Chapter 7
Creamed Cottage Cheese

Dave Potter and Doug Vargo

7.1 Cottage Cheese Defined

Creamed cottage cheese is a soft, unripened cheese that is usually made by coagulation of pasteurized skim milk by added lactic culture or acidulants, with or without the addition of minute quantities of milk-coagulating enzymes (as curd conditioners). The coagulum is cut into various-sized curd particles by special sets of knives, heated (cooked), and held for a sufficient time to facilitate firming of the curd and removal of the whey. Once the curd has developed the appropriate consistency (firmness or "meatiness"), the whey is drained. Then the curd is washed; creamed (usually) with a salted dressing in which other flavoring agents, cultures, and preservatives may be added; and packaged.

Cottage cheese is consumed as a fresh product and without preservatives will last a maximum of 2–3 weeks. Consequently, the flavor attributes of this product depend on a combination of the sensory qualities of skim milk and cream dressing ingredients, as well as properties of the lactic cultures employed in the manufacturing process. The overall sanitation procedures and temperature control exercised in manufacture also play a key role in determining product shelf life and sensory quality of this relatively perishable dairy product. Today, it is common practice among US cottage cheese processors to incorporate either a liquid diacetyl flavor, potassium sorbate, a dried fermentate produced from *Propionibacterium shermanii* (Sandine, 1984), and/or some CO_2 into cream dressing (Chen & Hotchkiss, 1991; Hotchkiss & Chen, 1996) for better flavor and shelf life extension before addition to the curd. This process has shown to routinely extend the shelf life of commercial

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cottage cheese to up to 6 or 7 weeks. There remain few manufacturers who will incorporate specially selected lactic cultures (*Streptococcus lactis* subsp. *diacetylactis* and/or *Leuconostoc* sp.) into the cream dressing to increase the "cultured aroma" (and coincidentally inhibit psychrotrophic spoilage bacteria, i.e., competitive exclusion). Hence, the addition of carefully selected lactic microorganisms to the dressing can simultaneously serve to significantly enhance flavor along with added liquid components such as diacetyl to increase the shelf life of creamed cottage cheese.

7.2 Cottage Cheese – An American Original

Creamed cottage cheese is an American (or US-original) cheese. In fact, it is generally presumed that cottage cheese is but one of only a few cheese types that have their actual origins in the USA. Several other cheese types considered to be US developments are Monterey Jack, Colby, and string cheese. Prior to the first or second decade of the twentieth century, skim milk, a by-product of farm milk separation, was either fed to pigs and/or chickens. The prime end product of separation – cream – was shipped to the local creamery for ice cream or butter manufacture. In a way, skim milk generated at the farm was often considered a waste product. The eventual commercial development of a viable cottage cheese industry in the Pacific Northwest in 1915 sufficed to change the nation's disposition of skim milk. A new segment of the cheese industry was born when Mr. and Mrs. Charles West of Tigard, Oregon, said "let's build a factory" to manufacture and sell this new product we have mastered – creamed cottage cheese. Thus, commercialization of fresh creamed cottage cheese in the Pacific Northwest (Angevine, 1964; Davies, 1942; Olsen, 1980) was the place and date (1915) of origin by this enterprising husband and wife team, and the springboard for would-be cottage cheesemakers in the upper mid-western USA. This initial development of the US cottage cheese industry and early technical expertise (the early pioneers and heroes) for the quality manufacture of this product is explored in more detail at this chapter's conclusion.

7.3 First Steps in the Development of Cottage Cheese

Centuries ago, most milk generally soured soon after it was collected from lactating animals, since timely cooling was practically nonexistent. It was also duly noted that "soured milk" does not readily undergo undesirable proteolysis and other unwanted physical and chemical changes. Hence, harvested milk was typically handled in a manner to insure souring and thus preserve it for several days or longer. Each tribe, ethnic group or locale with lactating animals, developed its own method of handling or treating the milk; consequently, the final products varied. This helps explain why a variety of cultured (fermented) milk and cream products originated,

each known and referred to by a unique name. The unique common denominator was that each product required either the natural presence or the addition of lactic-acid-producing bacteria to accomplish the preservation process.

Additionally, some of these products, such as kefir, underwent an alcoholic fermentation. In many countries (probably most countries), fermented milk foods are distinctly favored over fresh, fluid milk. This frequent preference for "sour milk" is based on a combination of public safety, preferred flavor and texture, and purported therapeutic effects. Where inadequate facilities for transport, storage, refrigeration, pasteurization, and/or distribution of milk exist around the world, many health authorities prefer that milk turns "sour" in the earliest stages of handling. In this approach, the presence of high populations of harmless lactic acid bacteria and their metabolic end products discourage and/or control the outgrowth of food spoilage and disease-producing bacteria (pathogens). In many countries, nutritionists and pediatricians prefer certain fermented milk products over fresh milk as a weaning food for infants (National Dairy Council Newsletter 1996).

In other locales, fermented milk foods are blended with cereals and other food ingredients to provide a nutritionally balanced food for the populace. For those countries where few or none of the above-described conditions or health philosophies exist, the acceptance of cultured milk products (such as cottage cheese) relates more to "slimming diets or a protein alternative to meat," cost considerations, adaptation of ethnic foods, recent food trends, and new technologies of food processing and distribution. In numerous countries, fresh fluid milk is the dominant product of commerce, but certain cultured milk foods enjoy increasing attention, modification, and modest popularity.

Cottage cheese most likely originated for the following several reasons:

1. A ready supply of a raw material that was often otherwise wasted – skim milk.
2. The process of converting skim milk into a cheese was simple – place the skim milk in a pot on the back of the warm stove top in the kitchen (or cottage).
3. The "skim milk cheese" lent itself to enhanced flavor by "dressing" it with whole milk or cream. All of the flavor comes from the creamed dressing.
4. The flavor profile for this new cheese product was "mild" and fresh tasting – thus providing flavor appeals to many prospective customers.

7.4 Types of Cottage Cheese

According to the US FDA Code of Federal Regulations (CFR Title 21. Part 133.128), "Cottage cheese is the soft uncured cheese prepared by mixing cottage cheese dry curd with a creaming mixture…The milkfat content is not less than 4 percent by weight of the finished food, within limits of good manufacturing practice. The finished food contains not more than 80 percent of moisture." Thus, creamed cottage cheese is the general term used to designate the fresh, soft, uncured, high-moisture cheese made from pasteurized skim milk, or occasionally from either reconstituted

nonfat dry milk or plain condensed skim milk. The inquisitive observer will note several distinct types, forms, or styles of cottage cheese in North American retail outlets. Various descriptor names as "schmierkase" (the name initially employed by nineteenth century German immigrants) and "pot cheese," and then later-used names such as "farmer-style," "country-style," "old fashioned," "sweet curd," "small curd," "large curd," and "popcorn cheese" have been employed to describe the products that result from variations in cheese manufacture. Some regional versions of cottage cheese have been labeled as New York-style, Michigan-style, and California-style (Kosikowski & Mistry, 1997).

Several other product names used to designate certain cottage cheese types or variations of cottage cheese have been "Dutch-," "pressed," "baker's-," and "hoop"-type cheese (Kosikowski & Mistry, 1997), and a unique Louisiana-style known as "Creole cream cheese" (an uncooked and congealed curd with half-and-half added as a dressing (Potter, 2007)).

