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CDR Wisconsin Center for Dairy Research

Change the Temperatures for Accurate Babcock Tests

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If you use the Babcock test to measure milkfat, then the July/August issue of the Journal of the Association of Official Analytical Chemists International (J.A.O.A.C.Int.) has information for you. The temperature of water added to the Babcock test bottles, the operating temperature for the centrifuge, and the tempering bath temperature have all been changed. This applies to the only Babcock tests specified by A.O.A.C.Int.; fat tests performed on raw whole milk and raw and heat treated cream.

Background

For decades we have known that the Babcock test reads slightly high compared to the Mojonnier or the Roese-Gottlieb solvent extraction method. S.M. Babcock, in his original method, added the thickness of the upper meniscus to compensate for some error with phospholipids and small fat globules not in the fat column. Later, his cream test read too high compared to the solvent extraction results. He advised that glymol be added to flatten the upper meniscus and bring the results closer to those obtained by solvent extraction.

Over the years, a number of other changes have been made in the original procedure to give more accurate results. For example, the calibrated area on the neck was lengthened to allow greater accuracy while reading the volume of fat. Other recommendations included using a magnifying glass and a reading light and raising the sample temperature to 38°C before withdrawing an aliquot to make sure fat wasn't sticking to the plastic container. The procedure was further modified to ensure that enough sulfuric acid was added for the milk/acid reaction temperature to peak at 108±2°C. The reaction temperature for cream ranges between 93 and 103°C, depending on the fat content.

For some time we've known that there was an in error the milkfat density factor in the calibration of Babcock bottles. Instead of starting over and eliminating all existing bottles, D. M. Barbano and his associates did some research on the most feasible alternative. An A.O.A.C. approved collaborative study followed, involving 9 USDA Milk Market laboratories and 18 samples ranging in fat content from 2.5 to 5.7 and 30.1 to 45.3%. All samples were analyzed in duplicate with the new temperatures in place.

Test Results

All results from this large study were handled in the required statistical manner, this data is from the A.O.A.C. published paper:

Method 989.04 Fat in Raw Milk, Babcock Method.
(This method is applicable to raw whole milk)

Performance:

S_r=0.037	RSD_r=0.0901%	r=0.105
S_R=0.047	RSD_R=1.147%	R=0.133

Method 995.18 Fat in Cream Babcock Method.
(This method is applicable to raw or heat treated cream containing 30-45% fat.)

Performance:

S_r=0.258	RSD_r=0.687%	r=0.73
S_R=0.353	RSD_R=0.940%	R=0.998

These statistics are slightly larger than in use currently for the Babcock method but still acceptable.

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Keeping competitive: It's also about Keeping Good Employees

by Tera Johnson, Business Counseling Program Manager, University of Wisconsin School of Business Agribusiness Program

Are you losing cheese makers, maintenance personnel, drivers, and other employees to area companies? Have you raised your wages only to attract marginal applicants? Do newly hired employees seem to have weaker skills than they used to? Do they seem less willing to work hard? If you answered yes to any of these questions, you're not alone. A strong Wisconsin economy over the past few years has created a very competitive labor market. Unemployment rates are at record lows, 3.3% statewide in May of 1997. Worse, there is no reason to expect the situation to improve.

Consider that US population growth has plateaued at around 2%. People are moving south, and companies are following them, to cities like Houston, Atlanta, and Phoenix. Despite all the predictions that technology was going to enable people to live and work in rural areas, the over-riding trend is still for young people to migrate to cities in search of jobs. City employers, strapped for qualified job applicants, are offering wages high enough to justify commuting in from rural areas. For example, Madison now routinely draws workers from as far away as Portage and Monroe.

What does a tight labor market mean for your business?

In a nutshell, a tight labor market means that effectively managing your human resources will be absolutely critical to the future profitability of your business. There are two golden rules:

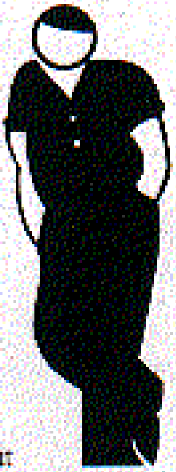
Keep Good Employees
Be a Smart Recruiter

This article is the first in a two part series dedicated to dealing with a tight labor market. It addresses golden rule number one: Keep Good Employees. The next issue will take up golden rule number two: Be a Smart Recruiter.

Hanging on to good employees

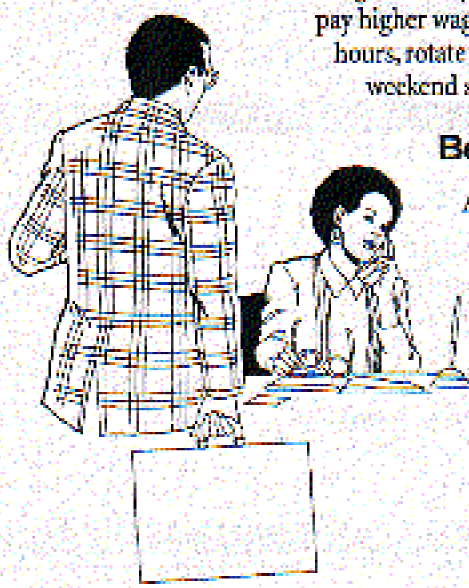
Keeping good employees does not happen automatically. It takes time and other resources. Interestingly, research on job satisfaction shows that pay is not the most important contributor to employee satisfaction on the job. Benefits, quality of work environment, opportunities to learn on the job, and advancement opportunities are consistently ranked as high or higher in the minds of employees. So what does this mean for your business?

