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Analyses of consumers' preferences and of the correspondence between direct and indirect label claims and the fatty acid profile of milk in large retail chains in northern Italy

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ABSTRACT

Combined results from 2 survey studies were used to obtain information useful for the industries and retailers involved in the milk production and selling chain in North Italy. The first survey identified different clusters of fluid milk purchasers by examining their preferences and attitudes toward 12 intrinsic–extrinsic and credence milk attributes, by applying best–worst scaling methodology, whereas the second survey characterized the fatty acid (FA) profiles of commercial milk sold by large-scale retailers to verify the correspondence between the actual FA profile and the direct and indirect claims on the labels. To summarize information about the FA profile of milk, which may be considered an advanced attribute of milk quality, the milk FA index (MFAI) was calculated for each milk sample. A total of 130 milk samples (around 85% of the labels in northern Italy) and a total of 502 participants who answered a face-to-face questionnaire were considered in the 2 surveys. The milk samples were 13.1% organic, 9.2% certified as being of mountain origin, and over 50% noncertified but linked to cow grazing or to a mountain environment on their labels. The FA profiles showed a wide range of variation, with saturated FA ranging from 63.4 to 71.8, and polyunsaturated FA from 2.76 to 5.85. The FA profile and MFAI index of certified milk (organic or mountain-derived) were significantly different from the profiles of noncertified milk, whereas no correspondence was observed between the retail price and milk quality. When ranked on the basis of MFAI, which proved to be a good discriminating tool, the certified milks presented a bimodal distribution, indicating that certification does not always guarantee a real difference. The consumers chose milk considering the origin of the product, brand, expiration date, and process certification as the most important attributes, whereas they rated price and organic certification as the least important attributes. The study showed that about 20% of the consumers had a high propensity to buy milk on the basis of its quality. However, this attribute is often incorrectly indicated or not indicated at all on the milk label, with misleading images or claims that do not correspond to the actual FA quality of the milk. Having a clear index that offers information about the FA profile could thus be an interesting tool to improve the awareness of buyers and to valorize and differentiate milk products.
Key words: retail milk, milk fatty acid profile, label claim, consumer preferences

INTRODUCTION

The controversy about the negative or positive effects of milk consumption on human health has recently been intense, and conflicting statements have emerged from long-term studies about public perceptions of harm to human health (Givens et al., 2014; McCarthy et al., 2017; Delley and Brunner, 2020). Givens et al. (2014), in their systematic review, concluded that milk consumption carries no risk for the health of consumers, and is instead associated with positive effects, such as reduction in blood pressure, no increase in body weight, and an important reduction in the risk of coronary disease. Furthermore, studies conducted over the last few decades have shown that milk fat has several positive effects on human health (Givens, 2010; Dilzer and Park, 2012). This new evidence has led to increased demand for products that have been deemed to be associated with improved human health.

To satisfy the expectations and preferences of consumers, it has become important for producers and retailers to know more about the quality characteristics that are relevant for their customers (Grunert et al., 2004). Consumers' perceptions about food products are very complex phenomena influenced by a wide variety of characteristics. Several literature studies

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have analyzed consumer preferences for food product characteristics that act as drivers that can influence an individual's purchasing decision-making process. A consumer's choice of milk may be influenced by a combination of evaluations of the different features of the commercially offered products (objective intrinsic and extrinsic attributes and beliefs), which may be related to an interest in health, sensory pleasure, ideological reasons, convenience, price, and familiarity (Johansen et al., 2011; Kempen et al., 2017; Harwood and Drake, 2018).

Furthermore, an attractive package creates a positive impact on the attention of consumers and generates expectations about a product (Durgee, 2003). Apart from some certified claims (such as organic labeling and non-GMO products) that are globally recognized and accepted as distinctive of a product, several images or designs (e.g., green herbage, cow grazing, mountains), which are positively perceived by many consumers as "green" images (Delley and Brunner, 2020) and associated with animal welfare, higher-quality product, and less-intensive environmentally friendly production, may be portrayed on a milk package (Croissant et al., 2007; Chintakayala et al., 2018). However, a mismatch between the actual characteristics of a product and consumers' expectations, based on the packaging image or design, or information on the label, may emerge, and consumers do not have the possibility of verifying the accuracy of the perceived properties or the characteristics of the product itself.