Creamed cottage cheese marketed in US and Canadian commercial channels can be classified according to the following methods of producing the curd or cream dressing:

1. *Producing the curd*, whether by
   (a) Lactic acid development by lactic culture only (acid curd).
   (b) Lactic acid, plus a slight amount of milk-coagulating enzyme.
   (c) Addition of approved food grade acidulants such as phosphoric and glucono-delta-lactone acid (which must be called "direct set" or "acidified" cottage cheese).
2. *Breaking or cutting the coagulum* by
   (a) Rigorous stirring (i.e., farmer-style, old-fashioned, Michigan-style, or pot).
   (b) Cutting with designed knife sets of varied wire spacing:
      1. Small curd (0.6–0.9 cm (1/4 in.))
      2. Medium curd (0.95–1.6 cm (3/8–5/8 in.))
      3. Large curd (1.27–1.9 cm (1/2–3/4 in.))
3. *Method of creaming* (or not) by
   (a) Traditional addition of cream dressing (˜9–10% milk fat) at a typical ratio from 43% dressing to 57% curd to 52% dressing and 48% curd, resulting in at least 4% milk fat in the finished product in the carton.
   (b) Addition of a lower milk fat "dressing mixture" (˜3–4% milk fat content) to attain a 1% or 2% milk fat content in the final product (low-fat cottage cheese).
   (c) Addition of a skim milk-based dressing (nonfat cottage cheese).
   (d) Occasionally, addition of either "whipped" or other higher fat cream dressings may be added to the curd to achieve a special effect (usually marketed under a coined name for the product).
   (e) Treatment of the cream dressing by

1. The addition of a lactic culture to the creaming mixture.
2. The addition of a liquid "starter distillate" or diacetyl flavor component.
3. Direct addition and fermentation of an aroma-producing lactic culture (*S. lactis* subsp. *S. diacetylactis* and/or *Leuconostoc* spp.) to the creaming mixture.
4. Addition of a dried cultured fermentate produced from *Propionibacterium shermanii* (primarily via the Microgard™ or Durafresh™ process) directly to the creaming mixture for a two to three-fold increase in shelf life (Salih et al., 1990; Sandine, 1984).
5. Addition of a chemical preservative such as potassium sorbate or sorbic acid.
6. Incorporation of carbon dioxide (CO_2) into the cream dressing (or the dressed cottage cheese) as an effective technique of increasing product shelf life up to 6–7 weeks or 52 days (Chen & Hotchkiss, 1991; Hotchkiss & Chen, 1996).

7.4.1 Other Products or Processes

Cottage cheese curd (without cream) is referred to or labeled as "dry cottage cheese curd." Plain curd may be sold wholesale in bulk for later creaming, packaging, and retail distribution or used as an ingredient substitution for other cheeses such as ricotta. Dry unsalted curd is also sold in retail packages for use in cooking, baking, and salads and for use in special "low-salt," "low-fat," "low-cholesterol," and/or "reduced calorie" diets.

Uncreamed cottage cheese is often evaluated by employing nearly the same product evaluation procedures used for the creamed product. Much attention is given to the body and texture of dry curd, but one will not find it to have much flavor. Most likely, a distinctive flat or plain dull flavor will be obvious to most evaluators of dry cottage cheese curd. Most dry curd cottage cheese is virtually devoid of aroma, unless an especially selected diacetyl-producing culture was used for curd manufacture. This causes other problems during curd manufacture such as gas production and floating curd. The flavor of dry curd cottage cheese should be clean and pleasantly acidic and show little persistence after the sample has been expectorated.

7.5 Sensory Evaluation of Creamed Cottage Cheese

7.5.1 Visual Observations

Cottage cheese is examined for sensory properties in a manner similar to other dairy products – by a combination of sight, mouthfeel, taste, and smell.

Initially, creamed cottage cheese is visually examined (without pre-stirring to optimize the first observations) for the possible presence or lack of "free whey" and non-absorbed (free) cream dressing, as well as a set of curd appearance features such as curd identity and the amount of fines present. If facilities and time are available, the equivalent of a large tablespoonful of creamed cottage cheese can be "rinsed or washed" in a beaker or a small vessel of cold water (7.2 °C (45 °F)). The spoonful of curd is allowed to settle and the milky water decanted. This process is usually repeated 2–3 times until a practically dry (surface) curd is attained. The washed curd is then closely observed for the relative shape and size of the curd particles. Close examination of "washed" cottage cheese curd in this manner commonly reveals appearance defects (fines) that may have escaped identification otherwise (i.e., by observing only unwashed cottage cheese). Subsequent observations are expanded upon in the following sections.

7.5.2 Sensory Attribute Categories of Cottage Cheese

High-quality creamed cottage cheese is expected to possess many of the following listed three major categories of sensory attributes (Elliker, 1949; Connolly et al., 1984; Kosikowski & Mistry, 1997; Bodyfelt et al., 1988).

7.5.2.1 Color and Appearance

After the initial observation in the intact container, the creamed cottage cheese should be mixed with a large spoon or ice cream scoop; then a representative sample should be removed from the cup and placed in the center of a white plate. The sample should be allowed to sit for no longer than 10 min before observations are made.

The general appearance or visual impression of creamed cottage cheese should be attractive and pleasing "to the eye." The curd particles are expected to be separate and distinct, moderately uniform in both size and shape (Bodyfelt et al., 1988; Tong et al., 1994); the overall product should exhibit a glossy, creamy-white color. In creamed cottage cheese, the bulk of the cream is expected to be absorbed by the curd particles, with a minimum of "free" or separated cream. The cream dressing should be reasonably viscous, relatively foam-free, and able to adhere or cling to the curd particles. A limited amount of excess dressing should form a uniformly smooth coating on the curd particles and be void of any separated water (free whey). Preferably, highest-quality cottage cheese exhibits little or no particle shattering (curd dust) and/or curd matting (lumps). However, the lack of any apparent shattered curd in finished products as an objective within most cheese plants is considered most difficult to attain (Tong et al., 1994).

Most appearance and color defects of creamed cottage cheese can be rather obvious to the alert evaluator. The terminology for these various appearance criticisms

is specific and descriptive. The occurrence of such cottage cheese defects frequently stem from deviations of generally recommended manufacturing procedures. Table 7.1 lists the more common color and appearance defects of creamed cottage cheese, their possible cause, and methods of control. Figure 7.1 illustrates various appearance and color defects of creamed cottage cheese.

The Collegiate Dairy Products Evaluation Contest scoring guide for various sensory defects of creamed cottage cheese (including flavor, body and texture, appearance, and color) is presented as Table 7.3. This scoring guide serves as the standardized guideline by which the contestants in the National and Midwest Collegiate Dairy Products Evaluation competitions assign scores for the slight, definite, and pronounced intensities for the respective defects noted for flavor, body and texture, and color, and appearance of cottage cheese samples.

The curd particles should be reasonably uniform in both their size and shape, regardless of the curd size (small or large) or the given product type. "Shattered curd," to some level of intensity, seems to occur in the vast majority of all commercial cottage cheese. The finest sizes of particles resulting from "curd shattering" are called either "grit," "fines," or "cheese dust." Other than subjective visual appraisal,

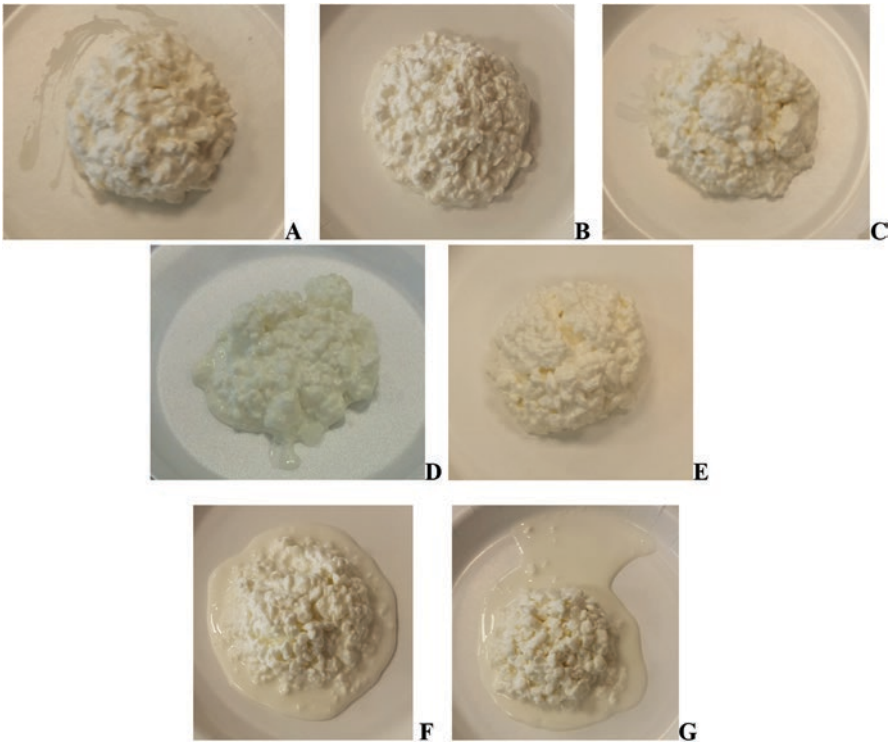


Fig. 7.1 Examples of some appearance and color defects of creamed cottage cheese: (**a**) shattered curd (score of 4); (**b**) shattered curd (3); (**c**) and (**d**) matted curd (3); (**e**) lacks cream (4); (**f**) free cream (4); and (**g**) free whey (2)

