



UW DAIRY ALERT!

A Technical Update for
Dairy Product Manufacturers

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Efficient Use Of Whey Cream In Cheesemaking

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In the past, some cheesemakers have added whey cream back to the milk they use for cheesemaking. Generally, using the milkfat in whey cream to make cheese provides a higher economic return than selling the whey cream to creameries. However, there has always been a question regarding the legality of using whey cream to manufacture standardized cheeses. Whey cream is not specifically listed in the definition of cream in the Code of Federal Regulations (20). In 1995, the Wisconsin Dept. of Agriculture, Trade and Consumer Protection (25) reaffirmed that it was not legal to use whey cream in the manufacture of standardized cheeses, although, it was acceptable to use it for the manufacture of butter. However, various other states, and the US. Dept. of Agriculture, have allowed whey cream as a dairy ingredient in the manufacture of cheeses. Just recently, the Wisconsin Dept. of Agriculture reviewed the status of whey cream and determined that whey cream should be included in the definition of cream for use in the manufacture of standardized cheeses (24). The purpose of this bulletin is to review the proper procedures for handling whey cream and the effective use of whey cream in the cheesemaking process.

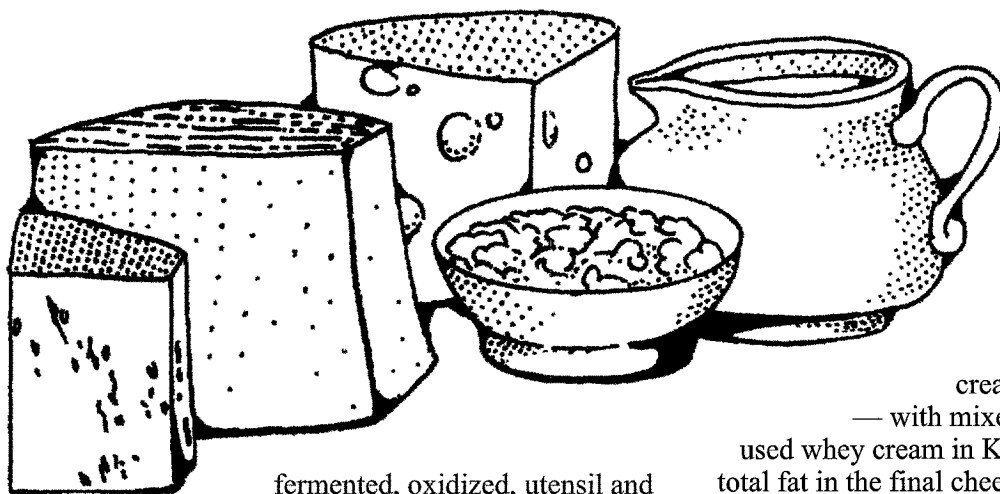
Take Precautions when Using Whey Cream

One of the main precautions to remember is that sweet cream and whey cream are not the same. Sweet cream is made up of milkfat and the serum portion is skim milk. Whey cream is composed of milkfat, and the serum portion is whey. Since whey cream does not contain casein, the increase in cheese yield you get from using whey cream comes from the recovery of fat. It's possible you will also see an increase in moisture retention in the curd due to whey protein denaturation and recovery.

A second concern you should note is that only a small percentage of the fat in whey cream is in a globular form, i.e., surrounded by a fat globule membrane (16). Some of the nonglobular fat will float and form large pods of free fat on the milk surface. This fat will be lost to the whey after the coagulum is cut. The main portion of milkfat released to whey occurs during the initial stages of curd treatment. Increases in temperature and curd handling during cheesemaking also lead to increases in whey fat (21). However, the size of intact fat globules in whey decreases as the cheesemaking procedure proceeds. Whey obtained at pressing contains the least fat, but the highest proportion of small fat globules. The higher quantity of "free" fat in whey cream makes it more susceptible to oxidation. Several researchers have reported that whey cream has higher free fatty acids and peroxide values (16,23). This is especially true if whey cream has been recycled through the separator and centrifugal pumps several times. All of these practices rupture additional fat globules, allowing active lipase enzyme in raw milk to attack the milkfat. The result is more free fatty acids and their typical undesirable rancid flavor.

During the latter stages of cheesemaking, when curd temperatures are higher, the molten fat in the curd may be pressed out into the whey. This liquid free fat generally contains more unsaturated fatty acids than normal milkfat (16,22). These fats, which have a lower melting and solidification point, could cause a sticky or greasy body in cheese (9,13). In addition, continued recycling of whey cream could lead to fractional crystallization — the percentage of unsaturated fats would continue to increase and the whey fat would become softer with continued use (16). To eliminate this potential problem, you should strictly limit recycling of whey cream.

Over the years, whey cream has been criticized for having a poor flavor and quality when compared to sweet cream. Chief criticisms of whey cream flavors include



fermented, oxidized, utensil and yeasty (16). Many of these off flavors resulted from microbial contamination of the whey. Russian researchers (1) found 3X more total microorganisms, 1.6X more psychrotrophs and 14X more yeast in fresh whey cream than in sweet cream. Although the quality of whey cream has improved in recent years, remember that the condition of whey cream depends entirely on sanitation conditions during cheese manufacture and whey handling prior to pasteurization.

