SENSORY EVALUATION OF MILK & DAIRY PRODUCTS
FLAVOR AND ODOR DEFECTS IN MILK
(AND OTHER DAIRY PRODUCTS)

Good quality milk should have a pleasantly sweet and clean flavor with no distinct aftertaste. Because of the perishability of milk and the nature of milk production and handling procedures, the development of off-flavors/odors is not uncommon. To prevent flavor/odor defects in milk, proper milk handling procedures from the farm to the consumer are essential. This guideline will describe the common flavor and odor defects found in milk and their potential causes. These defects may be classified according to the ABC's of off-flavors:

Absorbed/Transmitted
Bacterial/Microbial
Chemical/Enzymatic/Processing

Absorbed -- feedy, barny, cowy, weedy, unclean, lacks freshness, stale, refrigerator/cooler odors.

Raw or pasteurized milk products can absorb flavors during production, storage and distribution. On the farm, off-flavors can be absorbed, or more correctly transmitted, through the bloodstream of the cow from the lungs and/or rumen into the milk in the udder (e.g., onion/garlic, feedy, barny, cowy). Similar off-flavors may be absorbed into the milk during farm storage if ventilation is poor and the milk is not protected. Pasteurized milk can absorb flavors during refrigeration storage, especially in paperboard or low barrier cartons. Examples of off-flavors that might be absorbed include volatile compounds of fruits or vegetables or unclean odors associated with poorly cleaned milk coolers. Absorption of flavors by packaged milk can occur at the plant, in the supermarket or in the consumers' home refrigerators.

Bacterial -- acid, bitter, malty, lacks freshness, unclean, fruity/fermented, putrid and rancid.

Bacterial and other microbial (i.e., yeast or molds) off-flavors result from the growth of microorganisms that are present in milk due to poor sanitation and/or milk handling practices. Bacteria that are able to grow at refrigeration temperatures (≤45°F/7.2°C), or *psychrotrophic* bacteria, are most often responsible for spoiling refrigerated milks. The type of spoilage (e.g., fruity, rancid, acid) depends on the predominant type(s) of bacteria present and generally occurs when bacterial numbers (i.e., Standard Plate Count) exceed one to ten million per milliliter. The time it takes for bacteria counts to reach spoilage levels depends on the initial numbers of bacteria and the temperature of storage; the warmer the storage temperature, the quicker bacteria grow and produce off-flavors and the shorter the shelf-life. If the raw milk quality is good and post-pasteurization contamination is prevented during processing, the numbers of microorganisms should not reach spoilage levels before 14-21 days when milk is held under proper refrigeration. Bacterial and other microbial defects can occur in raw or pasteurized milk and in other dairy products.

Chemical -- cowy (ketosis), salty, rancid, bitter, oxidized, sunlight, foreign, astringent, medicinal, flat, cooked.

Chemical and enzymatic defects can occur in both raw and pasteurized milk. The cows may be suffering from ketosis (rare) or mastitis, which can affect milk flavor. Abusive handling of raw milk may result in a rancid flavor from the action of the naturally occurring lipase enzyme, which breaks down butterfat to free fatty acids (i.e., butyric acid is perceived as "rancid"). Oxidized flavors can be induced by heavy metals, particularly copper, or by exposure to sunlight and fluorescent lights. Chemical or foreign off-flavors can also occur due to contamination with cleaning chemicals, sanitizers, medicines, or other substances during production or processing. Processing parameters, if not managed properly, can result in off-flavors including cooked (from high heat) or flat (from added water).

A complete description of the characteristics of milk defects & guidelines for milk judging & scoring follows.

**Adapted from *Milk Flavor & Quality* (1984) by D.K. Bandler & S.E. Barnard and Bodyfelt et al, *The Sensory Evaluation of Dairy Products*.
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CHARACTERISTICS OF MILK OFF-FLAVORS

Typical Milk No criticism. Very little distinct odor, pleasantly sweet and clean with no aftertaste.

Acid Basic taste sensation. Sour, tart, may cause tingling sensation on tongue. "Cultured milk" or "sour" odor may be present.

Cause - Growth of lactic acid producing organisms such as *Lactococcus lactis*, due to poor refrigeration, especially when temperatures exceed 70°F (21°C). "Malty" milks may be acid also.

Astringent Peculiar mouth-feel, tongue & mouth lining feel shriveled, puckered, chalky (e.g., cranberry juice).