Table 7.1 Common color and appearance defects of creamed cottage cheese and their probable causes and remedial measures

Color/ appearance defects	Probable causes	Remedial measures
Free cream	1. Excessive cooking which causes a firm, rubbery curd; this prevents dressing adsorption	Reduce cooking temperature to avoid too firm a curd
	2. Insufficient washing of curd (contact time)	Allow wash water to remain in contact with the curd for a longer time
	3. Cutting pH of curd too high	Cut curd at a pH of 4.65–4.70
	4. Too rapid temperature rise during cooking of curd (causes surface denaturation and loss of dressing permeability)	Exercise better control of curd cooking (i.e., do not cook too fast)
Free whey	1. Undercooking of curd retains an excess amount of whey	Increase cooking temperature to help expel more whey
	2. Insufficient washing of curd	Increase curd washing or draining time
	3. Cutting pH of curd too high	Cut curd at pH of 4.65–4.70
Lacks uniformity	1. Uneven cutting of coagulum	Repair/replace knife wires, avoid overlap when cutting
	2. Too aggressive/abusive agitation during cooking	Use proper cutting techniques, train personnel in careful cutting, agitating, and curd cooking methods
Matted	1. Cutting pH of curd too high	Cut curd at pH of 4.65–4.70. Employ a "standardized" method of cooking and stirring out
	2. Insufficient/inadequate agitation especially during the first hour of cooking	
	3. Curd cooked too rapidly	Initiate cooking slowly and gradually, accelerate pace at midpoint of the cooking stage
	4. Missing wires in the knife sets	Repair or replace knife sets
Shattered curd	1. Excessive heat treatment of the skim milk	Use minimum pasteurization conditions (temperature and time)
	2. Excessive acidity (pH too low) at cut	Cut curd at pH of 4.65–4.70
	3. Total solid content of skim milk too low	Maintain total milk solids >8.75%
	4. Overly severe vat agitation	Stress gentle, careful agitation
	5. Excessive quantity of coagulator used	Use minimum coagulator amount
	6. Rough handling of curd during draining, pumping, and packaging	Restrict/minimized curd handling to a minimum, if possible; use gentle measures

Source: Adapted from Connolly et al. (1984). Courtesy of the American Cultured Dairy Products Institute., Washington, D.C

Table 7.3 The Collegiate Dairy Products Evaluation Contest scoring guide for the sensory defects of creamed cottage cheese (suggested flavor, body and texture, and color and appearance scores for designated defect intensities)

Flavor	Slight	Definite	Pronounced
Bitter	7	5	1
Cooked	9	8	6
Fermented/fruity	5	3	1
Flat	9	8	7
Foreign	7	4	1
High acid	9	7	5
High diacetyl	9	7	6
High salt	9	8	7
Lacks fine flavor	9	7	6
Lacks freshness	8	7	6
Metallic	5	3	1
Oxidized	5	3	1
Rancid	4	2	1
Sweet	8	7	6
Unclean	6	3	1
Whey	8	7	5
Body/texture			
Firm/rubbery	4	2	1
Mealy/grainy	4	2	1
Overstabilized	4	3	2
Pasty	4	3	2
Weak/soft	4	3	2
Appearance			
Free cream	4	2	1
Free whey	4	2	1
Lacks cream	4	3	2
Matted	4	2	1
Shattered curd	4	3	2

the Cornell Grit Test was developed. This method uses four sieve sizes as a separation process to more objectively assess the range of curd size and shape variations (Tong et al., 1994; Kosikowski & Mistry, 1997).

Creamed (or dressed) cheese should exhibit a moderate degree of gloss or sheen, and the cream dressing should definitely cling or adhere to individual curd particles. Clumping of curd particles in large masses is considered a potentially serious defect, since whey may be readily trapped and sealed inside the congealed curd pieces – subsequently rendering the product to more likely exhibit "high-acid," bitter, and/or "whey" off-flavors.

Lacks cream is an uncommon defect in creamed cottage cheese. Creamed cottage cheese with this defect lacks the "blanket" of cream dressing and may appear dull and dry.

Free cream (or dressing) can appear when the cottage cheese curd has been "dressed" with too high a level of cottage cheese dressing. When the dressing-to-curd ratio is too high, the finished cottage cheese in the retail container can appear "wet." Free cream can also occur when the curd texture is not correct. If the curd has been cooked to too firm of a texture it will not absorb the creamed dressing and will also appear wet. Also when the cottage cheese dressing viscosity is too thin (not enough stabilizer added), the dressing can easily run off of the curd (therefore no cling), and the finished cottage cheese will appear wet in the retail cup.

Free whey occurs when there is a clear or slightly yellow liquid that separates from the curd and dressing in the retail package. It will be observed on top or along the sides of the retail container. It can also occur when the creamed dressing lacks enough milk solids not fat (or total solids) in the dressing formulation. Free whey can then run away from the curd and dressing mixture. Finally, free whey can occur when the cottage cheese curd piece retains too much whey and/or rinse water on the inside of the curd piece and does not get squeezed out sufficiently during draining in the vat or through a mechanized piece of curd-draining equipment.

7.5.2.2 Body and Texture

The body and texture of cottage cheese can be well assessed by placing a half-spoonful of curd in the mouth and pressing the curd to the roof of the mouth with the tongue. The body should have a "meat-like" (meaty) consistency, but not be overly firm, rubbery, or tough when it is first chewed or masticated (placed against the teeth and gently, carefully masticated). The product texture should seem relatively smooth (meaty, silky) across or throughout the curd pieces that are chewed gently (Bodyfelt et al., 1988). The evaluator should be able to feel (as well as see) distinct curd particles. The curd particles are expected to be relatively uniform in both size and configuration for the given type of curd being considered. Ideally, creamed cottage cheese should demonstrate a relatively firm but tender body and exhibit a silky-smooth and meaty-like texture (Connolly et al., 1984; Bodyfelt et al., 1988).

Understandably, the size of curd particles and the relative degree of firmness of cottage cheese curd in the USA has not been fully and objectively standardized (Kosikowski & Brown, 1973; Rosenberg et al., 1994a, b). Body and texture characteristics are guided primarily by consumer preferences within a given market area of the country. Many manufacturers market two distinct types of cottage cheese: "small curd" and "large curd." Although large curd is usually firmer and tends to exhibit a somewhat more acidic taste (due to more entrapped lactic acid), both product types are of comparable flavor character (Bodyfelt et al., 1988).

The most desirable body for cottage cheese is presumably one that is apparently neither too firm nor too soft and should have uniform consistency across the curd particle (Connolly et al., 1984). The curd should be sufficiently firm to hold its general shape and maintain its individual identity (vs. matting), yet simultaneously be soft enough to yield a silky, "tacky" smear between the tongue and hard palate (also

observed when washed curd pieces are pressed lightly between the thumb and forefinger). Curd that is too firm tends to resist such pressing (i.e., there is a tendency for the curd to "spring back" or retain its original shape when the pressure is released).

