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Omics labeling and consumer preferences: Understanding aesthetic and taste evaluations in apple purchases☆

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ABSTRACT

The organic food market is rapidly expanding in both cultivated acreage and consumer demand, driven by ethical, environmental, and health considerations. However, food fraud schemes pose challenges that threaten product credibility. Omics technologies—advanced traceability methods employing genomics, transcriptomics, and metabolomics— may offer a potential solution for verifying the authenticity of organic products. Despite this, no studies have investigated yet how consumers perceive organic products certified through these technologies. The present study aims to fill this knowledge gap by exploring how the omics label affects consumer evaluations of taste, aesthetic and intention to buy apples. A sensory experiment involving 129 consumers assessed these attributes for a single batch of apples, which differed only in terms of the label used when presented to consumers. The labels used were ' conventional', 'organic', and 'omics certified'. Although "omics-certified" apples were generally well-received in terms of aesthetic and taste appreciation, there were no statistically significant differences between them and conventional apples. Similarly, no differences were found between omics and organic labels in terms of aesthetic and taste evaluations. However, purchase intention was significantly higher for apples labelled as omics-certified and organic compared to conventional ones. These findings suggest that labels play a critical role in influencing purchase intention, highlighting the potential of omics certifications as a credible alternative to organic labels and their ability to enhance consumer trust in food authenticity.

1. Introduction

In recent years, the organic market has grown rapidly. The global value of organic agriculture increased from €15,1 billion in 2000 to €120,6 billion in 2020 (Willer et al., 2022). The organic fruits and vegetables sector also experienced substantial growth in cultivated acreage and consumer demand (Pawlewicz, 2020), especially in Italy (Testa et al., 2021). Increasing awareness of environmental and health issues has made the organic market more important than ever (Dall'Asta et al., 2020). Consumers are progressively purchasing organic products, driven by ethical, environmental, and health reasons.

Organic food products can benefit from a more transparent and stringent monitoring system, since they are frequently associated with food fraud (Mihailova et al., 2021). As a result, to ensure consumer well-being and support the integrity of organic food, the supply chain must verify organic food attributes using reliable methods. The process of organic certification involves various standards and inspections to ensure that products meet specific criteria related to farming practices, handling, and processing. These standards typically include the avoidance of synthetic chemicals, Genetically Modified Organisms (GMO), and the use of sustainable practices. However, many consumers are not well-informed about these certification processes, even though they often demand greater transparency. In this context, omics technologies, have emerged as an innovative approach to food traceability

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certification within the agricultural and food sectors. Unlike conventional methods, these technologies rely on biological and chemical markers to certify the traceability and authenticity of organic food products, thereby providing more reliable and objective insights into food integrity (Mihailova et al., 2021).

Omics technologies encompass sophisticated analytical approaches, such as genomics, transcriptomics and metabolomics, paired with advanced data management techniques. These approaches provide a holistic depiction of genes, their expression levels, and/or metabolites within a particular matrix, including various food products. This strategy, which integrates untargeted profiling with multivariate statistics, facilitates the identification of integrity markers essential for certifying the origin and organic quality of food products. The application of omics thus represents a promising alternative to conventional methods, offering the potential to overcome their inherent limitations (Capuano et al., 2013). Certainly, over the past decade, interest in utilizing omics technologies to address challenges in food authentication, particularly in certifying organic food products, has grown (Cuevas et al., 2019; Martínez Bueno et al., 2018). A food product's omics profile functions as an analytical signature or fingerprint, that supports the discrimination of various production practices and food origins. This profile results from a combination of exogenous and endogenous factors, including both anthropic and environmental factors, across the entire agricultural and food production chain (Mihailova et al., 2021). When representative sampling, robust analytics, and effective data management are employed, omics technologies can enhance traceability and verify the organic nature of food products – including vegetables derived from organic farming systems (Davies, 2010). Within this context, omics technologies serve as a rigorous tool for certifying the quality of organic food products, enabling clear differentiation from conventionally produced alternatives and fostering greater consumer acceptance. Indeed, as highlighted in recent studies, consumers tend to be positively disposed toward such technologies and toward the consumption of vegetables certified through omics technologies, with many even expressing a willingness to pay a premium for these products (Castellini et al., 2022; Sesini et al., 2023). Moreover, these studies have demonstrated that psychological factors play a significant role in shaping consumer acceptance of organic food products certified using omics technologies. Specifically, consumption of organic products, the value attributed to food, and attitudes toward organic product certifications all contribute to the acceptance of omics technologies applied to organic vegetables. Nonetheless, additional factors, such as taste and aesthetic assessment, might also affect the evaluation and acceptance of organic food products, especially those certified through this technology. Notably, the presence of product information, such as omics labels, has the potential to shape consumers' perceptions of both aesthetics and taste of the product. As pointed out by many studies, a label on a product and the way it is presented can influence the perception of the product itself (Ufer & Ortega, 2023). While helping the consumer in decision-making, the label is ultimately a small frame (i.e., frames refer to the way information are presented within the decisional context), which is subject to a bias called the "halo effect". The halo effect can be defined as the influence of an overall evaluation of an object or person on attributing characteristics to that object or person (Nisbett & Wilson, 1977). The halo effect can influence both "non-sensory" characteristics, such as healthiness, and sensory characteristics, such as taste or aesthetic evaluation, ultimately affecting the intention to purchase. For example, when a product is labelled as "organic", the information transmitted can influence the perception of all the product's characteristics, from taste to its perceived healthiness (Ellison et al., 2016). Moreover, Naspetti and Zanoli (2014) have shown that both regular and occasional consumers tend to perceive organic products as more tasteful than their conventional counterparts, improving the intention to buy these products. However, experts point out that even the most trained palates can't recognize the difference in flavour (Schuldt & Hannahan, 2013). Furthermore, the organic label significantly influences consumer choices, leading to a higher intention to purchase compared to conventional options (Aitken et al., 2020). This preference is driven by the perceived benefits of reduced pesticide exposure and support for sustainable farming practices associated with organic certification (Dall'Asta et al., 2020).