Provide benefits. Employees no longer perceive health insurance as a perk; it is becoming a requirement. Shop around for health care coverage. Some of the larger HMO's and other managed care organizations will now accept small businesses into their membership, even if the group size is one. Investigate the impact of 80/20 co-pays on your premiums. Employees will far prefer a 20% co-pay to no insurance coverage.



Second on the benefits list is retirement. With the future of social security increasingly precarious, your long-term employees will only become more concerned about their retirement. Making a 401K plan available for your employees, even if you don't match their contributions, sends a signal that you care about their future. And there's an added bonus. In a privately held company, taking money out of the business over time and putting it in a 401K for the owner's retirement also makes passing the business on to the next generation much smoother.

Recognize that working on Saturday and/or Sunday is a significant detractor. Yes, your long-term employees have done it for years. Yes, you have always worked long hours. Unfortunately, that doesn't mean you are going to keep new employees if you ask them to work 7-day weeks. The world has changed. Young people have more options these days. Try to be creative in staffing your plant. For example, if your plant runs 7 days a week before the holidays, consider hiring (and training) someone just for weekends by recruiting people who are looking for a little extra income for the holidays. If your plant runs 7 days a week throughout the year, you may need to pay higher wages for weekend hours, rotate days off, or hire weekend staff.



Be flexible

A flexible employer can be a significant benefit for employees. People are under enormous pressure these days to juggle family and work obligations. Treat them as

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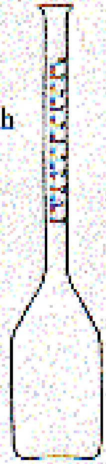
Babcock test, *continued from page 1*



Required Change

The changes recommended and approved by this research are the following:

Centrifuge Temperature 48.5±2.5°C
This temperature is difficult to control particularly during the 2 minute and 1 minute centrifuge times where the door is opened on a shorter interval with the resulting heat loss.

Hot Distilled Water 51±1°C

Tempering Waterbath 48±1°C
Of all temperature control steps this is the last temperature adjustment before measurement of the fat column. At measurement the density of milkfat is .9000g/ml. Exactly where it is needed to eliminate the bias between the Babcock and Mojonnier results.

Change your Babcock temperature controls to reflect these new temperatures for the centrifuge heater, distilled water heater and tempering bath. This method modification will be in the annual published method changes for the A.O.A.C. Official Methods of Analysis as well as the next revision of Standard Methods for the Examination of Dairy Products.

Reference

Joanna M. Lynch, D.M. Barbano and J.R. Fleming. Modification of Babcock Method to Eliminate Fat Testing Bias Between Babcock and Ether Extraction Methods (Modification of A.O.A.C. Official Methods 989.04 and 995.18): Collaborative Study. J.A.O.A.C.Int. 80 (4):845-859. 1997.

Fortifying Reduced Fat Cheese

So, how do you restore the level of vitamin A in reduced fat cheese? This is a technical issue that you will need to work on with your vitmain supplier. Vitamin A is a fat soluble vitamin, available commercially in several forms, usually water dispersable or oil based. After adding vitamin A to milk for cheesemaking, count on losing some in the whey. The amount partitioning into whey depends on several factors, including the form of vitamin A that you use, the size of the curd, pH, and your make procedure. At least initially, you will need to analyze your product for vitamin A to ensure that you have restored the levels correctly.

"Since vitamin A is a fat-soluble vitamin, removing fat when making lower fat cheese also removes some of it. Vitamin A is one of the nutrients present in measurable amounts in cheese. Therefore, you must add vitamin A to the modified product to restore the level to that found in the regular product. For reduced fat Cheddar cheese, for example, this means restoring the vitamin A in one serving to 6 percent of the Daily Value, and declaring the vitamin A preparation as one of the ingredients in the ingredient statement."
From "Fortifying Dairy Foods," by Emerita Alcantara, Dairy Pipeline, Spring 1997, Vol. 9, No. 2

Keeping competitive, *continued*

individuals. If you can design job responsibilities to allow an employee to be home when school gets out, or be off one morning a week to do errands for an ailing parent, you might be able to keep a valuable employee.

Provide opportunities for job enhancement. Although employees look for advancement opportunities, this is not the only way you can enrich their work lives. There are always exceptions, but most employees feel more committed to employers who help them keep their skills current. Training is a win-win: employees value it and their new skills improve the bottom line for the company. The bottom line results of training are highest when the employee and manager work together to identify new activities and needed skills that would benefit the company.

Continually review your compensation. How competitive are your wages? What was competitive two years ago may not be competitive this year. Watch the employment section of your local paper. Get a copy of the wage and salary survey for your county. It is not always necessary to pay the highest wages to retain the best people, but you do need to stay "in the ballpark."

In Wisconsin's tight labor market, finding and training replacement employees can be very expensive. National estimates of the impact of employee turnover suggest that it costs as much as 40% of an employee's salary to find and train a new one. All the more reason to take action now to help your business follow golden rule number one: Keep Good Employees.

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and above led to scorching of the melted cheese, we did not include other temperatures over 90°C. For each test, 5 g of cheese, formed into a 35-mm diameter, 21-mm high disc, was heated in a forced air convection oven for 5 min. The sample discs were formed by placing the shredded cheese in a 35-mm inside diameter and 25-mm high stainless steel ring and compressing the sample with a plunger (34 mm in diameter) to a constant distance (4 mm) so that the compressed cheese sample was a disk of 35-mm in diameter and 21-mm in height. The samples were heated without the steel ring around them.