In 1963, a skilled Pacific Northwest cottage cheesemaker, Willi Sprenger of Sunshine Dairy, Portland, devised the following simple, practical test for determining the appropriate curd firmness "end point" during the curd cooking stage. Typically, when a thoroughly washed curd particle was dropped onto the plant floor from waist level, an "appropriate-bodied" curd particle would exhibit a perceptible bounce (2.5–7.6 cm (1–3 in.)). A too-soft-bodied curd, by contrast, would "splatter" and break apart when it struck the floor, while a too-firm (tough, rubbery) curd generally "bounced" upward in excess of 7.6 cm (3 in.) when dropped from waist level (Sprenger, 1963; Bodyfelt et al., 1988). Scientific, mechanical methods using a penetrometer or a texture analyzer are now being evaluated to objectively determine curd firmness during the manufacturing process (Potter, 2007). The key to achieving consistent curd body is to employ a device that can be used in a cottage cheese production environment that provides immediate results, versus after the fact discovery.

The appropriate body and texture properties of cottage cheese should be associated with consumer acceptance in the particular market area that it is sold, but it should not be too firm or too soft. In a laboratory, an evaluator can "wash" creamed cottage cheese with the aid of a fine-mesh sieve to void the dressing. This can serve to present a truer picture of curd uniformity. By tearing apart curd particles, the evaluator can readily perceive the extent of the so-called meatiness and overall consistency of a cross-section of the curd (from the outer surface to the center). Curd particles that are smooth, meaty, and tender tend to exhibit distinct striations of protein fiber when the particle is torn apart and closely examined. Such curd texture has been reported to exhibit good liquid capillarity, and thus this feature facilitates more complete adsorption of added cream dressing. Conversely, curd that is undercooked with soft centers will not absorb the creamed dressing very readily and also appear wet.

7.5.2.2.1 Body and Texture Defects of Creamed Cottage Cheese

The more common body and texture defects of cottage cheese are the following:

Firm/rubbery (tough)	Overstabilized ("slick" mouthfeel)
Gelatinous (not on Collegiate contest scorecard)	Pasty (sticky, doughy) Weak/soft (mushy)
Mealy/grainy (gritty)	

Brief descriptions of the characteristics that are indicative of the above-listed body and texture defects of creamed cottage cheese are detailed in the following paragraphs. The intensities of various body and texture defects are usually scored according to the guide for scoring creamed cottage cheese shown in Figs. 7.2 and 7.3. Various causes and methods for controlling body and texture defects of cottage cheese are summarized in Table 7.2.

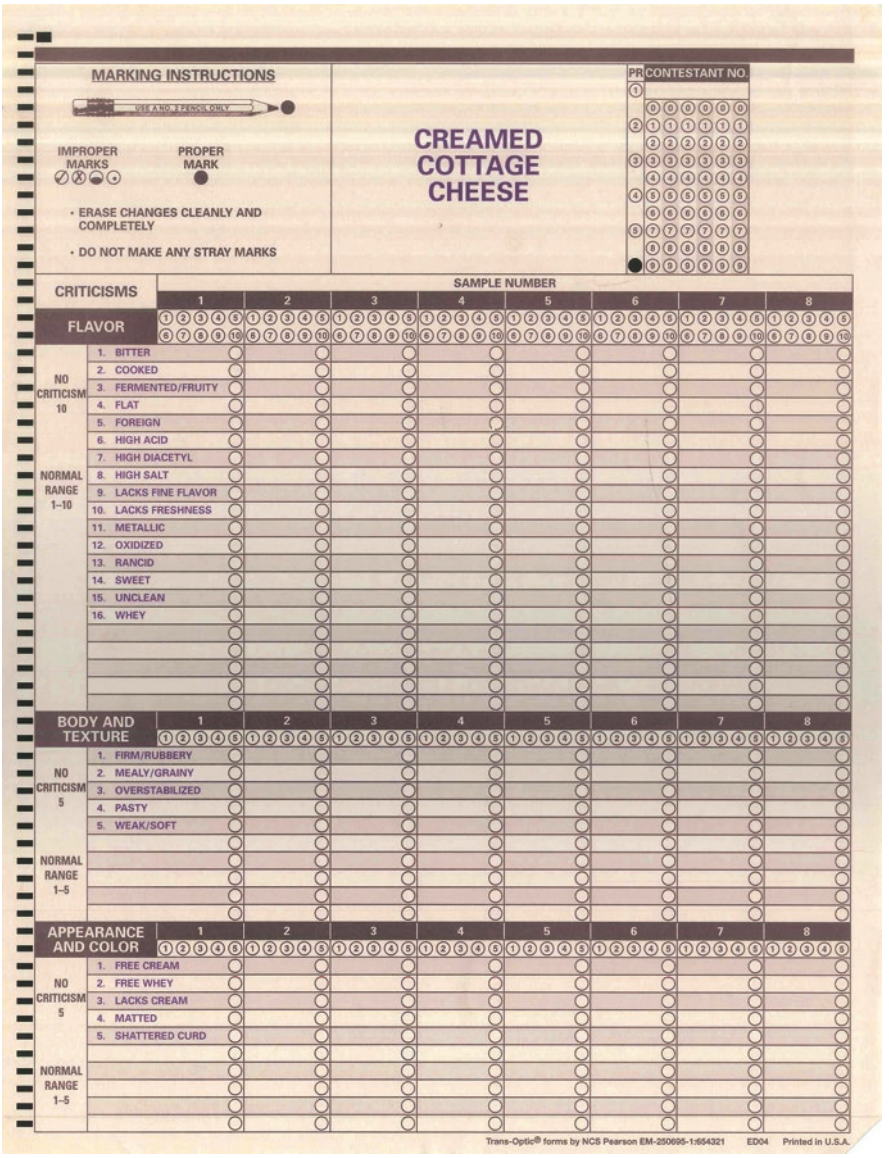
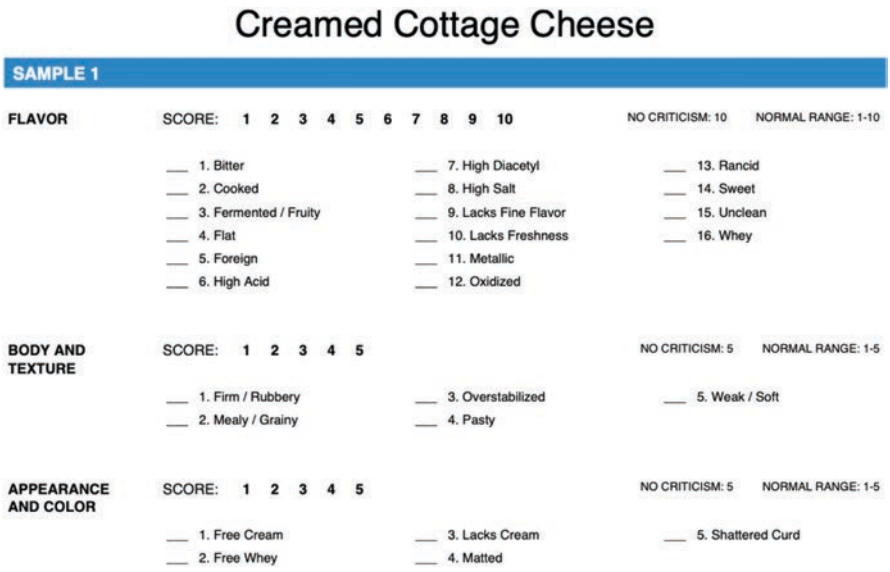


Fig. 7.2 Collegiate Dairy Products Evaluation Contest scorecard for creamed cottage cheese (used through 2017)


Creamed Cottage Cheese

SAMPLE 1

FLAVOR SCORE: 1 2 3 4 5 6 7 8 9 10 NO CRITICISM: 10 NORMAL RANGE: 1-10

___ 1. Bitter
___ 2. Cooked
___ 3. Fermented / Fruity
___ 4. Flat
___ 5. Foreign
___ 6. High Acid
___ 7. High Diacetyl
___ 8. High Salt
___ 9. Lacks Fine Flavor
___ 10. Lacks Freshness
___ 11. Metallic
___ 12. Oxidized
___ 13. Rancid
___ 14. Sweet
___ 15. Unclean
___ 16. Whey

BODY AND TEXTURE SCORE: 1 2 3 4 5 NO CRITICISM: 5 NORMAL RANGE: 1-5

___ 1. Firm / Rubbery
___ 2. Mealy / Grainy
___ 3. Overstabilized
___ 4. Pasty
___ 5. Weak / Soft

APPEARANCE AND COLOR SCORE: 1 2 3 4 5 NO CRITICISM: 5 NORMAL RANGE: 1-5

___ 1. Free Cream
___ 2. Free Whey
___ 3. Lacks Cream
___ 4. Matted
___ 5. Shattered Curd

Fig. 7.3 Computerized scoresheet for the Collegiate Dairy Products Evaluation Contest

Firm/Rubbery (Tough) When the curd of overly "firm or rubbery" cottage cheese is pressed between the tongue and the roof of the mouth, a modest (but sometimes subtle) resistance to crushing or mastication can be noted by the careful observer. Further manipulation of the product in the mouth may suggest either a high solids level or low moisture content of the internal curd structure. Unless this firmness is quite pronounced and/or associated with non-adsorption of cream dressing, this defect is not considered particularly serious. Refer to Table 7.3 for additional details.

