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Review Article

Sensory Descriptive Evaluation of Food Products: A Review

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Abstract

Sensory descriptive analysis of food products provides an understanding and control of the key attributes for consumer satisfaction and for market success. The present review describes the main application fields of this technique and the most significant studies. Particularly, it focuses on food quality, nutrition and health fields treating few other areas in which sensory analysis is applied as well. Moreover, the work highlights how, in many cases, sensory evaluation is used in combination with other methods, mostly chemical and microbiological, and how this integrated approach increases its potentialities and improves the quality of the results. The review also underlines how the most recent demand trend of consumers, based on more natural and functional food, led to the need to develop new products, for which a sensory testing phase is highly advised. Consequently, accurate sensory analysis methods have significatively risen in importance.

Keywords: Sensory Analysis; Food Quality; Nutrition; Health

1. Introduction

As simple as the following market rule may sound, if consumers don't like the appearance, flavour or texture of a given food product, they won't buy it. Therefore, the resulting overall sensory experience is crucial for the commercial success of food products. Specific protocols and methods were developed and are now available to measure and estimate consumers' sensory experiences, thus reducing the risk that the product is not acceptable, in a new growing scientific area known as sensory descriptive analysis or sensory descriptive evaluation. It may be defined as an interdisciplinary field including the description, measurement and interpretation of characteristics of the product that can be perceived by senses. Sensory evaluation can be performed through both objective and subjective tests. The first analysis generates as much neutral as possible information,

ideally comparable to data processed through chemical or physical instrumentation. Subjective tests, instead, are based on the personal impressions, such as the final consumers' preference for the considered product. When applied correctly, sensory evaluation allows understanding and control of the key attributes for the success of food products and beverages in the marketplace [1], providing data about consumers' attitudes and perceptions to food industry. In this context, many researches have focused on a further understanding and more specific applications of such techniques [2].

2. Food Quality

Flavour improvement is particularly difficult because assessing a specific phenotype to a given food product is quite a complex task. Moreover, the chemicals driving consumers' preferences are still little understood and further investigation is needed. As a whole, the quality of many food products available to the consumers has generally decreased, and surely agricultural and postharvest technologies contributed to lower it. Recently more and more consumers prefer higher quality and controlled foodstaffs produced in authentic and local areas. Organic products are largely satisfying this demand, leading to a lower environmental impact and higher nutritive characteristics. Organic crops also statistically contain more mineral nutrients and generally have better organoleptic qualities. Furthermore, as globalization progresses, consumers are exposed to a wider variety of foods from different cultures.

As a consequence, investigating traditional or artisanal foodstaffs, is now even more required, to accommodate consumers' growing demands. However, the number of studies conducted on these types of products which relied on good quality sensory testing is limited. A study [3] analysed the volatile organic compounds of three mango varieties for individuating sensory characteristics and differences between these authentic fruits. Another recent investigation consists of a review in which consumer research of culinary specialties is discussed [4].

Treatments during food production processes are relevant in affecting food sensory quality. For instance, the use of hydrogen peroxide resulted to bleach some types of fish, such as carp, which is used in surimi production process [5]. The impact of some pre-fermentation treatments on the profile of volatile compounds and on the organoleptic characteristics of wines were also investigated [6]. Results of the sensory descriptive analysis reported that some of these treatments slightly change the aroma. Another study aimed to analyse non-specific volatile compound profiles coming from SPME-GC (Solid-Phase Micro Extraction and Gas Chromatography) comparing the results to sensory data of a blanc wine co-fermented with different yeasts [7]. Similarly, the relationship between sensory attributes and volatile compounds of Polish dry-cured loin was investigated [8]. The obtained results suggest that smoking process is a critical step during Polish traditional dry-cured loins production.

Furthermore, it is known that modifying processing conditions may strongly affect the food matrix of many products, such as mayonnaise. A specific study was carried out to evaluate how characteristics of the emulsion bring changes to sensory properties of this product, which resulted quite limited, affecting texture, but not influencing appearance, taste and flavour [9]. The packaging phase is also important. For instance, microbial growth is one of the main causes of deterioration of leafy green vegetables and the addition of natural antimicrobial compounds in packaging seems to be a good and safe solution that can inhibit bacteria development and help to preserve quality over time. The

aim of recent studies [10] was to select natural compounds based on their antimicrobial activity and to evaluate their impact on sensory quality of the product. Eugenol, carvacrol, trans-anethole, trans-cinnamaldehyde, and a-pinene were tested against selected pathogens. The achieved results showed that natural antimicrobials can mask off-odours of packaged leafy greens.

