Food acceptance: The role of consumer perception and attitudes

E.Costell, A. Tárrega, S. Bayarri
Physical and Sensory Properties Laboratory. IATA.CSIC
PO Box 73. 461000 Burjassot. Valencia. SPAIN

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, 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 fulfils 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, 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 sensations interact, both at the perceptual and the physical level, and discuss the impact that each one of them has on flavour rating. Though all these inputs influence flavour perception, through physical or perceptual interactions, the interaction between taste and odour is so strong that they jointly constitute the flavour perceived. When either the taste or the odour compound of a highly familiar odour-taste pair is presented in isolation, it may elicit weak ratings of the missing component. For example, odours that are normally present together with sweet tastes in mouth, such as vanilla, are commonly described as "sweet" odours. This perception does not result from any direct physiological effect of such odours 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 odours that smell "sour" and "bitter", respectively (Sundqvist et al, 2006). A distinctive characteristic of odour-taste integration is that for effect enhancement to occur, the odour and taste components must be perceptually congruent (White and

Prescott, 2007). In studies using functional magnetic resonance imaging (fMRI), de Araujo et al, (2003) and Rolls (2005) located where interactions between taste and odour stimuli take place in the human brain. Two taste stimuli and two odour 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 flavour and reveal where the pleasantness of flavour is perceived in the human brain. Moreover, flavour perception is highly dependent on both the subject's past experience with specific odour-taste combinations (the origin of congruence) and on the cognitive factors that determine whether the flavour 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 odour compounds, product

99 modification during oral food processing, sensory techniques to ascertain how
100 flavour is perceived and how this perception affects the final acceptance of the
101 product under study. Regarding this last point, one must bear in mind that when
102 consumers eat food their responses are not only based on the sensory
103 characteristics of the product and on their physiological status but they are also
104 related to other factors, such as previous information acquired about the product,
105 their past experience, and their attitudes and beliefs (Aaron et al., 1994; Cardello,
106 1994; Zandstra et al., 2001; Schifferstein, 2001; Barrios & Costell, 2004; Wilcock
107 et al., 2004). The influence of attitudes, beliefs and opinions on food choice and
108 purchase is especially important in the acceptance or rejection of some types of
109 food such as organic food, genetically modified food or functional food, which are
110 presented to the consumer as a possible alternative to conventional food
111 (Roininen & Tuorila, 1999, Connor & Douglas, 2001; von Alvensleben, 2001;
112 Pearson, 2002). Consumer acceptance of organic, genetically modified or
113 functional food is far from being unconditional. Their benefits may provide added
114 value to consumers but cannot outweigh the sensory properties of foods (Siró et
115 al 2008).
116
117 In a simplified manner, consumer response to a given food is mainly defined by:
118 1) a sensory component, related with the sensory properties of the product; 2)
119 an affective component, responsible for positive or negative response towards a
120 product, 3) a cognitive component, coming from the knowledge and opinions
121 about a product; and 4) a behavioural component, involving intentions or
122 actions, defining how willing a consumer is to do something in certain situations.
123 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 behavioural component is related to an action or intention and reflects the person's intentions about his/her future behaviour.

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 (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 flavour profile method, the QDA®, the Spectrum™ method (Meilgaard *et al.* 1999) and the generic descriptive analysis (Hersleth *et al.* 2005). 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) (Gómez et al., 1998, Jahan et al., 2005, Jaeger et al., 2005, Hersleth et al., 2005). 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 seem 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 manifest 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). González-Tomas & Costell (2006) used the RGM plus FCP as a tool to obtain data on consumers' perceptions of