Gelatinous This is a rare defect observed in commercial cottage cheese; hence, it is no longer listed on the Collegiate Dairy Products Evaluation Contest scorecard. "Gelatinous" cottage cheese tends to have a sticky or slightly "jelly-like" character, or may resemble tapioca pudding. This body defect may have an accompanying bitter off-taste and a translucent curd appearance. A gelatinous defect is generally due to proliferation of psychrotrophic bacteria in the product and, hence, an indication of product spoilage; such a product is often unpalatable and, hence, unsalable cheese.

Mealy/Grainy (Gritty) Unfortunately, this is a quite prevalent defect in US cottage cheese. The "mealy/grainy" (the term used generally depends on primary particle size) defect can be detected by briefly pressing (with the tongue) masticated curd against the roof of the mouth and carefully attempting to perceive the presence or absence of a gritty or corn meal-like sensation (just prior to expectorating or swallowing the sample). Excessive tiny particles remaining in the teeth crevices after swallowing or expectoration also indicates the mealy/grainy defect. Another way of detecting curd graininess is to "wash" away the cream dressing, carefully knead the

Table 7.2 Common body and texture defects of creamed cottage cheese, their probable causes, and remedial measures

Body and texture defects	Probable causes	Remedial measures
Firm/rubbery	1. Cutting pH of curd too high	1. Cut curd at pH of 4.65–4.70
	2. Excessive cooking time or temperature	2. Carefully determine the optimum cooking endpoint
Mealy/grainy	1. Cooking rate too rapid, especially during initial stages of cooking	1. Slow, gradual cook temperature increments, accelerate at midpoint of cook
	2. Excess acidity developed	2. Cut curd at pH of 4.65–4.70
	3. Inadequate vat agitation	3. Controlled, steady agitation
	4. Too much curd in direct contact with hot vat surfaces	4. Minimize temperature gradient
Pasty	An extreme case of weak/soft	
	(see below)	
Overstabilized	Excessive use of stabilizer in dressing	Decrease amount of stabilizer in dressing
Weak/soft	1. Excessive heat treatment of skim milk	1. Use minimum pasteurization conditions
	2. Excessive acidity (low pH) at cut and during cook	2. Cut curd at pH of 4.65–4.70
	3. Inadequate cook-out temperature	3. Carefully determine optimum cook-out
	4. Overdressing the curd	4. Calculate and blend curd and dressing at appropriate ration (typical ~4/3 ratio)

Source: Adapted from Connolly et al. (1984). *Courtesy* American Cultured Dairy Products Institute

washed curd, and then smear it between the fingers. Instead of a silky, smooth smear (which is characteristic of an "ideal" curd texture), the evaluator often will find a somewhat dry, rough, serrated curd mass instead. The uncreamed curd of "gritty" cottage cheese is similar to the curd formed in the manufacture of casein.

The mealy/grainy defect of cottage cheese may be caused by too-low moisture and/or overdevelopment of acid during coagulum and/or curd formation (Connolly et al., 1984). To minimize this curd defect, more moisture can be incorporated by cooking the curd more gradually and by using lower cooking temperatures. Curd cutting should only be undertaken when the coagulum reaches the isoelectric point of casein (pH 4.65–4.70). Mealiness/graininess may also be caused by (1) nonuniform cutting of the curd; (2) uneven heating (cooking) of portions of the curd; (3) too-rapid cooking of the curd/whey mixture; (4) inadequate agitation during the cooking phase; and (5) allowing curd particles to contact extremely hot surfaces during cooking. The major techniques for controlling the extent of graininess/mealiness are cutting the coagulum at the proper pH (to avoid excess acidity) and maintaining sufficient, but gentle, agitation throughout the cooking stage of the cheese-making process.

Pasty (Sticky, Doughy) The "pasty" defect in creamed cottage cheese is closely associated with soft, weak, high-moisture curd or curd that is excessively ground up or shattered. En masse, pasty-bodied cheese resembles cereal dough, a flour-like paste, or glue. The curd particles have a tendency to mat or stick together in soft clumps. Authorities on cottage cheese quality simply regard the pasty defect as a possible extension or advanced degree of the weak/soft criticism (discussed next).

Weak/Soft (Mushy) This defect is characteristic of a higher-moisture cottage cheese of relatively low solids content. If a less-firm- or weaker-bodied cottage cheese is preferred for certain markets or customers, the cheesemaker has the option of employing a lower cook-out temperature for designated lots of cheese; this variation favors a higher retention of whey (moisture) in the curd. Weak-bodied cottage cheeses may not meet the legal maximum of 80% moisture content. Following storage, a weak, soft-bodied cheese may often manifest a bitter taste, due to the entrapped whey (and associated peptides). According to a quality manual published by the American Cultured Dairy Products Institute (Connolly et al., 1984), probable causes of the weak/soft and/or pasty defects in creamed cottage cheese are the following:

1. Excessive heat treatment of cheese milk (above 80 °C/170 °F).
2. Excessive acidity (low whey pH less than pH 4.40) at time of the start of cooking the curd and during the cooking process (final whey pH at the end of cook that is between 4.20 and 4.30).
3. Too-low cooking temperatures.

Overstabilized (Slick) In an attempt to "thicken" dressing, minimize free whey in the final product and/or enhance adherence of the dressing to the curd, processors may occasionally overdevelop dressing viscosity through excessive use of nonfat dry milk, stabilizers, and/or emulsifiers. The ideal dressing viscosity is between 45 and 60 s when measured on a Zahn #2 cup at 4 °C/40 °F. Overstabilized dressing may exceed a draining time of 60 s when timed in a Zahn #2 cup, or not drain out of the cup at all. Using ingredients in the stabilizer such as food starch, modified food starch, or maltodextrin may tend to promote this slick texture. When this defect occurs, it is quite apparent; creamed cottage cheese may appear markedly dry, and some individual curd particles may appear to be surrounded by a thick, pasty coating. Overstabilized dressing is not considered a serious defect unless it is so severe as to impart an off-flavor or unfavorable mouthfeel (slippery or slick) to the cottage cheese. The overuse of guar gum in the dressing may give a slick or slippery feel in the mouth when evaluated organoleptically. Decreasing the quantity or changing the source of stabilizer can effectively eliminate the so-called slick or overstabilized defect.

In addition to stabilizer, the use of fresh cottage cheese whey protein concentrate (WPC) has resulted in an overstabilized defect as well (Potter, 2007). In most cases, it is necessary to reduce the level of stabilizer to compensate for the moisture bonding and thickening action of the whey proteins. Also, the use of elevated levels of WPC can result in either pasty body and texture or possible off-flavor.