However, although some studies have examined how the organic label influences perceptions of product taste, aesthetics, and purchase intention, no research to date has investigated how the introduction of a novel product labelled and described as an "omics organic" food can impact consumers' organoleptic and aesthetic perceptions and, consequently, their purchase intention. Therefore, this study aims to: (I) compare the aesthetic evaluations of conventional, organic, and omics apples, assessing significant differences in consumers' perceptions of the appearance of each apple type; (II) compare the taste evaluations of conventional, organic, and omics apples, analysing differences in consumers' sensory experience and preferences; (III) evaluate the purchase intention for each apple type (i.e., conventional, organic, and omics), identifying significant variations in consumers' purchasing intentions; (IV) examine the influence of socio-demographic characteristics (i.e., gender, age, and education) and psycho-social variables (i.e., organic fruit consumption habits, openness to innovation in food, and attitudes toward organic certifications) on consumers' evaluations and purchase intentions by including these factors as covariates in the analysis.

2. Theoretical background and research hypotheses

2.1. Consumers' quality perception process

Fernqvist and Ekelund (2014) proposed a comprehensive model explaining the process by which consumers evaluate product quality, distinguishing between intrinsic and extrinsic attributes. Intrinsic attributes, such as sweetness, directly pertain to the product itself but, require consumption to be assessed. As a result, in the absence of immediate access to intrinsic information, consumers often rely on extrinsic cues, such as labels, to inform their quality judgments. These extrinsic signals can significantly influence perceptions of sensory properties and flavour during the decision-making process. Building on this model, the present research investigates how extrinsic cues, specifically labelling (i.e., organic and omics labels), may influence perceived product quality, with a specific focus on taste and aesthetic evaluation of apples. Additionally, this study examines how certain psycho-social variables may interact with the aesthetic evaluation, taste assessment, and intention to purchase these apples, also controlling for socio-demographic characteristics. Fig. 1 outlines the variables considered in our study, drawing inspiration from the model proposed by Fernqvist and Ekelund (2014).

2.2. Derivation of hypothesis

A positive effect of organic labelling on various food products, such as fruits, has been well-documented in the literature with respect to actual liking, visual evaluation, and intention to buy. Some studies have highlighted that food products bearing an organic label are perceived as tastier and visually more appealing than their conventional counterparts and are associated with higher intention to purchase (Hemmerling et al., 2013; Lee et al., 2013; Nadricka et al., 2020). Further studies have shown that the presence of a label emphasizing the use of traceability technologies to ensure specific product characteristics can lead consumers to perceive such products as superior in terms of taste and health benefits, compared to non-certified alternatives (Mazzù et al., 2021; van Rijswijk et al., 2008). However, to date, no studies have directly compared perception of taste, aesthetics, and purchase intention between foods certified as organic and those certified using omics technologies. Nevertheless, if omics traceability certification is a more advanced and valid certification compared to the conventional organic label currently on the market, we expect that products certified and

