



# THE SENSORY EVALUATION OF DAIRY PRODUCTS

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# THE SENSORY EVALUATION OF DAIRY PRODUCTS

# Preface

Three different methods are available for tracing causes of sensory problems in dairy foods: (1) chemical procedures, (2) microbiological tests, and (3) sensory evaluation. The simplest, most rapid, and direct approach is sensory evaluation. A food technologist trained and experienced in flavor evaluation of dairy products has an “edge” on someone who is competent only in performing the chemical and/or microbiological methods. Correct diagnosis of the type and cause(s) of a serious sensory defect is a prerequisite to application of remedial measures in production, processing, and distribution steps.

For dairy processors, the most important requirement of a comprehensive quality assurance program is careful flavor evaluation of all dairy ingredients. Based on sensory judgments, occasionally some milk, cream, or other dairy ingredients may require rejection. An important premise of the dairy industry is: “dairy products quality can be only as good as the raw materials from which they are made.”

In this book, the authors have attempted to present a reasonably complete overview of the sensory evaluation of most of the major commercial dairy products in the United States. Furthermore, the authors have de-emphasized the terms “judging” and “scoring” in favor of the more contemporary terms “flavor” or “sensory evaluation.” The latter terminology is more reflective of the marked progress made in relating flavor perception to the areas of sensory panel methodology, statistics, human behavior, psychology, and the psychophysics of human sensory perception.

This book is intended to serve as both a text and a general reference for students, production and quality assurance personnel in industry, and others interested in the sensory characteristics of the principal dairy products of the United States and Canada. The early chapters review the historical basis of relying on “flavor experts” or “judges” to critique the sensory characteristics of various dairy products, the fundamentals of human sensory perception and an overview of the sensory characteristics of dairy products. Subsequent chapters provide a description of various sensory defects, their causes, and remedial steps to minimize or eliminate their occurrence in fluid milk, frozen dairy

desserts (ice cream), cultured dairy products, cheese, butter, and concentrated milk products. The final two chapters guide coaches or instructors through the preparation of samples for instructional purposes and provide an overview of sensory panel methods.

In preparing this edition, the two senior authors have attempted to reflect their philosophy and instructional techniques in conveying the "knack of how to recognize" and describe the sensory shortcomings of dairy foods. The reader should recognize that a clear distinction exists between the concepts of "quality," "preference," and "acceptability." The primary aim of this book was to treat the subject of sensory quality.

Since publication of the previous edition of this book, under the title *Judging Dairy Products* (Nelson and Trout), the definitions of many dairy products have appeared in the U.S. Code of Federal Regulations (CFR). If product quality is perceived as the absence of sensory defects, the consequences of compositional changes of dairy foods (as introduced or changed by CFR specifications) need not be reflected in quality changes. However, certain product characteristics may change as the result of formulation alterations. For instance, reduction of the milkfat content of ice cream from 12% to 10% certainly could affect the product's sensory and hedonic characteristics without affecting quality. In defining various dairy products, reference has been made to the Code of Federal Regulations throughout the book. The reader is cautioned that since changes in the CFRs may occur at any time, only the latest edition of this official document should be consulted for purposes of legal compliance.

Technological progress has all but eliminated many of the sensory defects of milk products reviewed in previous editions; hence, those product shortcomings no longer require much "attention" in the current edition. Some flavor descriptors or terms have continued in use over the years more by habit than due to logic. A better understanding of the causality of certain defects suggests that a different or "advanced" terminology is appropriate. In this edition, an effort has been made to bridge the traditional terminology with more advanced knowledge of the defects. By necessity, this transition must be gradual, to preserve our ability to accurately communicate the sensory properties of dairy products.

For many of the dairy products discussed in this book, various quality standards have been cited in either the appropriate chapter or the appendices. The appendices also include information on milk sampling and grading, examples of some additional dairy products score cards, and selected tests for quality monitoring.

