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A conjoint study on apple acceptability: Sensory characteristics and nutritional information

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ABSTRACT

The main objective of this work was to study whether the intensity of intrinsic sensory attributes and different information about fibre and antioxidant content (extrinsic attributes) provided immediately before tasting could affect the acceptability of four apple varieties characterised by two levels of crunchiness and sweetness. The tested products (Fuji, Golden Delicious, Granny Smith, and Reinette du Canada) were selected on the basis of the results of the quantitative descriptive analysis performed on 21 commercially available varieties.

A panel of 346 consumers was asked to rate the overall liking of the selected cultivars, which were presented in duplicate with different information about fibres and antioxidants content using a fractional factorial design. A preliminary test was performed on 226 consumers to measure the acceptability without the effect of such information. Demographic data, fruit consumption data, and the importance of health aspects in nutrition were also collected by means of a questionnaire.

Significant effects were found for the sensory factors: overall liking was positively influenced by high levels of crunchiness and sweetness. Information about the nutritional content affected apple acceptance only for some consumer groups depending on their attitudes towards healthy food. This work demonstrates the effectiveness of conjoint analysis integrated with tasting in the case of fresh unprocessed product. Moreover, the proposed approach provides to Italian apple producers/distributors a better understanding of the relative importance consumers give to sensory attributes and nutritional information in order to support consumer-led breeding selections.

Introduction

In the last years, the number of publications investigating the basis of consumer choice evaluating simultaneously intrinsic and extrinsic product attributes by means of rating or choice-based conjoint experiments has increased (see among others De Pelsmaeker, Dewettinck, & Gellynck, 2013; Green, Krieger, & Wind, 2001). Consumer choice is based on a complex trade-off between external information such as price, packaging, labelling, and other psychosocial and individual aspects, including personal sensory preferences and attitudes. In order to develop new products or to improve those already on the market, most of these studies have focused on the effect of a combination of important characteristics such as functional and nutritional properties on liking or willingness to pay (e.g. see Gadioli et al., 2013), product origin (e.g. see Herseleth, Næs, Rødbotten, Videke, & Monteleone, 2012), and production method (e.g. see Lee, Shimizu, Kniffin, & Wansink, 2013). However, these effects also depend on the type of food product analysed.

Conjoint analysis for fresh unprocessed products

For fresh fruit, conjoint studies have shown that liking is influenced by intrinsic attributes such as size, shape, and colour (Gamble, Jaeger, & Harker, 2006; Jaeger et al., 2011; Skreli & Imami, 2012). For apples, in particular, few authors have observed the effect of external information about pesticide use, certification, percentage of fruit damage, origin, and method of production (Baker, 1999; Baker & Crosbie, 1993; Novotorova & Mazzocco, 2008; Wang, Sun, & Parsons, 2010). In general, the findings of these works show that consumers have a broad preference for locally grown apples. Price, despite being one of the most important factors, may play a minor role for consumers, who appear instead

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to be more sensitive to a reduced pesticide use, a minor percentage of fruit damage, or an organic production. Far fewer studies investigated the taste as a factor in a conjoint framework. Cerda, Garcia, Ortega-Farias, and Ubilla (2012) have evaluated the effect of the information on fruit taste (mostly sweet or mostly sour) varying at the same time different levels of price, production method, and variety. Del Carmen and colleagues (2013) have interestingly investigated the degree of fruit sweetness set up by a sensory panel on three levels: very sweet (>12°Brix), just right (10–12°Brix), or not sweet (<9°Brix) together with other factors such as absence of damage, degree of ripeness (percentage of yellow of peel colour), and price. Both these studies showed that fruit taste, especially sweetness, play an important role in consumer preferences. Nevertheless, the cited studies evaluated consumer responses to a set of hypothetical fruit profiles, but when the sensory variation is considered as a factor in the conjoint study, the tasting of real products should be included. Important examples of studies incorporating tasting in a conjoint framework are those described by Helgesen, Solheim, and Næs (1998) for sausages, by Rødbotten et al. (2009) and Enneking, Neumann, and Henneberg (2007) for juices, by Solheim and Lawless (1996), Haddad et al. (2007) and Johansen, Næs, Øyaas, and Hersleth (2010) for dairy products.