In the current highly competitive environment of the self-service economy, any effort to differentiate products and promote food quality will only be successful if new or advanced attributes can be communicated to consumers and can be easily perceived from the claims on the labels of milk packages (Grebitus et al., 2007). In this context, specific knowledge about the fatty acid (**FA**) profile of a given milk may be considered an advanced attribute of milk quality and may offer producers the possibility of differentiating dairy products (Markey et al., 2017; Vargas-Bello-Pérez et al., 2020), However, it is not possible to print a complete milk FA profile on a milk package, and it could be a challenging task for consumers to understand its relevance. The FA composition of milk is known to be remarkably variable as a result of differences in feeding strategies (Chilliard et al., 2001; Prache et al., 2020) and genetics of the animals (Schennink et al., 2007). Moreover, other than promoting health benefits, the FA composition of milk is known to play a role in the appearance, sensory characteristics, and taste attributes of fluid milk (Schiano et al., 2017), which are key drivers of food preferences and consumer choices (Markey et al., 2017). However, research conducted thus far indicates that consumers have little knowledge of how milk is produced and do not understand complex information about the FA profile of milk (Diekman and Malcolm, 2009; O'Donnell et al., 2010). In view of making the FA profile of milk more readable and understandable, Coppa et al. (2017) proposed a numerical index, called the milk fatty acid index (**MFAI**), which may be used to summarize the FA profile of milk, by taking into account 10 selected individual FA, their sum, and the resulting ratios. This index can be used to obtain concise information about the FA attributes of milk that are relevant for the health and nutrition of humans, as well as about the influence of the sensory properties of dairy products. To the best of our knowledge, no studies are available in which the correspondence between the actual FA profile of milk offered in the large-scale retail trade and the image, information, and claims reported on product labels have been evaluated.

Hence, the aims of the work were (1) to characterize the FA profile of commercial milk sold by large-scale retailers in northern Italy, to calculate the resulting MFAI, and to verify the correspondence between the direct and indirect claims on the labels and the actual FA profile of milk; (2) to investigate the preferences and attitudes of consumers toward 12 attributes used to describe milk, to analyze the socio-demographic profiles of the respondents, and to identify different clusters of consumers in relation to their consumption and purchasing habits; and (3) to combine results from the 2 survey studies to obtain information useful for the industries and retailers involved in the milk production and selling chains in North Italy.

MATERIALS AND METHODS

Milk Sampling and FA Gas Chromatography Analysis

A total of 130 milk samples, taken from different types of retailer stores (hypermarkets and supermarkets) in several regions in northern Italy, over the period from 2016 to 2017, were considered in this research.

The sampling was organized to collect as many different milk brands and labels as possible. More than 85% of the milk brands and labels sold by large retail suppliers in the studied area had been collected by the end of the survey. Of the total milk commercialized in Italy, 43.7% is destined to production of protected designation of origin (PDO) cheeses, 38.8% to other dairy products, and 17.5% to the fluid milk market. Around 2,450,000 t of fluid milk are sold per year; of which 69.7% is produced in northern Italy and 11.8% is imported from other European Union countries. The sampling priority for each brand of milk was UHT and full fat. When UHT was not available, we selected

HTST-pasteurized milk, and when full-fat milk was not available, we selected partially skim milk. When one of the mentioned characteristics was not satisfied, the milk was not included in the selection. Skim milk and enriched or fortified milk (i.e., with added n-3) were not included in the selection. If the same brand included conventional or organic milk, both were included in the survey. One-liter milk packages were collected and stored at 4°C until the analysis. The price per liter and all the indications reported on the label were recorded: organic or mountain certification; mountain reference (i.e., name referring to a mountain landscape or name, mountain image, or similar); images of pastures, grasslands, or grazing cows; the area or country where milking took place; and the country where the dairy plant is located.

The FA analyses, conducted by means of the GC method, were performed according to Coppa et al. (2015). Briefly, after lyophilization of the milk samples, they were methylated and analyzed. The FA methyl esters were analyzed using a 7890A GC-System (Agilent Technologies), equipped with a flame ionization detector. The FA methyl esters were separated on a 100-m × 0.25-mm internal diameter, fused-silica capillary column (CP-Sil 88, Chrompack). The injector temperature was maintained at 250°C, and the detector temperature was kept at 255°C. The initial temperature in the oven was held at 70°C for 1 min, increased by 5°C/min to 100°C (held for 2 min), then increased by 10°C/min to 175°C (held for 40 min), and then by 5°C/min to a final temperature of 225°C (held for 15 min). The carrier gas was hydrogen. Peaks were routinely identified by comparing the retention times against commercial authentic standards. The FAME proportions were corrected to FA proportions according to their respective molecular weights. The FA concentrations were measured by means of the reference GC method, as grams per 100 g of FA.