Cause - Associated with denatured proteins due to high heat treatments or with staleness (e.g., milk powder). May be more pronounced in skim milks and in Ultra High Temperature (UHT) or Ultra-Pasteurized (UP) products. Occasionally occurs with slight rancid, bitter or acid milk.

Barny Unpleasant odor and taste of a poorly maintained barn or unpleasant feed. May be perceived as "unclean." "Cowy" or "cow's-breath" may present a similar defect but generally with an unpleasant medicinal or chemical (i.e., acetone) aftertaste.

Cause - absorbed, transmitted odor/flavor due to cow inhaling barn odors associated with poor ventilation and unclean barn conditions. Similar defect may be due to ketosis in cows, but with more of a medicinal or chemical after taste (see cowy).

Bitter Basic taste sensation. Pure bitter has no odor. Taste sensation is detected on the tongue after expectoration (delayed) and tends to persist. (e.g., hops in beer, coffee may be bitter)

Cause - enzymatic breakdown (microbial or milk enzymes) of milk proteins to short bitter peptides. Certain weeds ingested by cows may also cause bitterness although this is rare.

Cooked Note odor and flavor. Varies in intensity from sweet, pleasant, with slight sulfurous or custard notes, to caramelized or cabbage-like, which may be objectionable. Flavor usually becomes less intense over time but may persist depending on packaging material.

Cause - Higher pasteurization temperatures and/or longer holding times. Intensity depends on the severity of heat treatment. Cooked flavors tend to be more pronounced in batch-pasteurized than HTST milk; most pronounced in Ultra High Temperature (UHT) or Ultra Pasteurized (UP) products.

Cowy Unpleasant odor & flavor; "acetone" or "cow's-breath"; unpleasant medicinal or chemical aftertaste.

Cause – metabolic disorder in cows such as acetonemia or ketosis. Rare in commingled bulk supplies. Similar defect may be transmitted/absorbed odors of poor barn conditions (i.e., barny).

Feed Odor & flavor is characteristic of associated feed; silage, hay, grassy, etc. Can be slightly sweet, generally not unpleasant, although could be unclean when strong or feed quality is poor. Most feed flavors clear up readily after milk is discharged from mouth. Common, though most often slight.

Cause - cows consume particular feed or inhale feedy odors prior to milking; transmitted to the milk. Feeding should be done after milking when practical, barns should be well ventilated.

Flat No odor. Lacks mouth-feel, flavor fullness, and/or sweetness of fresh milk. Watery characteristic.

Cause - adulteration with water or low milk solids content. Older milk may be "flat."

Foreign May have odor and/or flavor that is not commonly associated with milk. Often "chemical" in nature. Depends on causative agent; sanitizers, detergents, exhaust fumes, cow medications, citrus fruits, etc. Chloro-phenol compounds may give "medicinal" or "bandage-like" flavor.

Cause - Contamination of milk with foreign substance. May be direct contamination of the milk (e.g., udder ointment/chemical sanitizers, phenols/chlorine); may be transmitted through the cow or absorbed during raw storage or through retail packages in plant, store or home refrigerators.

Fruity/ Fermented Odor and flavor is usually pronounced, similar (*not exact*) to pineapple, apple, strawberry or other fruit (*fruity*); may have more of a sauerkraut or vinegar-like odor or flavor (*fermented*).

Cause - growth of psychrotrophic spoilage bacteria, especially certain psychrotrophic *Pseudomonas* species or some of the spore-forming organisms (e.g., *Bacillus, Paenibacillus*).

Garlic/Onion Characteristic pungent odor and flavor. Highly objectionable.

Cause - Animals ingesting wild onion or garlic weed; may also be absorbed through packaging during refrigeration storage with onion or garlic containing foods.

Lacks-Freshness Lacks fine, pleasing flavor. Mild off-flavor that lacks specific characteristic to make identification easy. May be "stale" or less sweet (e.g., "flat"). Generally not intense enough to fail product.

Cause - Usually due to age, staleness, residual milk enzymes or initial stage of microbial spoilage (e.g., psychrotrophic bacterial off-flavors such as unclean, bitter and rancid).

Malty Malt-like aroma or taste (like malted milk or Grape-Nuts®). May be similar to feed or cooked odors, but is considered a severe defect as microbial spoilage. Milk often is acid as well.

