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Know the Cultures You Grow

by Scott Wells, Matt Mathison, Sanofi Bio-Industries with Julia Barrett

The people of the ancient western world found they could make cheese simply by letting milk curdle. Through many centuries and around the world, cheese-making evolved to meet peoples' tastes. In the 1800's, dairy technology evolved rapidly as scientists discovered pasteurization and explained fermentation.

In starter technology, there are two basic types of lactic acid bacteria, mesophilic and thermophilic strains. The choice of cultures is based on the desired end product and its manufacture parameters, such as pH and cooking temperature. Dairy manufacturers use starter cultures with specific characteristics to make their products.

Whether that product is cheese, yogurt, sour cream or buttermilk, all lactic acid bacteria start production by fermenting lactose, a milk sugar, into lactic acid. Controlling the rate of acid production is absolutely essential when producing quality fermented dairy products.

Fermentation begins when lactose is split into its component sugars, glucose and galactose. Cultures differ in the way bacteria take up the lactose, how quickly they ferment it and the fermentation pathways they use. Some strains of lactic acid bacteria also metabolize citrate and certain amino acids.

Mesophilic Cultures

Mesophilic is a combination of the Greek words, *mesos*, which means middle, and *philos*, or preference. Thus, mesophilic cultures prefer intermediate temperatures. The upper limits of growth are 40°C (104°F), ideal for production of low cook cheeses like Cheddar, Colby, Gouda, and cottage cheese. Fermented milk products such as buttermilk and sour cream also use mesophilic cultures.

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What's Inside:

Lactose Drying

by A. Kent Keller, WHEY SYSTEMS, INC.
Adapted from Proceedings of the ADPI/CDR Dairy Products Technical Conference, April 1994

If you stop to think about it, spray drying certainly sets the standard for drying dairy products. The technique is used for drying skim milk, whey, whey protein concentrate, and a host of specialty products. Common to all of these products is the need to remove about 0.8 to 1.5 lb of water for each lb of final product (Fig 1). In the case of lactose drying we only need to remove about 1/20 lb of water per lb of final product. Another way to look at it is "For each lb of product produced in a spray dryer, we need to remove about 20 times as much water as we need to remove when drying lactose."

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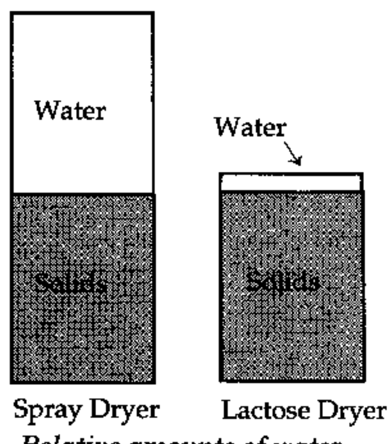

Figure 1. *Relative amounts of water removed to produce 1 lb. of dry product.*

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Basic mesophilic cultures include:

Lactococcus lactis subsp. lactis
Lactococcus lactis subsp. cremoris
Lactococcus lactis subsp. lactis biovar diacetylactis
Leuconostoc sp.

These strains ferment both glucose and galactose, leaving no residual sugars in the cheese. They grow over a broad temperature range of 10 – 40°C (50 –104°F), and a pH range of 4.5 to 7.5. The optimum temperature range is 30 – 37°C (86 – 98°F), and the optimum pH range is 5.5 to 6.5.

Cremoris and lactis strains vary in their upper temperature limits for growth. *Lactis* strains can grow up to 40°C (104°F). Temperature insensitive *cremoris* strains replicate and produce acid up to 39°C (102°F), but temperature sensitive strains become stressed and no longer replicate at 36 – 38°C (96 – 100°F). They still produce acid, but much more slowly.

Knowledge of temperature sensitivities is essential. The cooking temperature determines the final cell population. This residual starter guides the final pH drop after salting and pressing, thus flavor development in the cheese. The diace*tylactis* strains also metabolize citrate to diacetyl and CO_2 gas. Citrate occurs naturally in milk at a level of about 0.2%. CO2 gas is important in open-textured cheese such as Blue cheese. The d*iacetylactis* growth temperatures parallel the *lactis* strains. *Leuconostoc* strains also metabolize citrate, but they have lower temperature limits and grow more slowly than other mesophilic strains. In the U.S., they are rarely used to produce cheese due to their slow growth. However, they are used to manufacture buttermilk and sour cream because they produce diacetyl, a desirable flavor component of these products.

