum_ and _L. casei_ along with the _L. lactis_ isolate were tested for resistance to laboratory pasteurization. _L. lactis_ and one _L. fermentum_ strain were thermoduric while the remaining cultures were not. All isolates were proteolytic and all with the exception of the _L. fermentum_ isolates were psychrotrophic.

Results of the laboratory scale cheese making trials indicated that several of the Lactobacillus isolates had the ability to cause softening of Mozzarella cheese. At the beginning of the trials, all cheeses were somewhat soft and therefore it was necessary to make qualitative judgments on cheese softness before and after the storage period. The body of the control cheese, in which no lactobacilli were added, did not soften throughout a three week storage period at 7.2°C. Pronounced softening was observed in the two cheeses containing L. fermentum. In addition to a soft body, gas pockets ranging from 3-7 mm in diameter were found throughout each cheese. A gas build-up was also noted in the air tight packaging material. The cheese containing L. casei softened slightly during storage.

Conclusion

Undoubtedly, many variables have an influence on the body of Mozzarella cheese. The results of this preliminary investigation support the idea that contaminant or non-starter lactobacilli may be associated with the soft body defect and that when significant numbers of these organisms are added to cheesemilk, a soft body will develop during refrigerated storage.

Although we have been able to enumerate, isolate and tentatively identify lactobacilli associated with soft body defects, and then reproduce this defect in laboratory scale cheese making trials, additional work is necessary and several questions must be answered. For example, are individual milk supplies the primary source of contaminant lactobacilli and if so, how many organisms are necessary to cause the defect? How do cooking, stretching and rates of cooling influence of contaminant lactobacilli and development of the defect? Is cheese made by direct acidification procedures more susceptible to soft body defects caused by non-starter lactobacilli than cheese made with the traditional rod and coccus culture?

Control of soft body defects caused by lactobacilli may be a difficult task. Ability of the organisms to grow at refrigeration temperatures certainly contributes to reduced product shelf-life. With certain strains being thermoduric, the organisms can survive the pasteurization process and contaminate the cheese. Screening raw milk supplies using a microbiological media selective for lactobacilli could be used to identify milk supplies with high Lactobacillus counts.

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