Cause - Growth of *Lactococcus lactis* var. *maltigenes* (or possibly other organisms) due to poor refrigeration. May be followed by "acid" or "unclean" flavors.

Oxidized / Light-Induced Odor and taste of burnt-protein, burnt-feathers, or medicinal or plastic-like taste. May progress to metallic or lipid oxidized type flavor due to fat oxidation.

Cause - exposure of milk to sunlight or fluorescent lights resulting in protein degradation and/or lipid oxidation. Milk in unprotected or transparent milk jugs/bottles is more susceptible although this defect may occur in paper packaging if the light is intense and exposure time is sufficient.

Metallic-Oxidized Wet cardboard, oily, tallowy, chalky, or fishy flavor. Odor (old veg. oil) is pronounced when defect is intense. May have a lingering greasy or puckery mouth-feel. Sensation comes quickly.

Cause - milk fat oxidation catalyzed by copper or certain other metals contacting milk (e.g., copper pipe, white metal, metallic water supply). May be associated with raw milk of cows fed high fat feeds (e.g., soybeans) and/or lack of antioxidants (e.g., vitamin E). Sometimes occurs spontaneously. Raw or cream-line milk is more susceptible than pasteurized homogenized.

Carton/ Paperboard Plastic-like or wet paper flavor. Subtle, rarely pronounced unless there is evidence of carton burning during the sealing process.

Cause – associated with paper-board packaging with heat used to seal HDPE polymer coating. Generally more apparent in half-pints due to increased package surface area to volume ratio.

Rancid Pungent odor when extreme. Taste soapy, unclean, bitter, blue cheese-like or "baby vomit." Provolone cheese has a rancid flavor profile. Pronounced lingering aftertaste. Sensitivity varies.

Cause - free fatty acids (e.g., butyric acid) released from milkfat by natural or microbial enzymes (lipase). In raw milk it's associated with excessive agitation, temperature abuse or cow factors (e.g., poor health and/or nutrition). Pasteurization destroys natural enzyme (lipase), but spoilage microorganism may have similar enzymes that cause rancidity.

Salty Basic taste sensation. No odor. Generally easily detected. Clean mouth-feel.

Cause - associated with late lactation or mastitic cows. Would be rare in bulk supplies.

Unclean Unpleasant odor and taste. Mouth fails to clean up after expectorated. Suggestive of mustiness, putrid, "dirty dish-rag" or other "unclean" flavors.

Cause - generally due to growth of spoilage microorganisms in milk or on excessively dirty equipment. Can occur due to milk absorbing odors from dirty coolers or environment.

SENSORY EVALUATION OF MILK
JUDGING AND GRADING MILK

The sensory judging of milk for the general purpose of quality and shelf-life evaluation is most often performed under the established guidelines of the American Dairy Science Association (ADSA). Milks are scored on a scale of 1-10 based on the severity of perceived defects, if present. Suggested scoring guidance based on defect severity is included in this document along with a scoring/judging form.

Condition of the Evaluator:

Judging Condition. Evaluators should be in correct physical and mental condition and free from distractions (e.g., hunger, conversation). Panelist should be clean and free from significant odors. Perfumes, colognes or heavy scented deodorants or soaps should be not be used. Health factors, such as colds or sinus conditions, that may interfere with or influence taste and smell, should be noted on the score sheet. **Evaluators should refrain from smoking, eating or drinking beverages other than water at least one half hour before judging milks.**

Conditioning the Palate. Defect-free milk (i.e., a control sample) is useful for conditioning the palate before and as a reference while evaluating test samples.

Evaluation Procedure:

Temperature. Milks should be **tempered to 60 - 70°F** (15 – 21°C) to allow the release of odors and flavors. If milk is tasted cold or too warm due to circumstances beyond your control, note this on the score sheet.

Note Appearance. After milk has tempered **swirl the cup** and **observe for signs of coagulation and film formation**. If coagulated or otherwise visually unacceptable, check the appropriate criticism box and put **NT** (not tasted) in the sample score box.

Note Odor. Swirling leaves a thin film, which allows volatile compounds to evaporate. Immediately after swirling milk, **hold the cup up to your nose and remove the lid while inhaling**. Milks with objectionable odors do not need to be tasted. Note the perceived odor in the appropriate criticism box and put **NT** (not tasted) in the sample score box.