Thermophilic Cultures

Thermophilic cultures are also described by their name. The Greek word *therme* means heat, implying that optimal temperatures for thermophilic culture growth are higher than those for mesophilic cultures. Some thermophilic strains grow at temperatures of 55°C (131°F) and are used to produce high cook cheeses such as Mozzarella, Parmesan and Romano. They are also useful in producing cultured milk products such as yogurt.

The basic thermophilic cultures include:

Streptococcus salivarius subsp. thermophilus
Lactobacillus delbrueckii subsp. bulgaricus
Lactobacillus helveticus
Lactobacillus acidophilus
Bifidobacterium sp.

Thermophilic bacteria grow over a temperature range of 22 to 55°C (68 to 131°F) and a pH range of 4.0 to 7.0. The optimum temperature is between 40 and 47°C (104 to 114°F) and the optimum pH ranges from 4.5 to 6.0.

Thermophilic bacteria also ferment lactose to lactic acid. However, the th*ermophilus* and *bulgaricus* strains only ferment glucose completely. Residual galactose accumulates and can create problems in the finished cheese. For example, high galactose levels in Mozzarella cheese can cause excessive "browning" during cooking.

Helveticus cultures reduce galactose levels because they ferment both glucose and galactose. They use glucose faster, which leads to an accumulation of galactose during growth. However, once the lactose is exhausted, the residual galactose is soon fermented as well.

The thermophilic cultures are somewhat unique. *Thermophilus* is a coccus shaped species, and the *bulgaricus* and*helveticus* strains are rods. The coccus species paired with a single rod species form a symbiotic relationship; the two species grow better together than apart.

The coccus species has an optimum growth temperature between 108 and 113°F. It also likes a pH range of 4.5 to 6.0. During its growth, it supplies compounds such as formic acid which stimulates rod growth.

Rod species do best at a slightly higher temperature, optimally 113 to 118°F. They like a somewhat lower pH than thermoph*ilus*, in the range of 4.0-5.5. Rod shaped species metabolize proteins easily and supply peptides to the coccus culture, which has a weak proteolytic system.

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The *acidophilus* and *bifidus* cultures are used in the cultured products industry. *Bifidus* and *acidophilus* yogurt cultures have been introduced in the U.S. market over the past few years. Pyruvate and certain amino acids are metabolized to acetylaldehyde to produce the characteristic yogurt flavor.

Take Care of Your Starter

Temperature is only one parameter of culture survival. Salt sensitivity of the cultures is often overlooked. In general, a salt in the moisture phase of 4.0-5.0% is favored because it allows the culture to continue its final growth after salting. The cultures are also sensitive to phage, antibiotics and some bacteriocins.

In today's cheesemaking world it's critical to have a quality starter program. Understanding the requirements of starter cultures and knowing how they work are two important factors that will influence the quality of your starter program.

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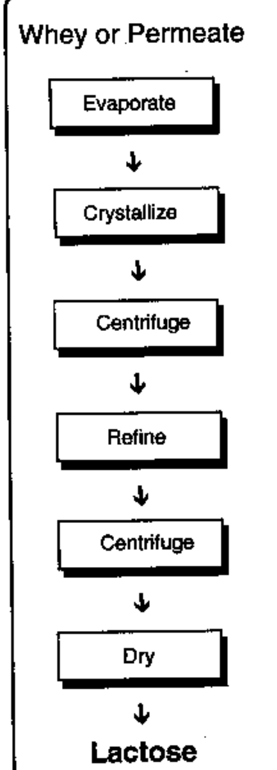

Figure 2. Basic lactose process

The reason for this can be seen in the flow diagram for a typical lactose process (Fig 2). Most water is removed mechanically with a centrifuge, rather than thermally. In a lactose dryer, we only need to remove the small amount of moisture left on the surface of the crystal. As a result, lactose dryers not only use much less energy per lb of product but they can also be built as very compact units.

Moisture considerations

The lactose of commerce is actually lactose monohydrate (Fig 3). That means each lactose molecule has a molecule of water loosely bound to it. Therefore, "dry" lactose actually contains 5.00% bound water.

A typical lactose plant will pay attention to three different moisture specifications (Fig 3). First of all, they need to be concerned about the Standards of Identity just so they can legally call it lactose. Next, they need to be concerned about the customer's specification so they can sell the final product. Finally, they may have an "In-house" specification.

The US Standards of Identity for lactose state that lactose must have a total moisture of less than 6.0%. In other words, it can contain 1% free moisture in addition to the 5% bound moisture. This is somewhat puzzling since one percent free moisture in commercial lactose would cause many problems.

