

Food Acceptance: The Role of Consumer Perception and Attitudes

Elvira Costell · Amparo Tárrega · Sara Bayarri

Received: 26 May 2009 / Accepted: 22 September 2009 / Published online: 8 October 2009
© 2009 Springer Science + Business Media, LLC

Abstract The process by which man accepts or rejects food is of a multi-dimensional nature. In complex food matrices, it is not always easy to establish relationships between the individual chemical stimuli concentration, physiological perception, and consumer reaction. Consumers' responses to food are not only based on the sensory characteristics of the product and on their physiological status but they are also related to other factors, such as previous information acquired about the product, their past experience, and their attitudes and beliefs. This paper discusses different methods to obtain information about consumer perceptions, attitudes, beliefs, and expectations.

Keywords Consumer Response · Perception · Attitudes · Expectations

Introduction

Sensory quality should be considered as a key factor in food acceptance because consumers seek food with certain sensory characteristics. The acceptance of a food will depend on whether it responds to consumer needs and on the degree of satisfaction that it is able to provide (Heldman 2004). The process by which man accepts or rejects food is of a multi-dimensional nature. Its structure is both dynamic and variable, not only among different individuals within a group but also within the same individual in different contexts and periods of time. Acceptance of a food is basically the result of the interaction between food and man

at a certain moment (Shepherd 1989). Food characteristics (chemical and nutritional composition, physical structure, and properties), consumer characteristics (genetic, age group, gender, and physiological and psychological state) and those of the consumer's environment (family and cultural habits, religion, education, fashion, price, or convenience) the influence of consumers' decision to accept or reject a food (Shepherd 1989; Shepherd and Sparks 1994). Apart from the characteristics of the food itself and the sensations consumers experience when ingesting it, a consumer's purchase choice and even the degree of pleasure when consuming it can be influenced by their attitude and opinion about the nutritional characteristics (Bruhn et al. 1992), safety (Resurreccion and Galvez 1999; Hashim et al. 1996; Wilcock et al. 2004), and even the trademark (Guerrero et al. 2000) or price (Caporale and Monteleone 2001) of the product. Other aspects of consumer response to food must also be considered. For example, the relationships that exist between taste genetics, taste function markers and preference or food intake (Dinehart et al. 2006), or the increase in acceptability due to habitual consumption (Luckow et al. 2005; Stein et al. 2003) or whether the food fulfills consumers' expectations of sensory quality (Cardello 1994). All of these influence consumer response and can lead to either repeated consumption or rejection of a product.

During food consumption, the brain receives different sensory inputs (visual, olfactory, gustatory, tactile, or trigeminal) and the information from physiologically distinct sensory modes is integrated in the final sensory perception (Prescott 2004; Small and Prescott 2005). For consumers, each perceived sensation responds not only to a certain sensory input but also to the other inputs perceived simultaneously and to physical or perceptual interactions among them. Delwiche (2004) have reviewed how all these

E. Costell (✉) · A. Tárrega · S. Bayarri
Physical and Sensory Properties Laboratory, IATA.CSIC,
P.O. Box 73, 461000 Burjassot, Valencia, Spain
e-mail: ecostell@iata.csic.es

sensations interact, both at the perceptual and the physical level, and discuss the impact that each one of them has on flavor rating. Though all these inputs influence flavor perception, through physical or perceptual interactions, the interaction between taste and odor is so strong that they jointly constitute the flavor perceived. When either the taste or the odor compound of a highly familiar odor–taste pair is presented in isolation, it may elicit weak ratings of the missing component. For example, odors that are normally present together with sweet tastes in mouth, such as vanilla, are commonly described as “sweet” odors. This perception does not result from any direct physiological effect of such odors on taste receptor, but it reflects a central neural process which appears to be based upon simultaneous associations between taste and smell. This type of learning effect has also been observed for sour and bitter tastes, resulting in odors that smell “sour” and “bitter”, respectively (Sundqvist et al. 2006). A distinctive characteristic of odor–taste integration is that for effect enhancement to occur, the odor and taste components must be perceptually congruent (White and Prescott 2007). In studies using functional magnetic resonance imaging, de Araujo et al. (2003) and Rolls (2005) located where interactions between taste and odor stimuli take place in the human brain. Two taste stimuli and two odor stimuli were delivered unimodally or in different combinations. The results obtained revealed that while some brain areas respond to either taste or retro-nasal olfactory stimuli, other brain areas respond to both. De Araujo et al. (2003) also showed that correlations with consonance ratings for smell and taste combinations and for their pleasantness were found in the medial anterior area of the orbitofrontal cortex. They concluded that these results provide evidence for the convergence of taste and olfactory stimuli to produce flavor and reveal where the pleasantness of flavor is perceived in the human brain. Moreover, flavor perception is highly dependent on both the subject’s past experience with specific odor–taste combinations (the origin of congruence) and on the cognitive factors that determine whether the flavor elements are combined or not (Prescott 2004).