174 the sensory characteristics of eight Spanish commercial vanilla dairy desserts.
175 The average sample space revealed that the consumers found the greatest
176 differences in color and texture of samples although differences in various flavor
177 notes were also perceived. The first dimension of sample space separated the
178 samples largely by yellow color intensity (pale yellow, soft yellow, deep yellow,
179 strong yellow, lemon yellow) and by consistency (liquid texture, light texture,
180 fluid texture, dense texture, thick texture, consistent texture). Dimension 2 was
181 mainly related to visual attributes of texture (light appearance, liquid
182 appearance, fluid appearance, liquid visual texture, thick visual texture), with
183 creaminess and with different flavor notes (vanilla, 'natillas' flavor, milk flavor,
184 off flavor). The third one was related to structural texture attributes (greasy,
185 compact, lumpy, earthy…), with yellow-orange color and with citric and artificial
186 flavors. The results obtained not only confirmed that the RGM in conjunction
187 with the FCP was a valuable tool to obtain data on consumers' perceptions but
188 also showed that consumers do not behave as a homogeneous group. Two
189 groups of consumers were detected: one of them separated samples mainly
190 according to yellow color intensity whereas the other related the largest
191 differences to textural characteristics. It can be concluded that the Repertory
192 Grid Method (RGM) in conjunction with the Free Choice Profile (FCP) constitute
193 a valid technique to obtain information about consumers' perceptions. One of
194 the advantages of FCP is that it allows one to gather information about cognitive
195 perception directly from consumers and to identify their common perceptual
196 dimensions (Gains &Thompson 1990, Moskowitz, 1996, Russell & Cox, 2003)
197 but it cannot be useful when used for describing sensory characteristics of
198 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 & Gower, 1991/2)

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 et al., 2001; Santa Cruz et al; 2002) or to study the structure of acceptability data with Internal Preference Maps (Greenhoff & MacFie, 1994). By analysing 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 at 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-orientated product optimization involves the consumer in product development at an early stage (Damasio et al., 1999; Gan et al., 2007, Choi et al 2007). 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. 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 & Meullenet, 2006). Recently, Lovely & 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 (JAR) 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

299 appropriate to study the psychophysical (stimuli-sensory response) or
300 psychohedonic (sensory response-liking) functions. Despite their practical
301 validity, the main drawbacks of JAR scales are related with the interpretation
302 and analysis of the JAR data and how these data relate to hedonics (Gacula et
303 al., 2007 and 2008, Xiong & Meullenet, 2006).
304
305 **Influence of consumer habits and attitudes on hedonic ratings and on**
306 **purchase intention**
307 The influence of food habits, attitudes, beliefs, and opinions on food choice and
308 purchase is of particular importance in the acceptance or rejection of foods
309 (Schifferstein, 2001; Jaeger, 2006, Villegas et al., 2009a). The most commonly
310 used methods to investigate consumers' attitudes, beliefs and opinions can be
311 classified in two main groups: qualitative and quantitative (Chambers and
312 Smith, 1991; Lawless and Heymam, 1998). The first ones, such as focus
313 groups or in-depth interviews, are of an exploratory nature. They generate oral-
314 descriptive, non-numerical information, and are usually carried out within small
315 groups of people. The second ones are usually based on questionnaires where
316 the answers to different questions are generally presented numerically.
317 However, the latter method requires responses to be gathered from much larger
318 groups of people than the qualitative methods.
319
320 When the research topic concerns certain personality traits or attitudes towards
321 complex topics such as the degree of interest in health or factors influencing the
322 acceptance of certain products, using a single simple scale does not usually
323 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 flavour, 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 intere*st 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 & 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 Tourila 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 & Sawyer, 1992; Tourila et al., 1994; Deliza & 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

399 the consumer and the actual linking moves in the direction of the expected
400 liking. The contrast model assumes the opposite to the assimilation model and
401 predicts that actual liking moves in the opposite direction to expectation. The
402 generalized negativity model predicts that product acceptance decreases when
403 any type of disconfirmation between expected and actual acceptance occurs.
404 The assimilation–contrast model is a combination of both the assimilation and
405 the contrast models and is based on the existence of certain limits on
406 acceptance of rejection of a product by consumers. According to Cardello
407 (1994) this model predicts that assimilation will occur when the acceptance of
408 the product differs only slightly to moderately from expectations; however, when
409 the acceptance differs significantly from expectations, a contrast effect occurs.
410 Among these four models, the assimilation and the contrast models are the
411 ones that usually predict the consumer response under conditions of positive or
412 negative disconfirmation more accurately (Mialon et al., 2002; Di Monaco et al.,
413 2004; Napolitano et al., 2007, Behrens et al, 2007).