A significant concern when using whey cream in the manufacture of cheese is the potential for introducing bacteriophage into the cheese milk when you add the whey cream (12). Bacteriophage are extremely heat-resistant and will survive pasteurization treatments. Researchers (5,14) have reported that phage survive temperatures of 167°F to 185°F. At least 1 minute at 194°F was needed to inactivate phage in whey cream containing 10^8 Plaque Forming Units (PFU). Russian researchers (10) reported that 194°F for 5 minutes was required to inactivate phage for 5 indicator strains of lactic streptococci. Thunell (17) recently reported that with an initial load of 100 million phage per ml. in 40% whey cream, it took 20 minutes at 190°F or 5 minutes at 195°F to destroy all the phage. Note that a limited number of phages were tested, particularly phage from thermophiles. It's likely that phages exist that are even more resistant than those tested. You'll need to rotate starter strains to thwart the most resistant phages. Another method for controlling bacteriophage when using whey cream is to add whey cream from cheese made with thermophiles (Mozzarella or Muenster) when you produce cheese made with mesophiles (Cheddar and Colby), and vice versa (2).

Heat treatment of Whey Cream

Heat treatments of whey cream in excess of 180°F will

result in significant whey protein denaturation (7). Denatured whey proteins will retain more moisture in the final cheese and provide yield increases. However, the cheese may develop a softer, weaker body or an acid flavor.

Cheesemakers have used whey cream for many years in aged cheese — with mixed results. Russian workers (9) used whey cream in Kostroma cheese up to 20% of the total fat in the final cheese. They reported that cheese with whey fat had increased total soluble nitrogen and non-protein N during ripening and resulted in cheese with increased moisture. Organoleptic quality of the cheese made with whey cream was slightly below cheese without whey cream. Primary defects reported included flat or bitter flavor and sticky consistency. In Chanakh cheese, higher levels of Swiss-type whey cream resulted in higher moisture in the final cheeses (3). After 45 days of ripening, the cheese with whey cream scored higher in taste, aroma and consistency than the standard cheese. These Russian researchers suggested that whey cream can be used as the source of about 50% of the total fat of Swiss-type cheeses. Higher levels resulted in softer fats and sticky cheeses. German researchers (6) found that whey cream disrupted the primary and secondary proteolysis in Edam cheese with negative effects on cheese ripening and flavor. On the other hand, Thunell (17) reported that adding whey cream to milk for Cheddar cheese did not significantly affect the flavor of the final aged cheeses. A yield of 1.5 lb. of cheese per lb. of added whey fat was reported from plant trials (18).

Proper Handling of Whey Cream

As with any food, the quality of the final product depends entirely on the quality of ingredients going into that product. The quality of raw milk, handling that milk through the cheesemaking process, cultures used for cheesemaking, and handling the whey are all critical to the quality of the whey cream. State regulators (4) recommend that you "keep it clean and keep it cool". Wisconsin regulations (26) require that whey cream shall be kept at a temperature of 50°F or less until pasteurized. No whey cream may be held for more than 4 hours at a temperature above 45°F and lower than 140°F. Harper (8) recommends the following steps to ensure high quality whey cream:

- ◆ Pasteurize whey immediately after production.
- ◆ Minimize holding time between whey production and processing.
- ◆ Cool and hold whey at temperatures below 39°F.
- ◆ Maintain the same good cleaning and sanitation practices for whey handling as for handling fluid milk.

Never add whey cream to raw milk in a storage silo. Active lipase enzyme in the raw milk will easily attack free milkfat from fat globules that were ruptured in the cheesemaking process or by pumping with centrifugal pumps. This enzymatic reaction could lead to rancid cheese milk. If whey cream is blended with raw whole milk in the balance tank of the pasteurizer, then pasteurized and standardized for fat content, the separated cream must be labeled as “whey cream” (19). Analytical tests can detect as little as 1% whey cream in sweet cream (11).

Effect of Whey Cream on Cheese Composition and Cheese Yield

Since milkfat has more value when turned into cheese, it appears that using whey cream for cheese manufacture has become a common (but not universal) practice in the industry. However, adding this extra fat to the cheese milk when making some traditional cheeses, like Cheddar, where the milk is not standardized, may

Original fat = 3.70% fat, 2.5% casein

No whey cream added % yield = 10.27 .54 FDM

Whey cream fat as 10% of the total fat: Milk = 4.07% fat, 2.47% casein.

% whey fat recovered	% total fat recovered	FDM	% yield	extra cheese per pound whey fat
93.0	93.0	.564	10.83	1.51
80.0	91.8	.561	10.74	1.27
60.0	90.0	.557	10.61	.92
40.0	88.0	.552	10.47	.54

Whey cream fat as 5% of the total fat: Milk 3.88 % fat, 2.49% casein.