In complex food matrices, it is not always easy to establish relationships between the individual chemical stimuli concentration, physiological perception, and consumer reaction. It is difficult to make predictions as to the possible perceptible differences between products differing in composition and/or structure, as a result of changes in formulation or processing. It is even more difficult to predict to what degree the consumer will accept it and it is necessary to combine information on different factors: concentration of both volatile and non-volatile stimuli, structure, and other physical characteristics of the food matrix; physico-chemical mechanisms governing the release of taste and odor compounds; product modification

during oral food processing; and sensory techniques to ascertain how flavor is perceived and how this perception affects the final acceptance of the product under study. Regarding this last point, one must bear in mind that when consumers eat food their responses are not only based on the sensory characteristics of the product and on their physiological status but they are also related to other factors, such as previous information acquired about the product, their past experience, and their attitudes and beliefs (Aaron et al. 1994; Cardello 1994; Zandstra et al. 2001; Schifferstein 2001; Barrios and Costell 2004; Wilcock et al. 2004). The influence of attitudes, beliefs, and opinions on food choice and purchase is especially important in the acceptance or rejection of some types of food such as organic food, genetically modified food, or functional food, which are presented to the consumer as a possible alternative to conventional food (Roininen and Tuorila 1999; Connor and Douglas 2001; von Alvensleben 2001; Pearson 2002). Consumer acceptance of organic, genetically modified, or functional food is far from being unconditional. Their benefits may provide added value to consumers but cannot outweigh the sensory properties of foods (Siró et al. 2008).

In a simplified manner, consumer response to a given food is mainly defined by: (1) a sensory component, related with the sensory properties of the product; (2) an affective component, responsible for positive or negative response towards a product; (3) a cognitive component, coming from the knowledge and opinions about a product; and (4) a behavioral component, involving intentions or actions, defining how willing a consumer is to do something in certain situations. The sensory component reflects an individual’s sensory perception of the product; the affective component summarizes the general response a person has to a product; the cognitive component is related to the information that a person has about a product and to his/her attitudes and beliefs, while the behavioral component is related to an action or intention and reflects the person’s intentions about his/her future behavior.

In studies about food acceptability, four critical questions arise: how consumers perceive the sensory characteristics of food; to what extent the variation in perceived sensory characteristics influences consumer response; how certain consumer habits, attitudes, or beliefs affect hedonic ratings and purchase intention and to what extent hedonic ratings are influenced by the expectations created by different types of information.

How Consumers Perceive Sensory Characteristics?

Because knowing exactly what consumers perceive is difficult, the main goal of studies about acceptability or

preference is usually to establish the relationship between the intensity of perceptible attributes and degree of acceptance (Pastor et al. 1996; Costell et al. 2000; Jaeger et al. 2003; Santa Cruz et al. 2002; Tenenhaus et al. 2005; Rodbotten et al. 2009). Sensory evaluation of the perceptible attributes of foods and beverages is usually carried out using conventional techniques, such as descriptive analysis (Deliza et al. 2005). There are several different methods of descriptive analysis, including the flavor profile method, the QDA[®], the Spectrum[™] method (Meilgaard et al. 1999) and the generic descriptive analysis (Hersleth et al. 2003). However, most of these techniques imply the use of trained and experienced assessors, who normally tend to generate complex and scientifically orientated terms. On the contrary, consumer sensory panels generate easily understandable vocabularies, but have the disadvantages that they are too personal to be interpreted by anyone except the subject (Piggott et al. 1990). One way to avoid these drawbacks and to obtain direct information about what sensations consumers perceive when eating food is to use the Repertory Grid Method (RGM) in conjunction with the Free Choice Profile (FCP) (Gomez et al. 1998; Jahan et al. 2005; Jaeger et al. 2005; Hersleth et al. 2003). The RGM is the term used to describe a set of techniques related to Kelly's personal construct theory which can be used to investigate the individual constructs (Gains 1994) and it seems particularly suited to develop consumer-related vocabulary. A problem which usually arises when working with consumers is to generate sufficient and suitable descriptors to describe their sensory perceptions. As stated by Gains (1994), the idea behind the use of RGM is that individuals should be able to create their own unique set of constructs to describe a given set of objects. If there are common dimensions of perception across consumers these will be manifested as geometrical similarities in the mathematical spaces obtained for each individual data set. With respect to FCP, on one hand, it differs from conventional profiling in that each consumer develops an individual list of terms to describe the samples rather than using a common scorecard. On the other hand, it is similar in that the assessors must be able to detect differences between samples, verbally describe the perceived attributes and quantify them (Oreskovich et al. 1991). The assessors only have to be objective, capable of using line scales, and of using their developed vocabulary consistently (Piggott et al. 1990). Gonzalez-Tomas and Costell (2006) used the RGM plus FCP as a tool to obtain data on consumers' perceptions of the sensory characteristics of eight Spanish commercial vanilla dairy desserts. The average sample space revealed that the consumers found the greatest differences in color and texture of samples although differences in various flavor notes were also perceived. The first dimension of sample space separated the samples largely by yellow color intensity (pale yellow, soft yellow, deep yellow,

