



## A 100-Year Review: Sensory analysis of milk<sup>1</sup>

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### ABSTRACT

Evaluation of the sensory characteristics of food products has been, and will continue to be, the ultimate method for evaluating product quality. Sensory quality is a parameter that can be evaluated only by humans and consists of a series of tests or tools that can be applied objectively or subjectively within the constructs of carefully selected testing procedures and parameters. Depending on the chosen test, evaluators are able to probe areas of interest that are intrinsic product attributes (e.g., flavor profiles and off-flavors) as well as extrinsic measures (e.g., market penetration and consumer perception). This review outlines the literature pertaining to relevant testing procedures and studies of the history of sensory analysis of fluid milk. In addition, evaluation methods outside of traditional sensory techniques and future outlooks on the subject of sensory analysis of fluid milk are explored and presented.

**Key words:** sensory analysis, flavor, fluid milk

### INTRODUCTION

Sensory evaluation is critical for every application of milk. It is necessary to understand the sensory qualities of milk in part because of the widespread familiarity of fluid milk and its typical sensory profile. Sensory evaluation of the flavor or at least the aroma of raw milk can identify handling or production problems before milk is processed. In the processing and preparation of commercial milk products, fluid milk may be exposed to multiple unit operations at varying temperatures. In turn, sensory evaluation of the finished milk product helps identify deviations in processing or handling. In many cases, the deviation of quality may not be significant day-to-day changes but rather a drift over time, which requires frequent sensory evaluation and strong

documentation of evaluations to successfully address areas of concern.

Though formal sensory analysis as we know it today is a relatively new practice, sensory measures of food quality have been practiced and documented throughout history (see Appendix Table A1). As early as the 1800s, studies focused on understanding human psychometrics (the study of quantitatively explaining human perceptions and decision making) and psychology as well as the statistical relevance on which those stimuli should be judged (Fechner, 1860; Thurstone, 1931). Eventually, those theoretical practices gave way to a practical desire for understanding consumer perceptions, especially as they applied to food. By the 1940s, affective consumer testing approaches, in conjunction with the US Army Corps of Engineers' 9-point hedonic scale methodologies for measuring acceptability (Peryam and Pilgrim, 1957), had become a regular practice among many US food companies. Sensory evaluation of milk traditionally has been based on the identification of off-flavors or defects. The dairy product scorecard for fluid milk quality, which was based on defect identification, was first proposed by the Federal Dairy Division in the early 1900s, although several scorecards relating to milk handling and cleanliness were in circulation well before (North, 1917; Harding, 1921). Newer mainstream sensory approaches have been applied to fluid milk research and investigations into predicting and preserving acceptable milk quality. This review addresses a holistic view of the sensory history of fluid milk as well as the constituents, processes, and other factors that have contributed, and continue to contribute, to the sensory properties of fluid milk.

### SENSORY EVALUATION TECHNIQUES

#### Quality Judging

The first standardized method for the sensory evaluation of dairy products was dairy product judging and the American Dairy Science Association (ADSA) scorecard system (Clark and Costello, 2008). As branding became an established concept in the early 20th century, companies began to turn to officially recog-

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**Table 1.** Undesirable flavors in milk, 1934<sup>1</sup>

Defect	Description
Barny, cowy	Conveys the suggestion of an unclean, poorly ventilated cow stable
Bitter	Associated with milk from cows far advanced in lactation
Cardboard	Resembles freshly dampened cardboard
Cooked	Suggestive of boiled milk; results from improper pasteurization
Disinfectant	Differs by disinfectant
Feedy, silage	Characteristic cleanliness after expectoration distinguishes feedy from barny and cowy flavors
Flat, watery	A reference may be made by adding water to a sample of milk
Garlic, leek, onion	Characterized by intensity and offensiveness
Lacking richness	Sufficient flavor but lacking in creamy smoothness and exhibiting slightly greater sweetness; found in milk from which butterfat has been removed
Malty	Malty, walnut, or maple flavor, which may be attributable to the action of microorganisms
Metallic	Puckery feeling obtained when a piece of tinfoil or new metal is rotated within the mouth
Musty, stale	Suggests a damp, moldy, poorly ventilated cellar
Rancid, strong	Undesirable; often sour, soapy, or bitter
Salty	Associated with milk from cows far along in the lactation period or cows with mastitis
Sour	Detectable by odor sooner than taste due to fermentation
Unclean	Characterized by an unclean, unpleasant, and unwholesome aftertaste

<sup>1</sup>Data from Nelson and Trout (1934).

nized standards of quality to promote their quality to consumers. In 1917, when the first National Collegiate Dairy Products Evaluation Contest was held for milk, a USDA-developed, ADSA-approved scorecard was used that considered flavor as well as bacterial content, sediment, temperature, acidity, and bottle and cap appearance (Clark and Costello, 2008). In addition to the ASDA scorecard system, several other scoring systems were used in the 1920s and 1930s, and there was often debate within the industry about how scorecards should be used. By the early 1930s, the ADSA scorecard had become the standard scorecard for judging fluid milk (Nelson and Trout, 1934; see Table 1).

Traditional quality judging techniques are defect oriented and use 1 or 2 trained judges to document defects rather than profile the intensities of sensory attributes. By this approach, a large number of samples can be rapidly screened for recognized sensory defects. Early sensory studies on milk used quality judging techniques because better techniques were not yet available (Weaver et al., 1935; Hening and Dahlberg, 1939; Kratzer et al., 1987). These tests were designed to link a designated sensory defect with a specific root cause. Quality judging techniques are useful for on-the-spot evaluations of quality in industrial settings and for judging dairy competitions, but they are of limited utility for research for numerous reasons that have been reviewed previously (Drake, 2004, 2007; Alvarez, 2009). The modern ADSA milk and cream scorecard grades milk on a 0-to-10 scale, placing milks into categories of excellent (10), good (7–9), fair (4–6), poor (1–3), and unacceptable (0; see Table 2; Alvarez, 2009). Points are deducted for specific defects and their perceived intensities. In cases where a milk sample exhibits multiple

defects, it typically is assigned a flavor score based on the most serious defect (Alvarez, 2009).

Many of the sensory defects found on the modern scorecard have remained unchanged from the 1934 version, although some changes have been made. Due to modern dairy sanitation measures, cowy, barny, and unclean flavors are rarely found in samples to be judged and therefore are not usually printed on the scorecard, and musty/stale has been removed as a defect entirely. Astringent, a defect added after 1934, is also rarely encountered and not usually printed (Alvarez, 2009). Cardboard and disinfectant attributes have been removed from the scorecard and are now considered part of the defect foreign, a defect term used to refer to atypical off-flavors or aromas from varied sources not commonly found in milk. The metallic defect has been clarified as metal oxidized, and light oxidized has been added as a defect. The defect cooked, once perceived as a severe defect before the widespread pasteurization of milk, is now viewed with far less criticism (Alvarez, 2009). When dairy judging contests first began, raw whole milk was evaluated. Eventually, pasteurized whole milk and, subsequently, pasteurized 2% milk replaced raw whole milk in dairy judging contests (Clark and Costello, 2008). Lacking richness, a defect from the 1934 scorecard associated with skim milk, has been removed from the modern scorecard, perhaps due to the change to evaluating reduced-fat milks instead of whole milks. Flat, a term on the current scorecard, was added to recognize the rare adulteration of milk with water.

Descriptive sensory analysis, developed in the 1950s, has slowly replaced quality judging techniques for all published research due to its versatility, specificity, and statistical robustness. Descriptive analysis uses

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