Taste the Milk. **Take a generous sip of milk -- roll it in your mouth -- note the flavor sensation and expectorate**. **Do not swallow the milk**. Flavors can be enhanced by drawing in a breath of fresh air through the mouth followed by a slow exhale through the nose.

Rinse with Water Between Samples when Needed. Rinse with water as the situation warrants. The mouth should always be rinsed after a severe defect. Fresh, unsalted crackers may be used to cleanse the palate.

Scoring Milks:

The ADSA scoring guide and a sample score sheet follow.

Criticisms. Where defects are noted, mark the appropriate defect box on the score sheet with the intensity of the defect as follows:

S = Slight; **D** = Definite; **P** = Pronounce

Flavor Score. Use the suggested ADSA Scoring Guide to determine the overall flavor score of the milk based on the intensity of the defect. Scoring should reflect the overall acceptability of the milk as follows:

Excellent	9 - 10
Good	8 - 9
Fair - Good	7 - 8
Poor/Unacceptable	less than 6

The American Dairy Science Association Guide for Scoring Off-Flavors in Milk.

	Intensity of Defect & Corresponding Score[a]		
Flavor Criticisms	Slight	Definite	Pronounced
Acid	3	1	0
Astringent	8	7	6
Barny	5	3	1
Bitter	5	3	1
Carton/Paperboard [b]	9	8	6
Coagulated [b]	0	0	0
Cooked	9	8	6
Cowy	6	4	1
Feed	9	8	6
Fermented/Fruity	5	3	1
Flat	9	8	7
Foreign	5	3	1
Garlic/Onion	5	3	1
Lacks Freshness	8	7	6
Malty	5	3	1
Oxidized – Light	6	4	1
Oxidized – Lipid	5	3	1
Rancid	4	1	0
Salty	8	6	4
Unclean	3	1	0
Other			

Source: American Dairy Science Association, 1987 (Adapted from Bodyfelt et al, 1988. *The Sensory Evaluation of Dairy Products*, Van Nostrand Reinhold, NY).

[a] Normal Range is 1-10. "No Criticisms" is assigned a score of "10"

Excellent	9 - 10
Good	8 - 9
Fair - Good	7 - 8
Poor/Unacceptable	Less than 6

[b] Criticisms not included in original ADSA guideline.

MILK JUDGING SCORE CARD

Name: **Date:**

Sample Code										
Overall Score										
Acid										
Astringent										
Barny										
Bitter										
Carton/Paperboard										
Coagulated										
Cooked										
Cowy										
Feed										
Fermented/Fruity										
Flat										
Foreign										
Garlic/Onion										
Lacks Freshness										
Oxidized – Light										
Oxidized – Lipid										
Rancid										
Salty										
Unclean										
Other (describe)										
Notes:										

Mark the intensity of the perceived defect in the corresponding box and score accordingly (use ADSA Scoring Guideline, considering overall acceptability of the milk):

S = slight
D = definite
P = pronounced

Overall Score: 10-9 = Excellent; 9-8 = Good; 8-7 = Fair; Less than 6 = poor/unacceptable

CHOCOLATE MILK JUDGING SCORE CARD

Name: **Date:**

Sample Code/ID										
Overall Score										
Appearance& Flavor Aroma										
Non-Uniform Appearance										
Cocoa Sedimentation										
Cream Separation or Particles										
Lighter Color*										
Darker Color*										
Stronger Chocolate Aroma*										
Weaker Chocolate Aroma*										
Atypical Aroma (describe)										
Body & Flavor Profile										
Thinner Body*										
Thicker Body*										
Atypical Body (describe)										
Stronger Chocolate Flavor*										
Weaker Chocolate Flavor*										
Atypical Flavor (describe)										
More Sweet*										
Less Sweet*										
Flavor/Visual Defects										
Bitter										
Cooked										
Fruity/Fermented										
Foreign, Chemical										
Rancid										
Unclean										
Coagulated										
"Bandage"/Phenolic										
Other (describe below/back)										
Notes:										

Mark the intensity of the perceived defect in the corresponding box and score accordingly: **S** = slight, **D** = definite, **P** = pronounced. **Attributes with asterisk (*) should be evaluated as compared to a reference sample**. Atypical aroma, flavor or body or **o**ther defects should be described. Overall Score: 10-9 = Excellent; 9-8 = Good; 8-7 = Fair; Less than 6 = poor/unacceptable