strong yellow, and lemon yellow) and by consistency (liquid texture, light texture, fluid texture, dense texture, thick texture, and consistent texture). Dimension 2 was mainly related to visual attributes of texture (light appearance, liquid appearance, fluid appearance, liquid visual texture, and thick visual texture), with creaminess and with different flavor notes (vanilla, 'natillas' flavor, milk flavor, and off flavor). The third one was related to structural texture attributes (greasy, compact, lumpy, earthy...), with yellow-orange color and with citric and artificial flavors. The results obtained not only confirmed that the RGM in conjunction with the FCP was a valuable tool to obtain data on consumers' perceptions but also showed that consumers do not behave as a homogeneous group. Two groups of consumers were detected: one of them separated samples mainly according to yellow color intensity whereas the other related the largest differences to textural characteristics. It can be concluded that the Repertory Grid Method in conjunction with the Free Choice Profile constitute a valid technique to obtain information about consumers' perceptions. One of the advantages of FCP is that it allows one to gather information about cognitive perception directly from consumers and to identify their common perceptual dimensions (Gains and Thomson 1990; Moskowitz 1996; Russell and Cox 2003) but it cannot be useful when used for describing sensory characteristics of slightly different samples (Guerrero et al. 1997). As stated by Deliza et al. (2005), FCP is a good method to obtain information on target consumers' perceptions of a product, rather than the descriptive profile typically obtained by a trained panel. Moreover, the data obtained from FCP cannot be analyzed using traditional statistical methods due to the different dimension of individual matrices. The individual configurations obtained can be matched and compared by generalized Procrustes analysis and can be combined to form an average or consensus configuration (Gower 1975; Dijksterhuis and Gower 1991/1992).

To What Extent Does the Variation in Perceived Sensory Characteristics Influence Consumer Response?

One must accept that variability in perceived intensity of certain attributes by a trained panel or by a group of consumers may not affect acceptability. One way to investigate this is to analyze the relationships between variations in attribute intensity perceived by a trained panel and the variability in consumer acceptability. This approach can tell us which attributes most influence consumer acceptance. Validity of the results obtained with this approach mainly depends on the homogeneity of the preference criteria of the consumers surveyed. When the individual responses come from consumers with different

preference criteria, the average values obtained from the whole population tested do not reflect the actual situation. Average results are not correctly interpreted if the individual differences are ignored (Lundgren et al. 1978). To study individual differences, the average values from the whole group of consumers must be substituted by the analysis of the average values provided by subgroups, created by classical segmentation criteria, like gender, age, frequency of consumption, etc. (Thybo et al. 2004; Villegas et al. 2009a). Another possibility is to establish subgroups of consumers as a function of their individual sensory preferences. Several techniques can be used to create the subgroups: grouping those consumers who prefer the same products by applying cluster analysis to the acceptance data (Vigneau and Qannari 2002; Santa Cruz et al. 2002) or to study the structure of acceptability data with Internal Preference Maps (Greenhoff and MacFie 1994). By analyzing the relationships between the dimensions of the preference map and the values assigned to the intensity of the sensory attributes evaluated by a trained panel, information can be obtained on the relative influence that each attribute has on each consumer subgroup's acceptance criteria (Costell et al. 2000). Jaeger et al. (2003) used the Internal Preference Map to investigate consumers' preference criteria regarding eight kiwi genotypes and concluded that the consumer population studied responded differently to the different kiwi genotypes. Two of the genotypes were particularly acceptable to one of the consumer subgroups but not to another one. To identify consumer subgroups with different preference criteria, Carbonell et al. (2008) proposed a method based on the correlation coefficients between consumer acceptability data and sensory-attribute intensity scores from a trained panel. They correlated intensity data of the sensory attributes of different apple varieties evaluated by a trained panel with acceptability data from different consumer subgroups. Their results revealed that one consumer subgroup preferred crispy, hard, and acidic apples, whereas the other subgroup preferred sweet and aromatic apples. These methods can be used to identify groups of consumers with different preferences and can help to explain why a consumer accepts some samples but rejects others according to the intensity of each sensory attribute. Nevertheless, this approach requires the use of two types of panels: trained and consumers.

The approach is different when direct consumers' sensory evaluation is important for product development, new-product development guidance, or product improvement and optimization. Consumer-oriented product optimization involves the consumer in product development at an early stage (Damasio et al. 1999; Gan et al. 2007; Choi et al. 2007; Acosta et al. 2008). In these situations one must remember there is not a direct connection between the independent factors (ingredients) controlled by the experimenter and the