7.5.2.3 Flavor

Pertinent information about cottage cheese may be gained from a focused aroma check of the opened package after stirring of the curd and dressing just prior to tasting. Creamed cottage cheese of high quality should have a fresh, pleasant, clean, delicate acid, and mild diacetyl (buttery) flavor (Elliker, 1949; Connolly et al., 1984; Bodyfelt et al., 1988; Kosikowski & Mistry, 1997) that imparts no aftertaste when the sample has been expectorated or swallowed. There should be no particular aftertaste and only a sufficient salty taste (Bodyfelt, 1982; Wyatt, 1983) to "bring out" the desired flavor. There are conceivable regional differences across the USA, wherein variations of the intensity of the acidity taste and the diacetyl flavor note are either more or less preferred (Mather & Babel, 1959; Connolly et al., 1984; Bodyfelt et al., 1988; Rosenberg et al., 1994a; Kosikowski & Mistry, 1997).

7.5.2.3.1 Evaluation of Flavor

Cottage cheese flavor attributes are a "composite" of curd acidity, volatile compounds formed by the lactic culture fermentation, and/or from addition of aroma-producing microorganisms or added diacetyl compounds to the cream dressing. The composition of the cream dressing and the added salt also serve to greatly enhance the flavor of creamed cottage cheese. Salt is a flavor potentiator. Cream dressing should be added in such quantities that the curd can readily absorb it within a reasonable time period before marketing (2–3 days). The evaluator should recognize the possibility of two types of cream dressing, often depending on the US region: (1) a dressing virtually devoid of much aroma, but seems clean, sweet, and pleasantly acidic and (2) the other type with either a detectable (or definite), diacetyl (buttery-like), or cultured aroma with an acidic character. Both types of flavor characteristics generally are considered equally appropriate in the discretion of experienced dairy product judges, as well as most consumers.

7.5.2.3.2 Flavor Defects of Creamed Cottage Cheese

As a rule, creamed cottage cheese is a highly perishable product, even with rigorous sanitation and product-handling precautions (Bodyfelt, 1981b) that are usually practiced in manufacturing.

The specific flavor defects of creamed cottage cheese are as follows:

Bitter	Malty (not on Collegiate Contest scorecard)
Cooked	Metallic
Fermented/fruity	Musty (not on Collegiate contest scorecard)
Flat (lacks flavor)	Oxidized
Foreign, chemical, and medicinal	Rancid

High acid (sour)	Unclean (dirty aftertaste)
High diacetyl	Whey
High salt	Yeasty (vinegar-like; not on Collegiate contest scorecard)
Lacks fine flavor (acetaldehyde, plain yogurt-like)	
Lacks freshness (stale, storage)	

A brief description of the characteristic features of each of the off-flavors listed above is helpful in trying to identify them; some flavor defects are distinctive and unique to cottage cheese (refer to Table 7.3). Most cottage cheese produced today is usually flat, lacks fine flavor, high acid, high diacetyl, or has a whey flavor. One brand has a cooked flavor due to packaging the product "hot" to get extended shelf-life.

Bitter A "bitter" off-taste in cottage cheese is characterized by its (1) relatively slow reaction time and delayed perception; (2) detection at or near the back of the tongue; and (3) persistence after sample expectoration. Pronounced bitterness is not unlike the sensation imparted by quinine or caffeine. This defect is frequently encountered in older samples of cottage cheese or in cheese stored at favorable growth temperatures for psychrotrophic organisms (which are the principal causative agents). In the past, a bitter off-taste in cottage cheese may have resulted from the consumption of certain weeds by cows; however, bitter cottage cheese from this source would be extremely infrequent today.

Cooked Cottage cheese that is slightly cooked need not be faulted or critiqued. However, excessive heating of the cream dressing typically imparts sulfur notes that are considered detrimental to the desired delicate flavor of creamed cottage cheese. Presumably, the cooked flavor note derives from a definite intensity of cooked flavor of the cream dressing, rather than from the curd cooking process, which by necessity must be limited in order to control curd firmness within the finished product.

Fermented/Fruity Surprisingly, a "fruity" or "fermented" defect may have a pleasant, aromatic quality (to some individuals), suggestive of pineapple, apples, bananas, or strawberries (Morgan, 1970b). Fermented cream cottage cheese is more reminiscent of vinegar. A mere "whiff" of the just-opened package usually confirms the presence of this serious defect. Follow-up tasting usually suffices to substantiate the already-noted aroma and may also reveal an associated unpleasant, distinctive lingering aftertaste. The given cottage cheese may be near its "sell-by" date and/or have been stored at elevated and favorable temperatures for psychrotrophic bacterial growth. The product may soon reach a point of unpalatability. Complete spoilage is often imminent.

Flat (Lacks Flavor) A "flat" flavor in cottage cheese may be noted by an absence or lack of the characteristic flavor and aroma. Identification is that simple and direct.

A dry, unsalted, washed, "rennet curd" yields a distinctly flat taste, unlike that of pure casein. A creamed cottage cheese may also tend to yield a flat taste and aroma during an early or intermediate stage of the development of an oxidized off-flavor. In this case, the initial "flatness" may lead to a delayed flavor perception that suggests a metallic off-flavor; the evaluator should be alert to this possible follow-up off-flavor. Even when pronounced, a flat flavor defect is not considered serious enough to classify the cottage cheese as a poor product (unless an associated and more objectionable off-flavor accompanies the flatness). Reduced fat and nonfat cottage cheese products obviously exhibit lower flavor intensities, due to the reduction or absence of added cream dressing and its related richness and overall "flavor-rounding" effects. The relative freshness and flavor quality of the skim or low-fat milk sources for curd formation are important to the flavor attributes of the resultant cottage cheese products. In today's marketplace, due to the manufacturer wanting to reduce the sodium content per serving of cottage cheese, the cottage cheese may be judged as "flat" merely due to a reduced level or lack of salt in the cream dressing.

Foreign (Chemical/Medicinal) A "foreign" off-flavor, though only occasionally noted in creamed cottage cheese, distinguishes itself by being entirely unlike any off-flavor that might be anticipated in the product – it seems "atypical" or most unusual. Sometimes, the actual nature of the off-flavor betrays its identity. The persistent, atypical, or "out-of-place" off-flavor may suggest possible contamination either by cleaning compounds, chlorine, iodine, phenol, or various other chemical substances that may have accidentally or unfortunately gained entry to the product.

High Acid (Sour) The terms "high acid" or "sour" basically designate various intensities of the same defect. They generally reflect an excess of lactic acid, a level of acidity beyond that which is generally considered desirable or highly acceptable to taste. However, it should be emphasized that this particular intensity is generally clean and sharp (with no particular aftertaste). The so-called sour taste can be pronounced, and it may sometimes be associated with other bacterial defects, such as bitter or fruity/fermented.

The development of lactic acid by the culture inoculated into skim milk in making cottage cheese is essential for curd formation, unless the cheese milk is chemically acidified (direct set). Also, the formed lactic acid or added acidulant helps contribute to cheese flavor. However, if too much acid is developed in the course of curd formation or curd cooking, it usually results in a high-acid (sour) curd. A high-acid curd tends to mask some of the more delicate, volatile, organic compounds responsible for the desirable flavor of cottage cheese. Insufficient washing(s) of the curd prior to dressing may result in too much whey retention in curds and hence cause or lead to high-acid flavor. A cottage cheese, such as just described, may sometimes merit another related flavor criticism – "whey taint."

The specific types of lactic culture(s) used in dressings for enhancing flavor and/or product shelf life may become somewhat active within their shelf life period, and hence produce additional levels of lactic acid, which can "announce" itself with either definite or pronounced high-acid or sour flavors.

High Diacetyl This flavor defect is generally noted by an overall lack of aroma balance, or a too distinct intense aroma of diacetyl, plus the possible masking of other important or delicate flavor notes. It is often characterized by the presence of a harsh buttery flavor and/or excess aroma, which seems "out of balance" for cottage cheese. Additionally, some evaluators suggest the terms of "coarse" or "too harsh" to help define the flavor character. Some product manufacturers appear tempted to "over-flavor" reduced fat and nonfat cottage cheeses with either flavor concentrates or whey distillates, and this approach may lead to products that may seem "too high in diacetyl," harsh and/or coarse in flavor character.