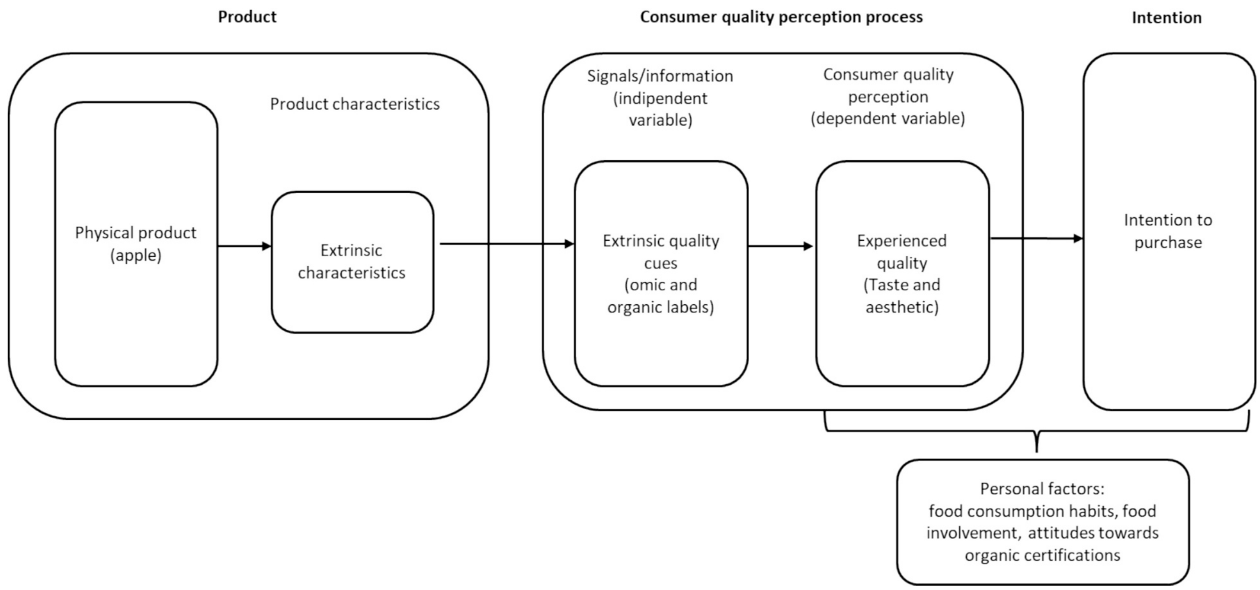

Fig. 1. Effect of extrinsic characteristics on consumers' experienced sensory quality of food and intention to purchase.

labelled with this certification will lead consumers to perceive their taste and aesthetics even more favourably compared to products labelled only as organic, thus increasing the intention to purchase omics-certified products.

Consequently, the hypotheses about aesthetic evaluation are:

Hypothesis 1a. (H1a).

Apples cued with information certified as organic are aesthetically evaluated more positively than unlabelled (i.e. conventional) apples.

Hypothesis 1b. (H1b).

Apples cued with information certified with omics technology are aesthetically evaluated more positively than unlabelled (i.e. conventional) apples.

Hypothesis 1c. (H1c).

Apples cued with information certified with omics technology are aesthetically evaluated more positively than apples with organic labels.

The hypotheses about taste evaluation are:

Hypothesis 2a. (H2a).

Apples cued with information certified as organic are perceived to have a better taste than unlabelled (i.e., conventional) apples.

Hypothesis 2b. (H2b).

Apples cued with information certified with omics technology are perceived to have a better taste than unlabelled (i.e., conventional) apples.

Hypothesis 2c. (H2c).

Apples cued with information certified with omics technology are perceived to have a better taste than apples with organic labels.

The hypotheses about the intention to purchase are:

Hypothesis 3a. (H3a).

Consumers exhibit a stronger intention to purchase apples cued with information certified as organic compared to unlabelled (i.e., conventional) apples.

Hypothesis 3b. (H3b).

Consumers exhibit a stronger intention to purchase apples cued with information certified with omics technology compared to unlabelled (i.e., conventional) apples.

Hypothesis 3c. (H3c).

Consumers exhibit a stronger intention to purchase apples cued with information certified with omics technology than apples with organic labels.

3. Method

3.1. Consumers sample

A total of 129 consumers were recruited with a convenience sampling method from November 2022 to February 2023. Consumers were involved in the research through posters that communicated the opportunity to participate, which were disseminated via the main social media channels of Università Cattolica del Sacro Cuore. Only healthy adult (>18 years old) volunteers living in Italy were included. People with relevant food allergies were excluded from the study. All consumers were asked to sign written informed consent before participating in the study. To guarantee the pseudo-anonymity of the consumers and the confidentiality of their data, a code (ID number) was used to identify them in the dataset for processing. This study was implemented in full compliance with American Psychological Association (APA) guidelines on the conduct of research involving human subjects and with the Declaration of Helsinki, and it has been approved by an independent ethics committee (CERPS) on March 25, 2022 (*22–22* protocol number). To estimate the sample size needed to reach our aims, a G*Power Analysis (a priori) was carried out using G*power software (version 3.1.9.4) (Faul et al., 2007). Given that there are no similar studies that can be used to define the effect size relating to the analyses performed, we set a small effect size (Cohen's d) = 0.14 (small partial eta squared 0.02), considering the general guidelines defined by Cohen (1988) with a significance criterion of $\alpha = 0.05$ and power = 0.90. This analysis showed a 95.1 % chance of correctly rejecting the null hypothesis of no difference in assessing the three kinds of apples with a total of 129 consumers.

3.2. Samples of apples used for the Sensory Experiment

Apples shown to consumers belonged to the same crop and were therefore similar to each other, but labelled with three different labels: conventional, organic, and omics. They were provided to us by the

Melinda Consortium and were of the Golden Delicious variety, grown according to the Organic method in the "Valle di Non" area, Trento province, Italy. In fact, the study did not aim to understand how the three types of apples were perceived differently, but rather how different labels (i.e., conventional, organic, and omics) could generate varying feelings regarding visual appeal, taste, purchase intention, and willingness to pay a premium price. Therefore, in this study, it is the different types of labels, not the apples, that represent the three treatments considered.