dependent factor (acceptability). It is necessary to analyze to what extent variation in ingredients or a possible interaction between them could cause perceptible variations in the sensory features and if any such variations affect acceptability. The Just About Right (JAR) scales can play a diagnostic role to determine how the consumer feels about the product. The data obtained with these scales provide an idea of the proportion of consumers who perceive each sample in a certain way and allow to determine how much the sample varied or to approach the intensity of an attribute considered ideal for a given product. As a rule of thumb, to conclude that a specific attribute is at its optimal level, a minimum of 70% of responses are usually expected to be in the "just about right" group, and to conclude that an attribute is not at its optimal level, usually a minimum of 20% of consumers necessarily falls in the "too weak" or "too strong" categories (Meullenet et al. 2007). The use of JAR scales for product optimization has been questioned by some authors who do not consider it as effective as other methods (Epler et al. 1998). Other authors indicate that JAR scales can be used with the hedonic scale in consumer testing to provide directional information for food optimization (Gacula et al. 2008; Xiong and Meullenet 2006). Recently, Lovely and Meullenet (2009) compared four approaches to optimize acceptance of strawberry yogurt and observed that the JAR scales were an acceptable alternative to more complicated methodologies based on different deterministic and probabilistic preference mapping approaches. The overall liking mean for the ideal product obtained using JAR scales was not significantly different to that obtained with the other methods tested. Villegas et al. (2009b) used the JAR scales to assess the appropriateness of specific sensory attribute levels of different formulations of a new prebiotic vanilla beverage. According to the results obtained, perceptible differences in color, sweetness, vanilla flavor, and thickness, due to sample formulation, were detected by consumers. Moreover, the highest variability was detected in the appropriateness of the level of sweetness, vanilla flavor, and thickness. For example, despite color differences, defined by instrumental and sensory analyses, practically all samples were considered to have an optimal color level by consumers. The percentage of consumers considering the samples' color "just about right" was over 79% except for one of the samples (68%). Vanilla flavor appropriateness highly varied between samples. None of the samples showed a minimum of 70% of the responses in the "just about right". The results revealed that variations in the composition of vanilla beverage samples can produce products whose sensorial differences are perceived by the consumer; however, not all these differences influenced consumer response to the same extent. The Just About Right scales can be a good alternative to link the sensory differences perceived by consumers with product acceptance and can reveal to what

extent the sensory differences consumers perceive influence acceptability. However, JAR scales are not appropriate to study the psychophysical (stimuli–sensory response) or psychohedonic (sensory response–liking) functions. Despite their practical validity, the main drawbacks of JAR scales are related with the interpretation and analysis of the JAR data and how these data relate to hedonics (Gacula et al. 2007, 2008; Xiong and Meullenet 2006).

Influence of Consumer Habits and Attitudes on Hedonic Ratings and on Purchase Intention

The influence of food habits, attitudes, beliefs, and opinions on food choice and purchase is of particular importance in the acceptance or rejection of foods (Schifferstein 2001; Magnusson and Koivisto 2002; Harker et al. 2003; Urala and Lahteenmaki 2004; Jaeger 2006; Villegas et al. 2009a). The most commonly used methods to investigate consumers' attitudes, beliefs, and opinions can be classified in two main groups: qualitative and quantitative (Chambers and Smith 1991; Lawless and Heyman 1998). The first ones, such as focus groups (Barrios et al. 2008) or in-depth interviews, are of an exploratory nature. They generate oral-descriptive, non-numerical information, and are usually carried out within small groups of people. The second ones are usually based on questionnaires where the answers to different questions are generally presented numerically. However, the latter method requires responses to be gathered from much larger groups of people than the qualitative methods.

When the research topic concerns certain personality traits or attitudes towards complex topics such as the degree of interest in health or factors influencing the acceptance of certain products, using a single simple scale does not usually provide enough information. In these situations, multiple scales comprising a group of Likert scales are the most common and the interviewee uses them to indicate a degree of agreement or disagreement with several statements related to the topic under study. Each sub-scale measures an aspect of a common factor, which constitutes the basis for the construction of multiple scales. It enables a single score to be obtained for each individual by adding the values procured with each sub-scale. An example of this type of scale is the one designed to measure consumers' attitudes towards new food (Food Neophobia Scale) by Pliner and Hobden in 1992. This scale comprises ten Likert sub-scales of seven points to measure the degree of agreement or disagreement for each of the expressions selected to represent different attitudes to new food. Steptoe et al. (1995) developed and validated some multiple scales in order to measure the factors influencing food choice (Food Choice Questionnaire). The aforementioned questionnaire included aspects related to health and to food

flavor, as well as a wide range of factors related to their choice. Likewise, Roininen et al. (1999) developed a questionnaire to measure the relative importance that different aspects related to health and sensorial characteristics have in the food selection process (Health and Taste Attitudes Questionnaires). The latter questionnaire included three multiple scales related to health: general health interest; light product interest, and natural product interest and three related with hedonic aspects: craving for sweet foods; using foods as reward and pleasure. These scales can be used to determine and quantify the individual attitudes of a group of consumers and to analyze how well these attitudes can predict their behavior when faced with the choice of different types of foods.

In a recent work (Villegas et al. 2008), we studied how the habitual consumption of milk and soya beverages or certain attitudes, such as an interest in healthy eating (Roininen et al. 1999) or food neophobia (Pliner and Hobden 1992) affect hedonic ratings and purchase intention with respect to milk and soybean vanilla beverages. On analyzing the differences in sample acceptability between consumers and non-consumers of soymilk, a significant effect was found of the interaction between this consumer habit and sample acceptability. Habitual soymilk consumers awarded significantly higher acceptability values to this type of beverage. However, differences were not detected in the acceptability of the milk samples between consumers and non-consumers of soymilk. This would seem to confirm that habitual consumption of a food increases its acceptability. Luckow et al. (2005) observed a significant increase in the acceptability of a series of probiotic beverages after they had been consumed daily for a week, and Stein et al. (2003) found a positive correlation between familiarity and the level of liking in a study on the acceptance of bitter beverages. Consumer population distribution in terms of their interest in healthy eating and their attitudes to new foods indicated that most people in the population were interested in eating healthily and that very few consumers displayed neophobia. Accordingly, respondents were divided into tertiles depending on their scale values, using the 33rd and 66th percentile points as cut-off points. The moderate group was removed in order to study the subgroups with more clearly defined attitudes. While differences in the degree of consumer neophobia did not influence either acceptability or purchase intention, differences in the degree of interest in eating healthily influenced both acceptability, and purchase intention for the different samples. A soy beverage sample was considered significantly more acceptable by consumers with higher interest in eating healthily. Moreover, the aforementioned group of consumers declared a significantly higher purchase intention for all soymilk samples. These results are in accordance with the observations reported by Aaron et al.