After cooling to room temperature for 5 min, the spread of the melted cheese was characterized by measuring both the maximum diameter (as per the Schreiber test) and area. The maximum diameter of the cheese spread was measured manually using a set of concentric circles similar to the industry practice. The spread area was measured using a computer imaging system. The system consists of a CCD video camera, light source; digitizer, computer, a 15-inch video monitor, and Optimas image processing software. All the tests were conducted in triplicate. Statistical significance of the data was tested by a multifactor analysis of variance. The level of significance of $P<0.05$ was used.

Results And Discussion

Among different surfaces tested, the surface area of cheese melt on the aluminum plate was the highest. Also, when sample-to-sample variation is considered in terms of coefficient of variation1 (CV, %) the aluminum plate was better than the glass petri dish both when diameter and spread area were determined. The CV was much worse when diameter was measured than the spread area suggesting that the spread area measurements are more consistent for cheese meltability determinations. However, quick and easy spread area measurements would require a computer imaging system similar to the one we used.

There was a considerable data overlap regardless of the test surface or temperature. The five samples can only be grouped reliably into three distinct meltability groups. The meltability ranking of the samples in each group varied slightly depending on the surface and temperature used. Thus, some knowledge and understanding of the cheese chemistry and make procedure should be used in conjunction with these test results in picking the most suitable surface and temperature combination. Nonetheless, tests on aluminum plate tended to provide larger spread areas and lower sample-to-sample variabilities compared to other surfaces. Tests on aluminum plate also tended to discriminate samples according to their meltability fairly well. The spread area and diameter increased as temperature increased. However, temperatures greater than 100°C led to charring of outer edges of the cheese spread contributing to some loss of accuracy in measurements with all heating surfaces. Therefore, it appears that temperatures over 90°C are not necessary for evaluating cheese meltability. Data from tests using the stainless steel plate were comparable to, but not better than, those from tests using the aluminum plate. The protocols tested in this study are only valid for full fat cheeses, since we did not evaluate the meltability of reduced fat cheeses.

Conclusion

The Schreiber test for cheese meltability evaluation should be modified so that the test is performed at a lower temperature (90°C) on an aluminum plate and the area of the melted cheese should be measured as an indicator of cheese meltability.

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Table 1. Chemical composition of shredded Mozzarella cheeses

Sample	pH[1]	Fat (%)[2]	Moisture (%)[3]	Salt (%)[4]
A	5.16	22.0	46.8	.72
B	4.96	25.0	52.4	.92
C	5.14	24.3	48.2	.59
D	5.11	23.0	48.8	.80
E	5.01	21.5	49.8	.86

[1] gold electrode/quinhydrone method (Van Slyke and Price, 1979)
[2] Babcock method (Bradley et al., 1992)
[3] vacuum oven method (Vanderwarn, 1989)
[4] coulometrical method (Johnson and Olson, 1985)

Table 2. Results of the Schreiber tests as measured by the *maximum diameter (cm) of cheese spread* on different surfaces (stainless steel, ss; aluminum plate, ap; and Petridish, pd) at different temperatures (60, 70, 90, and 232°C)

	60°C				70°C		
Sample	ss[1]	ap	pd	Sample	ss	ap	pd
A	2.08^{a}	2.50^{b}	2.25^{a}	A	2.08^{a}	2.75^{c}	2.17^{a}
B	2.17^{a}	2.50^{b}	2.00^{a}	B	2.92^{b}	3.00^{d}	2.42^{a}
C	2.00^{a}	2.08^{a}	2.00^{a}	C	2.08^{a}	2.17^{a}	2.00^{a}
D	2.00^{a}	2.08^{a}	2.17^{a}	D	2.25^{a}	2.42^{b}	2.33^{a}
E	2.33^{b}	2.83^{c}	2.00^{a}	E	2.75^{b}	3.17^{d}	2.50^{a}
	90°C				232°C		
Sample	ss	ap	pd	Sample	ss	ap	pd[2]
A	3.08^{a}	3.33^{b}	2.92^{ab}	A	4.42^{a}	5.33^{a}	4.33^{a}
B	4.08^{b}	4.17^{c}	3.33^{bc}	B	5.17^{b}	7.25^{b}	4.92^{b}
C	3.17^{a}	3.25^{ab}	3.00^{ab}	C	4.58^{a}	6.92^{b}	4.83^{b}
D	2.83^{a}	3.08^{a}	2.42^{a}	D	4.17^{a}	4.83^{a}	4.25^{a}
E	3.83^{b}	3.92^{c}	3.67^{c}	E	6.58^{c}	8.75^{c}	5.83^{c}

[1] Data with same letter superscripts within each column are not significantly different at 0.05 % level.

[2] Data obtained as per the actual Schreiber test protocol.

Table 3. Coefficient of variation (CV, %) of the *spread area* (cm^2) *and maximum diameter of spread (cm)* of melted cheese on different surfaces heated at 90°C

Sample	Stainless Steel Plate		Aluminum Plate		Petridish	
	Area	Diameter	Area	Diameter	Area	Diameter
A	0.8	3.8	2.5	7.1	0.5	4.0
B	4.5	2.9	3.9	5.7	1.8	7.1
C	2.3	7.4	2.3	6.3	5.8	13.6
D	2.7	8.3	1.1	3.8	1.5	4.9
E	1.1	6.2	1.8	3.0	3.4	12.9
Mean CV, %	2.3	5.7	2.3	5.2	2.6	8.5

CV = 100*(standard deviation/mean)

Modified Schreiber Test for Evaluating Cheese Meltability

K. Muthukumarappan[1], Y.-C. Wang and S. Gunasekaran, Dept. of Biological Systems Engineering, University of Wisconsin-Madison

Meltability is the ability of the cheese to flow or spread when heated. Currently, the most commonly used method for evaluating meltability of cheese is the Schreiber test (Kosikowski, 1977). In this test, a plug of cheese, placed in a glass petri dish, is heated in an oven set at 232°C for 5 min. The melted cheese is cooled for 30 min and the largest diameter of spread is taken as an estimate of its meltability.