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From 1934 to 1965, when the first four editions of this book were published under the title *Judging Dairy Products*, the first author was the late Dr. John A. Nelson, Professor of Dairy Industry, Montana State College, Bozeman, Montana. Although his name has been omitted from the present revision, the authors are profoundly aware of his pioneering contributions to the unique and very successful early treatment of this subject matter.

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# The Development of Dairy Products Evaluation

The senses of smell and taste have always been used for guidance in our selection of food and beverages. The ability to discriminate between desirable and undesirable foods is apparently as old as the human race.

The selection of dairy-based foods that possess desirable flavor, particularly milk, butter, and various cheeses, dates back to the early use of these products in the U.S. Early American agricultural writers apparently recognized that the consumption of dairy products depended primarily upon their flavor characteristics. These writers cautioned dairymen concerning certain feeding and milk handling practices if a high quality dairy product was to be obtained. For example, Deane (1797) advised: "In feeding milch cows, the flavour of the milk should be attended to, . . . Feeding them with turnips is said to give an ill taste to the butter made of the milk."

## EARLY HISTORY OF DAIRY PRODUCT EVALUATION

Displays of butter and cheese at fairs, exhibitions, and agricultural society meetings played an important role in the development of a consciousness of the quality of dairy products in the United States. However, not until the latter part of the nineteenth century did the grading of dairy products receive national and international attention. The establishment of product grades (with their attendant score cards), as well as standards for various dairy products, has paralleled quite closely growth of the dairy industry and development of dairy product markets.

Although the early dairy industries departments of U.S. agricultural colleges emphasized and taught the merits of quality in dairy products, it was not until 1916 that the first Students' National Contest in Judging of Dairy Products was held. In the first contest, butter was the

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only product judged, but the following year both Cheddar cheese and milk judging were introduced. Vanilla ice cream was evaluated in collegiate judging competition for the first time in 1926. Cottage cheese was added in 1963 and Swiss-style strawberry yogurt was introduced to the contest in 1977.

The International Collegiate Dairy Products Evaluation Contest, its current name, has been held annually from 1916, with the exception of 1918 and 1942 to 1946, inclusive, due to World Wars I and II (Trout *et al.* 1939, 1981). As many as 33 teams of 3 people each have participated in this international contest in a given year. This program has been most effective in helping provide the dairy industry with better-qualified personnel throughout the years. These students enter the dairy and food industry with developed skill levels and a basic knowledge of what constitutes quality in dairy products.

### ESTABLISHMENT OF BRANDS AND TRADEMARKS

Basic and applied food research continues to play an important role in development of the U.S. dairy industry. During the past three decades, attention has been focused on the palatability of dairy products, with



**Fig. 1.1.** The Danish "Lur Brand" has become a widely recognized benchmark of quality for various dairy products, especially butter.

particular research directed toward the improvement and stability of dairy products' flavors. This research has given significant impetus to the evaluation and grading of dairy products.

The beginning of the twentieth century marked the establishment of brands and trade names for dairy products, particularly butter and cheese. This development necessitated recognition of set standards of quality by the manufacturer and the subsequent need for grading of finished products by an experienced, competent judge. Some brands of dairy products have become widely known and touted for their high quality. For example, the Lur mark for high-quality Danish butter (Fig. 1.1), instituted in 1906, has become perhaps the most famous export butter trademark. The Iowa trademark for butter (Fig. 1.2), adopted in 1915, was based upon specific quality factors that were established for the product, and also upon sanitary conditions and manufacturing methods within the plant (Iverson, 1942). While the Lur brand is still prominent in the international and domestic trade of Danish butter, the Iowa trademark has lost its market significance, and has succumbed to federal consumer grades established by the United States Department of Agriculture (Fig. 1.3).

Land O' Lakes Creameries, Incorporated, of Minneapolis, MN, established the Land O' Lakes brand of butter which is also based upon high quality. Likewise, Sealtest, Inc., a subsidiary of Kraft, Inc., has established the Sealtest brand for high-quality dairy products, primarily ice cream and milk. Many regional and national firms offer individual brands of dairy products which are readily recognized by the public based on the high standards of sensory quality. Official USDA product grades, though attached to many private labels, enjoy prominent significance when seen on butter, cheese, and nonfat dry milk (Fig. 1.4).