414

415 Recently, Villegas et al (2008) studied how hedonic ratings and purchase
416 intention were affected by information type (picture of real package or card with
417 beverage type and nutritional facts) in commercial milk and soybean vanilla
418 beverages. The results show that package characteristics can influence
419 consumers' opinion about possible product acceptability and their purchase
420 intention. A badly designed or unattractive package can make consumers think
421 the product is of low quality, thereby dimishing their interest in acquiring it. By
422 contrast, a well-designed package suggests that the product it contains is high
423 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 soy-milk 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 soy-milk 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 & 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

449 food in question; b) information acquired from the surrounding social and
450 cultural context; c) information gained from the physiological effects (pleasure,
451 satiety, dislike, discomfort, etc) experienced when eating and after eating a
452 certain food and d) comparison with information stored in the memory of past
453 experiences. Depending on the subject under study, different approaches and
454 methodologies may be adopted to study food acceptability as discussed in this
455 paper. Therefore one must take care to select the most suitable tool to assess
456 each case and to consider both its appropriateness and its possible drawbacks.
457

458 **Acknowledgement**

459 To MICINN of Spain for financial support (Project AGL 2007-63444). To Fondo
460 Social Europeo for financing the contract of author S. Bayarri in the program I3P
461 from CSIC. The useful comments of the two anonymous reviewers are
462 gratefully acknowledged.
463

464 **References**

465 Aaron JI, Mela DJ & Evans RE (1994) The Influences of Attitudes, Beliefs and
466 Label Information on Perceptions of Reduced-Fat Spread. Appetite, 22, 25-37.

467 Acosta O, Viquez F & Cubero E (2008) Optimisation of low calorie mixed fruit
468 jelly by response surface methodology. Food Quality and Preference, 19, 79-85.

469 Barrios EX & Costell E (2004) Review: Use of methods of research into
470 consumers' opinions and attitudes in food research. Food Science and
471 Technology International, 10, 359-371.

472 Barrios EX, Bayarri S, Carbonell I, Izquierdo L & Costell E (2008) Consumer
473 attitudes and opinions toward functional foods: A focus group study. Journal of
474 Sensory Studies, 23, 514-525.

475 Behrens JH, Villanueva NDM & Da Silva MAAP (2007) Effect of nutrition and
476 health claims on the acceptability of soyamilk beverages. International Journal
477 of Food Science and Technology,l 42: 50-56

478 Bruhn CM, Cotter A, Diaz-Knauf K, Sutherlin J, West E, Wightman N,
479 Williamson E & Yaffee M. (1992). Consumer attitudes and market potential for
480 foods using fat substitutes. *Journal of Dairy Science* 75 (9), 2569-2577.

481 Caporale G & Monteleone E. (2001). Effect of expectations induced by
482 information on origin and its guarantee on the acceptability of a traditional food:
483 olive oil. Sciences des Aliments 21 (3), 243-254.

484 Carbonell L, Izquierdo L, Carbonell I & Costell E (2008) Segmentation of food
485 consumers according to their correlations with sensory attributes projected on
486 preference spaces. Food Quality and Preference, 19, 71-78.

487 Cardello AV (1994) Consumer expectations and their role in food acceptance.
488 In: HJH MacFie and DMH Thomson (Eds.). Measurement of Food Preferences
489 pp 253-297. Blackie Academic and Professional, London.

490 Cardello AVA and Sawyer FM (1992) Effects of disconfirmed consumer
491 expectations on food acceptability. Journal Sensory Studies, 7, 253-277.