(1994) and by Tuorila et al. (1998) concerning the relationship between consumer attitudes and beliefs and their response to food. The former authors observed that when consumers tasted the samples, the effects of information were more important on purchase intention than on hedonic ratings and Tuorila and co-workers found that nutritional information had an effect on purchase interest but less impact on the perceived pleasantness of a snack food.

To What Extent Do the Expectations Created by Different Types of Information Affect Hedonic Ratings?

Consumers' expectations, of either sensory or hedonic characteristics, can be generated by a variety of factors and play an important role in food selection and consumption. Subsequent confirmation or disconfirmation can lead to either repeated consumption or rejection of a product. Related to food acceptance the key question is how the confirmation or disconfirmation of these expectations affects food acceptance (Cardello 1994). Four models, based on four psychological theories, can be used to explain how disconfirmation created by expectations may influence product acceptance: assimilation, contrast, generalized negativity, and assimilation–contrast (Cardello and Sawyer 1992; Tuorila et al. 1994; Deliza and MacFie 1996). The assimilation model predicts that regardless of whether positive or negative disconfirmation occurs, any discrepancy between expected and actual liking of a product is assimilated by the consumer and the actual liking moves in the direction of the expected liking. The contrast model assumes the opposite to the assimilation model and predicts that actual liking moves in the opposite direction to expectation. The generalized negativity model predicts that product acceptance decreases when any type of disconfirmation between expected and actual acceptance occurs. The assimilation–contrast model is a combination of both the assimilation and the contrast models and is based on the existence of certain limits on acceptance or rejection of a product by consumers. According to Cardello (1994) this model predicts that assimilation will occur when the acceptance of the product differs only slightly to moderately from expectations; however, when the acceptance differs significantly from expectations, a contrast effect occurs. Among these four models, the assimilation and the contrast models are the ones that usually predict the consumer response under conditions of positive or negative disconfirmation more accurately (Mialon et al. 2002; Di Monaco et al. 2004; Napolitano et al. 2007; Behrens et al. 2007).

Recently, Villegas et al. (2008) studied how hedonic ratings and purchase intention were affected by information

type (picture of real package or card with beverage type and nutritional facts) in commercial milk and soybean vanilla beverages. The results show that package characteristics can influence consumers' opinion about possible product acceptability and their purchase intention. A badly designed or unattractive package can make consumers think the product is of low quality, thereby diminishing their interest in acquiring it. By contrast, a well-designed package suggests that the product it contains is high quality and increases the consumer's interest in acquiring it. When the consumer, as well as seeing the package, tastes the product, the package may not influence either acceptance or purchase intention. In general, consumers' response to the expectations generated by the two information types followed an assimilation model. However, an analysis of the individual responses indicated different response trends in terms of the information type. The percentage of consumers whose response fitted the assimilation model was higher for the samples of soymilk beverages (55–67%) than for the dairy beverages (31–64%), independent of information type supplied. Globally, the percentage of consumers that were not influenced by the information or whose response did not follow a clear model was greater for the dairy beverages (32–57%) than for the soymilk ones (16–36%). This leads us to the conclusion that acceptance depends not only on the expectation generated by information (including nutritional facts), but also on the sensory properties of a food product. Similar results were obtained by Solheim and Lawless (1996) who analyzed the influence of price and fat content information and liking on consumer purchase probability of regular fat and reduced fat Cheddar cheese. No difference was detected between hedonic ratings given in blind tastings and those awarded when information was given together with the samples. They also observed that liking and sensory factors exerted greater influence on purchase choice than information about fat content; leading them to the conclusion that the key to repurchasing lies in how much the cheese is enjoyed when consumed.

Conclusion

The acceptance or rejection of a given food occurs when the human brain jointly processes: (a) information obtained from observing, handling, and consuming the food in question; (b) information acquired from the surrounding social and cultural context; (c) information gained from the physiological effects (pleasure, satiety, dislike, discomfort, etc) experienced when eating and after eating a certain food; and (d) comparison with information stored in the memory of past experiences. Depending on the subject under study, different approaches and methodologies may be adopted to study food acceptability as discussed in this

paper. Therefore one must take care to select the most suitable tool to assess each case and to consider both its appropriateness and its possible drawbacks.

Acknowledgement To MICINN of Spain for financial support (Project AGL 2007-63444). To Fondo Social Europeo for financing the contract of author S. Bayarri in the program I3P from CSIC. The useful comments of the two anonymous reviewers are gratefully acknowledged.