Fig. 1.2. The "Iowa Butter" trademark, adopted in 1915, served as a vital factor in helping establish quality butter in the U.S.

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**Fig. 1.3.** Examples of the grading and inspection marks (shields) of the Food Safety and Quality Service, U.S. Department of Agriculture: A—Graded products packed under USDA inspection; B—Graded products processed and packed under USDA inspection; C—Inspected products processed and packed under USDA quality control service (when there are no U.S. grade standards for the product).



**Fig. 1.4.** Examples of brands and trademarks of dairy products of regional or national significance in the U.S.

## THE IMPORTANCE OF DAIRY PRODUCTS EVALUATION

While dairy products can be analyzed for chemical composition, microorganisms, vitamin content, enzymatic activity, color, physical properties, and so forth, these determinations do not measure the true or actual "eating quality" of a product. Two samples of butter may have identical chemical composition, color, firmness, and spreadability; however, one sample may be highly relished by consumers, while the other product may leave a poor impression. A dairy food that is liked or preferred by a majority of consumers is considered to have good "eating quality." Butter of good to excellent quality generally conveys the impression of being clean, creamy, aromatic in flavor, and seems distinctly fresh and appetizing, whereas the sample that left a poor impression may be stale, rancid, oxidized, fishy, or have some other objectionable off-flavor.

Establishing the "eating quality" of a dairy product requires the application and "correct" interpretation of such sensations as mouthfeel, taste, and smell. The alert consumer experiences these "components of flavor" when the product is taken into the mouth. Although the essential parameters that constitute the "eating quality" of dairy products cannot be easily measured, either chemically or physically, they can be determined by using sensory evaluation techniques, such as those used by competent judges or trained panelists (Bodyfelt 1981).

The judging and grading of dairy products has received continuous attention due to: (1) increased consumer interest; (2) the interest of processors who prefer to sell their products on the basis of grade; and (3) the purchase of certain dairy products by the federal government (Nelson and Trout, 1964). Anyone engaged in the production, manufacture, sale, and purchase of dairy products should have some interest in how the grades for these products are established, updated, or revised as technology and consumer preference may dictate.

## THE SEARCH FOR EXCELLENCE

Milk producers, who are co-partners with dairy products manufacturers in establishing a demand for uniform quality dairy products, should recognize that *dairy products cannot be of higher quality than the raw material from which they are made*. Without definite knowledge as to what constitutes desirable and undesirable flavors in finished products, successful production of high-quality raw material is

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more difficult. Unfortunately, milk flavor quality receives too little attention from most producers. Dairy producers should have a better understanding or awareness of the flavor demands and preferences of consumers. A knowledge of the relative importance of certain off-flavors and the various desirable flavors, plus specific methods of minimizing or eliminating objectionable off-flavors, should enable the production of milk that can be made into high-quality finished products. Such efforts should enhance dairy product sales.

Every enterprising dairy processor has, or should have, the desire to produce products of high quality. The ability to prevent certain objectionable off-flavors and manufacturing defects, and to recognize desirable flavors and product acceptance characteristics, enables processors to manufacture products that better meet consumer demands. A manufacturer who sells dairy products on the wholesale market should know product grades and be familiar with the flavor properties and workmanship required to meet the various grades. The manager who understands market demands and who has the ability to consistently select the grade or quality level desired by certain markets, will discover that his or her products, because of uniformity, meet with ready sale. During production shortages, dairy plant managers must occasionally purchase dairy products on the open market or from nearby plants to be sold as their own product. In such instances, the ability to discern quality or detect certain undesirable flavors is indispensable.

Consumers are interested in obtaining knowledge which will enable them to buy dairy products more intelligently. This knowledge includes an awareness of the product defects that may occur, the desirable and undesirable qualities of dairy food flavors and the important points in careful selection of high-quality dairy products. This information enables consumers to more wisely and economically purchase the dairy products which comprise an important part of the daily diet in most U.S. homes.