The Schreiber test has two major problems—the cheese spread may be noncircular and the outer edges of the spread often scorch. These problems induce errors in this empirical test, leading to inconsistent results. However, because of its simplicity, the Schreiber test is still very popular. We think that modifying the Schreiber test can improve consistency of the results. For example, measuring the spread area instead of the diameter circumvents measurement error caused by the noncircular spread of the melted cheese. You can avoid scorching the cheese by evaluating meltability at a temperature lower than the current 232°C. Thermal and surface tension properties of the heating surface may also contribute to scorching and extent of spread. We have determined that full fat cheeses soften and flow in the temperature range of 50 to 60°C (Muthukumarappan et al., 1996). Thus, the 232°C setting is excessive. Even in practical applications, like baking a pizza, the cheese temperature does not reach above 100°C during heating (Muthukumarappan and Gunasekaran, 1996). From the following research, we conclude that you don't need to heat cheese above 100°C to evaluate meltability.

In our recent study, our objective was to investigate the effect of the following factors on cheese meltability evaluation:
(1) oven temperatures in the range of 60 to 232°C,
(2) three heating surfaces: glass petri dish, aluminum plate and stainless steel plate,
(3) measuring the area of melted cheese rather than its maximum diameter.

We used five shredded Mozzarella cheeses supplied by a commercial manufacturer. The chemical composition of these cheeses was determined by published methods and results are presented in Table 1. In addition to the glass petri dish, a 0.7-mm thick stainless steel plate and a 2.5-mm thick aluminum plate were selected as surfaces over which the cheese plug was heated and allowed to flow. Four oven temperatures, 60, 70, 90, and 232°C were selected. These temperatures range from just over the softening point of cheese, to the current Schreiber test setting. Since our preliminary tests indicated that temperatures 100°C
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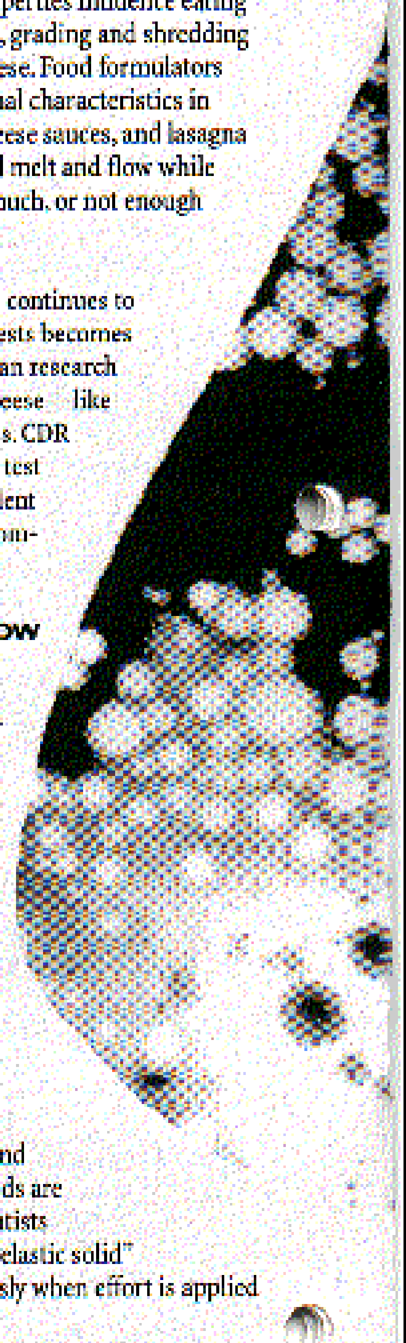
Rheology—Describ



Greek, *rheos*, stream< *rhein*, to flow
This is the most succinct way to define rheology—simply trace the word to its roots and learn that rheology is the study of flow. However, it turns out that the study of flow is not succinct and it's not all that simple.

But it is important, since rheological properties influence eating quality, handling and packaging, cutting, grading and shredding characteristics and eye formation in cheese. Food formulators need predictable and consistent functional characteristics in cheese. For example, cheese burritos, cheese sauces, and lasagna are all foods that contain cheese that will melt and flow while heating. Cheese that melts too fast, too much, or not enough influences the entire product.

As the use of cheese as a food ingredient continues to grow, the need for accurate rheological tests becomes more important. Before food scientists can research and control the physical properties of cheese — like meltability— they need reliable methods. CDR researchers are working on a meltability test that gives reproducible results, independent of test conditions and operator. (See accompanying articles.)

Extending the concept of flow

According to the Encyclopedia of Food Science and Technology, you can "extend the concept of the flow of a material to include the idea of any change in its shape, under the action of an external agency, which is not instantaneous, and which is not entirely recoverable." Deformation is the short term for this concept, thus rheology is the study of flow and deformation.

The essential vocabulary of rheology comes from the physical sciences. Start with matter: solid, liquid, or gas. Now, consider the differences between solid and liquid; the obvious difference is that solids are rigid and liquids are fluid. Physical scientists refine these definitions, for example an "elastic solid" recovers its original shape instantaneously when effort is applied and the shape changes.