492 Chambers E. & Smith EA. (1991). The uses of qualitative research in product
493 research and development. In: HT Lawless & BP. Klein (Eds.), Sensory Science
494 Theory and Applications in Foods, pp 395-412. Blackie Academic &
495 Professional, London,

496 Choi ID, Phillips RD & Resurreccion AVA (2007) Consumer-based optimization
497 of a third-generation product made from peanut and rice flour. Journal of Food
498 Science, 72, S443-S449.

499 Connor R & Douglas L (2001) Consumer attitudes to organic foods. Nutrition
500 and Food Science, 31, 254-264.

501 Costell E, Pastor MV, Izquierdo L & Duran L (2000) Relationships between
502 acceptability and sensory attributes of peach nectars using internal preference
503 mapping. European Food Research and Technology, 211, 199-204.

504 Damasio MH, Costell E & Duran L (1999) Optimising acceptability of low-sugar
505 strawberry gels segmenting consumers by internal preference mapping. Journal
506 of the Science of Food and Agriculture, 79, 626-632.

507 de Araujo IET, Rolls ET, Kringelbach ML, McGlone F & Phillips N (2003) Taste-
508 olfactory convergence, and the representation of the pleasantness of flavour, in
509 the human brain. European Journal of Neuroscience, 18, 2059-2068.

510 Deliza R & Macfie HJH (1996) The generation of sensory expectation by
511 external cues and its effect on sensory perception and hedonic ratings: A
512 review. Journal of Sensory Studies, 11, 103-128.

513 Deliza R, MacFie H & Hedderley D (2005) The consumer sensory perception of
514 passion-fruit juice using free-choice profiling. Journal of Sensory Studies, 20,
515 17-27.

516 Delwiche J (2004) The impact of perceptual interactions on perceived flavor.
517 Food Quality and Preference, 15, 137-146.

518 Di Monaco R, Cavella S, Di Marzo S & Masi P (2004) The effect of expectations
519 generated by brand name on the acceptability of dried semolina pasta. Food
520 Quality and Preference, 15, 429-437.

521 Dijksterhuis, GB & Gower JC (1991/2) The interpretation of generalized
522 procrustes analysis and allied methods. Food Quality and Preference, 3, 67-87

523 Dinehart ME, Hayes JE, Bartoshuk LM, Lanier SL, Duffy VB (2006) Bitter taste
524 markers explain variability in vegetable sweetness, bitterness and intake.
525 Physiology and behaviour, 87, 304-313

526 Epler S, Chambers E & Chen XQ (1998) Hedonic scales are a better predictor
527 than just-about-right scales of optimal sweetness in lemonade. Journal of
528 Sensory Studies, 13, 191-197

529 Gacula M, Rutenbeck S, Pollack L, Resurreccion AVA, Moskowitz HR (2007)
530 The Just–about-right intensity scale: Functional analyses and relation to
531 hedonics. Journal of Sensory Studies, 22, 194-211

532 Gacula M, Mohan P, Faller J, Pollack L & Moskowitz HR (2008) Questionnaire
533 practice: What happens when the jar scale is placed between two "overall"
534 acceptance scales? Journal of Sensory Studies, 23, 136-147.

535 Gan HE, Karim R, Muhammad SKS, Bakar JA, Hashim DM & bd Rahman R
536 (2007) Optimization of the basic formulation of a traditional baked cassava cake
537 using response surface methodology. LWT-Food Science and Technology, 40,
538 611-618.

539 Gains N (1994) The repertory grid approach. In: HJH MacFie and DMH
540 Thomson (Eds.). Measurement of Food Preferences pp 51-75. Blackie
541 Academic and Professional, London.

542 Gains N. & Thomson DMH. 1990. Contextual evaluation of canned lagers using
543 repertory grid method. International Journal of Food Science and Technology.
544 *25*, 699-705.

545 Gomez C, Fiorenza F, Izquierdo L & Costell E (1998) Perception of mealiness
546 in apples: a comparison of consumers and trained assessors. Zeitschrift fur
547 Lebensmittel-Untersuchung Und-Forschung A-Food Research and Technology,
548 207, 304-310.

