

Communication

Qualitative Preliminary Approach for the Development of a Sensory Vocabulary for *Actinidia arguta* Fruits

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Featured Application: To date, no studies have been reported on the sensory lexicon for the characterization of *Actinidia arguta* fruits, for which validation could be important to improve the knowledge of the qualitative characteristics of baby kiwi. The aim of this manuscript, reported as a short communication, was to use the check-all-that-apply (CATA) method, recently introduced into sensory science, to create a sensory vocabulary for two of the most important varieties: cv. Hortgem Rua[®] and cv. Hortgem Tahi[®].

Abstract: *Actinidia arguta* fruits (baby kiwi) have recently been introduced and marketed in Italy under the Nergi[®] brand. The freshness of fruits and the maintenance of their quality after the harvest time influence the perception of taste and the sensory attributes for final acceptance by the consumer. In this work, we propose to use recently introduced sensory methods to create a sensory vocabulary not yet available for the two varieties covered by the brand: cv. Hortgem Rua[®] and cv. Hortgem Tahi[®]. The check-all-that-apply (CATA) method was performed with 15 trained tasters of Sata s.r.l. company (Alessandria, Italy) and a set of attributes were defined through a focus group (recruited at DISAFA, University of Turin) with habitual fruit consumers. The results obtained by CATA identified different profiles for the two varieties marketed under the brand, offering the opportunity to better position and communicate the taste characteristics of the product to the consumer.

Keywords: baby kiwi; quality; panel test; CATA; consumer



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1. Introduction

The globalization process dictated by standardization, deregulation, and the use of new technologies has led to the introduction of several players in the internationalized market, which has increased the competitiveness among food operators in the horticultural sector as well. Within this context, the ability of food operators to identify and incorporate tangible drivers of consumption in their products is essential to increase the perceived quality and customer satisfaction, and to obtain a sustainable advantage over competitors [1]. Quality, however, has become a very complex concept in the past 20 years, as the socioeconomic and cultural changes in society have created a multidimensional construct of the term, which may assume several meanings over different targets of consumers, food operators, and stakeholders, as they have different perspectives throughout the food chain [2]. As a consequence, quality assessment has become a multidisciplinary science, where several attributes need to be investigated with a wide spectrum of protocols and statistical techniques. Quality has often been described as a combination of intrinsic and extrinsic features [3], where the intrinsic features regard the physicochemical properties that are inherent to the nature of the product and are strongly influenced by genotype, environmental conditions, and agronomic techniques [4], while the extrinsic features regard mostly consumer preferences and expectations, which are highly impacted by cultural, socioeconomic, and marketing factors to different degrees [3]. In the agricultural sector,