Sensory evaluation was often used in combination with instrumental methods, linking chemical techniques based on volatile compounds analyses and integrating the achieved data. Important studies using this approach and devoted to improve food quality are briefly illustrated below. The relationship between volatile compounds and sensory properties of coloured raw carrots was analysed by a group of experts in the sector. A sensory map was developed [11]. Investigations about tomato, having a very complex matrix food and a specific flavour profile, were based on the combination of chemical and sensory approaches [12-13]. Studies about the quality and emphasizing the flavour of this vegetable are described in Klee and Tieman [14].

Quite recent studies describe various types of instrumental measurements (such as electronic noses and tongues) that are relevant to appearance, texture and flavour, and show how significant data can be correlated with sensory ones, using different statistical procedures [15]. A significant descriptive sensory method was carried out to evaluate the organoleptic properties of Taiwan chicken meat and individuate correlations between sensory characteristics and instrumental measurements [16]. Furthermore, the quality of oils and fats in fat-based foods was evaluated using a combination of sensory and analytical methods [17]. Other works were aimed to apply a chemo-sensory strategy providing different odourless fractions. For instance, food beverages and particularly wines with different mouthfeel properties were analysed by using liquid chromatography and SPE (Solid Phase Extraction) [18].

Microbiological analyses were also combined with sensory evaluation. Particularly, microbiological quality and sensory evaluation of new cured products obtained from sheep and goat meat were investigated in a relatively recent work [19], aimed to investigate the impact of spices and maturation period on the chemical and organoleptic properties of these products. A trained panellist carried out the sensory analysis, evaluating aroma, texture, appearance and taste. Sheep meat submitted to longer processing presented the most intense flavour. Sensory properties of different concentrations of phenolic component related to smoked flavour have been investigated in a paper [20]. Recent developments in sensory evaluation are discussed in a research work [2], focused mainly on products like virgin olive oil and turron. The formed was analysed according to its commercial classification and turron to its almond content that, however, is not a guarantee of high quality.

3. Nutrition and Health

Nowadays, in both the nutrition and health field a wider variety of new food products ready to meet different consumers' needs is available. Examples of such products include gluten free foodstuff and foods supplemented and fortified with probiotics and antioxidants. The demand of the so called 'functional foods' is on the increase. At the same time, the replacement or the reduction of some components considered harmful for human health (for instance, salt, fat and glutamate) is becoming increasingly relevant simultaneously with a higher demand of organic natural foods. In this context, sensory analysis is acquiring importance, in order to test and evaluate the acceptability of these new products by the final

consumers. Several researches, for instance, focused on gluten free products. An investigation focused on a gluten-free formulation of bread containing a given percentage of orange pomace [21]. Sensory evaluation was developed and panellists analysed the flavour, the appearance of the crumb and the acceptability of the new composition of bread. A study in which light buckwheat flour was used to replace rice flour to produce gluten-free cookies [22] was another relevant example. This substitution contributed to increase their mineral composition, with particular reference to magnesium, potassium, iron and copper. Basing on the evaluated sensory properties, cookies containing 20% of light buckwheat flour resulted more acceptable than others. About products with improved nutritional properties many researches have been carried out.

Some studies about foods with enhanced nutritional values are briefly discussed below.

3.1 Ice cream

Sensory and chemical optimisation of ice cream prepared using new sweeteners resulted in an acceptable candidate formulation [23].

