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Sensory evaluation techniques — Make "good for you" taste "good"

Gail Vance Civille, Katherine Nolen Oftedal *

Sensory Spectrum, Inc, 554 Central Ave., New Providence, NJ 07974, USA

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ABSTRACT

Sensory evaluation techniques are frequently used, however applied sensory is most often used within private industry. Basic sensory techniques can be an invaluable aid to research on nutritional or functional benefits of natural products such as whole fruits, nuts and vegetables (through varietal selection, breeding, etc.) in addition to clinical trials of botanicals. Products' sensory properties, including fruits and vegetables, must be tailored to ultimately appeal to the "consumer": no matter how healthy and nutritious a food is, if it does not appeal to its intended end user, it is unlikely to succeed in today's marketplace. This paper outlines the "5 S's" or basic principles of applied sensory testing; Subjects, Site, Samples, Statistics, and Sensory Methods. Two case studies are detailed where applied sensory is used to benefic academic research; one as a clinical trial of broccoli sprout extract, and the second as plant breeding research on strawberries. Finally, more in-depth techniques are discussed so that one can ensure that product sensory properties are aligned with consumer expectations, in other words, that sensory congruence is achieved.

1. Introduction

With the rise in diet-related chronic disease in recent years, private industry and academic institutions alike have focused their research on leveraging nutritional or functional benefits of natural products such as whole fruits, nuts and vegetables (through varietal selection, breeding, etc.) as well as increasing the nutritional quality of processed foods (through fortification, fat, sodium or sugar reduction initiatives, to cite only a few examples. As part of the effort to discover, develop and market healthier products, understanding nutritional and functional benefits is key. Of additional importance is highlighting and refining the products' sensory properties in an attempt to ultimately appeal to consumers: no matter how healthy and nutritious a food is, if it does not appeal to its intended end user, it is unlikely to succeed in today's marketplace.

Used by many industries, sensory evaluation techniques have been shown to be critical in the development, production and quality maintenance of foodstuffs, personal care products, household goods, textiles, pharmaceuticals and even furniture and automobile driving experience. Sensory evaluation is defined as the scientific discipline which encompasses all methods to evoke, measure, analyze and interpret human responses to the properties of foods and materials, as perceived by the five senses: taste, smell, touch, sight and hearing. Specific senses of heightened interest are taste and smell, particularly in their relationship with ingestive behavior. The application of sensory methods to the development of healthy foodstuffs seems a natural fit. This paper gives an overview of sensory evaluation techniques, from established practices to new methods and their applications, with a focus on health.

2. Overview of basic sensory techniques

Sensory evaluation is concerned with the human response to physical stimuli. The sensory process can be simplified as follow: A stimulus (food for example) first hits the mouth, at which point nerve signals are generated, integrated in the chorda tympani and sent to the brain [1,2]. As one individual ingests a sucrose solution, for example, the sucrose molecules bind with the gustatory cells in the taste buds, which generates an influx of information sent to the brain [3]. The brain then processes the information: it organizes, analyzes and interprets the sensations into perceptions [4]. Once the stimulus is recognized, the brain formulates a response. The response might be one of objective identification of the perception: "this is sweet", or one of subjective affective reaction to the stimuli: acceptance or rejection: "I like it/I don't like it", and/or emotional response: "it gives me comfort", "it brings back happy memories of my childhood". Sensory evaluation is concerned with all of these types of responses. It focuses both on the objective measurement of the sensory properties of products (also referred to as "product understanding") and the subjective responses of individuals to physical products (often referred to as "consumer understanding"), as well interpretation of consumer response through understanding the response to product ("linking product and consumer understanding" [5].

* Corresponding author.
E-mail addresses: gvciville@sensoryspectrum.com (G.V. Civille), koftedal@sensoryspectrum.com (K.N. Oftedal).

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2.1. Product understanding

The techniques that measure the product sensation, or product understanding, are considered objective measurements and are either discriminative or descriptive. Discrimination tests answer the question "Are two or more products perceptibly similar or different?". For example, if the objective is to reduce sodium and maintain sensory properties, discrimination is a good method. The most common types of discrimination tests are triangle tests, duo-trio or alternative forced choice [5]. In industry they are commonly used to test for ingredient substitutions when the objective is to maintain product similarity.

Descriptive analysis is another objective sensory technique, and requires a highly trained panel. Descriptive methods document the qualitative and quantitative sensory aspects of a product. The qualitative aspects of products include specific appearance, aroma, flavor or texture characteristics, called attributes. The quantitative aspect is the intensity of each of the attributes. Different descriptive analysis methods differ primarily on their scale usage. The Spectrum™ method is used in the case studies presented, which uses a 15 point scale with ratio properties, where 0 is no detectable amount of attribute and 15 is a high amount [5]. Descriptive analysis is often used when the objective is to determine how samples differ. Two case studies described in Sections 4 and 5 use Spectrum™ Method descriptive analysis.