food trends are composed of different product features that can be distinguished between search, experiential, and credence attributes based on the type of quality that can be assessed by the consumer at different stages [5]. Search and experiential features are tangible characteristics that can be assessed before (visually) or after consumption, such as price, dimension, size and color in the first case and texture, taste, aroma, and ease of consumption in the second one. Credence features, instead, are intangible outcomes related to environmental conservation, origin, supporting small-scale agriculture and local rural communities, farmers living or producing conditions and workers' rights [5]. At the present, the sector has identified a mixture of different types of food trends as most influential, such as convenience, functional foods, organic, food flavor and regional food [3,6], which are, in turn, a result of a partially contradictory demand for healthy, novel, reliable, and sustainable products with higher standards of experiential eating quality in terms of convenience and flavor. It is well known that the demand for credence features has increased in recent years [5], especially among young adults such as the so-called "Y" (or "millennials") [7] and "Z" generations [8], even though it is not possible to find a uniform and static flavor preference among consumers during the course of their lives. Confirming this, it has been shown in studies relative to the horticultural sector that when price varies within a precise range, purchase decisions are mostly based on the perceived and experiential quality [9]. With respect to the abovementioned food trends, whether they are based on credential or experiential features, vegetables and fruits are very fashionable due to their proven health benefits [10], the intense development of commercial and agronomic strategies that are more environmentally friendly [6], and the possibility to please different consumer targets due to the widespread availability of different quality profiles among vegetable and fruit crops. This awareness has led to the transfer of many of the existing marketing strategies in the industrial segment to the horticultural sector in order to communicate credentials and experiential values intrinsic to a vegetable product. Some examples are the development of premium and private label brands, the development of traditional single-variety processed products for taste segmentation and local proposition, and intense research to introduce novelty and "premiumness" by means of new crops or club varieties on the market. All of these marketing strategies are valuable examples of how the sector is valorizing horticultural products by promoting recognition and reliability (through branding), differentiation and sustainable consumption of products (through processing followed by the creation of different versions of a product), and, finally, innovation, but also creation and protection of the value of new cultivars (especially with the introduction of club varieties). Inevitably, all of these factors will have an impact on consumers' and stakeholders' expectations. To fulfill the requirements of different consumer segments, the various consumer preferences first have to be identified, especially those concerning perceived taste, considering its primary role in food acceptance, the product itself, and hence assessment of its quality attributes [2]. Moreover, the estimation and quantification of key quality attributes is important, as it enables food operators to monitor the quality of products throughout the supply chain [2] and verify its standardization. At the research level, an important issue concerning fruit and vegetable quality assessments has become the choice of parameters, instruments, and statistical models to investigate a product's quality, particularly in global terms, when several parameters need to be integrated to formulate a global judgment of a complex quality attribute. While many efforts have been made to individuate factors that affect the quality of vegetable and fruit products, there is a limited understanding on how variations in quality attributes may affect consumer perceptions and how each attribute affects the perception and overall liking of a product across different horticultural crops [2]. This phenomenon is even more prevalent for products that are described by multicomponent attributes, which are a result of the interaction of specific parameters. For example, the global attribute texture involves specific but complex parameters, such as crispness and juiciness, that can be described by a set of phenomena of different nature, such as sound and hardness to describe an apple's crispness or the amount of water and the velocity of water release to describe apricot's juiciness. This is

why the use of sensory methods is still the most advantageous way to assess consumer perceptions. The ability to integrate different aspects of an attribute to formulate a global judgment [11] is a key component of a quality assessment that is not easily replaced by laboratory instrumentation. Because there is a huge amount of available quality protocols to be chosen, at the research level an important issue concerning fruit and vegetable quality assessments has become the choice of parameters, instruments and statistical models to investigate product's quality either in global terms, when several parameters need to be integrated to formulate a global judgment of a complex quality attribute (e.g., texture or freshness), either from a specific point of view, when a specific parameter is potentially a strong indicator of a quality attribute (e.g., total soluble solids and sweetness perception). However, when considering the industrial sector, the quality assessment is still conducted using only conventional parameters, such as the total soluble solids (TSS), the titrated acidity (TA) and the firmness measured with a penetrometer to monitor the quality throughout the supply chain or to validate new products and brands, as the limits of some of these parameters have also been established by regulations for the determination of crops (e.g., the Commission Implementing Regulation (EU), 2011, concerning citrus fruits or the UNECE standard concerning melons) or are important for logistic purposes (e.g., firmness for kiwifruits). Along with them, several visual parameters are assessed as they are imposed by European regulation with the sole goal of performing an easy quality assessment to ensure product standardization and an acceptable shelf life. Unfortunately, this type of assessment is limited and there is still a huge lack of correlation between the current industrial approach and the consumer perception of a product attribute or its degree of liking, as it was demonstrated by numerous works [2]. In fact, currently this type of assessment is merely ensuring an ideal of acceptance linked to the appearance of products, which is expressed in terms of absence of defects concerning external and internal parts of fruits, color and shape development, regardless their taste. As a result, over the past twenty years, the appearance of products has mostly determined their commercialization value and breeding companies have dedicated most of their resources on intense research for varieties that are more appealing to the eyes at expense of varieties that are more appealing to the taste [12]. This has obviously increased the level of dissatisfaction among consumers, whose recurrent purchase is mainly based on taste and flavor perception [13]. In the last few years, the development of new sensory protocols and the introduction of new statistical models have opened up a whole new world to the research and industrial fields, where it will be possible to perform sensory protocols that are less time consuming than conventional methods, as they do not require a training phase and are more effective, usually relying on our better ability to compare products rather than evaluate them on an absolute scale. It will also be possible to use statistical models that compute data of a very different nature, such as those of analytical, sensory, and consumer tests [14].