The term "viscous liquid" incorporates viscosity into the concept of fluid. Viscosity describes the relation between effort applied to a liquid and the flow rate. Think of sticking your hand into a

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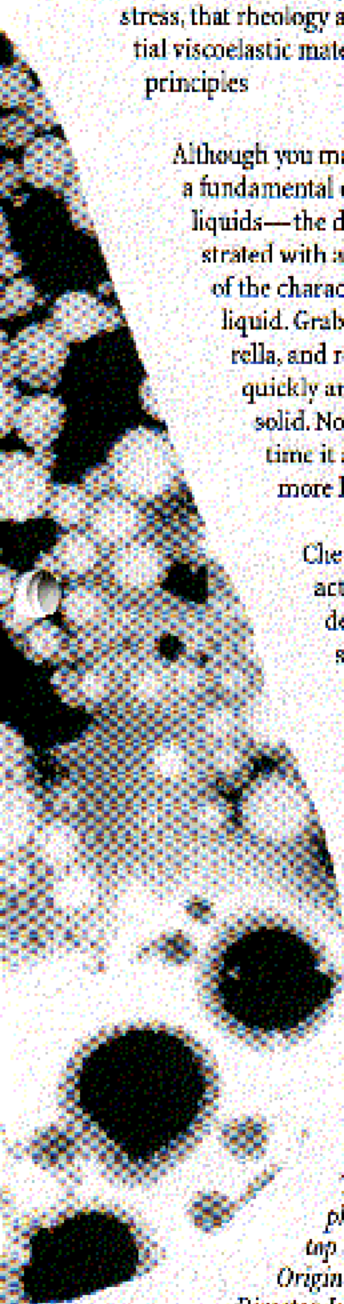
moving stream and pushing against the current, when you pull your hand out, it is the rate of flow that returns to where it was before you applied the "force." It is the interplay and variation in properties of viscosity and elasticity, and how they respond to stress, that rheology attempts to explain. Cheese, the quintessential viscoelastic material, is ideal for demonstrating rheological principles



Although you may not realize it, you have already observed a fundamental difference in behavior between solids and liquids—the dimension of time. This is easily demonstrated with any viscoelastic material, one that has some of the characteristics of an elastic solid and a viscous liquid. Grab some Playdoh, or warm, stretchy Mozzarella, and roll it into a cylinder. Pull both ends apart quickly and it snaps with a quick break, acting like a solid. Now, try again and pull it apart slowly. This time it stretches slowly before it breaks, acting more like a liquid.

Cheese makers and cheese graders have actually drawn on rheological principles for decades, even before rheology evolved as a scientific specialty. Using the "finger test" to split the curd to assess coagulation, grading the body and firmness of cheese—these are some of the subjective evaluations that rheological tests are attempting to standardize. Projecting from current trends indicates that the use of cheese as a food ingredient will continue to increase. Another avenue of growth is the export market. Standardized rheological tests play a role in both of these areas by offering a precise, reproducible international language to describe the physical properties of cheese.

This droplet was adapted from a photo of phase inversion–oil dispersed in water at the top and water dispersed in oil at the bottom. Original photo taken by Karsten Qvist, Research Director, Institute of Dairy Research, Royal Agricultural and Veterinary University, Copenhagen, Denmark.

Resources

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Try a new device to evaluate melting cheese

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For years the dairy industry and food processors have used empirical methods to determine the "meltability" of cheese. The most popular methods are the Arnott test (Arnott et al., 1957) and Schreiber test (Kosikowski, 1977). The Arnott method is based on measuring changes in height while the Schreiber test measures the diameter of a cylindrical sample of cheese after it is heated. However, when different researchers, using various specimen dimensions and heating conditions, use the Schreiber and Arnott tests, the results do not correlate (Park et al., 1984). An objective method for evaluating the melting quality of cheese is needed.

There are many methods available for rheological analysis of materials that could be used to study the behavior of melted cheese (Ruegg et al., 1991). For example, capillary extrusion is an appropriate way for estimating cheese flowability (Smith et al., 1980). Dynamic rheological testing has been applied to cheese (Nolan et al., 1989, Diefes et al., 1993, and Ustunol et al., 1995) to evaluate the viscoelastic behavior of different cheeses. Biaxial extensional viscosity data for Mozzarella cheese and American processed cheese from lubricated squeezing flow methods have been reported (Casiraghi et al., 1985, Campanella et al., 1987, and Ak and Gunasekaran, 1995). Among these, squeezing flow

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capillary extrusion
In this rheological method melted cheese (or any test fluid) is pushed or pumped through a small diameter tube (or capillary). Pressure drop and flow rate through this tube are used to determine viscosity.

extensional behavior
Describes the response of a material (such as melted cheese) subjected to extensional flows. For example, stretching melted cheese in one direction (e.g., during fork test for pizza cheese) is considered "uniaxial extensional flow." Viscosity calculated from this type of test is called "uniaxial extensional viscosity."

biaxial extensional viscosity
This is another type of viscosity calculated, for melted cheese, from compression tests between lubricated plates (also called squeezing flow test). These compression tests can be considered a biaxial extension test. Our meltmeter operates in this configuration and gives results that can be converted into biaxial extensional viscosity.

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rheometry is the most popular. This technique, based on compression of a specimen between two parallel plates, was developed for evaluating the extensional behavior of high-viscosity polymers (Chatraei et al., 1981). The main advantage of this method is that the presence of slip, as a result of self-lubrication due to fat separation in cheese, is not only a prerequisite for a proper test but also incorporated in the calculation of results (Campanella and Peleg, 1987).