When real products are investigated, it is important to focus on specific sensory attributes and to base the choice of samples to be tested on a sensory profile which measures the actual variability of the available products (Johansen et al., 2010). In addition, an effective experimental design is necessary for this type of study (De Pelsmaeker et al., 2013; Green & Srinivasan, 1978). Processed products are best suited for sensory studies because they are modifiable according to a specific design. In the case of unprocessed products, one option would be to use instrumental methods for estimating different levels of a specific sensory attribute (e.g. using dry matter or soluble solid content as a proxy of sweetness). Nardozza et al. (2010) have demonstrated for kiwifruit that fruits with high dry matter have a high soluble solid content and are perceived as sweeter than low-dry matter fruits by a sensory panel. A strong relation between dry matter and soluble solid content is also known in apples (Palmer, Harker, Tustin, & Johnston, 2010). However, it remains to prove their relation with the perceived sweetness for which interactions with other attributes are involved (Corollaro et al., 2014; Harker et al., 2002). Literature provides only a few examples of non-processed product tasting where the effects on liking of different dry matter categories were measured (Gamble et al., 2010; Jaeger et al., 2011). Furthermore, there are no conjoint studies examining the effects of combining taste and texture with information about health benefits while considering unprocessed food products. This means that product taste and texture have not been manipulated in respect to controlling the variation within the sensory attributes. Here, for the first time a conjoint study including tasting was carried out on unprocessed food, apple in particular, measuring the effect on liking of sweetness and texture evaluated by a sensory panel.

Objective of the study

To enter the shortlist of marketed apples, any new cultivar should have a comparable or superior eating quality than those already available. Being eating quality difficult to measure, it often happens that new varieties never achieve commercial success (Hampson et al., 2000). The extensive consumer acceptability of successful apples such as Fuji, Braeburn, and Gala is attributed to their superior eating quality (Stebbins, Duncan, Compton, & Duncan, 1992), strictly correlated with freshness and thus, texture attributes (Péneau, Hoehn, Roth, Escher, & Nuessli, 2006). Harker, Gunson, and Jaeger (2003) have confirmed the importance for consumer acceptability of texture properties but acceptability is generally based on a combination between texture and taste attributes (Gatti, Di Virgilio, Magli, & Predieri, 2011).

It is also known that nutrition and health claims have a role in consumers' perception influencing food choices. Purchases of food with health and nutritional properties are increasing, especially in health conscious consumers (Mai & Hoffmann, 2012). The health benefits from antioxidant and fibre content are information widely used in the marketing of different products and quite clear concepts to the consumer (see among others Bravo, 1998; Yang, Wang, Zhou, & Xu, 2012). The presence of these substances with beneficial properties in apples is well known so that in few studies apples are used to enrich the nutritional value of other products such as drinks and biscuits (Kayacier, Yuksel, & Karaman, 2014; Laguna, Sanz, Sahi, & Fiszman, 2014; Sun-Waterhouse, Bekkour, Wadhwa, & Waterhouse, 2014).

Aiming at optimally match taste and nutrition, this work studied consumer acceptability of apples focussing on intrinsic sensory properties (such as sweetness and crunchiness) and on additional information (on fibre and antioxidant content) given just before tasting. These issues were addressed by combining a consumer acceptability test with a rating-based conjoint analysis on fresh unprocessed products such as apples. The approach to the experimental design was mainly focused on sensory attributes and their variability in the samples. Samples were not prepared but just selected on the basis of a wide descriptive sensory analysis previously conducted on 21 cultivars (Corollaro et al., 2013). Analysis of conjoint data was performed using the standard mixed model ANOVA methodology with all the factors involved providing the estimates of the relative importance on acceptability of intrinsic and extrinsic attributes and their interactions. Consumer demographics and food attitudes relevant to the provided nutritional information were also identified on the basis of data provided by a questionnaire filled just after tasting. Therefore, the objective of this work is two fold: (a) to propose a conjoint approach to study fresh unprocessed product; (b) to help apple producers by gaining a better understanding of the relative importance consumers give to sensory attributes and nutritional information for successful breeding selections and for activating successful strategies to promote the consumption of healthy food.

Design and methods

Descriptive sensory analysis

The first step consisted in investigating the realistic and relevant variability of the sensory attributes in apples. This was achieved analysing a wide number of apple varieties (21 in total) by means of sensory profiling. A trained panel of 13 assessors from FEM (Fondazione Edmund Mach, a non-profit organisation in Italy involved in education, research, services, and technology transfer in the fields of environment, agriculture, and nutrition) performed the sensory profile of apples according to quantitative descriptive analysis (Stone & Sidel, 2004) in a sensory laboratory compliant to the ISO standards 8589 (ISO, 1988). The assessors were selected and trained over 9 sessions according to ISO standards 13299 (ISO, 2010) during which they agreed on a 15-attribute list describing flesh appearance (2), texture (7), tastes (4, including astringency), and overall odour intensity perceived by both ortho- and retronasal evaluation (2). All attributes were evaluated on a 100-point linear scale labelled with 50 (mid-point), 0 and 100 (end-points). For each of the six samples randomly presented in a test session, eight apple cylinders (1.8 cm diameter, 1.2 cm high each) were cut, dipped in an antioxidant solution, and served in a plastic cup labelled with three-digit numbers and presented in a balanced order over the panel. Two replicates were performed for each