Actinidia arguta fruits (baby kiwi) have recently been introduced and marketed in Italy under the Nergi® brand. The freshness of fruits and the maintenance of their quality after the harvest time influence the perception of taste and the sensory attributes for final acceptance by the consumer. To date, no studies have been reported on the sensory lexicon for the characterization of baby kiwi, for which validation could be important to improve the knowledge on the qualitative characteristics of these fruits. In this work, we used the check-all-that-apply (CATA) method recently introduced in the sensory science [14,15] to create a sensory vocabulary, not yet available for the two varieties covered by the brand: cv. Hortgem Rua® and cv. Hortgem Tahī®. The CATA method allow users to characterize products and investigate the perceptions of attributes in an easier way by exploiting our more natural capability of judging products by comparison rather than evaluating them on an absolute scale [16].

2. Materials and Methods

2.1. Fresh Sample

Two *Actinia arguta* L. (Siebold & Zucc.) Planch. ex Miq varieties, Hortgem Tahi[®] and Hortgem Rua[®], branded under the Nergi[®] name, were considered. The material was supplied by Ortofruttitalia (CN, Italy). The sizes of the fruits were similar to those of grapes, weighing 6–16 g with a soft edible skin.

Hortgem Tahi[®] has small, generally spheroid or apple-shaped fruits with green, hairless, edible skin. This fruit comes from a controlled pollination of AA02_01, a female [17].

Hortgem Rua[®] has ovoid fruits with a tapered, distal end and it comes from a controlled pollination of AA05_01 with AA13_01. This fruit is green during development, but the pulp turns red upon ripening [18].

Standard kiwi fruit agricultural practices were used during the growing season. Fruits were hand harvested at the ripening stage (middle of August) and were directly placed into punnets. The fruits were not subjected to treatment prior to the sensory evaluation and, in accordance with the explorative research strategy, selection of more/less similar fruits was performed.

2.2. Focus Group

A focus group of 12 participants from the Department of Agricultural, Forest and Food Sciences (DISAFA), University of Turin, was created to generate and select relevant and important attributes to be part of a check-all-that-apply (CATA) questionnaire for the quality assessment of the kiwi fruits. All terms used on the focus group were transcribed on an excel sheet and a frequency analysis was applied in order to select the most relevant terms. This step was important due to the lack of a sensory vocabulary, which was expected due to the novelty of the brand. The questions formulated to the participants were posed with the goal of extrapolating descriptive and emotive responses about the product.

2.3. Consumer Test Assessment

Forty consumers of 18–25 years old (60% female and 40% male) were recruited from Cuneo, Italy, where the baby kiwi production is mainly produced. Consumers were first asked to score their overall liking using a nine-point hedonic scale, from “dislike very much” (1) to “like very much” (9) for cv. Hortgem Rua[®] and cv. Hortgem Tahi[®]. A CATA questionnaire with 46 attributes related to the sensory (20), hedonistic (20), and emotional (6) characteristics of kiwi fruits was compiled. Consumers were instructed with a 1 h lesson in order to ensure the meaning of these terms were well understood. During the test, they were asked to check only the attributes they considered to be appropriate descriptors of each sample. After testing each sample, the consumers were asked to complete the CATA questionnaire to describe their ideal kiwi fruit.

2.4. Sensorial Evaluation

Evaluation of baby kiwi was also determined by means of sensory analysis, involving 15 panelists from the Sata s.r.l. company (Alessandria, Italy) (seven men and eight women, aged 25–60 years old). Panelists were selected based on their previous experience in the fruits and vegetables training [19,20]. A quantity of around 30 g of each baby kiwi variety (5 whole fruits) into plastic cups was codified with a three-digit code and presented simultaneously, in random order, for each assessor. For palate cleaning, water was provided to the subjects during the session, which lasted 1 hour. They provided sample descriptions based on consistency, sweetness, acidity, odor, astringency, aroma, and overall liking. All of the attributes were evaluated using a nine-point scale (ranging from “dislike very much” (1) to “like very much” (9)). The sensory judgment was performed at room temperature (20 ± 1 °C).