Customer specifications typically require 0.3 to 0.5% free moisture. This would be marginal for storage stability. In-house specs often call for 0.1 to 0.2% free moisture.

Before getting too concerned about which is the right specification, we need to consider analytical methods used to determine lactose moisture. You would think analyzing for moisture would be about as simple as it gets for quality control of dairy products. However, this is far from the case. In general, lactose moisture analyses are so unreliable that I am very skeptical about using them unless I have devel-

Specification	Total	Free
Standards of Identity	6.0%	1.0%
Typical customer	5.3 - 5.5	0.3 - 0.5
Inhouse	5.1 - 5.2	0.1 - 0.2

Lactose ∘ H_2O

MW 342 + 18 = 360

95.00 % 5.00%

Figure 3.

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oped a great deal of confidence in the lab and the procedures they use to analyze the product.

There are a couple of reasons it is difficult to obtain reliable lactose moistures. If someone is trying to obtain free moisture results around 0.2%, they must achieve analytical results within 1/100ths of a percent just to get accuracy within 2 significant figures. Therefore, removing just 1 percent of the bound moisture would render the results meaningless.

An alternative to analyzing for free moisture is to analyze for total moisture and then subtract 5.00% to obtain free moisture. However, since we want accuracy within 1/100ths of a percent it takes a good procedure, some good equipment and some very conscientious people to deliver that kind of accuracy day in and day out.

Incidentally, I strongly recommend that all lactose moistures be reported as free moisture if for no other reason than psychologically the difference between 0.1 and 0.2% seems to be much greater than the difference between 5.1 and 5.2%. As we will see later, the practical significance of 0.1% or 0.2% excess moisture is dramatic; therefore, we want the numbers to reflect real life.

My final bit of advice about lactose moisture analyses is "be skeptical." If you are not, you may come up with some very logical conclusions based on bad data.

Consequences of improper drying

Improper lactose drying can cause problems. In the aviation world it is said that there are two kinds of pilots that fly small, complex aircraft — those who have landed with the landing gear up ... and those who will. Similarly, in the lactose world there are two kinds of plants — those who have had caking and mold problems... and those who will.

Lactose does not respect people, it does not respect drying equipment, it does not respect national origin. It does, however, respect experience. It seems like once a plant has lost some product due to caking or molding they tighten up procedures and virtually eliminate the problem. I hope the following comments can accelerate the learning curve and reduce the cost of obtaining that experience.

Imagine, if you will, that we have a bulk container of lactose sitting in front of us. You have seen these containers. They hold about a ton of powder, the outer bag is a woven plastic material and the inner liner is clear plastic. This particular container was filled last evening right off the production line.

As we step up to the bag and pull back the outer shell; we notice some fog and some droplets of water on the inside of the plastic liner. If we're new to lactose manufacturing we might not have seen moisture inside a bag. We certainly never see this with milk powder or whey powder. Now, why do we have it with lactose?

The answer ... no moisture binding

The answer lies in the fact that lactose has virtually no moisture binding capability. It's probably right next to sand in this respect. Other dairy products contain considerable protein, ash and amorphous lactose that bind moisture. Therefore, we never see this phenomenon with those products.

Since lactose does not bind moisture tightly, any free moisture is literally free to move around the container. The warmer the lactose container, the more active the moisture. As moisture moves around in the container, the surface of the lactose crystal can soften and then recrystallize. As it recrystallizes, it fuses to adjacent crystals. The result is caking.

The moisture droplets that we see on the liner of our imaginary container of lactose do not occur just in the head space. There is also condensation down in the container at the interface of the powder and the plastic liner. This localized condition of high moisture makes it possible for mold to start growing. As the mold grows, it respires, releasing more free moisture from the carbohydrate. The respired moisture moves back into the container setting up a condition for mold growth throughout the container. If we open up this imaginary container a week or two from now it might be caked and grey with mold.

I used the example of a bulk container because these containers, with their higher mass to surface area ratio, are more prone to the problem than smaller containers. The same problem can occur in 50 lb bags, but as a rule they are more forgiving.

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I hope I've helped you visualize the problem. The solution is getting the product dry enough and packaging it cool enough to prevent moisture migration.

Some myths about lactose caking and molding

There are a few myths about what causes lactose caking and molding. One theory I've heard is, "Caking is caused by too much beta-lactose in the product; therefore, we need to modify the crystallization process." Well, think about it. At normal crystallization temperatures, beta-lactose is much more soluble than alpha-lactose. For all practical purposes there won't be any beta-lactose in the final product; therefore it can't cause caking problems.