High Salt "High salt" manifests itself as an unwanted, sharp, piercing, biting taste sensation that detracts from the pleasant delicate flavor of high-quality cottage cheese. Addition the proper amount of salt (approximately 1% or less) enhances cottage cheese flavor; however, oversalting defeats the purpose of this product ingredient. Both the reaction and adaptation times of the taste buds are of short duration for the salty taste sensation. The initial sensation encountered upon tasting high-salt cottage cheese is soon dissipated and relieved by an induced copious flow of saliva. Experienced evaluators of cottage cheese commonly recognize that 0.6–1.0% added salt is generally required to help enhance the flavor of cottage cheese. However, a distinct or obvious "salty taste" in creamed cottage cheese should not be consciously perceived by the product evaluator (Bodyfelt, 1982; Wyatt, 1983).

Lacks Fine Flavor (Acetaldehyde, Plain Yogurt-Like) When a given lactic culture that has been added to the cream dressing produces acetaldehyde as a principal volatile component, a "green-apple" or yogurt-like off-flavor often occurs in the final product. Such cottage cheese is said to "lack fine flavor," due to formation of substantial levels of acetaldehyde. The lacks fine flavor critique of cottage cheese also suggests a note of "coarseness" or "harshness" off-flavor. The term may also be used to describe cottage cheese that is clean, but lacks some flavor such as added diacetyl or one that doesn't use cultures in the dressing.

Lacks Freshness (Stale, Storage) These three off-flavors have been grouped together because they have much in common. The relative age of the product or ingredients seem to be the underlying factors for this group of flavor defects. A difference in defect intensity exists between "lacks freshness" and "stale." The latter is more obvious or intense, whereas the former defect tends to almost shield its true identity; it is simply a general lack of refreshingness in the product. Staleness may also be imparted by old ingredients (e.g., dry skim milk, cream, and stabilizer).

Cottage cheese flavor is usually at its best or "peak" within 1–5 days after manufacture. When properly made and adequately refrigerated, cottage cheese should retain its "typical flavor" for a reasonable period of time (2–3 weeks). Frequently during storage and distribution, even under adequate refrigeration (<4.4 °C (<40 °F)), cottage cheese progressively deteriorates in flavor quality. This is

undoubtedly due to the simultaneous occurrence of microbiological and chemical changes. This resulting flavor deterioration can be referred to as "lacks freshness," since the cottage cheese seems to lack the refreshing flavor characteristics of a more recently made product. A storage off-flavor can develop in cottage cheese that is packaged and subsequently exposed to "volatiles" within the refrigerator or cold storage space. Hence, the "storage" off-flavor, if and when it does occur, is appropriately classified as an absorbed flavor defect.

Malty A "malty" off-flavor defect in cottage cheese is rather specific or distinctive; maltiness tends to predominate over most flavor defects that may be present. This off-flavor, which resembles "Grape Nuts®" or malted milk, is quite easy to identify due to its uniqueness. It generally has a quick reaction time; the aftertaste is not prolonged. Since a malty off-flavor is the result of contamination by an outgrowth of *S. lactis* var. *maltigenes*, additional developed acidity (a sourness taste) may accompany a malty aroma defect (Morgan, 1970a).

Metallic and Oxidized Fortunately, these two more serious off-flavors are infrequently encountered in cottage cheese. If they do occur, improper selection and/or handling of the cream for preparation of the curd dressing is usually indicated. "Metallic" has a slightly astringent, "rusty nail-like" taste, while "oxidized" is an off-flavor more reminiscent of wet cardboard or paper. Smelling the sample usually gives little indication of a metallic defect, but a weak off-odor may sometimes suggest the characteristic or "generic oxidized" off-flavor. Some research indicates that these two defects may be different intensities of the same basic defect (e.g., lipid autoxidation) resulting from light exposure or copper or iron contamination of susceptible milk or cream used.

Musty "Musty" cottage cheese exhibits an aroma that resembles that of a damp, poorly ventilated cellar. This serious, but seldom encountered, defect in cottage cheese is due to the outgrowth of various microbial contaminants, primarily molds, in cottage cheese. Cheese curd may sometimes become contaminated with certain psychrotrophic bacteria (*Pseudomonas taetrolens*) as the result of faulty plant sanitation (Foster et al., 1957). When this development is coupled with inadequate refrigeration and processing methods, the musty defect may occur; it usually intensifies as cottage cheese is held in storage. The product would soon become unpalatable, if such is not already the case. This defect may be noted more frequently during late fall, winter, or early spring, when cows are more apt to be on dry feed for extended periods (Bodyfelt et al., 1988). Also, if a milk supply that is susceptible to milk fat autoxidation is used to produce cottage cheese curd, this potential off-flavor could likely be retained by the curd. An oxidized flavor defect will generally intensify during storage and may occasionally develop into a distinct, "tallowy" off-flavor. Any copper contamination, especially of the cream or milk used in preparing the dressing, can easily catalyze development of an oxidized off-flavor.

Sweet The term "sweet" was recently added to the Collegiate Dairy Products Evaluation Contest scorecard to account for an atypical (for the product) sweet off-

flavor that has become more notable since the advent of the use of lactose and/or maltodextrin in custom blends of certain stabilizers that are used in the cottage cheese industry. As new sources of ingredients continue to be utilized in the manufacture of creamed cottage cheese, novel and somewhat unfamiliar flavor notes associated with this product are observed. Hence, new flavor descriptors may continue to be identified with the progress of innovations and time. Application of the term "sweet" in conjunction with the acid-coagulated type of cheese seems contradictive, but in the instance just cited, this descriptor is appropriate.

Rancid "Rancidity," in cottage cheese, as in milk, may be noted by an astringent, puckery feeling at the base of the tongue and throat, as well as an associated bitter aftertaste, following sample expectoration. The objectionable rancid off-flavor tends to persist as an unpleasant aftertaste for a considerable period of time. Short-chain fatty acids (C_4–C_{10}) are readily formed by the hydrolysis of milk fat under certain adverse physical conditions or improper processing protocols. Subsequently, the free fatty acids react with the salts of milk, leading to formation of aromatic compounds (i.e., soaps), thus leading to hydrolytic rancidity. Rancidity is variously described as "soapy," Romano cheese-like, with a delayed "bitter" aftertaste.

If rancid milk or cream is used to manufacture cottage cheese curd and/or dressing, this serious off-flavor will carry over into the finished product. Since rancidity is due to the action of the enzyme lipase on milk fat, this flavor defect is derived from the added cream, not from the curd. This defect may intensify as the cheese becomes older, particularly if the homogenized dressing was not adequately heat treated. Proper pasteurization of all milk products used in making cottage cheese prevents rancidity, providing the raw milk and cream supplies were free of this defect.

Unclean The designation for this serious defect is self-explanatory. The off-flavor "unclean" cannot be easily expressed in other descriptor terms. Some judges have dared to use the term "dirty" to describe the unpleasant, objectionable, unclean-like off-flavor that sometimes proliferates as an undesirable aftertaste in cottage cheese that has commenced to spoil or exhibit microbial deterioration. This unpleasant flavor note, often accompanied by a distinct bitter off-taste, generally remains for some time after sample expectoration; product palatability is at stake. Skim milk used to make cottage cheese that might have a "barn-like or cowy-type" of flavor could be also judged as "unclean."

Whey The so-called whey off-flavor in cottage cheese manifests itself as either a "sweet brothy-like" flavor (due to the presence of residual lactose), or an acidic whey flavor (due to residual fermented whey), which results from insufficient chill water rinsing of the curd prior to addition of the dressing. Added whey protein concentrate or added sweet or acid whey in the cottage cheese dressing as an economical solids source can also contribute to this flavor criticism. A processor strategy that utilizes cottage cheese acid whey permeate as a solids source in cream dressing formulation in order to help minimize whey disposal costs may contribute to the "acidic whey" off-flavor defect. The whey flavor defect of cottage cheese may or

may not be associated with the visible "free whey" appearance defect as observed within the product package upon opening the closure, inasmuch as product stabilizers and emulsifiers may aid in masking the visual defect.