3. Statistical Analysis

Concerning the consumer test, the overall liking scores were analyzed using the paired *t*-test, considering a sample as a fixed source of variation and the consumer as a random effect. The frequencies of each sensory attribute from the CATA questions were determined by counting the number of consumers that used that term to describe each sample and the ideal. In order to determine when a particular descriptor was significantly selected to describe each sample, the goodness-of-fit test was used to assess how the observed frequency values for each sample were significantly different from the expected frequency values, where the expected frequency was considered to be the number of times a descriptor would be selected from random chance.

Considering the possibility of choosing “*d*” attributes that were present in the CATA questionnaire, as well as the possibility of choosing from one to five attributes for each sample, for each assessor, the expected frequency *E* was calculated as follows:

$$E = P \times \text{number of judges} \quad (1)$$

where *P* is the probability that a descriptor is chosen from the CATA questionnaire by an assessor, calculated as the following:

$$P = C/TC \quad (2)$$

where *TC* is the number of possible combinations to select from 1 to *n* descriptors, and *C* is the number of possible combinations to select one specific descriptor from 1 to *n* descriptors. Therefore, *TC* and *C* were calculated as follows:

$$TC = d!/(1! \times (d-1)!) + d!/(2! \times (d-2)!) + d!/(3! \times (d-3)!) + d!/(4! \times (d-4)!) + \dots + d!/(n! \times (d-n)!) \quad (3)$$

$$C = ((d-1)!/(1! \times (d-1-1)!) + ((d-1)!/(2! \times (d-1-2)!) + ((d-1)!/(3! \times (d-1-3)!) + ((d-1)!/(4! \times (d-1-4)!) + \dots + ((d-1)!/(n! \times (d-1-n)!) \quad (4)$$

The *t*-test for paired means was used to assess the significant differences between the means of both samples for all sensory attributes scored by the panel test.

4. Results and Discussion

The hedonistic judgments indicate a higher appreciation of the Tahī variety’s appearance and color. These highlight the similarity with the fruits, which is in line with the positioning of the product on the market (kiwiberry).

In this preliminary work, the proposed methodology allowed determining which qualitative attributes characterized the fruits of *A. arguta* varieties in terms of sensory characteristics, hedonistic attributes, and recalled emotions (Figures 1 and 2). From a total of 46 attributes present in the questionnaire, 13 were validated for the Tahī variety and 15 for the Rua variety, covering the description of the two products under the macro-aspects of quality: appearance, flavor, and texture. This indicates that the focus group was effective in providing sensory descriptors relevant to the product typology, despite many attributes having a low number of citations. The consumers highlighted important differences in the descriptions, perceived emotions, and appreciation of the two varieties. A greater appreciation of the appearance of the Tahī variety was emphasized, in which the similarity to small fruits was highlighted, which is important in terms of the classification of the Nergi[®] brand as a berry on the market. Meanwhile, the appearance of the Rua variety was described in less-positive terms, such as the “olive appearance” and the unwanted association of green color with that of an unripe fruit. The differences highlighted could probably affect the image of the brand in terms of homogeneity. However, the results of this work must be validated in larger samples of the population.

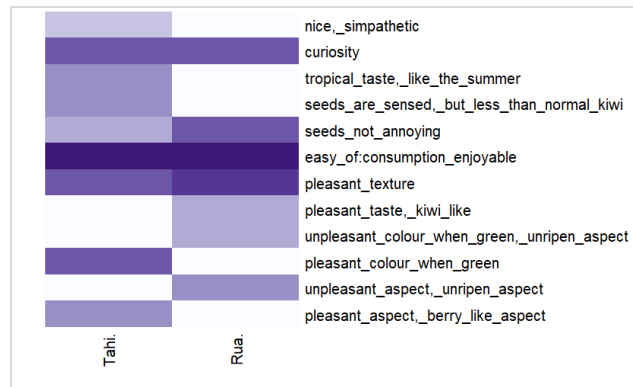


Figure 1. Heatmap 1 of the *p*-values of descriptive and emotive responses.