2.2. Consumer understanding

The second branch of sensory evaluation focuses on the consumer response. These techniques measure the subjective personal reaction of consumers, such as acceptance (liking) or preference. In addition the consumer perception of product performance benefits can be measured such as "comfort", "therapeutic" or "healthy", which may be important to brand identity, product quality or setting up consumers' expectations. Consumer Understanding focuses on measuring the perception of product attributes as filtered through the consumers' screen of expectations. For example if a brown liquid was served to consumers as "cola" but is actually a fine coffee, it would be perceived quite negatively based on the consumer's expectations of cola. The same can be true for benefits; a "healthy shake" will have a different set of expectations by consumers from an "indulgent shake". There are two types of consumer testing; quantitative and qualitative. Testing with consumers for quantitative results requires high numbers of participants (at least $n = 75$) due to the person-to person variability in preferences and physiological sensitivity [5]. During quantitative testing respondents are asked specific closed-ended questions and given a scale in which to rate liking or hedonics. Qualitative consumer testing, such as focus groups or triads, is more discussion-based and generates data that is verbal. Participants are asked open-ended questions and a moderator verbally probes for more depth in response. Qualitative testing often focuses on language to describe products, emotions around products and usage behaviors. Often quantitative testing is used towards the end of the development phase or in product benchmarking within a category. Qualitative testing is used towards the earlier phases in product development and can uncover potential reasons why a product is liked or disliked as well as the emotional links to product sensory characteristics.

3. Basic guidelines for sensory testing

One of the difficulties in sensory evaluation is managing the many sources of variability. Tests should be designed in such a way as to balance controlled testing environments with the high variability that is the reality of normal product consumption. An example can be found in the legal advertising case of Kimberly Clark vs. Procter & Gamble over a dispute in paper towel claims [6]. Kimberly Clark asserted in an advertising claim that SCOTT towels absorb faster than Bounty paper towels, and the implication was that this was true of typical, everyday usage conditions. The exact verbal claim was "SCOTTS unique ridges soak up everyday spills even faster than Bounty towels". Kimberly Clark's absorbency test was based on a visual assessment of a paper towel placed over a 10 mL spill, and allowed to sit over the spill for several minutes. One of the primary criticisms was that "Whole Sheet Pickup Test relies on parameters that are not Consumer Relevant", meaning when a spill occurs in the home, an average consumer will not place one sheet over the spill and allow it to sit for 5 min. In that challenge, P&G won. However, the crux of the case is central to much of modern sensory research. Sensory scientists must design studies that are controlled, reproducible and reasonable, without compromising the relevance to consumer behavior. When designing a sensory test, the 5 S's should always be considered; Subjects, Site, Samples, Statistical Analysis and Sensory Method, which has been discussed in Section 2.

3.1. Subjects

Firstly, are the subjects of the study trained assessors, as in descriptive analysis, or are they untrained consumers? When testing with consumers, it is important to decide the population to which the study is making inferences. The subjects tested should be representative of the population for whom the product is intended. Products that are commonly consumed may be tested with "general population" without strict guidelines on age, gender or brand usage, however with niche products it may be important to recruit individuals of a particular demographics. In addition, with many personal care products such as lotion, skin is needed as a substrate for proper evaluation. It must be decided whether the assessor uses his or her skin, or if a separate individual is required; one as substrate and one as assessor/evaluator. Often with skin-care products the assessor is the same individual as the substrate (self-assessment).

3.2. Site

The second aspect to consider is site or location. Where is the test or assessment taking place? Determine whether the product should be evaluated in the home or can the environment be reasonably re-created in a lab setting. As in the case of Kimberly Clark vs. P&G discussed in Section 3, a laboratory assessment may need to be specially designed to replicate a consumer in-home experience. Fine fragrances and air fresheners can often be evaluated in a laboratory setting using odor booths more consistently than in a home environment. However, in some cases, such as sunscreen, it may be necessary to additionally test in a real-use environment to account for extreme environmental factors. In the case of sunscreen, sunlight, heat and water assault may change product properties that are not present in a laboratory test environment. Food products can be legitimately tested in a controlled environment for early comparisons of ingredient effects on prototypes differences. However, at some time in the product evaluation cycle the researcher needs to test final product options with consumers in both controlled and home environments to reflect better the end use context.

3.3. Samples

What products are you testing? How much control in preparation is needed? Often the study objectives determine the samples, and in the preparation of instant coffee within a controlled laboratory environment, high consistency can be achieved, however it is quite laborious. For a typical evaluation of coffee by an expert panel there are 20 steps in preparation to ensure that each cup of coffee is the same within a sample. A truncated version of the preparation protocol is as follows; heat water, weigh the instant coffee, weigh boiling