549 Gonzalez-Tomas L & Costell E (2006) Sensory evaluation of vanilla-dairy
550 desserts by repertory grid method and free choice profile. Journal of Sensory
551 Studies, 21, 20-33.

552 Gower JC (1975) Generalized procrustes analysis. Psychometrika, 40 (1), 33-
553 51

554 Greenhoff K & MacFie HJH (1994) Preference mapping in practice. In: HJH
555 MacFie and DMH Thomson (Eds.). Measurement of Food Preferences pp 137-
556 166. Blackie Academic and Professional, London.

557 Guerrero L, Colomer Y, Guardia MD, Xicola J. & Clotet R. (2000) Consumer
558 attitude towards store brands. Food Quality and Preference 11 (5), 387-395.

559 Harker FR, Gunson FA & Jaeger SR (2003) The case for fruit quality: an
560 interpretive review of consumer attitudes, and preferences for apples.
561 Postharvest Biology and Technology, 28, 333-347.

562 Hashim IB, Resurreccion AVA & McWatters KH. (1996) Consumer attitudes
563 toward irradiated poultry. *Food Technology 50 (3), 77-80.*

564 Heldman DR (2004). Identifying food science and technology research needs.
565 Food Technology, 58: 32-34.

566 Hersleth M, Mevik BH, Naes T & Guinard JX (2003) Effect of contextual factors
567 on liking for wine-use of robust design methodology. Food Quality and
568 Preference, 14, 615-622.

569 Jaeger SR (2006) Non-sensory factors in sensory science research. Food
570 Quality and Preference, 17, 132-144.

571 Jaeger SR, Rossiter KL & Lau K (2005) Consumer perceptions of novel fruit
572 and familiar fruit: a repertory grid application. Journal of the Science of Food
573 and Agriculture, 85, 480-488.

574 Jaeger SR, Rossiter KL, Wismer WV & Harker FR (2003) Consumer-driven
575 product development in the kiwifruit industry. Food Quality and Preference, 14,
576 187-198.

577 Jahan K, Paterson A & Piggott JR (2005) Sensory quality in retailed organic,
578 free range and corn-fed chicken breast. Food Research International, 38, 495-
579 503

580 Lawless HT & Heymam H (1998). Sensory Evaluation of Food. Principles and
581 Practices. Chapman & Hall, New York,

582 Lovely C & Meullenet JF (2009) Comparison of preference mapping techniques
583 for the optimization of strawberry yogurt. Journal of Sensory Studies, DOI:
584 10.1111/j. 1745-459X2009.00221.x

585 Luckow T, Sheehan V, Delahunty C & Fitzgerald G (2005) Determining the odor
586 and flavor characteristics of probiotic, health-promoting ingredients and the
587 effects of repeated exposure on consumer acceptance. Journal of Food
588 Science, 70, S53-S59.

589 Lundgren B, Jonsson B, Pangborn RM, Sontag AM, Barylko-Pikielna N,
590 Pietrzak E, Dos Santos Garruti R, Chaib Moraes, MA, Yoshida M (1978) Taste
591 discrimination vs. hedonic response to sucrose. An interlaboratory study,
592 Chemical Senses, 3, 249-265

593 Magnusson MK & Koivisto H, (2002). Consumer attitudes towards genetically
594 modified foods. Appetite 39 (1), 9-24.

595 Meilgaard M, Civille GV & Carr BT (1999) Sensory evaluation techniques. CRC
596 Press. Boca Raton, Fla, USA.

597 Meullenet JF, Xiong R, Findlay, CJ (2007) Multivariate and probabilistic
598 analyses of sensory science problems. IFT Press, Blackwell, Ames, Iowa, USA.

599 Mialon VS, Clark MR, Leppard PI & Cox DN (2002) The effect of dietary fibre
600 information on consumer responses to breads and "English" muffins: a cross-
601 cultural study. Food Quality and Preference, 13, 1-12.