MFAI Calculation

The MFAI and its human health, dairy product sensory property, animal welfare, and environmental sustainability sub-pillars were also calculated from the FA profile of the milk, according to Coppa et al. (2017). Briefly, 10 FA were selected to calculate MFAI (C18:3n -3, CLA *cis*-9,*trans*-11, even-chain SFA, branched-chain FA, MUFA, PUFA, the sum of n-3, the ratio of n-3 to n-6, the ratio of C18:1 *cis*-9 to C16:0, and the ratio of C18:1 *trans*-10 to C18:1 *trans*-11) according to their relevance for human health, potential cheese sensory properties, animal welfare, and environmental sustainability, on the basis of the literature detailed by Coppa et al. (2017). These factors were selected as dimensions of MFAI. The rationale behind the attribution of an FA to a pillar or sub-pillar is presented in the work of Coppa et al. (2017). The MUFA, PUFA, C18:3n-3, total n-3 FA, and ratio of n-3 to n-6 FA were included in the human health dimension because of their effect of lowering the risk factors of cardiovascular disease, and even-chain SFA were included because of their effect of increasing the risk factors of cardiovascular disease. High concentrations of CLA *cis*-9,*trans*-11 and branched-chain FA concur in reducing body fat, cardiovascular diseases, and cancer, modulating immune and inflammatory responses, and improving bone mass (Vlaeminck et al., 2006; Dilzer and Park, 2012). As far as the dairy product sensory property dimension is concerned, richness in PUFA has been associated with richness in odor-active compounds and specific sensory descriptors in milk and cheese (Urbach, 1990; Giaccone et al. 2016); high concentrations of even-chain SFA and low concentrations of MUFA and PUFA, as well as a high ratio of C18:1 *cis*-9 to C16:0, reduce the melting ability and creaminess of butter and cheese (Prache et al., 2020). As for the animal welfare dimensions, the ratio of C18:1 *trans*-10 to C8:1 *trans*-11 is an indicator of subacute ruminal acidosis (Enjalbert et al., 2008). Moreover, branched-chain FA decrease as the fiber proportion in the cow diet decreases, thus favoring ruminal metabolic disorders (Bauman and Griinari, 2003). As far as the environmental sustainability dimension is concerned, soil carbon storage and biodiversity are higher in grasslands than in arable lands, and water pollution and soil erosion are lower (Peeters, 2012; Arnould et al., 2013). The inclusion of grass-derived forage in cow diets increases CLA *cis*-9,*trans*-11 and C18:3 n-3 in milk (Coppa et al., 2019). A class approach was applied, using the procedure described by Coppa et al. (2017), to establish the classes, the reference values, and the limits of each class, as well as a positive or negative note, according to the positive or negative role of each FA in the listed dimensions. The sum of the notes of the class of each FA was used to generate MFAI. Details on the calculation procedure are given in Coppa et al. (2017).

Consumer Survey: Data Collection and Analysis

A choice experiment, based on face-to-face interviews, was conducted at different points of the milk purchase chain of 4 large retail chains, considering 2 metropolitan areas in northwestern Italy to investigate consumers' stated preferences pertaining to the intrinsic–extrinsic and credence attributes of milk. The surveys were carried out, using a paper questionnaire,

Table 1. Conceptual framework developed in the paper questionnaire and used for the consumer study

I. Socio-demographic characteristics

Sex	Age	Family size	Household average annual income	Educational level	Employment
• Male • Female	Age ranges (yr): • 18–25 • 26–35 • 36–45 • 46–55 • 56–65 • 66–75 • >75	Number of family members: • 1 • 2 • 3 • 4 • >4	Range (€/yr): • <25,000 • 25,000–40,000 • 40,000–60,000 • >60,000	• Primary school; lower secondary school • Upper secondary school • Master's degree	• Homemaker • Unemployed • Employed • Self-employed • Retired • Student

II. Exploration of consumer habits of purchase and consumption regarding milk
Milk type based on product shelf life:
• Conventional pasteurization (must be kept in the refrigerator for a maximum of 3–4 d)
• Shelf-stable (does not require refrigeration until opened)