Yeasty (Vinegar-Like) "Yeasty" and "vinegar-like" defects in cottage cheese have a peculiar aromatic quality in addition to a possible associated high-acid note. While this defect may be caused by growth of yeasts and tends to exhibit a yeasty or earthy off-odor, the often-associated sharp, pungent taste may be suggestive of vinegar (possibly due to bacterial fermentation). Various microbial contaminants, including certain kinds of psychrotrophic bacteria, are generally responsible for this objectionable off-flavor. Usually, serious sanitation shortcomings in manufacture and/or packaging are at fault and in need of elimination to correct this serious off-flavor problem in cottage cheese. The shelf life of this relatively perishable product is significantly reduced by poor sanitation and lack of temperature control throughout the distribution chain (Bodyfelt, 1981a, b; Morgan, 1970a, b).

7.6 Historical Development of the Cottage Cheese Industry

7.6.1 Improvements in Product Quality

Obviously, research conducted since the 1930s on lactic cultures and specialized equipment at US and Canadian universities, as well as commercial suppliers (Olsen, 1980), has played a major role in solving many of the manufacturing, sensory quality, and shelf life challenges posed by delicate properties of creamed cottage cheese over the decades. Research efforts focused on this fresh cheese category were quite limited, if nonexistent, prior to 1930. At about this time, dairy technologists, scientists, and microbiologists recognized that cottage cheese was gradually becoming a significant product category for the North American dairy industry. Several forms of technology transfer were implemented to bring new knowledge and sanitation protocols to the budding North American cottage cheese industry. The most common and effective methods of product quality maintenance and improvement involved the in-plant presence of trained personnel from lactic cultures and specialized ingredients suppliers and cottage cheese-making equipment providers, who visited plants and transferred their technical knowledge and scientific advances related to lactic cultures selection, bacteriophage (an infectious virus) control, and reduction of cheese culture/milk agglutinin interactions (i.e., curd sludge formation). Basic and applied research at university experiment stations focused on modified, improved cottage cheese manufacturing procedures (i.e., short and intermediate set protocols), more specific sanitation and curd cooling/handling methods, and product shelf life extension (Angevine, 1964; Olsen, 1980), which had been a limiting factor in marketing cottage cheese beyond local market areas (<100 mi).

Traditionally, cottage cheese was only made with lactic acid producing mesophilic culture based strains. Now, most of it is made with direct set cultures which contain a blend of lactic-acid-producing mesophilic *and* thermophilic lactic acid bacteria strains. This gives additional bacteriophage control and makes for a shorter incubation time . With an elevated set temperature of the skim milk in the vat, thermophilic lactic-acid-producing bacteria strains produce lactic acid faster and to a greater degree over time than mesophilic lactic acid bacteria strains do. Whey pH after cut needs to be monitored so a soft-textured cheese curd is not obtained. This means adding less cooking acid or no cooking acid to the whey before cooking is started. Additionally, higher cook temperatures need to be utilized in order to drive the whey from the curd piece during cooking, since more acid produced from the culture itself usually means softer cheese when cooked out to the same temperature endpoint.

7.6.2 Cottage Cheese Industry Pioneers

Mr. Neil Angevine, who commenced his cottage cheese work in the early 1920s, was saluted by Olsen (1980) as the one person (self-developed in requisite skill sets, technical applications, and applied sciences) who more than any other individual advanced the US and Canadian cottage cheese industries for over four decades. Mr. Angevine did not benefit from the possession of a college degree. He learned his lessons from personal contacts with several persons within the mid-western small cottage cheese plants he worked in through the 1920s. By the 1930s, Mr. Angevine had earned a reputation as being a superior "technologist" on lactic cultures, cultured products, and creamed cottage cheese. He was soon employed by a cultures supply company to visit plants all over the USA and Canada for demonstrating the best preparation and use of cultures, with emphasis on his relatively new "short-set method" for cottage cheese making. Thus, this was the beginning of a dedicated career of over 40 years of service to the lactic cultures and cottage cheese industry, which culminated in Mr. Angevine being appointed as the lead product judge when cottage cheese was added to the National Collegiate Dairy Products Evaluation Contest in 1962. Angevine's enthusiasm for demonstrations of "best techniques" soon drew in other processor and supplier personnel involved with lactic cultures, cottage cheese, and other cultured product processing. This "passion for more perfection" eventually evolved into regularly scheduled and conducted "Cultured Dairy Products Training Schools," which were subsequently transferred to the responsibility of the Cultured Dairy Products Institute, and eventually called the "Kurds and Kultures Klinics."

Another recognized "giant" of the cottage cheese and cultured products industry in the USA was Erik Lundstedt, an immigrant in 1929 from Denmark, who earned a degree in dairy chemistry from Iowa State College. After working several years in US butter and cheese plants, he next became affiliated with H.P. Hood and Sons Inc. of Boston, as the manager of Hood's cottage cheese operations for 15 years, before

retiring as a worldwide consultant on cultures and cultured products and author of numerous articles in his areas of expertise (Angevine, 1964; Olsen, 1980).

Lundstedt continually looked for better methods and better quality control in cottage cheese and related products. Some of the significant achievements of Lundstedt's research were as follows:

1. Several new cultured products processing methodologies that were patented.
2. A device for more precisely determining the firmness of cottage cheese curd was created.
3. The use of citrated whey for lactic culture propagation was begun.
4. A method for enhancing the aroma of various cultured products was developed.
5. A high-protein, low-fat, unripened cheese was developed.
6. A process for drying acid whey with subsequent applications was developed.

Erik Lundstedt continued in retirement as a prolific writer of practical and scientific articles. Lundstedt, along with Dr. Frank Kosikowski and David Bandler of Cornell University, founded the American Cottage Cheese Institute in 1959–1960, with Lundstedt serving as the first president, and Angevine as the second. This organization later was re-named as the American Cultured Dairy Products Institute, which commenced publishing a well-received journal by 1961.

A mid-western leader in developing what was generally recognized as the most precise protocol for manufacturing consistent, high-quality cheese was Al Shock, who developed the Nordica System process (Potter, 2007) of cottage cheese manufacture in South Dakota in the 1950s. The Nordica System process developed and provided its own lactic cultures and manufacturing protocols, and formally licensed plants in the USA and Canada to use the specific and detailed manufacturing protocols (eventually extending the manufacturing system to England and Australia). By the late 1960s, there were over 100 cottage cheese producers licensed under the Nordica process.

7.7 Conclusion

US cottage cheese per capita consumption has continued to decline throughout the past 20 years as reported by the USDA. It can be speculated that the primary reason for little or no real growth in cottage cheese sales has been due to inconsistent product quality and lack of market focus and promotion, as compared to the dairy industry's experience and successes with yogurt. Cottage cheese manufacturers have reformulated their products over recent decades to maintain profitability in cottage cheese production by increasing the ratio of dressing to curd and using less costly or more functional ingredients. With each such change or innovation, new challenges are encountered to maintain or assure consistent flavor, texture, and appearance attributes.

A prime example of an innovation that has not necessarily enhanced product quality has been the introduction of automated curd washing and draining

equipment. The increase in particle fines and broken curds retention has led to the vast majority of cottage cheese exhibiting markedly higher levels of less appealing shattered curd. In turn, this results in inconsistent dressing absorption and more visual defects in final product appearance and texture. The additional use of functional ingredients – such as cottage cheese acid whey permeate to help with minimizing cottage cheese whey disposal, improve dressing adsorption, and reduction of stabilizer costs – also leads to additional flavor defects. By contrast, the benefits of producing cottage cheese with longer shelf life periods (especially with CO_2 incorporation into dressing) and extension of yields through solids (fines) retention have helped the industry in several ways.

The future success of the cottage cheese industry will require continued development of better manufacturing methods to make this product more consistent and economical, while maintaining optimal flavor, texture, and appearance. The ability of cottage cheese industry personnel to recognize and identify the resulting defects and apply possible remedial measures will be more important than ever to expand the cottage cheese market.

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