Another myth is "Caking is caused by amorphous lactose." Again, by definition, amorphous lactose doesn't crystallize, so we are not going to be able to recover it with a centrifuge. As for the small amount of lactose in solution in the moisture layer on the surface of a crystal, it is going to tend to crystallize as the crystal dries.

An example of how much time and money can be wasted in pursuing some of these myths is a plant that I saw some time back that had installed a large unit after their fluid bed dryer. The unit looked like a drum dryer, but they called it a "conditioner". Unfortunately, the unit was sitting idle because they found it did not solve their caking problem. As I said, a lot of time and money can be wasted chasing some of these myths.

The third "myth" that I want to mention is "Lactose molding is caused by environmental problems such as air borne spores or improperly cleaned equipment." It's true that very low levels of mold (for example, under 50/g) can be caused by these factors. However, these factors will not give counts in the thousands or cause a container to be gray with mold. The gross contamination that I have been addressing is strictly the result of growth in the container. The solution is producing a product that is stable enough that mold cannot grow in it.

To preventing caking and molding

1. Get the product dry (Let's say 0.1 to 0.2% free moisture, but don't rely too heavily on moisture analyses. See No. 6 below.)

2. Keep it dry. Avoid reintroducing moisture. Note that it only takes 4 lb of water to raise the moisture content of 2000 lb of lactose by 0.2%. This is enough to put the product into the danger zone. Water can be reintroduced by humid conveying air, steam or water leaks in the dehumidifier, careless use of a water hose, or water in the compressed air supply.

3. Cool the product to reduce water activity (80-100°F, depending on residual moisture).

4. Set up procedures for isolating any product produced outside of normal operating parameters.

5. "Store in a cool, dry place" applies here.

6. Routinely monitor product in the warehouse. Check for condensation on plastic liners and/or monitor absolute humidity in head space. When opening a bag, immediately check for moldy odor. As you walk through the warehouse, press the corner of the bags to check for caking.

I told you earlier I would give you a qualitative method to see if lactose had been sufficiently dried. You've already heard it — check for condensation inside the plastic liner within 24 hours of production. If you are using a powder silo, check the inside of the top dome for sweating. These checks will not only tell you if the product is dry enough but they will also tell you if it has been cooled enough. If you want to be quantitative, you can use a hygrometer to monitor the moisture in the head space of the container. Another good indicator of dryness is the electrostatic charge that dry lactose has as it leaves the dryer. Lactose from whey seems to have more of an electrostatic charge than lactose from permeate.

For production control purposes, it has not been practical to try to analyze on-line for free moisture. Rather, we use laboratory results along with qualitative observations like visible moisture and electrostatic charge to adjust dryer parameters. Once the parameters are set and maintained, good quality lactose can be produced day in and day out.

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Dryer selection criteria.

When buying a lactose dryer it is important to weigh regulatory, heat source and efficiency factors.The following checklist may help you. Some of these considerations are common to other dairy dryers, and some are unique to lactose dryers.

♦ Is the dryer able to remove the free moisture to an acceptable level without removing the water of hydration?

♦ Are there any customer restrictions on the type of heat source? The question of steam vs. direct-fired burner is usually an energy concern, but any concern the customer might have about combustion products contaminating the lactose is more important than energy considerations. If any of your potential customers are concerned about this, then steam would be the heat source to use. Keep in mind a lactose dryer requires so little energy that energy considerations are secondary to quality considerations.

♦ Is heat recovery economically justified? With air-to-air heat exchangers, we can preheat the inlet air 50-70 Fahrenheit degrees. Currently, paybacks are not great unless the utility company offers rebates, which some do. So check with your utility company.

♦ Can the dryer receive regulatory approval? Here we need to be concerned about USDA and State agencies, and the FDA if the product is for pharmaceutical or Grade A use. Other countries will have their respective regulatory agencies.

♦ Does it cause product agglomeration, discoloration and/or scorched particles? If so, milling may be required to cover-up the defect.

♦ Will mechanical complexity cause expensive maintenance?

♦ Will air seals allow excessive air leaks and/or create areas that are difficult to clean in place? We have replaced a number of older dryers that had almost 40 lineal feet of air seals that leaked and could not be cleaned.

♦ What are the space requirements? Is the dryer flexible enough to fit into an existing building?

♦ What type of dust collector is required? Cyclone or Baghouse? Fortunately, lactose is the easiest dairy product there is to recover in a baghouse if one is required.

♦ Is there positive, automatic control of air flow through the system? This is especially important if a baghouse is being used because air flows will change with time. Air flows will also change from day to day depending upon ambient conditions.