III. Milk attribute (n = 12) choice sets based on best–worst methodology

Intrinsic attributes	Credence attributes	Extrinsic attributes
• Fat content (skim, partially skimmed, or whole) • Taste • Nutritional value	• Organic certification • Locally farmed • Origin indication (national or abroad) • Certification (of both process and product)	• Brand • Label claims (visual and verbal) • Expiration date • Price • Package type (plastic jug, cardboard carton, glass)

from May to July 2019, from Monday to Sunday, over 2 time slots (0800 to 1200 h and 1500 to 2000 h) by randomly intercepting respondents outside shops that sold milk. Respondent eligibility criteria, which were checked before the interview, were the following: being 18 yr of age or older, buying milk for personal or for other family component consumption, being responsible for household food shopping, consuming or purchasing fluid milk at least once a month, and not being a market researcher or a dairy food industry employee. Subdivision of the sample into age ranges followed the criteria used to characterize the consumer panel in surveys by Nielsen, a research company that is a world leader in the collection and management of media and market data (ISMEA, 2017). The questionnaire included a first part dedicated to the socio-demographic characteristics of the individuals, a second part on their milk purchasing habits, and a final part on the implementation of the best–worst scaling methodology (**BWS**; Table 1). This multivariate and quantitative method was introduced by Finn and Louviere (1992) and then formalized by Marley and Louviere in 2005. Compared with other methods used for the indirect assessment of individual preferences, BWS allows the degree of preference of subjects to be measured directly over a set of attributes that describe a product. Our BWS-based choice experiment involved showing respondents several subsets of features for which they were asked to choose the best and the worst attributes for choosing milk (Table 2). Such a procedural approach overcomes the reduction of survey efficiency due to the limits of ranging and ranking, which imply a high cognitive effort on the part of the respondent (Marley and Louviere, 2005).

The responses to all the attribute subsets were analyzed to create a preference ranking of the quantitative scores (raw average score) obtained from the individual levels of preference declared by the respondents, which were then defined and assigned to each considered

Table 2. Example of survey scheme of best–worst choice set questions as implementated in the questionnaire for selecting milk attributes: respondents were instructed, "Thinking about milk, tick only the one attribute that is MOST important for you and the attribute that is LEAST important in making your product choice"

Most important (check one)	Milk attribute	Least important (check one)
☐	Price	☐
☐	Local origin	☐
☐	Fat content (skimmed, partially skimmed, whole milk)	☐
☐	Brand	☐

qualitative attribute (Umberger et al., 2010). The BWS experimental design adopted in our research was developed using Sawtooth MaxDiff Designer software (SSI-version 8.4.6; http://www.sawtoothsoftware.com/) in accordance with the standard design commonly used in BWS surveys: given a set of n attributes, r choice sets are provided, each containing t attributes (constant condition $n > t$), according to a balanced incomplete block scheme (Mori and Tsuge, 2017; Liu et al., 2018). Therefore, each attribute appears s times in the experimental design, and each couple of items appears λ times. The λ and s numbers are integers, and λ can be calculated with the equation $\lambda = s \times (t - 1)/(n - 1)$ (Crouch and Louviere, 2007; Liu et al., 2018).

In our research, 12 (n) intrinsic–extrinsic and credence milk features were selected and organized into 9 sets (r) of 4 attributes (t), and each single attribute appeared 3 times (s). In addition, the software created 4 different questionnaire versions to increase the variability by which the different attribute combinations were presented to the respondents. After a literature research review on evaluation of consumer food preferences, and of milk in particular (Colonna et al., 2011; Palupi et al., 2012; Uzundumlu et al., 2018), the following 12 milk attributes were selected for application of BWS: (1) price, (2) organic certification, (3) fat content (skimmed, partially skimmed, or whole), (4) expiration date, (5) taste, (6) package type (plastic bottle, cardboard carton, glass), (7) certification (of both the process and product), (8) locally farmed origin, (9) indication of the origin (national or foreign), (10) brand, (11) label claims (visual and verbal), and (12) nutritional value.

Linking the Milk FA Survey to the Consumer Survey

The FA profile of milk was analyzed, and MFAI was calculated to obtain overall information about milk quality. The FA profile is considered an advanced attribute of milk quality, and it was chosen to take into account the intrinsic–extrinsic and credence features of the "fat content," "taste," and "nutritional value" of the milk considered in the consumer survey. On the basis of the other intrinsic–extrinsic and credence milk features used in the consumer survey, the milk samples were clustered into (1) organic (to express the attributes of both "organic" and "certified" milk); (2) certified as originating from a mountain environment (to express the attributes of both "locally farmed" and "certified" milk); (3) not certified as originating from a mountain environment but with a name or image clearly referring to mountains (to express the attributes of both "locally farmed" milk and "label claim"); (4) not certified as originating from grazing cows but with labels clearly showing pasture or herbage images or grazing cows (to express the "label claim" attribute); and (5) commodity milk with claims or images that were not included in the previous categories. The analyzed samples were also clustered according to the country where the milk was packaged, using EU codification (to express the "origin indication" attribute), and to the retail price ranges (to express the "price" attribute). Finally, the analyzed samples were categorized according to the following brand categories to express the "brand" attribute (ASSOLATTE, 2018): distributor brand or private label, leading producers, local brand (when the regional indication of origin was reported on the label), and other brands (all samples not included in the previous 3 categories). Retail prices were categorized considering the following thresholds: <1 €/L, between 1 and 1.5 €/L, and >1.5 €/L.