3.2 Yogurt

A study [24] was carried out to see if it is possible to add corni fructus extract into yogurt to improve its neutraceutical properties. Corni fructus has been often used in many Asian countries as traditional medicine or as supplement in diets, because of its beneficial characteristics for health, such as anti-inflammatory and anti-oxidation properties. Based on the data resulting from the study, it was possible to conclude that very low concentrations of Corni fructus extract could be introduced for obtaining a yogurt without significant adverse effects and still showing acceptable sensory properties. The purpose of another study was to create new food products improving the nutritional value of a probiotic yogurt, as well as to provide further health benefits. The research investigates yogurt supplemented with grown fruit purees, with inulin and Moringa oleifera by using sensory evaluation and microbial testing. The results showed that no parameters significantly differed from the control, except for appearance [25]. Furthermore, an investigation [26] studied the impact of extracts of Korean traditional plants on the organoleptic characteristic of herbal yogurts whose sensorial properties was found to be affected from this addition. Increasing the protein content of yogurts is also a research topic, in order to obtain better products from a nutritional point of view. Nevertheless, the addition of protein can affect palatability, leading to an inhomogeneous texture. Oral tribology and lubrication along with the sensory properties of protein-added yogurts have been investigated in relation with oral texture sensations in a recent study [27].

3.3 Cookies

In a research work [28] peanut skins were introduced at very low percentages in the ingredient formulation of cookies in order to increase their polyphenol composition. Sensory analysis results showed that peanut skin-supplemented cookies presented good organoleptic properties, suggesting that the adopted formulation may lend for commercial exploitation of the products. Saturated fatty acids are considered harmful for human health. Consequently, alternative fats with lower levels of such compound are highly requested by consumers. Oleogels are gels of edible oils showing such characteristics. In a study [29], sunflower wax and beeswax oleogels of hazelnut oil were introduced in cookie formulation. The achieved results showed that oleogel cookies may be compared to commercial ones.

Wine grape pomace has been recorded with nutritional and antioxidant properties as well. In the light of this, in an investigation [30] part of wheat flour was substituted with wine grape pomace powder at different levels of percentage in the composition of cookies. This new formulation significantly increased antioxidant properties including

phenols and flavonoids content. Addition of 5% of grape pomace was well accepted in the organoleptic analysis.

3.4 Cheeses and milky products

A research [31] was carried out to analyse the sensory characteristics of ovine cheese including probiotics among its components. Cheese with probiotics resulted having lower humidity and rubbery. A study [32] investigated how the introduction of buriti oil instead of ground corn in the goats' diet impacts on digestibility, composition, and organoleptic properties of milk. Its sensory characteristics were not significantly modified and this new product could help to protect from cardiovascular disease. The aim of another investigation [33] was to evaluate chemical and sensory characteristics of quark cheese fortified with ginseng extract. The aim was to produce a new healthy cheese product. The results showed that quality attributes of no-fortified and fortified quark cheese are quite similar (less than 0.5%), suggesting that the latter could be considered as a functional food.

3.5 Chocolate

Nowadays polyphenol-rich, probiotic and prebiotic chocolates are getting more attention as functional foods. An investigation [34] studied the effects of a probiotics supplement, such as *Lactobacillus acidophilus*, *Lactobacillus rhamnosus* and *Bifidobacterium lactis*, and the survival of these microorganisms in milk chocolate prepared at high temperatures. Basing on the results of this work, the probiotics addition may be done before chocolate shaping and contributes to improve the healthiness of the product. Dark chocolate including microencapsulated phytosterols (MP) among its compounds has been analysed to reduce cholesterol levels in individuals [35]. In this work, several dark chocolates containing different percentages of cocoa and supplemented with MP have been investigated. Sensory descriptive analysis showed a good level of acceptability of these new products.

3.6 Pasta

The nutritional properties of the faba was well known in the food industry and if subjected to fermentation it improves these characteristics. In a study [36], experimentations aimed to fortify pasta by using faba bean flour fermented with *Lactobacillus plantarum* were carried out. A supplement of 30% showed that pasta had a more homogeneous texture compared to 50% addition. At the same time, the nutritional profile (digestibility and nutritional indexes) of pasta containing this percentage of faba bean flour was markedly improved. Relatively few studies analysed changes affecting food products due to the inclusion of alternatives fibers, such the non-digestible carbohydrate inulin. However, its inclusion could alter the organoleptic characteristics of the product, so it is necessary to evaluate the level of satisfaction of consumers. A research work [37] was aimed to produce pasta added with inulin for diabetics and the results reported that this supplement improves the overall quality in cooked spaghetti compared to the control.