♦ Will an environment for microbial growth exist in the feed equipment, or in the product inlet area, or in the air outlet duct? Again, we have replaced a number of dryers where this was a problem, so check it out.

♦ Will caking to dryer surfaces result in excessive noise to dislodge it, high BOD loadings of CIP solutions, or an environment for microbial growth?

♦ What is total system cost including building, foundation, feed system, dryer, powder cooler, dust collectors, mill, controls, *etc.*?

By using the right equipment, combined with analytical procedures and knowledge of product characteristics, you will be well on your way to consistently producing a clean, free flowing product.

Inventing A New Niche Product

Part 3 of a continuing series by Paul Scharfman, Wisconsin Specialty Cheese Institute

What is your company good at?

Asking this deceptively simple question is a good starting point for a thorough self-assessment – a crucial exercise before venturing into new markets. A firm must know what it is good at before it can develop new products. Taking an astute look at both the abilities of your firm and those of your competition should be part of your evaluation.

Many small cheese companies lack the capacity to produce the lowest cost cheese. We have small cheese vats, non-automated make processes and high cost (skilled) labor in our plants. Indeed, many of our plants are so small they are barely considered a "pilot plant" for our country's largest cheese plants.

So what competitive advantages does a small plant have? Flexibility and "personal attention to quality" are the likely cornerstones of many small cheese plants' self-assessment. Our small cheese plants are ideally suited to enter emerging specialty cheese markets. These plants can make as little as 500 pounds of cheese at a time once every third week as a way to slowly enter a market. The plants can flexibly meet the needs of their customers by tailor-making small amounts of cheese to customer specification, producing test batches that larger plants would never consider.

In our last article we discussed how a small, four employee Cheddar plant could assemble a new product development team. Let's revisit that team to see how they used self-assessment to focus their efforts.

The company — we called it the Reenap company — assembled a new product development team. The team's first task was assessing the company's competitive strengths and weaknesses. Several team members brought in competitive cheese packages from around the country and the group spent a day doing its assessment. This is what they developed:

Reenap Company Self-Assessment

Strengths

- Cheddar making skill
- strong customer relations
- capable of making small vats
- highly skilled cheesemaker
- several unused rooms in plant
- employee enthusiasm

Weaknesses

- no experience making non-Cheddar types
- only two major customers
- inefficient at making commodity cheeses
- high cost of labor per pound of cheese
- high fixed cost to operate plant

Based on this assessment, the team felt they could move forward. They planned to build on their strengths in three ways. First, they would commit to a thorough study of their two customers' operations. This study would be followed by brainstorming new product ideas for their customers. The Reenap company owner would then visit the customers and present his suggested list of new products and solicit new product needs from the customers. The Reenap team clearly understood that the best source of new product ideas is from existing customers.

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The team committed to a second task, a thorough literature search for new cheese product ideas. The third task for the team was to solicit the suggestions of team members, industry associations, and industry "experts."

Let's assume that the Reenap team developed the following list of new product ideas:

- small package size, aged Cheddar
- Brie with pesto herbs
- Queso Blanco
- Cheshire
- Stilton
- Feta
- Manchego
- bacon and mushroom Jack
- twisted American string cheese

The Reenap team used their self-assessment to sift through these ideas. They were able to discard some ideas immediately. For example, the team knew they had neither the temperature controlled curing rooms nor the sanitary conditions to successfully enter the Brie business. They ruled out making high pH, high moisture, low salt Queso Blanco both because of their fears of contamination and their lack of adequate cooling and packaging facilities. They decided Feta and string cheese were out because their plant was not set up to make these cheeses.

Nonetheless, the team felt they had several viable new product ideas. Some of the ideas even had the support of their existing customers. And the ideas required only a limited extension of their existing business capabilities. While the team was still a long way from having achieved a new product success story, they were well on their way.

Self-Assessment — a step in developing a new product

Our lesson of the Reenap Company's self-assessment is important in three ways. First, their lists of strengths and weaknesses were about equal in length. As you assess your company you should also try to keep your lists of strengths and weaknesses about equal. You can accomplish this if you are imaginative – almost every weakness can be used as a competitive strength.

The second lesson you can learn from our Reenap Company example is that a self-assessment does not have to be a tortuously long process. While you must learn enough about the market and your competition to accurately compare your skills to those of other firms, you usually do not need to do more than compile an approximate assessment.