% whey fat recovered	% total fat recovered	FDM	% yield
93.0	93.0	.552	10.54
80.0	92.4	.550	10.51
60.0	91.4	.548	10.44
40.0	90.5	.546	10.38

produce a finished cheese with an undesirable high fat content. In this case, cheese makers may decide to use condensed milk (or rehydrated nonfat dry milk) to compensate. However, the economic feasibility of using nonfat dry or condensed milk to manufacture lower moisture cheeses (like Cheddar) requires careful cost analysis.

Unanswered Questions

There are a number of unanswered questions you will confront when using whey cream for cheesemaking. Is there a limit to the amount of whey cream that can be used without affecting quality? How much of the whey fat is retained in the form of cheese? Can homogenization of the cream improve fat retention without detrimental effects on the cheese? Will proteins in whey cream be captured in the cheese? Unfortunately, reports offering insights into these questions are limited. Regarding the latter question, when whey cream is heated to kill bacteriophage, most of the whey protein is denatured. Some of the denatured whey protein will be captured in the cheese and will contribute to yield both as a solid and as a water binder (may also slow syneresis). Since the level of whey protein in whey cream is low, the impact may be small.

Effect on Yield

Consider the effect on cheese yield and composition of Cheddar cheese when you add 5 versus 10% of the total fat in the cheese vat in the form of whey cream (40% fat). (See tables at left.) The retention of

they fat varies from 93% to 40%. Assume that the original milk fat is retained at 93% and use the Van Slyke cheese yield formula. Also, assume no additional whey protein is captured and cheese is made at the same moisture level (38%).

When whey cream is added, the percentage of casein in the milk is very slightly reduced, although this depends on the amount of whey cream added. Both the cheese yield and FDM (fat-in-dry matter) increase when adding whey cream, **even** when only 40% of the whey cream fat is retained. Decreased whey fat retention decreases the total fat retention and also lowers the FDM of the cheese. However, the impact of low whey fat recovery on the reduction of total fat recovered is less when a low level of whey fat is added. Conversely, if more of the fat in the milk is derived from whey cream, a more severe reduction in total fat retention could result. In all cases, more fat would appear in the cheese whey (to be recycled again?). Daily use of the whey cream fat would progressively lead to more and more whey cream. It is conceivable that the retention of whey fat in cheese would decrease with the number of times that the whey fat is recycled and would increase the amount of whey fat collected from each vat. In addition, it would be very hard to standardize cheese milk accurately with nonfat dry milk or condensed milk if you don't know the value for the retention of fat.

Now, assume that you want to make Cheddar cheese with a .54 FDM yet you want to add 10% of the total fat as fat from whey cream. (See Table below) You now must add casein in the form of nonfat dry milk or condensed skim milk to make cheese with the desired FDM. Given a price of \$1.30 per pound of cheese sold, if nonfat dry milk is \$1.10 per pound and whey cream is \$.70 per pound fat, the following is obtained when based on 100 pounds milk (3.7% fat, 2.5% casein):

	Yield	FDM	Gross Return
No whey cream added	10.27	.540	\$13.53
Whey cream added	10.94	.564	\$14.14
Whey cream + NDM	11.33	.540	\$13.78

In this example, the addition of NDM improved yield, but did not return more than the addition of whey cream alone. Of course, this would change as the price for cheese and other solids fluctuates, however, it may be more feasible than removing cream. This example emphasizes the need to do a cost analysis on the methods of standardization. Keep in mind the increase in efficiency when higher solids milk is used to make cheese; this may off-set the cost of standardization with addition of nonfat dry milk. Although the economics of using whey cream fat appear desirable, if an inferior quality cheese with reduced economic value is produced and you risk your reputation as a producer of quality cheese, what have you gained?

Conclusions

In general, whey cream may represent an economic potential for cheesemakers if it is handled properly in the cheesemaking process. Based on the previous concerns discussed, and recommendations from literature (2, 7,15), we suggest you follow these guidelines to use whey cream effectively in the manufacture of natural cheeses.



Guidelines:

- **Closely evaluate the quality and flavor of whey cream. Don't allow off-flavors that suggest processing problems—acid, bitter, unclean, fermented, or oxidized.**
 - **Avoid long whey residence times in curd filling units.**
 - **Minimize excess agitation and/or pumping which could lead to shearing of milkfat globules.**
 - **Whey cream should be cooled properly and held cold (<50°F) prior to batch pasteurization. Heat whey cream at 190°F for 20 minutes or 195°F for 5 minutes to inactivate bacteriophage. Rotate cultures.**
 - **Limit whey cream fat to no more than 20% of the total fat of the final cheese.**
 - **Limit recycling of whey cream to no more than 3-4 days of production before breaking the cycle. This eliminates the build-up of undesirable microorganisms or the increasing percentage of unsaturated fats in the cheese milk.**
 - **Never mix whey cream with raw milk in a silo. Always add whey cream at the balance tank of the pasteurizer or blend pasteurized whey cream with pasteurized milk**
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