The fruit was transported to the sensory analysis laboratory, placed in plastic bags without atmosphere modification and stored at 4 °C, until the experiment. All samples appeared fresh at the time of the experiment. Apples were washed in running water and immersed in a sodium hypochlorite solution (200 ppm) for 15 min to sanitize them, then washed again in running water.

3.3. Setting of the sensory experiment

The experiments were conducted over six days (9–11–23-30 November 2022, 31 January, and 1 February 2023) at the SensoryLab of Università Cattolica del Sacro Cuore in Piacenza (Italy) and were fully compliant with ISO standards 8589:2007 "Sensory analysis—General guidance for the design of test rooms".

The study consisted of 6 phases, lasting approximately 60 min (see Fig. 2.):

(I) Initially, consumers underwent a brief 15-min explanation session describing the three different types of apples presented (labelled as conventional, organic, and omics) (see Fig. 3).
(II) In the second part of the study, consumers were provided with an informed consent form explaining the project's objectives. Only after reading and accepting the informed consent, consumers gained access to the study. Those who decided to take part in the study were given a questionnaire uploaded to the Qualtrics platform.
(III) In the third part of the study, consumers were randomly shown the three apples (labelled as conventional, organic, and omics) and asked to evaluate them from an aesthetic point of view through some questions in the survey. Each product was identified by a label indicating the kind of apple.
(IV) During the fourth phase of the study, consumers were given three apple slices, each from one of the three types of apples (labelled as conventional, organic, and omics), and asked to evaluate the taste of the apples through some questions in the survey. Each product carried a label indicating which type of apple was being tasted. In addition, consumers were asked to indicate their purchase intention and willingness to pay a premium price for all three types of apples. Between different tastings, they were asked to clean their mouths by providing them with rice cakes and a glass of water.
(V) During this phase of the experiment, consumers were asked to complete the last section of the questionnaire, which included questions about their socio-demographic information (age, gender, geographical origin, etc.), consumption of organic products, and their opinions and beliefs regarding food certification and openness to innovation in food.
(VI) This last part of the experiment was devoted to a debriefing phase, which explained the true objectives of the research and revealed to consumers that all three apples were organic, with no conventional or omics-treated apples shown. The only difference between the apples was the labelling. At this point, consumers were asked to sign the informed consent form again. Data were analysed only if they provided their consent after the debriefing phase.

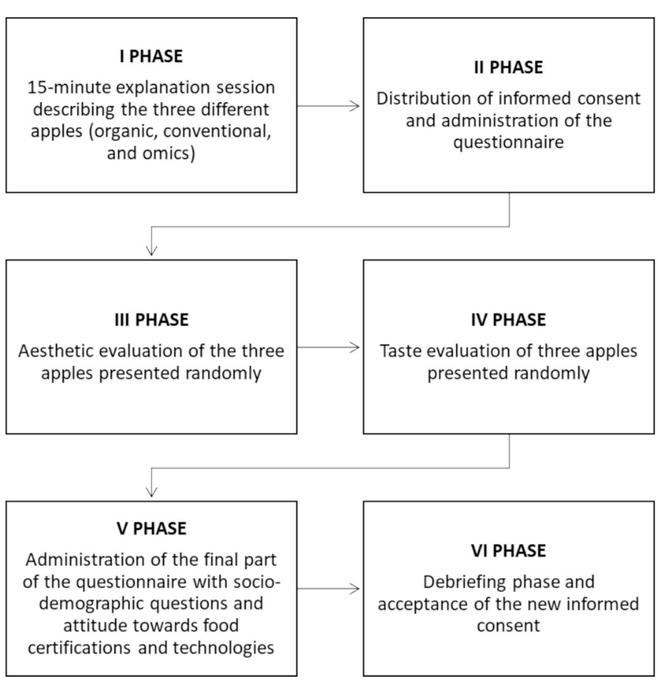

Fig. 2. Description of the research phases.

3.4. Measures

The questionnaire was presented in Italian and was uploaded to the Qualtrics platform. It was composed of 4 main sections described below.

Aesthetic evaluation section: This battery of questions was presented after showing the consumers the different types of apples. They were asked to indicate how pleasant the apples looked using a nine-point Likert scale (1 = I do not like it at all; 9 = I like it very much). This question was repeated for all three types of apples (conventional, organic, and omics).

Taste evaluation section: This section was presented to consumers after they tasted the three apple slices. They were asked to rate their pleasantness using a 9-point Likert scale (1 = I do not like it at all; 9 = I like it very much). This scale is an adapted version of the Hedonic scale (Lawless & Heymann, 2010). This question was repeated for all three types of apples (conventional, organic, and omics).

Purchase intention section: Consumers were also asked to indicate their purchase intention using an ad hoc item on a 5-point Likert scale (1="I will definitely not buy it" and 5 ="I will definitely buy it"), following previous research (Eberle et al., 2022; Nasir & Karakaya, 2014). This section was repeated for all three types of apples (conventional, organic, and omics).

Consumption habits and psycho-social characteristics: In this section, consumers were asked some questions related to their consumption habits and psychosocial aspects using ad hoc questions and validated scales described in detail below.