The third lesson you can learn from our example, is that self-assessments tend to narrow a company's options and thus increase its chances of success. A small Cheddar maker probably has no business trying to compete on price with the largest cheese plants in the country. Nonetheless, a small Cheddar maker with solid cheesemaking skills is probably very well suited to make specialty cheeses like Stilton, Cheshire, and iron-fortified* Cheddar. Similarly, it is smarter for a small Mozzarella maker to begin manufacture of Oaxaca, or twisted Armenian string cheese, than to engage in a price war on block Mozzarella.

The markets for these specialty cheeses seem very promising, yet few vendors exist. Of course, there is competition for all these specialty markets, but it is certainly not as fierce nor as price competitive as bulk Cheddar or Mozzarella. And, while the existing competitors will fight any new entrant, it is likely that in these small, emerging categories a new entrant can carve out a niche without significantly hurting existing manufacturers' volume. In fact, a new entrant can plan marketing and sales strategies so it increases total market demand rather than taking volume from existing competitors.

The decision to enter a specialty market hinges on the competitive advantages a firm possesses. While small cheese companies can easily bemoan their inefficiency, they can also gloat in their unsurpassed flexibility. Using your firm's strengths as a starting point in the new product development process will greatly increase your odds of success. Next time, I'll review another essential factor that can help you evaluate and build on your ideas – market research.

*Note: Always check with the technical experts for labeling and consumer information needed when making this type of cheese.

From Minnesota-South Dakota Dairy Foods Research Center

Swapping Fatty Acids – from Feed to Cows to Cheese

by R.J. Baer and D. J. Schingoethe

Can you influence the fatty acid composition of milk and cheese by putting cows on an experimental diet? Bob Baer and Dave Schingoethe, of the Minnesota-South Dakota Dairy Foods Research Center at South Dakota State University, say it's possible. They recently evaluated milk and dairy products from milk higher in unsaturated fatty acids, produced by cows on special diets. They also assessed the methods currently used to analyze milkfat to determine if these same methods apply to milk and dairy products higher in unsaturated fatty acids.

It's no secret that cheese, when compared to other foods, contains a high percentage of fat. A large portion of that fat is in the form of saturated fatty acids, a group of fatty acids which seem to raise cholesterol levels. Continuing research on individual saturated fatty acids may change the way nutritionists view them, (See related article on dietary fats in this issue) but for now a lowfat diet, particularly low in saturated fatty acids, is often recommended for people with high cholesterol levels. Baer and Schingoethe had this recommendation in mind when they experimented with animal diets to produce dairy products containing more unsaturated fatty acids and fewer saturated fatty acids.

Control vs. Experimental Diets

They fed a control diet and two experimental diets to nine midlactation Holstein cows randomly assigned to one of three treatments in a five week study. The control diet was a typical diet, primarily rolled corn and soybean meal in a concentrated mixture. The experimental diets contained either extruded soybeans or sunflower seeds substituted for part of the typeical feed mix. The amounts of extruded soybeans and sunflower seeds were intended to provide equal amounts of supplemental fat and to raise the dietary fat content to 5 to 6% on a dry matter basis.

In this study, the resulting percentages of milkfat were similar for all dietary treatments. Analysis by Mojonnier ether extraction and midinfrared spectroscopic methods produced milkfat percentages that were similar for all diets, although the midinfrared spectroscopic method underestimated the percentage of milkfat by .05% (extruded soybean diet) and .09% (sunflower seed diet).

Milk from cows fed the experimental diets contained higher concentrations of unsaturated fatty acids and neither protein nor fat content were depressed. After feeding these diets, milkfat concentrations of short-and medium-chain fatty acids were lower, and concentrations of long-chain fatty acids were higher in milkfat. Milkfat from cows fed the experimental diets, either extruded soybeans or sunflower seeds, contained similar concentrations of unsaturated fatty acids.

Baer and Schingoethe suggest that extruded soybeans may offer several advantages over sunflower seeds as a supplemental dietary fat source to increase concentrations of unsaturated fatty acids in milkfat. Extruded soybeans are readily available to dairy producers. Also, some of their earlier diet studies found reductions in milkfat percentages, and extruded soybeans did not reduce milkfat percentages as much as the sunflower seeds.

Next step – cheese

Baer and Schingoethe took the next step and used the experimental milk to make cheese. They produced acceptable Cheddar cheese with milk from cows fed the extruded soybean and sunflower seed treatments. Although the fat percentage didn't change, this experimental cheese contained 48% more unsaturated fatty acids than cheese made from the milk of cows fed the control diet. Cheese manufactured with milk from cows fed either of the two experimental treatments had flavor, body, and texture characteristics similar to those of cheese from milk of cows fed the control diet.