The management of the U.S. dairy foods industry needs to appreciate that increased sales of dairy foods is highly dependent upon the production and distribution of high-quality dairy products. Such products impart a pleasant, delicate flavor sensation to the consumer's palate. For dairy products, *high quality implies a relative degree of excellence.*

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# Principles of Sensory Perception: An Overview

The evaluation of dairy products for flavor is primarily a matter of noting carefully and interpreting correctly a set of sensory reactions after each product is sampled. The ability to critically evaluate dairy products can be learned, if close attention is directed to the delicate senses of smell, taste, touch, and sight with which practically everyone is endowed.

Some observers consider the process of evaluating dairy products to be an art skill. On the contrary, sensory evaluation is more appropriately based upon science. However, attaining proficiency in sensory judgment might best be considered an art skill based upon scientific principles.

This chapter will discuss the sensory physiology (psychophysics) of the human senses and their applications in the sensory evaluation of dairy products.

## **FLAVOR IS THE "VOICE" OF FOOD AND BEVERAGES**

Moncrieff most eloquently summarized the complexity of flavor sensation at an Oregon State University symposium on the chemistry and physiology of flavors (Moncrieff 1967b):

The study of flavor is one of those subjects in which science has never caught up with everyday experience. Mainly, flavor is composed of taste and odor. Hold the nose or even hold the breath, and flavor vanishes in a second; breathe again and it reappears at once. Of the other qualities that enter into it, texture is probably the most important: smoothness or roughness, particle size, solubility, even a glutinous quality can modify flavor. Less usual modifiers of flavor are the hotness of spices such as ginger, the coolness of menthol. Then there are the metallic, alkaline, and meaty tastes. If we are to accept the orthodox view that there are only four true tastes;



sweet, bitter, sour, and salt, then the metallic and alkaline tastes must presumably be accepted as modalities of the common chemical sense.

## SOME FUNDAMENTALS OF SENSORY PHYSIOLOGY

*The Human Senses.* Psychologists generally recognize 22 special senses (or subdivisions) within human beings (Amerine *et al.* 1965). On the authority of no one less than Aristotle, humans supposedly possess five primary senses for perceiving stimuli. They are the familiar senses of sight, hearing, touch, smell, and taste. The latter two senses are considered to be the most primitive (Brown and Deffenbacher 1979, Coren *et al.* 1978). Other human senses include temperature sensation (heat and cold), pain, visceral hunger, thirst, fatigue, sex (drive), and equilibrium (balance). See Table 2.1 for a more complete listing of human senses.

In human beings, at least three different senses respond to specific chemical stimuli: taste, smell, and the so-called common chemical or pain sense. Humans are primarily sight-guided in their search for food, whereas other animals, such as dogs and pigs, are scent-guided. Within humans, smell has a great complexity of qualities and features; in fact, the olfactory membrane compares well in absolute sensitivity with the retina (sight) and the organ of Corti (hearing) (Amerine *et al.* 1965).

*The Sensory Receptors.* As organisms, we experience our environment and many events occurring within our bodies not by direct means, and not in their entirety, but rather through specialized sense organs or sensory receptors. The more familiar of these sense organs are the eye, the ear, the skin as an organ of touch or pressure, the tongue as the organ of taste, and the nose as the organ of smell. Each of these sensory receptor devices responds to a particular range of environmental influences (stimuli) and transmits corresponding information to the brain via the central nervous system (Dudel 1981). In turn, specific sites in the brain are stimulated or energized by the initial sensory input. Up to a certain point, the response of the sensory cells is proportional to the stimulus intensity. Objectively, the response of the nerve is a function of the frequency of the electrical discharge of the nerve; the higher the frequency, the stronger the sensation. Nearly all sensory receptors vary in their sensitivity to stimuli (Amerine *et al.* 1965; Schmidt 1981; Coren *et al.* 1978; and Brown and Deffenbacher 1979).

*Modality, Quality, Stimuli, and Sensory Impression.* A group of similar sensory impressions, mediated by a given organ, is referred to as a