- *Organic fruit consumption habits:* A single item was created to map the frequency of organic fruit consumption in the past month. Consumption frequency was assessed using an 8-point Likert scale (1 = never; 8 = every day). This item was created inspired by the study of (Castellini et al., 2022).
- *Openness to innovation in food:* To assesses consumers' tendency to seek out and adopt new food products, the food innovativeness subscale (ω = 0.870) was adopted from Brunsø et al. (2021). This scale reflects an individual's willingness to try innovative food items, including those featuring novel ingredients, processing methods, or culinary experiences. As such, it serves as a useful construct for understanding consumer behavior in relation to food innovation and

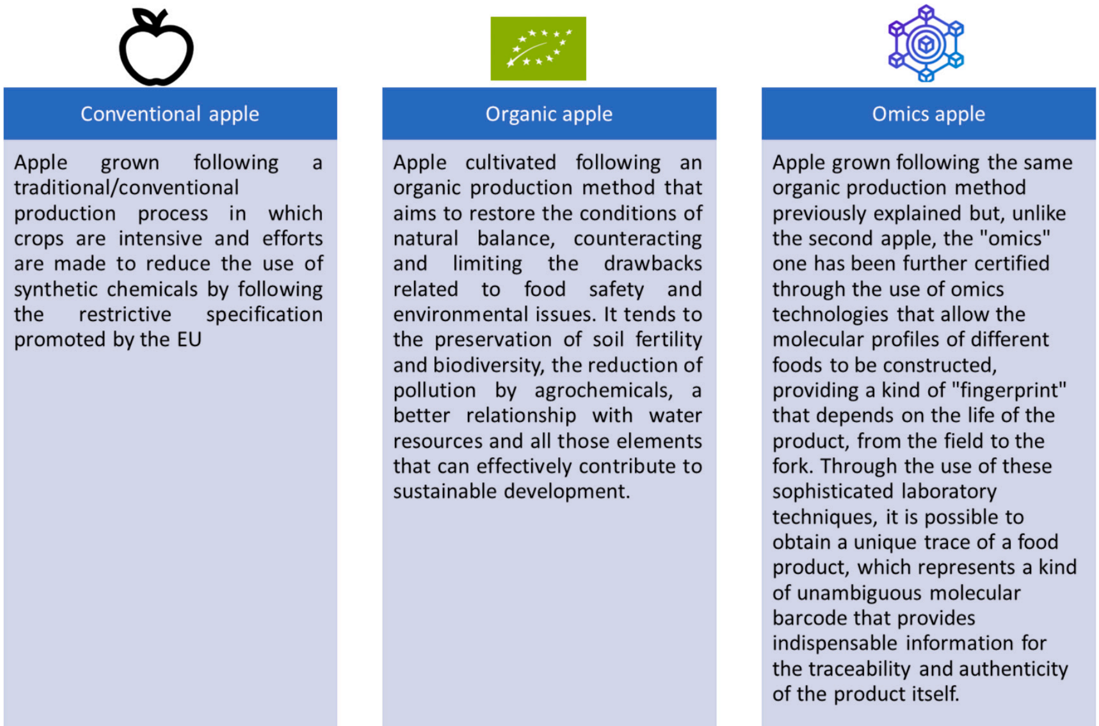

Fig. 3. Descriptions of the three apple labels.

market acceptance of new products. The sub-scale consists of 5 items, each measured on a 7-point Likert scale, ranging from "completely disagree" to "completely agree".

- *Attitudes toward organic certifications*: 6 items inspired by the study conducted by Kaczorowska et al. (2019), were included to investigate the significance of organic certifications for consumers (ω = 0.856).

Socio-demographic section: In this section, consumers indicated their socio-demographic features, such as age, gender, and educational level.

3.5. Data analysis

To test differences among the three types of apples (i.e., conventional, organic, and omics) in terms of both aesthetic (H1a, H1b, H1c) and taste (H2a, H2b, H2c) evaluation, as well as intention to buy (H3a, H3b, H3c), three general linear models were performed, comparing evaluations by each consumer for the three apples (i.e., each consumer was presented with all three types of apples). Control variables - organic fruit consumption, openness to innovation in food, attitudes toward organic certifications, and sociodemographics (i.e., gender, age, and education) - were included in the models as covariates. Furthermore, to assess specific differences among the three apples, post-hoc analyses were conducted using Tukey's Honestly Significant Difference (HSD) test. Analyses were conducted in SPSS (version 28).

4. Results

4.1. Description of the sample

The sample included 129 individuals, of whom 29.5 % were male and 70.5 % were female. The age range varied from 21 to 87 years, with a mean age of 46.19 years (SD = 22.54). Table 1 reports the detailed socio-demographic characteristics of the sample. The dataset, along with the questionnaire, is freely available at https://osf.io/3x96m/?view_only=547927c07e8b4e24b230b890a3e52c45.

Table 1
Socio-demographic characteristics for the sample (N = 129).