References

- Aaron JI, Mela DJ, Evans RE (1994) The influences of attitudes, beliefs and label information on perceptions of reduced-fat spread. *Appetite* 22:25–37
- Acosta O, Viquez F, Cubero E (2008) Optimisation of low calorie mixed fruit jelly by response surface methodology. *Food Qual Prefer* 19:79–85
- Barrios EX, Costell E (2004) Review: use of methods of research into consumers' opinions and attitudes in food research. *Food Sci Technol Int* 10:359–371
- Barrios EX, Bayarri S, Carbonell I, Izquierdo L, Costell E (2008) Consumer attitudes and opinions toward functional foods: a focus group study. *J Sens Stud* 23:514–525
- Behrens JH, Villanueva NDM, Da Silva MAAP (2007) Effect of nutrition and health claims on the acceptability of soyamilk beverages. *Int J Food Sci Technol* 42:50–56
- Bruhn CM, Cotter A, Diaz-Knauf K, Sutherland J, West E, Wightman N, Williamson E, Yaffee M (1992) Consumer attitudes and market potential for foods using fat substitutes. *J Dairy Sci* 75 (9):2569–2577
- Caporale G, Monteleone E (2001) Effect of expectations induced by information on origin and its guarantee on the acceptability of a traditional food: olive oil. *Sci Aliments* 21(3):243–254
- Carbonell L, Izquierdo L, Carbonell I, Costell E (2008) Segmentation of food consumers according to their correlations with sensory attributes projected on preference spaces. *Food Qual Prefer* 19:71–78
- Cardello AV (1994) Consumer expectations and their role in food acceptance. In: MacFie HJH, Thomson DMH (eds) *Measurement of food preferences*. Blackie Academic and Professional, London, pp 253–297
- Cardello AV, Sawyer FM (1992) Effects of disconfirmed consumer expectations on food acceptability. *J Sens Stud* 7:253–277
- Chambers E, Smith EA (1991) The uses of qualitative research in product research and development. In: Lawless HT, Klein BP (eds) *Sensory science theory and applications in foods*. Blackie Academic & Professional, London, pp 395–412
- Choi ID, Phillips RD, Resurreccion AVA (2007) Consumer-based optimization of a third-generation product made from peanut and rice flour. *J Food Sci* 72:S443–S449
- Connor R, Douglas L (2001) Consumer attitudes to organic foods. *Nutr Food Sci* 31:254–264
- Costell E, Pastor MV, Izquierdo L, Duran L (2000) Relationships between acceptability and sensory attributes of peach nectars using internal preference mapping. *Eur Food Res Technol* 211:199–204
- Damasio MH, Costell E, Duran L (1999) Optimising acceptability of low-sugar strawberry gels segmenting consumers by internal preference mapping. *J Sci Food Agric* 79:626–632
- de Araujo IET, Rolls ET, Kringelbach ML, McGlone F, Phillips N (2003) Taste-olfactory convergence, and the representation of the pleasantness of flavour, in the human brain. *Eur J NeuroSci* 18:2059–2068
- Deliza R, MacFie HJH (1996) The generation of sensory expectation by external cues and its effect on sensory perception and hedonic ratings: a review. *J Sens Stud* 11:103–128
- Deliza R, MacFie H, Hedderley D (2005) The consumer sensory perception of passion-fruit juice using free-choice profiling. *J Sens Stud* 20:17–27
- Delwiche J (2004) The impact of perceptual interactions on perceived flavor. *Food Qual Prefer* 15:137–146
- Di Monaco R, Cavella S, Di Marzo S, Masi P (2004) The effect of expectations generated by brand name on the acceptability of dried semolina pasta. *Food Qual Prefer* 15:429–437
- Dijksterhuis GB, Gower JC (1991/1992) The interpretation of generalized procrustes analysis and allied methods. *Food Qual Prefer* 3:67–87
- Dinehart ME, Hayes JE, Bartoshuk LM, Lanier SL, Duffy VB (2006) Bitter taste markers explain variability in vegetable sweetness, bitterness and intake. *Physiol Behav* 87:304–313
- Epler S, Chambers E, Chen XQ (1998) Hedonic scales are a better predictor than just-about-right scales of optimal sweetness in lemonade. *J Sens Stud* 13:191–197
- Gacula M, Rutenbeck S, Pollack L, Resurreccion AVA, Moskowitz HR (2007) The just-about-right intensity scale: functional analyses and relation to hedonics. *J Sens Stud* 22:194–211
- Gacula M, Mohan P, Faller J, Pollack L, Moskowitz HR (2008) Questionnaire practice: what happens when the jar scale is placed between two “overall” acceptance scales? *J Sens Stud* 23:136–147
- Gains N (1994) The repertory grid approach. In: MacFie HJH, Thomson DMH (eds) *Measurement of food preferences*. Blackie Academic and Professional, London, pp 51–75
- Gains N, Thomson DMH (1990) Contextual evaluation of canned lagers using repertory grid method. *Int J Food Sci Technol* 25:699–705
- Gan HE, Karim R, Muhammad SKS, Bakar JA, Hashim DM, Rahman R (2007) Optimization of the basic formulation of a traditional baked cassava cake using response surface methodology. *LWT-Food Sci Technol* 40:611–618
- Gomez C, Fiorenza F, Izquierdo L, Costell E (1998) Perception of mealiness in apples: a comparison of consumers and trained assessors. *Z Lebensm Unters Forsch A Food Res Technol* 207:304–310
- Gonzalez-Tomas L, Costell E (2006) Sensory evaluation of vanilla-dairy desserts by repertory grid method and free choice profile. *J Sens Stud* 21:20–33
- Gower JC (1975) Generalized procrustes analysis. *Psychometrika* 40 (1):33–51
- Greenhoff K, MacFie HJH (1994) Preference mapping in practice. In: MacFie HJH, Thomson DMH (eds) *Measurement of food preferences*. Blackie Academic and Professional, London, pp 137–166
- Guerrero L, Gou P, Arnau J (1997) Descriptive analysis of toasted almonds: a comparison between expert and semi-trained assessors. *J Sens Stud* 12:39–54
- Guerrero L, Colomer Y, Guardia MD, Xicola J, Clotet R (2000) Consumer attitude towards store brands. *Food Qual Prefer* 11 (5):387–395
- Harker FR, Gunson FA, Jaeger SR (2003) The case for fruit quality: an interpretive review of consumer attitudes, and preferences for apples. *Postharvest Biol Technol* 28:333–347
- Hashim IB, Resurreccion AVA, McWatters KH (1996) Consumer attitudes toward irradiated poultry. *Food Technol* 50(3):77–80
- Heldman DR (2004) Identifying food science and technology research needs. *Food Technol* 58:32–34