602 Moskowitz HR (1996) Experts versus consumers: A comparison. Journal of
603 Sensory Studies, 11, 19-37.

604 Napolitano F, Caporale G, Carlucci A & Monteleone E (2007) Effect of
605 information about animal welfare and product nutritional properties on
606 acceptability of meat from Podolian cattle. Food Quality and Preference, 18,
607 305-312.

608 Oreskovich DC, Klein BP & Sutherland JW (1991) Procrustes analysis and its
609 application to free choice and other sensory profiling. In: Lawless and Klein
610 (eds.) Sensory Science Theory and Application in Foods, pp. 353-394. Marcel
611 Dekker, New York, USA.

612 Pastor MV, Costell E, Izquierdo L & Duran L (1996) Optimizing acceptability of a
613 high fruit low sugar peach nectar using aspartame and guar gum. Journal of
614 Food Science, 61, 852-855.

615 Pearson D (2002) Marketing organic food: Who buys it and what do they
616 purchase? Food Australia, 54, 31-34.

617 Piggott JR, Sheen MR & Apostolidou SG (1990) Consumers' perceptions of
618 whiskies and other alcoholic beverages. Food Quality and Preference, 2, 177-
619 185.

620 Pliner P & Hobden K (1992) Development of A Scale to Measure the Trait of
621 Food Neophobia in Humans. Appetite, 19, 105-120.

622 Prescott J (2004) Psycological processes in flavour perception. In: Taylor and
623 Roberts (eds.) Flavor Perception, pp 256-27. Blackwell Publ. Ltd, Oxford, UK.

624 Resurreccion AVA & Galvez FCF (1999) Will consumers buy irradiated beef?
625 Food Technology 53 (3), 52-55.

626 Rodbotten M, Martinsen BK, Borge GI, Mortvedt HS, Knutsen SH, Lea P &
627 Naes T (2009) A cross-cultural study of preference for apple juice with different
628 sugar and acid contents. Food Quality and Preference, 20, 277-284.

629 Roininen K & Tuorila H (1999) Health and taste attitudes in the prediction of use
630 frequency and choice between less healthy and more healthy snacks. Food
631 Quality and Preference, 10, 357-365.

632 Roininen K, Lahteenmaki L & Tuorila H (1999) Quantification of consumer
633 attitudes to health and hedonic characteristics of foods. Appetite, 33, 71-88.

634 Rolls E (2005). Taste, olfactory and food texture processing in the brain, and the
635 control of food intake. Physiol. Behavior. **85**: 45-56

636 Russell CG & Cox DN (2003) A computerised adaptation of the repertory grid
637 methodology as a useful tool to elicit older consumers' perceptions of foods.
638 Food Quality and Preference, 14, 681-691.

639 Santa Cruz MJ, Martinez MC & Hough G (2002) Descriptive analysis, consumer
640 clusters and preference mapping of commercial mayonnaise in Argentina.
641 Journal of Sensory Studies, 17, 309-325.

642 Schifferstein H (2001) Effects of product beliefs on product perception and liking
643 In: Frewer, Risvik & Schifferstein (eds.) Food, People and Society. A European
644 Perspective of Consumers' Food Choices, pp 73-96. Springer Verlag, Munich,
645 Germany.

646 Shepherd R (1989) Factors influencing food preferences and choice. In:
647 Shepherd (ed.), Handbook of the Psychophysiology of Human Eating. pp. 3–24.
648 John Wiley and Sons Ltd, Chichester, UK.

649 Shepherd, R & Sparks, P. (1994). Modelling food choice. In: H. J. H. MacFie &
650 D. M. Thomson (Eds.). *Measurement of Food Preferences*, pp 202-223. Blackie
651 Academic & Professional, London,

652 Siró I, Kàpolna E, Kàpolna B, Lugasi A (2008). Functional food. Product
653 development, marketing and consumer acceptance. A review. Appetite: 51,
654 456-457

655 Small DM & Prescott J (2005). Odor / taste integration and the perception of
656 flavour. Exp. Brain Res. **166**: 345-357

657 Solheim R & Lawless HT (1996) Consumer purchase probability affected by
658 attitude towards low-fat foods, liking, private body consciousness
659 andinformation on fat and price. Food Quality and Preference, 7, 137-143

660 Stein LJ, Nagai H, Nakagawa M & Beauchamp GK (2003) Effects of repeated
661 exposure and health-related information on hedonic evaluation and acceptance
662 of a bitter beverage. Appetite, 40, 119-129.