We decided to:

1. Design and develop a device for objectively evaluating melt characteristics of cheeses (based on squeezing flow configuration) under a constant force or a constant deformation rate

2. Study the effect of test temperature and fat content on the melting characteristics of Mozzarella cheeses.

Modified squeeze flow test device (UW-Meltmeter)

A schematic of the modified squeeze flow test device (hereafter referred to as the UW-Meltmeter), designed and fabricated in the Food Engineering Laboratory of the Biological Systems Engineering Department at the University of Wisconsin-Madison, is shown in Figure 1. It consists of the following components:

- aluminum body with a doughnut-shape heater inside,
- a lever to start the test,
- a temperature controller to operate the heater,
- a linear variable differential transformer (LVDT) connected to a circular plate to monitor the change in height of sample
- a personal computer with a data acquisition board and for data collection and analysis.

The UW-Meltmeter can either be operated alone as a constant force test, or with a uniaxial compression device (like Instron) to provide the constant deformation rate (i.e. constant cross-head speed) test. You can do the testing at the low strain rate normally

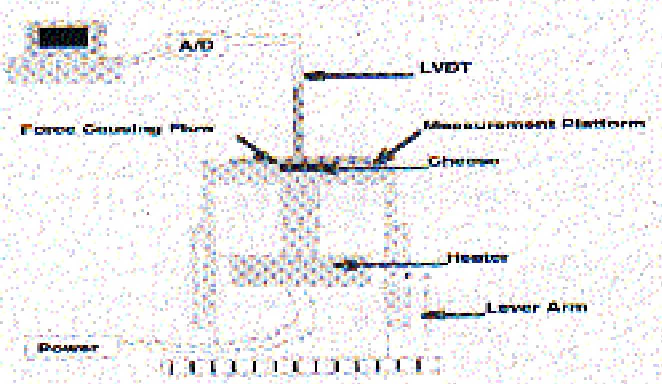

Figure 1. Schematic of the modified squeeze flow test device (UW-Meltmeter)

experienced by cheese during melt/flow on foods such as pizza by adjusting either the compression rate or the magnitude of the imposed load.

Modified squeeze flow test

To do the test, raise the lever and place the cheese sample (7 mm in height and 30 mm in diameter) in the sample well. The two metal surfaces in contact with cheese during a test are lubricated with mineral oil to obtain lubricated squeezing flow. The cheese is heated with a circular plate placed over the sample to prevent any moisture loss. Once the sample reaches the desired uniform test temperature, the data acquisition system is started and then the lever arm is lowered, pushing up the cheese and allowing it to flow. In case of the constant force test, the circular plate connected to the LVDT moves in contact with top surface of the cheese to measure the strain rate. When we used with a uniaxial test device (we used an Instron Model 1130 Universal Testing Machine), the cross-head movement in contact with the cheese was used to calculate the sample strain rate. Each test was replicated three times. Output of the melt-meter is height of specimen vs. time for constant force test. The output of the meltmeter with a uniaxial test device is force vs. time for constant deformation rate test.

Summary

A device to objectively characterize the melting behavior of cheeses at different temperatures was designed and developed. It consists of a temperature-controlled heater, an LVDT (linear variable differential transformer), and a personal computer with a data acquisition system. This device, named UW-Meltmeter, can be operated in the squeeze flow configuration and can either be operated alone at a constant force or in conjunction with an Instron-type machine at a constant deformation rate (i.e., constant cross-head speed). The meltmeter test developed in this study was validated using two milkfat fractions with known dropping points.

Flow of melted Mozzarella cheeses under a constant force and a constant deformation rate were studied. The stress and strain rate data were collected and the biaxial extensional viscosity and biaxial extensional strain rate were calculated. Mozzarella cheeses of different fat contents (14 and 43%) were studied at different temperatures (40 and 60°C). The results supported the expected trend of increased meltability at higher fat levels and at higher temperatures. The biaxial extensional viscosity could be used as a tool for objectively characterizing the cheese meltability, because it eliminates slip as a source of artifacts.

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Fortifying Dairy Foods

Part 2 Voluntary Addition of Nutrients

by Emerita N. Alcantara, Ph.D., R.D.
Vice President, Nutrition & Regulatory Services, Dairy Council of Wisconsin

In the last issue of the Dairy Pipeline (Spring 1997), we covered the rules governing **mandatory** addition of nutrients to milk, cheese and other dairy products. The requirements are spelled out in the standards of identity for the different dairy products (CFR Title 21, Sections 131 and 133) and in what has become commonly known as "generic standards" (Section 130.10). The generic standards set forth, among other things, nutritional equivalency requirements when a product that is subject to a standard of identity has been nutritionally modified, e.g., reduced fat Cheddar cheese.

In this issue, we will deal with the applicable rules and guidelines when a dairy processor or cheesemaker wants to **voluntarily** add nutrients to a dairy product, either for marketing purposes or in order to meet identified consumer needs. For example, suppose you want to produce a nonfat yogurt containing five added vitamins (A, C, E, B-12 and folate). This value-added product is targeted for kids and is positioned as a fun and delicious way of getting vitamins instead of through vitamin pills. What should a dairy manufacturer keep in mind when contemplating a voluntary addition of nutrients to dairy products?

Review the standards of identity

As a baseline, check the standards for information on what may be allowed as optional ingredients, including any vitamins or minerals that may be added. These standards also dictate what the product name should be.

Familiarize yourself with FDA's fortification policy

FDA recognizes the importance of maintaining the nutritional quality of the nation's food supply. Adding nutrients to specific foods can be an effective way of achieving this important objective. However, the agency cautions that random fortification of foods can result in over-or-under-fortification in consumer diets and create nutritional imbalances in the food supply. Thus, FDA established a fortification policy which sets forth the agency's view regarding rational and appropriate fortification. The policy is non-binding and, admittedly, needs revision. Nevertheless, it can serve as a guide for acceptable fortification practices. The details of the policy may be found in CFR Title 21, Section 104.20. Among other things, manufacturers are advised to fortify only when there is a general public health consensus of

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Meltmeter

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dietary insufficiency for that particular nutrient. In addition, the added level should bear some reasonable relationship to the overall amount of the nutrient required in the total diet (e.g., avoid touting that the cheese contains 1000% of the daily value for X nutrient).