- Hersleth M, Mevik BH, Naes T, Guinard JX (2003) Effect of contextual factors on liking for wine-use of robust design methodology. *Food Qual Prefer* 14:615–622
- Jaeger SR (2006) Non-sensory factors in sensory science research. *Food Qual Prefer* 17:132–144
- Jaeger SR, Rossiter KL, Wismer WV, Harker FR (2003) Consumer-driven product development in the kiwifruit industry. *Food Qual Prefer* 14:187–198
- Jaeger SR, Rossiter KL, Lau K (2005) Consumer perceptions of novel fruit and familiar fruit: a repertory grid application. *J Sci Food Agric* 85:480–488
- Jahan K, Paterson A, Piggott JR (2005) Sensory quality in retailed organic, free range and corn-fed chicken breast. *Food Res Int* 38:495–503
- Lawless HT, Heyman H (1998) Sensory evaluation of food. Principles and practices. Chapman & Hall, New York
- Lovely C, Meullenet JF (2009) Comparison of preference mapping techniques for the optimization of strawberry yogurt. *J Sens Stud*. doi:10.1111/j.1745-459X.2009.00221.x
- Luckow T, Sheehan V, Delahunty C, Fitzgerald G (2005) Determining the odor and flavor characteristics of probiotic, health-promoting ingredients and the effects of repeated exposure on consumer acceptance. *J Food Sci* 70:S53–S59
- Lundgren B, Jonsson B, Pangborn RM, Sontag AM, Barylko-Pikielna N, Pietrzak E, Dos Santos Garruti R, Chaib Moraes MA, Yoshida M (1978) Taste discrimination vs. hedonic response to sucrose. An interlaboratory study. *Chem Senses* 3:249–265
- Magnusson MK, Koivisto H (2002) Consumer attitudes towards genetically modified foods. *Appetite* 39(1):9–24
- Meilgaard M, Civille GV, Carr BT (1999) Sensory evaluation techniques. CRC, Boca Raton
- Meullenet JF, Xiong R, Findlay CJ (2007) Multivariate and probabilistic analyses of sensory science problems. IFT, Blackwell
- Mialon VS, Clark MR, Leppard PI, Cox DN (2002) The effect of dietary fibre information on consumer responses to breads and "English" muffins: a cross-cultural study. *Food Qual Prefer* 13:1–12
- Moskowitz HR (1996) Experts versus consumers: a comparison. *J Sens Stud* 11:19–37
- Napolitano F, Caporale G, Carlucci A, Monteleone E (2007) Effect of information about animal welfare and product nutritional properties on acceptability of meat from Podolian cattle. *Food Qual Prefer* 18:305–312
- Oreskovich DC, Klein BP, Sutherland JW (1991) Procrustes analysis and its application to free choice and other sensory profiling. In: Lawless, Klein (eds) Sensory science theory and application in foods. Marcel Dekker, New York, pp 353–394
- Pastor MV, Costell E, Izquierdo L, Duran L (1996) Optimizing acceptability of a high fruit low sugar peach nectar using aspartame and guar gum. *J Food Sci* 61:852–855
- Pearson D (2002) Marketing organic food: who buys it and what do they purchase? *Food Aust* 54:31–34
- Piggott JR, Sheen MR, Apostolidou SG (1990) Consumers' perceptions of whiskies and other alcoholic beverages. *Food Qual Prefer* 2:177–185
- Pliner P, Hobden K (1992) Development of a scale to measure the trait of food neophobia in humans. *Appetite* 19:105–120
- Prescott J (2004) Psychological processes in flavour perception. In: Taylor AJ, Roberts DD (eds) Flavor perception. Blackwell, Oxford, pp 256–277
- Resurreccion AVA, Galvez FCF (1999) Will consumers buy irradiated beef? *Food Technol* 53(3):52–55
- Rodbotten M, Martinsen BK, Borge GI, Mortvedt HS, Knutsen SH, Lea P, Naes T (2009) A cross-cultural study of preference for apple juice with different sugar and acid contents. *Food Qual Prefer* 20:277–284
- Roininen K, Tuorila H (1999) Health and taste attitudes in the prediction of use frequency and choice between less healthy and more healthy snacks. *Food Qual Prefer* 10:357–365
- Roininen K, Lahteenmaki L, Tuorila H (1999) Quantification of consumer attitudes to health and hedonic characteristics of foods. *Appetite* 33:71–88
- Rolls E (2005) Taste, olfactory and food texture processing in the brain, and the control of food intake. *Physiol Behav* 85:45–56
- Russell CG, Cox DN (2003) A computerised adaptation of the repertory grid methodology as a useful tool to elicit older consumers' perceptions of foods. *Food Qual Prefer* 14:681–691