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Learning the language of fat

Fat. It's a simple three letter word that is shorthand for the broader, sometimes confusing language that classifies and describes a major portion of our diet. Here's your chance to learn some of that language. Trans fatty acids, saturated fat, "good" and "bad" cholesterol – these terms are frequently found in newspapers, magazines and ads. Recent labeling changes seem to have increased awareness of food content, particularly the amount of fat.

Why even pay attention to dietary fat? A common sense approach to nutrition suggests that reducing the percentage of fat in your diet helps to maintain an ideal body weight since excess calories are stored as fat. The Surgeon General's Report on Nutrition and Health (1988) further suggests that dietary changes can improve health and decrease the risk of chronic disease, particularly coronary heart disease. The report singles out saturated fat as a prime culprit. More recently, researchers described evidence that trans fatty acids, found in processed vegetable oils like margarine, are associated with a higher risk for coronary heart disease. (Willett, The Lancet, Vol. 341,1993)

Why are questions about dietary fat so difficult to answer? Variation in food, metabolism, and lifestyle complicate both research and analysis. For one thing, fat in food is rarely a single type of fatty acid, butterfat contains 400 to 500 different fatty acids. Genes influence individual differences in fat metabolism and some of the numerous risk factors for heart disease. Finally, individual differences in lifestyle, both diet and exercise, can modify the genetic differences. Statistical analysis allows researchers to "control" the influence of factors like diet, cholesterol level, and lifestyle when they are sorting through experimental data to look at the health effects of specific dietary fats.

Fatty acids are components of fats (solid at room temperature) and oils (liquid at room temperature). Fats and oils are components of a broader category – lipids.

Chain length refers to the number of carbons in the fatty acid molecule. In edible fatty acids the length varies from 4 to 24. Short chain fatty acids usually have 8-14 carbons, medium chain fatty acids with 16-18 carbons (the most common), and longer chain fatty acids have over 18 carbons.

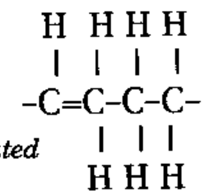
Cholesterol is a fat soluble compound that is a precursor for crucial message systems of the body – hormones. We produce about half of our own cholesterol, the other half comes from the food we eat.

LDL, low density lipoprotein, (the "bad" cholesterol) distributes cholesterol in the blood by linking it with a receptor protein and transferring it to cells that need cholesterol. High fat diets, diseases, and aging all reduce the number of receptors. This forces cells to make their own cholesterol and leaves LDL to build up in the circulation, raising blood cholesterol levels and increasing the risk of coronary heart disease.

HDL, high density lipoprotein (the "good" cholesterol) is another cholesterol distributor, this one may actually carry some of the cholesterol lining (and potentially blocking) blood vessels back to the liver for recycling. Thus HDL may lower circulating cholesterol levels and lessen the risk of coronary heart disease.

Monounsaturated fatty acids (MUFA) sources: olive, canola, peanut oils Contains one double bond in the carbon chain, thought to have a neutral effect on cholesterol. Recent work suggests MUFA's may lower total cholesterol levels, without lowering HDL levels.

Structure of a monounsaturated fatty acid



Fatty Acids, *continued*

Successfully producing cheese with fewer saturated fatty acids may open a new market for the dairy industry. Health care professionals sometimes recommend diets that are lower in saturated fat and individuals following this advice may find fluid milk and other dairy products with lower saturated fatty acids appealing. This research is the first step to increasing the nutritional options for consumers.

Polyunsaturated fatty acids (PUFA)
sources: corn, soybean, safflower, and sunflower oils, fish oils
Contains two or more double bonds in the carbon chain. Evidence suggests PUFA's lower total cholesterol and LDL cholesterol, however some PUFA's may promote tumor growth.

Structure of a polyunsaturated fatty acid

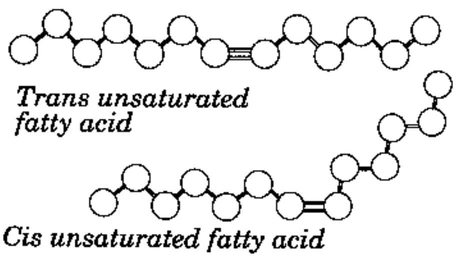
```
H H H H H
| | | | |
-C=C-C-C=C-
    |
    H
```

Saturated fatty acids
sources: animal fats, coconut oil, palm oil. Each carbon atom is linked by single bonds to hydrogen atoms. Strong evidence suggests that diets high in this group of fatty acids raise total and LDL cholesterol, which increases the risk of coronary heart disease. However, not all saturated fatty acids raise cholesterol levels, and there is a great deal of controversy about individual saturated fatty acids and their effect on human health.