Keep in mind that FDA retains the legal authority to take enforcement action against a product where it considers a particular fortification practice and accompanying claims to render the product labeling false or misleading.

Understand the applicable provisions of the "generic standards" (Section 130.10)

This new rule, which came about as a result of NLEA (Nutrition Labeling and Education Act), allows for nutritional modification of standardized foods consistent with certain parameters. Its successful application to a particular product requires the combination of marketing, technological and regulatory expertise. Although written primarily to allow lower fat versions of standardized foods, FDA interprets the rule as also authorizing positive fortification i.e., addition of nutrients, and accompanying claims for standardized foods. Thus, Section 130.10 not only **requires** the modified food to be nutritionally equivalent to its regular counterpart, but also **allows** the addition of nutrients above and beyond what is in the standardized product.

Under this rule, the product name or statement of identity must be qualified to indicate how the modified food differs from the standardized food. Some common example are "Reduced Fat Cheddar Cheese" or "Lowfat Milk." However, positive fortification may produce odd results in the product name, e.g., "Excellent Source of Vitamin E Cheddar Cheese." In this case, it would be appropriate to modify the product name simply by adding the word "Fortified" to the name of the cheese, e.g., "Fortified Cheddar Cheese" and including an accompanying statement, "Contains 20% more of the Daily Value for vitamin E than the regular Cheddar cheese." The terms "fortified," "enriched," "added," and "more" are considered synonymous by FDA and may be used interchangeably. To qualify for the use of these terms, at least 10% of the Daily Value of a given nutrient must be added.

Other product names that may be used in the above example include: "Cheddar Cheese with added vitamin E," "Vitamin E enriched Cheddar Cheese," and "Cheddar Cheese fortified with vitamin E." Or, from a marketing standpoint, it may be more desirable to use a fanciful name that is short and catchy. This is appropriate as long as an accompanying descriptive statement properly identified the product, including the addition of nutrient(s). Clearly, marketing and regulatory perspectives are essential in developing an appropriate statement for the product.

The best and safest course

Great care should be taken in considering how best to tout the addition of nutrients to a standardized product. The best and safest course is to use FDA-defined nutrient content claims such as "fortified," "enriched," etc. Claims about the health benefit of an added nutrient or statements concerning the role that a nutrient plays in the normal, proper functioning of the body involve unique and often complicated regulatory issues that should be evaluated carefully.

In summary, current regulations allow the voluntary addition of nutrients to standardized dairy products. However, it is important that such fortification practices be in line with FDA's view of rational and appropriate fortification. In addition, the product name or statement of identity must be properly qualified to indicate how nutritionally modified food differs from the standardized product. And, as with any nutrient content claim, there are additional labeling requirements triggered by such claims that the manufacturer must take into account when designing labels for the modified products.

Still have questions about fortifying dairy foods? Call Dr. Alcantara at the Dairy Council of Wisconsin, (630) 655-8866.

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Jan. 5-9 Ice Cream Makers Short Course. Madison, WI. Call Bob Bradley at (608) 263-2007 for information, or the CALS Outreach Services (608) 263-1672 to register.

Jan. 12-15 Milk Pasteurization and Process Control School. Madison, WI. Call Bob Bradley at (608) 263-2007 for information, or the CALS Outreach Services (608) 263-1672 to register.

Feb. 3-4 Wisconsin Dairy Field Reps Conference. Madison, WI. Call Bill Wendorff at (608) 263-2015.

Feb. 25-27 Wisconsin Process Cheese Short Course. Madison, WI. Call Jim Path at (608) 262-2253 for more details.

Curd Clinic

Curd clinic doctor for this issue is Marianne Smukowski, CDR Safety Applications Coordinator

Q. I know it is common practice in many cheese plants to "recycle" fines. However, after working on our HACCP plan, we are rethinking the practice. What are the pros and cons of reusing cheese fines?

A. You can recycle those fines—defined as curd, regardless of size, that are removed with whey. The key is where they end up when you recycle them.

There are two main issues to resolve, the first one is safety. If you try to add fines to the next batch of cheese you make, you are asking for trouble. Fines are notorious for carrying microorganisms with them. In a recent CDR study looking at microbiological testing in cheese plants, coliforms were frequently detected in fines samples.

Safety issues aside, adding fines to the next batch of cheese also influences quality. The CDR study also looked at yeasts and molds, and found them present in over one third of the fines samples tested. The study also found presumptive lactobacilli present in concentrations ≥ 1,000 CFU/ml or g in the vast majority of fines and whey cream samples. Although these are not indicator organisms per se, they still may have an effect on cheese quality. If you knew you had these numbers in your fines, would you really add them back to contaminate the entire vat of cheese?

Another quality issue also stems from mixing fines into a different batch of cheese. Most likely, the composition of the batches is different. For example, differences in moisture content, pH, and fat may allow the fines to really stand out in a finished block of cheese. Thus, fines can cause spot, or color defects.

What are acceptable avenues for recycling fines? Consider using them in a process cheese operation. Many cheesemakers press the fines into forty pound blocks and recycle them safely this way. Process cheese is a safer alternative because the fines are heated and more salts are added.

Some other, less profitable, methods you might consider include using fines for animal food or fish bait. Probably the least desirable method of disposing fines is simply landspreading them.

Whatever you do with your fines, my advice is to avoid recycling them for table cheese. You really need to ask yourself if the short term financial gains make up for the potential long term quality and safety losses.