663 Steptoe A, Pollard TM. & Wardle J (1995). Development of a measure of the
664 motives underlying the selection of food: the Food Choice Questionnaire.
665 Appetite 25 (3), 267-284.

666 Sundqvist NC, Stevenson RJ & Bishop IRJ(2006). Can odours acquire fat-like
667 properties? Appetite 47: 91-99

668 Tenenhaus M, Pages J, Ambroisine L & Guinot C (2005) PLS methodology to
669 study relationships between hedonic judgements and product characteristics.
670 Food Quality and Preference, 16, 315-325.

671 Thybo AK, Kuhn BF & Martens H (2004) Explaining Danish Childrens
672 preferences for apples using instrumental, sensory and
673 demographic/behavioural data. Food Quality and Preference, 15, 53-63

674 Tuorila H, Andersson A, Martikainen A & Salovaara H (1998) Effect of product
675 formula, information and consumer characteristics on the acceptance of a new
676 snack food. Food Quality and Preference, 9, 313-320.

677 Tuorila H, Cardello AV & Lesher LL (1994) Antecedents and Consequences of
678 Expectations Related to Fat-Free and Regular-Fat Foods. Appetite, 23, 247-
679 263.

680 Urala N & Lahteenmaki L (2004) Attitudes behind consumers' willingness to use
681 functional foods. Food Quality and Preference, 15, 793-803.

682 Verbeke W, Sioen I, Pieniak Z, Van Camp J & De Henauw S (2005) Consumer
683 perception versus scientific evidence about health benefits and safety risks from
684 fish consumption. Public Health Nutrition, 8, 422-429.

685 Vigneau E & Qannari EM (2002) Segmentation of consumers taking account
686 external data. A clustering of variables approach. Food Quality and
687 Preference,13, 515-521

688 Villegas B, Carbonell I & Costell E (2008) Effects of product information and
689 consumer attitudes on responses to milk and soybean vanilla beverages.
690 Journal of the Science of Food and Agriculture, 88, 2426-2434.

691 Villegas B, Carbonell I & Costell E. (2009a) Acceptability of Milk and Soymilk
692 Vanilla Beverages. Demographics Consumption Frequency and Sensory
693 Aspects. Food Science and Technology International, 15, 203-210

694 Villegas B, Tárrega A, Carbonell I & Costell E. (2009b). Optimising acceptability
695 of new prebiotic low-fat milk beverages. Food Quality and Preference, DOI:
696 10.1016/j. foodqual.2009.03.001

697 von Alvensleben R (2001) Beliefs associated with food production methods. In:
698 Frewer, Risvik & Schifferstein (eds.) Food, People and Society. A European
699 Perspective of Consumers' Food Choices, pp 381-399. Springer Verlag,
700 Munich, Germany.

701 White TL & Prescott J (2007) Chemosensory cross-modal stroop effects:
702 Congruent odors facilitate taste identification. Chemical Senses, 32, 337-341

703 Wilcock A, Pun M, Khanona J & Aung M (2004) Consumer attitudes, knowledge
704 and behaviour: a review of food safety issues. Trends in Food Science &
705 Technology, 15, 56-66.

706 Xiong R & Meullenet JF (2006) A PLS dummy variable approach to assess the
707 impact of jar attributes on liking. Food Quality and Preference,17, 188-198

708 Zandstra EH, de Graaf C & Van Staveren WA (2001) Influence of health and
709 taste attitudes on consumption of low- and high-fat foods. Food Quality and
710 Preference, 12, 75-82.

711