Variable	n	%
Gender		
Male	38	29.5
Female	91	70.5
Age		
18–24	39	30.2
25–34	21	16.3
35–44	6	4.7
45–54	10	7.8
55–64	1	0.8
65–74	44	34
> 75	8	6.2
Education		
Elementary/middle-school	8	6.2
High-school degree	48	37.2
University degree	73	56.6
Profession		
Entrepreneur / freelancer	2	1.6
Employee / teacher / military	17	13.2
Housewife	1	0.8
Student	55	42.6
Retired	53	41
Unoccupied	1	0.8
Household net monthly income		
Up to 600 €	2	1.6
601–900 €	3	2.3
901–1200 €	5	3.9
1201–1500 €	3	2.3
1501–1800 €	9	7
1801–2500 €	18	14
2501–3500 €	24	18.6
More than 3501 €	28	21.7
Missing	37	28.6

4.2. Testing evaluation and purchase intention differences among apples

Before performing the three GLMs, sociodemographic differences for the three control variables (i.e., organic fruit consumption habits, openness to innovation, and attitudes toward organic certifications) were explored. No significant differences across gender were found for organic fruit consumption habits, openness to innovation in food, and attitudes toward organic certifications. Age differences, however, emerged for both openness to innovation in food and attitudes toward organic certifications. Specifically, older individuals showed lower levels of openness to innovation but more positive attitudes toward organic labels. Regarding education level, no differences were found for organic fruit consumption habits and attitudes toward organic certifications, while individuals with higher education showed a greater preference for novel foods.

Descriptive statistics for the (aesthetic and taste) appreciation and purchase intention for the three kinds of apples are summarized in Table 2. As for the three general linear models (see Table 3), we found a significant difference in the aesthetic evaluation of the three apples [F (15, 371) = 1.759, $p = .039$, partial $\eta^2 = 0.066$]. However, no significant differences between the three types of apples were found. Although both organic ($p = .144$) and omics ($p = .288$) apples received higher aesthetic appreciation compared to conventional ones, the differences were not significant. Additionally, the aesthetic evaluation of organic and omics apples was not significantly different ($p = .924$). Therefore, H1a, H1b, and H1c were not supported. While no substantial differences were found between the three apples, the interaction effect between labels

Table 2
ANOVA results for socio-demographic differences in psycho-social variables.

Variable	Independent variable		M	SD	*df*	F	*p*
	N	Gender					
Organic fruits consumption	38	Male	3.50	2.12	1, 127	1.211	0.273
	91	Female	3.93	1.98			
Openness to innovation in food	38	Male	5.05	1.39		0.271	0.603
	91	Female	4.90	1.45			
Attitudes to organic certifications	38	Male	3.43	0.83		1.207	0.274
	91	Female	3.59	0.75			
	N	Age (years)					
Organic fruits consumption	39	≤ 24	3.59	1.99	3, 125	0.643	0.589
	26	25–39	4.15	2.03			
	33	40–70	4.00	2.12			
	31	≥ 71	3.57	1.98			
Openness to innovation in food	39	≤ 24	5.16	1.27		2.993	0.033
	26	25–39	5.28^{a}	1.13			
	33	40–70	5.02	1.25			
	31	≥ 71	4.31^{a}	1.84			
Attitudes to organic certifications	39	≤ 24	3.18^{a}	0.67		7.581	< 0.001
	26	25–39	3.42^{b}	0.61			
	33	40–70	3.66^{a}	0.73			
	31	≥ 71	3.98^{a,b}	0.85			
	N	Education					
Organic fruits consumption	56	Lower	3.85	2.15	1, 127	0.061	0.805
	73	Higher	3.76	1.93			
Openness to innovation in food	56	Lower	4.78	1.47		1.359	0.246
	73	Higher	5.07	1.39			
Attitudes to organic certifications	56	Lower	3.62	0.88		0.950	0.332
	73	Higher	3.49	0.68			

Note. Within the analysis, due to the imbalance in education categories, "elementary/middle school" and "high school degree" were combined into a single category (i.e., lower), which was compared to "university degree" (i.e., higher). Age categories were estimated by calculating frequency quartiles. Values with the same subscript letter differ significantly from each other (Tukey's HSD test; $p < .05$).

Table 3
Means (Standard Deviations) for apples evaluation and purchase intention.

Variable	Conventional apple	Organic apple	Omics apple
Aesthetic evaluation *Likert scale 1-9*	6.89 (2.04)^{a,b}	7.37 (1.99)^{a,b}	7.27 (2.07)^{a,b}
Taste evaluation *Likert scale 1-9*	5.30 (2.12)^{a,b}	5.86 (2.20)^{a,b}	5.63 (2.10)^{a,b}
Intention to buy *Likert scale 1-5*	2.71 (1.02)^{a}	3.17 (1.16)^{b}	3.05 (1.08)^{b}

Note: Data were compared by row. Values with the same subscript letter do not differ significantly from each other (Tukey's HSD test; $p < .05$).

and education was significant. Specifically, both organic and omics labels increased aesthetic appreciation among higher-educated consumers (see Table 4).