- Santa Cruz MJ, Martinez MC, Hough G (2002) Descriptive analysis, consumer clusters and preference mapping of commercial mayonnaise in Argentina. *Journal of Sensory Studies* 17:309–325
- Schiffstein H (2001) Effects of product beliefs on product perception and liking. In: Frewer, Risvik, Schiffstein (eds) Food, people and society. A European perspective of consumers' food choices. Springer, Munich, pp 73–96
- Shepherd R (1989) Factors influencing food preferences and choice. In: Shepherd (ed) Handbook of the psychophysiology of human eating. Wiley, Chichester, pp 3–24
- Shepherd R, Sparks P (1994) Modelling food choice. In: MacFie HJH, Thomson DM (eds) Measurement of food preferences. Blackie Academic & Professional, London, pp 202–223
- Siró I, Kápolna E, Kápolna B, Lugasi A (2008) Functional food. Product development, marketing and consumer acceptance. A review. *Appetite* 51:456–457
- Small DM, Prescott J (2005) Odor/taste integration and the perception of flavour. *Exp Brain Res* 166:345–357
- Solheim R, Lawless HT (1996) Consumer purchase probability affected by attitude towards low-fat foods, liking, private body consciousness and information on fat and price. *Food Qual Prefer* 7:137–143
- Stein LJ, Nagai H, Nakagawa M, Beauchamp GK (2003) Effects of repeated exposure and health-related information on hedonic evaluation and acceptance of a bitter beverage. *Appetite* 40:119–129
- Stepoe A, Pollard TM, Wardle J (1995) Development of a measure of the motives underlying the selection of food: the Food Choice Questionnaire. *Appetite* 25(3):267–284
- Sundqvist NC, Stevenson RJ, Bishop IRJ (2006) Can odours acquire fat-like properties? *Appetite* 47:91–99
- Tenenhaus M, Pages J, Ambroisine L, Guinot C (2005) PLS methodology to study relationships between hedonic judgements and product characteristics. *Food Qual Prefer* 16:315–325
- Thybo AK, Kuhn BF, Martens H (2004) Explaining Danish Childrens preferences for apples using instrumental, sensory and demographic/behavioural data. *Food Qual Prefer* 15:53–63
- Tuorila H, Cardello AV, Leshner LL (1994) Antecedents and consequences of expectations related to fat-free and regular-fat foods. *Appetite* 23:247–263
- Tuorila H, Andersson A, Martikainen A, Salovaara H (1998) Effect of product formula, information and consumer characteristics on the acceptance of a new snack food. *Food Qual Prefer* 9:313–320
- Urala N, Lahteenmaki L (2004) Attitudes behind consumers' willingness to use functional foods. *Food Qual Prefer* 15:793–803
- Vigneau E, Qannari EM (2002) Segmentation of consumers taking account external data. A clustering of variables approach. *Food Qual Prefer* 13:515–521
- Villegas B, Carbonell I, Costell E (2008) Effects of product information and consumer attitudes on responses to milk and soybean vanilla beverages. *J Sci Food Agric* 88:2426–2434
- Villegas B, Carbonell I, Costell E (2009a) Acceptability of milk and soymilk vanilla beverages. Demographics consumption frequency and sensory aspects. *Food Sci Technol Int* 15:203–210

- Villegas B, Tárrega A, Carbonell I, Costell E (2009b) Optimising acceptability of new prebiotic low-fat milk beverages. *Food Qual Prefer*. doi:10.1016/j.foodqual.2009.03.001
- von Alvensleben R (2001) Beliefs associated with food production methods. In: Frewer, Risvik, Schifferstein (eds) *Food, people and society. A European perspective of consumers' food choices*. Springer, Munich, pp 381–399
- White TL, Prescott J (2007) Chemosensory cross-modal stroop effects: congruent odors facilitate taste identification. *Chem Senses* 32:337–341
- Wilcock A, Pun M, Khanona J, Aung M (2004) Consumer attitudes, knowledge and behaviour: a review of food safety issues. *Trends Food Sci Technol* 15:56–66
- Xiong R, Meullenet JF (2006) A PLS dummy variable approach to assess the impact of jar attributes on liking. *Food Qual Prefer* 17:188–198
- Zandstra EH, de Graaf C, Van Staveren WA (2001) Influence of health and taste attitudes on consumption of low- and high-fat foods. *Food Qual Prefer* 12:75–82