Structure of saturated fatty acid

```
H H H H
| | | |
-C-C-C-C-
| | | |
H H H H
```

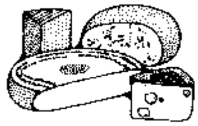
Trans fatty acids
Unsaturated natural fatty acids occur primarily in the *cis* form. Processing vegetable oils, so they harden and melt at a higher temperature, changes them to the *trans* form. Researchers continue to evaluate the long term health effects.



Trans unsaturated fatty acid

Cis unsaturated fatty acid

The Curd Clinic



Q: In an October issue of one of the cheese newspapers, a western cheese plant was describing how they effectively used their whey components in their cheesemaking process. It was reported that they used their whey cream or whey fat to standardize milk for cheesemaking. Is it legal to use whey cream in manufacture of cheeses?

A: No, not in any of the standardized cheeses covered by the US regulations. As listed in Chapter 133 of Title 21 of the Code of Federal Regulations (CFR), only milk, cream, and nonfat dry milk may be used as dairy ingredients for the production of cheeses with a standard of identity. For the purposes of the regulation, "milk" means cow's, goat's and/ or sheep's milk. You may adjust the milk by separating part of the fat or by adding one or more of the following: cream, skim milk, concentrated skim milk, nonfat dry milk, water, in a quantity sufficient to reconstitute any concentrated skim milk or nonfat dry milk.

"Cream" means cream, reconstituted cream, dry cream, and plastic cream. It does not include whey cream. The regulatory staff in the dairy division of FDA has confirmed that whey cream is not the same as cream and can **not** be used to produce standardized cheeses. Standardized cheeses produced with added whey cream or whey fat are considered adulterated and would be subject to recall.

We have also had some questions concerning the addition of whey protein concentrate (WPC) to cheese milk to produce standard cheese varieties. It is illegal to directly add WPC as a dairy ingredient to cheese milk to produce cheese. WPC can be legally used in formulating starter media for bulk starters. The level of WPC in starter media is limited to the amount needed by the starter for nutritional purposes. The WPC present in the bulk starter added to the cheese vat would be considered an incidental additive. At the Marschall Italian and Specialty Cheese Seminar last September, Tracy Schonrock of USDA indicated that maximum allowable levels of starter addition in cheese production would be about 2.5-3.0%.

In conclusion, whey components are not allowed in standardized cheeses. You can use them to produce whey cheeses such as ricotta, gjetost, mysost and other whey cheeses. Careful planning in the use of whey components is necessary to ensure that they are being used legally in other dairy products.

Curd Clinic Doctor for this issue was Bill Wendorff, Associate Professor, Dept. of Food Science, University of Wisconsin-Madison

Calendar of Events

Mar. 13-17 Wisconsin Cheese Technology Short Course. Madison, WI. Call Bill Wendorff at (608) 263-2015.

Mar. 13 Applying Statistical Process Control. Madison, WI. Call Steve Ingham at (608) 265-4801.

Mar. 15 Wisconsin CIP Workshop. Madison, WI. Call Bill Wendorff at (608) 263-2015.

Mar. 22-23 Wisconsin Cheese Industry Conference. Green Bay, WI. For information, contact the Wisconsin Cheese Makers Assn. at (608) 255-2027 or CDR at (608) 262-5970.

March 21-24 The Fifth Cal Poly/U.C. Davis Cheese Short Course. San Luis Obisp0, CA. For Program information call Dr. Phillip Tong (805) 756-6102, for registration information call Ms. Leslie Cooper, (805) 756-6101.

Mar. 30 The Great Lakes Dairy Sheep Symposium. Madison, WI. For information, contact Wis. Sheep Breeders Co-op at (414) 377-1491.

April 18-21 Basic Cheesemaker's License Short Course. UW-River Falls. Contact Ranee May at (715) 425-3150 for details.

April 25-26 Mexican Cheese Short Course. Madison, WI. Call Jim Path at (608) 262-2253.

April 25-26 The Second Cal Poly/U.C. Davis Milk Processing Short Course. San Luis Obispo, CA. Call Dr. Phillip Tong for program information, (805) 756-6102, for registration, (805) 756-6101.

May 23-24 Applied Dairy Chemistry Short Course. Madison, WI. Call Bill Wendorff at (608) 263-2015.

June 1-2 Wisconsin Cheese Grading Short Course. Madison, WI. Call Bill Wendorff at (608) 263-2015.

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