Concerning the taste evaluation of the three apples, the model was non-significant [F (15, 371) = 1.633, $p = .063$, partial $\eta^2 = 0.062$]. Hence, H2a, H2b, and H2c were not supported. Consumers' intention to buy the three apples, however, showed significant differences [F (15, 371) = 2.366, $p = .003$, partial $\eta^2 = 0.087$]. Precisely, a higher willingness to buy was reported for organic and omics apples compared to conventional apples (H3a and H3b supported). The difference was statistically significant for both organic ($p = .002$) and omics ($p = .027$) apples. At the same time, consumers' intention to buy was not significantly different between organic and omics apples ($p = .660$), thus not supporting H3c. The interaction effect between gender and education was significant as well, indicating that these factors can influence the willingness to buy, regardless of the type of apple.

5. Discussion

This study investigated consumer perceptions of apples labelled as conventional, organic, and omics, with a focus on aesthetic and taste evaluations, as well as purchase intentions, controlling for socio-demographic characteristics (i.e., gender, age, ad education) and psycho-social variables (i.e., organic consumption habits, openness of innovation in food, and attitudes toward organic certifications). Although the findings only partially supported our hypotheses, they provide valuable insights into consumer behavior in relation to emerging food certification technologies, particularly those involving omics-based technologies.

Contrary to expectations, the study found no significant differences in aesthetic or taste evaluations among the three types of apples. This may suggest that the presence of omics and organic labels did not substantially influence consumers' perceptions of these sensory attributes. These findings are consistent with prior research indicating that, although consumers often perceive organic products as higher in quality (Schuldt & Hannahan, 2013), actual differences in sensory evaluations are minimal or even non-existent (Naspetti & Zanoli, 2014). However, a significant interaction between labels and education emerged, indicating that consumers with higher levels of education rated apples labelled as organic and omics as more aesthetically appealing. This may reflect a greater familiarity with these concepts or a stronger inclination to value attributes related to sustainability and technological innovation.

Furthermore, the lack of significant differences highlights that although the labels do not alter sensory judgments when consumers evaluate the product, they are still influential for purchase decisions. Indeed, significant differences emerged in purchase intentions, with both organic and omics-certified apples being preferred over conventional apples.

This finding underscores the role of extrinsic cues, such as certification labels, in shaping consumer preferences. Both organic and omics-certified apples were perceived as more desirable compared to conventional ones, likely due to the perceived health, environmental, and ethical benefits associated with these labels (Castellini et al., 2022;

Table 4
Results of general linear models comparing aesthetic and taste evaluations, and purchase intention among the three apple labels (i.e., conventional, organic, and omics).

Variable	Aesthetic evaluation			Taste evaluation			Intention to purchase		
	F	*p*	partial η^2	F	*p*	partial η^2	F	*p*	partial η^2
Global model	1.759	0.039	0.066	1.633	0.063	0.062	2.366	0.003	0.087
Label	1.324	0.267	0.007	2.035	0.132	0.011	5.658	0.004	0.030
Gender	<0.001	0.999	< 0.001	0.012	0.912	< 0.001	0.793	0.374	0.002
Gender * Label	0.154	0.858	0.001	0.207	0.813	0.001	0.177	0.837	0.001
Age	0.874	0.350	0.002	0.982	0.322	0.003	0.014	0.905	< 0.001
Education	1.372	0.242	0.004	0.482	0.488	0.001	2.371	0.124	0.006
Education * Label	3.907	0.021	0.021	0.033	0.968	< 0.001	0.391	0.677	0.002
Education * Gender	2.595	0.108	0.007	6.716	0.010	0.018	16.706	< 0.001	0.043
Education * Gender * Label	2.144	0.119	0.011	0.208	0.812	0.001	0.052	0.949	< 0.001
Organic fruits consumption	3.352	0.068	0.009	0.612	0.435	0.002	0.157	0.692	< 0.001
Openness to innovation in food	1.271	0.260	0.003	2.211	0.138	0.006	1.710	0.192	0.005
Attitudes to organic certification	1.864	0.173	0.005	0.072	0.789	< 0.001	0.037	0.847	< 0.001

Note. Within the analysis, due to the imbalance in education categories, "elementary/middle school" and "high school degree" were combined into a single category, which was compared to "university degree".

Dall'Asta et al., 2020). Notably, no significant differences were found in purchase intentions between organic and omics-certified apples. This lack of differentiation may be interpreted as an added value for omics certifications, as omics-certified apples were perceived on par with organic ones. This suggests that consumers may regard omics certification as a credible alternative to organic labeling, particularly when compared to conventional products. However, the absence of higher evaluation for omics-certified apples could indicate that the perceived scientific rigor or innovation behind omics technologies does not enhance consumer assessments beyond what is already conferred by the organic label – regarded as the gold standard for food quality. Additionally, it should be considered that omics technologies currently lack meaning or familiarity for most consumers, which may limit their impact on perception. However, the perceived equivalence between bio and omics apples might indicate the potential for omics technologies to integrate seamlessly into the organic food market, capitalizing on the trust and positive perceptions already associated with organic labels, while providing added value through enhanced traceability and authenticity.