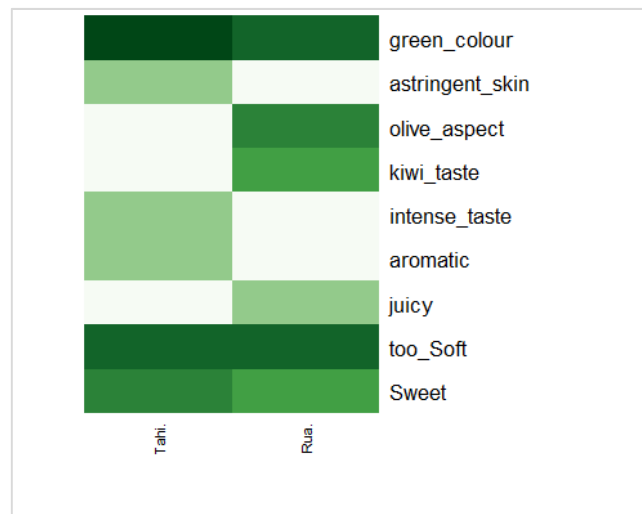


Figure 2. Heatmap 2 of the *p*-values of sensorial responses.

The consumption quality was expressed by the personal preferences of the panelists, and the results are reported in Figure 3. The sensory profiles of the samples showed that the two cultivars globally differ in terms of acidity and astringency. Statistically significant differences in fact regard these two attributes of taste; judgments of 4.3 and 3.6 were recorded for the acidity for Tahiti and Rua, while 4.2 and 3.4 for the astringency, respectively.

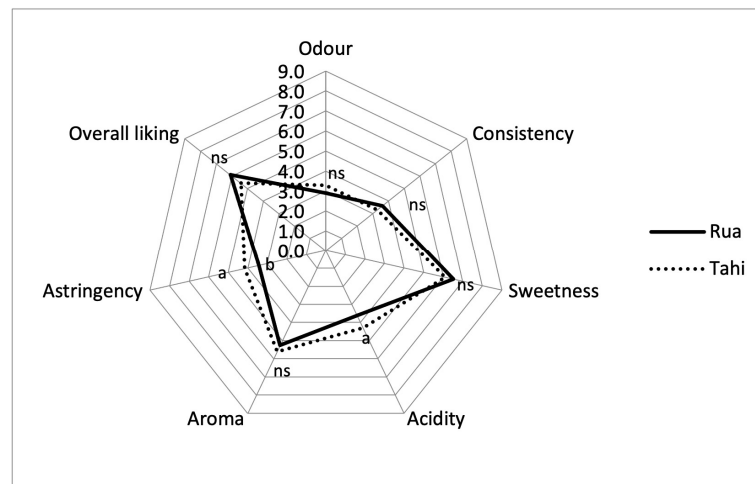


Figure 3. Sensory profiles of *Actinidia arguta* cv. Rua and cv. Tahiti.

5. Conclusions

A shared and deep understanding of diverse quality perspectives is key to building solid collaborations in order to increase the quality of products and, hence, customer satisfaction. The approach employed herein on baby kiwi fruit characterization was efficient, as assessors, who were semi-trained people or consumers, were able to distinguish the different varieties subjected to the assessments. Thanks to the statistical approach, the number of attributes to be considered relevant for the baby kiwi varieties was not determined a priori, reducing the arbitrariness of interpretation. This preliminary research suggests that sensory study could be a valuable tool in quality control of the fruit supply chain, and a sensory vocabulary could also facilitate a distinction between high- and low-quality products in terms of sensory attributes. The current situation forces warehouses and industries to develop different strategies to differentiate their products in order to create and deliver value to consumers, who have countless options in the market and have become more demanding when it comes to products with higher standards of quality. The development of a sensory vocabulary for fruits consumed in limited amounts, such as *Actinidia arguta* fruits, could help operators to better market their product in relation to the correct maturity index.

However, it is important to note that a drawback of this preliminary work was the impossibility to validate data with different groups of assessors or to recruit a large number of consumers. This research is a first step toward standardizing the sensory terminology for baby kiwi fruits. The developed methodology should be applied by other researchers in order to confirm its efficacy.

Author Contributions: N.R.G. and C.P. designed the research, interpreted the results, and wrote the paper. N.R.G., T.M.d.S., and L.B. collected the data, collaborated in the literature review, and checked the results. All authors read and approved the final manuscript, analyzed the data, and participated jointly in the discussion. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest: The authors declare no conflict of interest.

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