3.7 Cereal

Other investigations [38] tested the sensory acceptability of infant cereals by using a low percentage of whole grain, comparing them to similar foodstuffs produced with refined flour. The result showed that it is possible to introduce these products in the feeding of children, accelerating, in this way, the intake of whole grain.

3.8 Wine

A paper [39] describes a comprehensive study about the presence of glutathione in white wines. In fact, this metabolita is able to reduce agents in many oxidation reactions, as well as protecting against heavy metals

toxicity. The research included sensory and mass spectrometry metabolomics analysis of aged chardonnay wines, made after glutathione levels spiked during the fermentation process. The results confirmed the glutathione influence on oxidative properties of the considered wines.

3.9 Soup

Soup manufacturers are removing monosodium glutamate to meet consumer demand for more natural ingredients. Current works analysed the influence of this additive and of its substitutes, such as yeast extract, mushroom or tomato concentrate. The results showed that consumers significantly preferred monosodium glutamate 0.1%, yeast extract 0.025% and salt 0.5% samples than others, and good sensory appealing was the most important attribute influencing consumer satisfaction [40].

Reducing salt intake is a relevant public health target: a recent study focused on the sensory analysis of less salty foods [41]. Preserving good sensorial properties of these products is a difficult goal, and many case studies were discussed. Moreover, current investigations analysed what is meant to be a natural ingredient in food products and the preferences of costumers. Surprisingly, a preference for genetically modified foods had no influence on their perceptions of natural [42].

4. Other Application Fields

Sensory analysis application fields does not include only the ones discussed in the previous paragraphs, but this technique is also used in other areas, less crucial but equally important. Some of them are discussed below.

4.1 In the field of food composition

In a study about the influence of pectin concentration on melted cheese it seems that pectin can be increased without affecting its sensory properties [43].

4.2 For shelf-life assessment

The importance of sensory techniques at the end of shelf-life are also treated in Rogers [44]. Shelf-life studies of meat products and sensory analyses were also carried out in Raimondi [45].

4.3 When alternative techniques are used during the production process

For instance, pulsed electric fields (PEF) is a relatively recent non-thermal technology that may cause physical disruption to the muscle tissue of meat. This technique could alter its sensorial profile in both a positive (e.g., enhanced tenderization) and a negative way (e.g., off-flavour development). A study [46] was aimed to investigate how various PEF treatments effected the qualitative characteristics of turkey breast meat

4.4 As method of characterizing origin of food products

Chemical, isotopic and sensory parameters were elaborated by using statistical analysis to study wine traceability [47]. The results showed that multivariate statistical analysis PCA (Principal Component Analysis) of the integrated data can be a good approach to characterize different types of wines.

4.5 In finding alternative foods, not based on meat but, for instance, on insects

The use of insects as food is a sustainable alternative to meat, being comparable to meat and fish in terms of protein composition. Sensory attributes are very important in order to enable insects as an ingredient in cooking and production. In this context, current investigations focused on how it is possible to make insects available for use in the production of food and meals. For instance, in a study [48], flour worms were proposed as the principal ingredient with the aim to estimate the influence on organoleptic properties, modifying particle size, oil and water content. Sensory

and instrumental analyses were performed. Particle size was found to significantly influence the appearance, odour, taste and texture.

5. Conclusion

As highlighted in the previous sections, food sensory analysis is gaining importance for testing the quality of products but above all for evaluating new healthy foods for consumers. Its application may also be considered significant in the other mentioned fields. The novel sensory evaluation field and its application led to the definition of a standardized vocabulary defined by food scientists for describing sensory attributes of a given product. A current review [49] provided examples of sensory lexicons for fruits and vegetables, grains and nuts, beverages, dairy and meat products. The new vocabulary is an effective means of communication in the product development process, in quality control stage, and for monitoring changes during the shelf life of the product it- self, as well as being useful to objectively describe features. The previous paragraphs also showed that sensory analysis in many cases is used combined with other methods, mostly chemical and microbiological. This integrated approach increases its potentiality and further extends its application fields. It is no coincidence that recently many investigations focused on how sensory properties, including consumers' perception, are measured and on the specific sensory characteristics of many food products [50].

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