Questions for the Curd Clinic?
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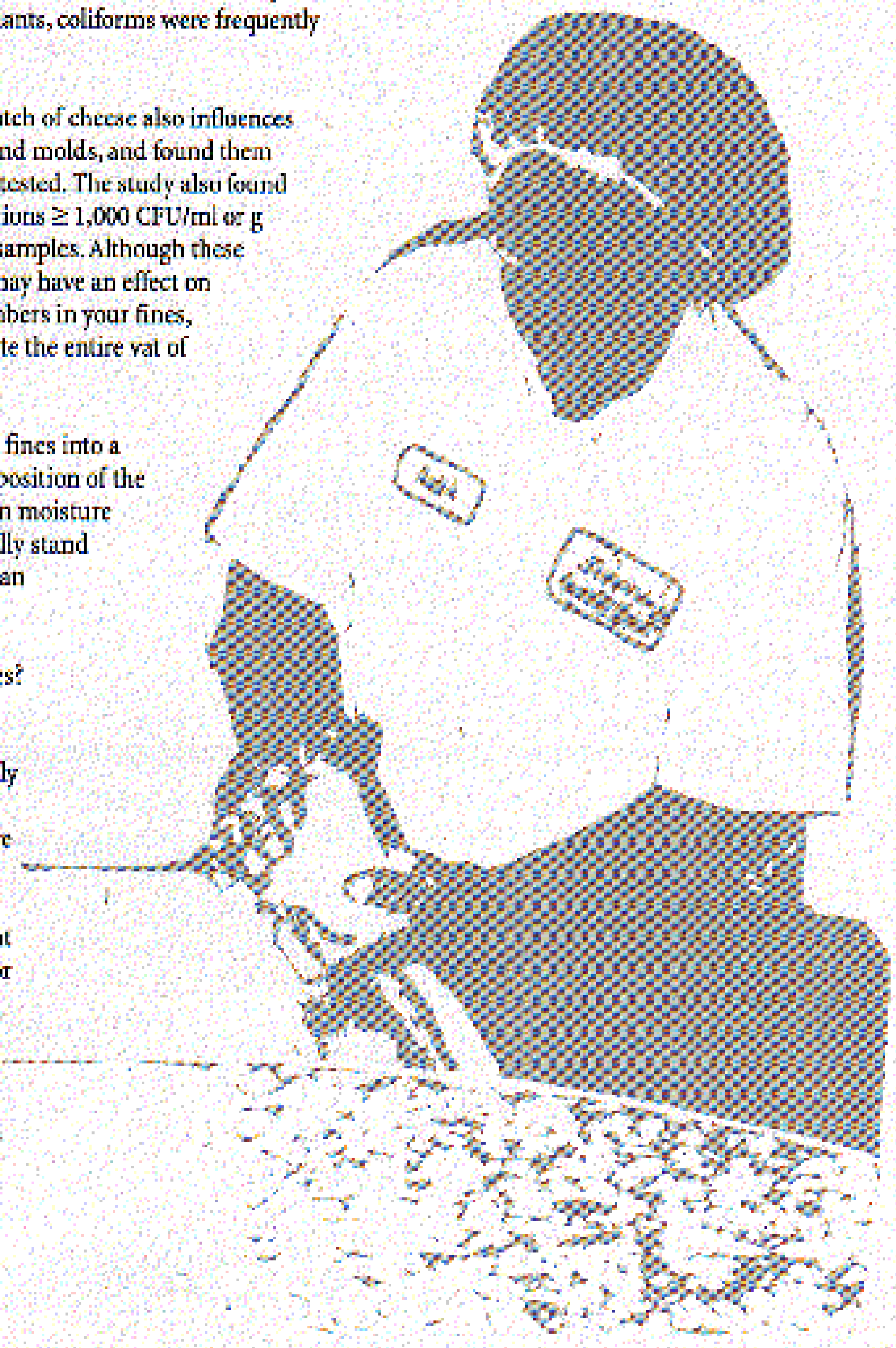

Calendar

Sept. 25 Southwestern Wisconsin Cheesemakers Assn. Annual Meeting. For registration, call Tom Jenny at (608) 348-9706.

Oct. 1 Central Wis. Cheesemakers and Buttermakers Assn. Annual Convention. Marshfield, WI. For registration, call Gordon Moen at (715) 687-4148.

Oct. 6-10 Wisconsin Cheese Technology Short Course. Madison, WI. Call Bill Wendorff at (608) 263-2015.

Oct. 15-16 Pasteurization Short Course for Trained Operators. UW-River Falls. River Falls, WI. Call Ranee May at (715) 425-3702.

Oct. 15-16 No. Central Cheese Industries Assn. Annual Conference. Minneapolis, MN. For information, call Dr. David Henning at (605) 688-5477.

Oct. 21-23 Milkfat as an Ingredient Short Course. Madison, WI. Call Kerry Kaylegain at (608) 265-3086.

Oct. 22-24 Current Concepts in Foodborne Pathogens and Rapid and Automated Methods in Food Microbiology. University of Wisconsin-River Falls. Call (715) 425-3150 for details.

Oct. 27-29 International Whey Conference. Chicago, IL. Call ADPI at (312) 782-4888.

Nov. 4-5 French Specialty Cheese Artisan Course. Madison, WI. Call Jim Path at (608) 262-2253.

Nov. 5 Eastern Wisconsin Cheesemakers and Buttermakers Assn. Annual Convention. Green Bay, WI. Call Art Loehr at (414) 999-3895.

Nov. 11-12 Wisconsin Cheese Grading Short Course. Madison, WI. Call Bill Wendorff at (608) 263-2015.

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