Our findings carry significant implications for the organic food industry, food certifiers, and marketing strategies aimed at fostering consumer trust and encouraging the adoption of emerging technologies. First, omics technology could be perceived as an added value within the food supply chain, as evidenced by the differing willingness to purchase conventional versus omics-certified apples. Furthermore, the observed equivalence in purchase intentions between omics-certified and organic apples suggests that omics certifications have the potential to be integrated into the existing organic certification field, particularly among consumers who already value on organic labels. While omics technologies could be perceived as potentially undermining the authenticity or effectiveness of organic labels in certifying the organic nature of food, the findings of the present study do not support this concern, particularly in light of the results related to purchase intention. Rather, omics certifications appear to function as a complementary layer – enhancing rather than diminishing – the value of organic label. Instead of casting doubt on the reliability of organic certification, omics technologies provide scientific validation that may further reinforce consumer trust in the authenticity of the organic product. Therefore, this positive consideration of omics technologies underscores the opportunity to position them as a scientifically advanced yet consumer-friendly alternative or complement to traditional organic certifications. For producers and certifiers, omics technologies provide an opportunity to address key challenges related to transparency and fraud prevention in the organic market. Traditional organic certifications, while widely trusted, are not immune to skepticism due to the complexity of verifying compliance across supply chains. By adopting omics certifications, producers can enhance their credibility, offering scientifically validated traceability that reassures consumers about product authenticity. From a marketing perspective, these findings suggest the importance of strategic communication in presenting omics certifications. By framing omics certifications as a "natural" evolution of organic practices, marketers can build trust and mitigate resistance to new approaches, especially among consumers who may be wary of technological advancements in food production.

This study has some limitations. The study utilized convenience sampling, which may introduce bias as consumers were recruited from specific channels (social media of Università Cattolica del Sacro Cuore). This limits the generalizability of findings to a broader population. Moreover, despite using validated scales, self-reported measures may be subject to recall bias and might not fully capture consumers' actual behaviors. In addition, findings derived from controlled sensory lab settings may not fully replicate real-world consumer experiences or purchasing decisions made in natural shopping environments, potentially limiting the applicability of results to actual market scenarios. Finally, the study mapped only a few psychosocial variables, overlooking certain constructs that could be important for interpreting the results and providing new insights, such as food responsibility (Brunsø et al., 2021). Addressing these limitations in future research could enhance the understanding of consumer perceptions and behaviors toward omics-labelled foods across diverse populations and settings, thereby strengthening the applicability of findings in food market contexts. Moreover, this study also underscores the need for further research into the taste and aesthetic perception of omics-labelled foods, exploring the use of other relevant psychosocial variables that could provide new insights. While this study revealed no significant differences between omics and organic labels in these aspects, it suggests that consumer education and awareness campaigns about the benefits of omics technology could enhance its acceptance and perceived value. Possibly, for omics certification to have a more significant impact, it would require better consumer education, effective communication strategies, and perhaps time to build trust and recognition similar to what organic labels have achieved over the years.

6. Conclusion

This study contributes to the understanding of how omics certifications are perceived in comparison to organic and conventional labels with respect to aesthetic and taste evaluations and purchase intentions. Although no differences emerged in sensory evaluations, purchase intentions for omics-certified apples were comparable to those for organic apples and significantly higher than for conventional apples. This finding highlights that omics certifications are regarded as equally credible and desirable as organic labels, while being perceived as offering greater value than conventional products.

The equivalence in purchase intention between omics and organic certifications represents an important advantage. Omics certifications, which provide advanced traceability and authenticity, can build on the existing trust in organic labels while addressing gaps in transparency and verification. These findings suggest that omics certifications are well-positioned to integrate into the organic food market.

In conclusion, omics certifications constitute a scientifically robust and consumer-accepted alternative to traditional organic certifications. By emphasizing their added benefits, such as enhanced traceability and reliability, stakeholders can maximize their market potential of omics technologies while reinforcing consumer trust within the organic food sector.

CRediT authorship contribution statement

Greta Castellini: Writing – review & editing, Writing – original draft, Methodology, Data curation, Conceptualization. **Matteo Robba:** Writing – review & editing, Writing – original draft, Methodology, Data curation. **Giovanni Vedani:** Writing – review & editing, Writing – original draft. **Milena Lambri:** Writing – review & editing, Supervision. **Fosca Vezzulli:** Writing – review & editing, Supervision. **Guendalina Graffigna:** Writing – review & editing, Supervision, Project administration, Conceptualization. **Luigi Lucini:** Writing – review & editing, Supervision, Project administration, Conceptualization. **Paola Iannello:** Writing – review & editing, Writing – original draft, Supervision, Conceptualization.

Ethics statement

This study was implemented in full compliance with American Psychological Association (APA) guidelines on the conduct of research involving human subjects and with the Declaration of Helsinki, and it has been approved by the ethics committee of Università Cattolica del Sacro Cuore (CERPS).

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data is freely available on the Open Science Framework (OSF) database: https://osf.io/3x96m/?view_only=547927c07e8b4e24b230b890a3e52c45

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