Statistics

Statistical analyses were performed using SPSS, version 27.0 for Windows (SPSS Inc.). To test for a possible difference in the FA profile and MFAI index of milk for any studied label claim, a general linear ANOVA model was performed on the 10 FA composing the MFAI, on the total MFAI, and on its sub-pillars, using the studied label claim as a fixed effect. The Bonferroni test was used as the post-hoc test, and differences were declared at $P < 0.05$.

Individuals' responses to the consumer survey were analyzed using the same Sawtooth software. Analysis of the frequency responses to the maximum difference of the attribute pairs (best–worst) provided the preference level of each attribute, which was indicated as the raw average score (**RAS**). The matrix analyzed by the software was composed of several rows equal to the sample size and 18 columns containing the position of the attributes chosen as "best" and "worst" (numbered from 1 to 4) in each of the 9 sets (9 × 2 columns); for example, the best1 and worst1 columns (for the first set of attributes), the best2 and worst2 columns (for the second set) up to the best9 and worst9 columns (for the last set in the questionnaire). An additional column was included to contain the version number of the questionnaire (4 different versions were administered in our study). The individual sums of the "best" and "worst" attributes of each of the 12 attributes were then summed over all the individuals to determine an aggregate measure of "plus" and "minus" for each attribute (Umberger et al., 2010). By asking the respondents to repeatedly choose the 2 most extreme attributes (best and worst) for each submitted subset, the RAS of each attribute was obtained by dividing the number resulting from the difference between the total number of times each attribute was chosen as "best" and the total number of times each attribute was listed as "worst" by the number of times each attribute appears in the experimental design ($r = 3$), multiplied by the sample size (number of observations). These preference scores (which measure the importance of each single item) can be positive or negative, and their sum is always equal to zero. The standard deviation was used as a raw indicator of variability for the preference definition of the whole sample.

The rescaled scores—the relative preference scores of each attribute obtained by the RAS, for which the sum is equal to 100—were then used as dependent variables in the latent class analysis. This method was employed to examine respondents' heterogeneity and identify homogeneous individual groups in the sample population with respect to the expressed preferences for each milk attribute (Casini et al., 2009; Merlino et al., 2018). The rescaled score in the cluster analysis allows groups to be compared and the individual preferences to be analyzed and interpreted (Cohen, 2009). The theoretical properties of the latent class analysis are explained in Umberger et al. (2010). In general, the sample in a latent class analysis is divided into k latent classes, whose number and size are unknown a priori: in our research, the preferable sample segmentation provided by the software was chosen after selecting the lowest values of the log-likelihood and the related Bayesian information criterion for each model, according to Dekhili et al. (2011). Therefore, the 5-cluster model was chosen on the basis of parsimony and interpretability, to describe the heterogeneity of the sample, as shown in Table 3 (Dekhili et al., 2011; Chrysochou et al., 2012). Clusters were analyzed considering the relative preference level expressed by individuals for each attribute and their socio-demographic characteristics. An ANOVA test was conducted in SPSS 27.0 for Windows, using the Tukey HSD (honestly significant difference) test to examine whether any significant differences in individual's preferences existed across the 5 clusters (Umberger et al., 2010).

RESULTS

Fatty Acid Profile of the Analyzed Milk

The descriptive statistics of the gas-chromatographic data of the retail milk collected in the survey, pertaining to the main FA of milk, are reported in Table 4, together with their sums and ratios. A wide range of variation appears for the different FA, with SFA ranging from 63.37 to 71.83, MUFA from 23.77 to 30.37, and PUFA from 2.76 to 5.85. Moreover, the FA and some ratios and indexes that are favorable for human health showed a wide variation (i.e., n-3/n-6; ΣCLA). The n-3/n-6 ratio and the sum of CLA had mean values of 0.35 and 0.68, and reached maximum values of 0.98 and 1.33, respectively. The MFAI indexes showed low mean values, whereas the maximum values reached interesting values for the human health, animal welfare, and environmental sustainability sub-pillars.

The profiles of the 10 selected individual FA, as well as the indexes and ratios of the organic and nonorganic retailed milk are reported in Table 5. The 2 analyzed groups present significant differences for all the analyzed items, with greater C18:3n-3, CLA *cis*-9,*trans*-11, branched-chain FA, MUFA, PUFA, total n-3, n-3/n-6 ratio, and C18:1 *cis*-9/C16:0 ratio values, and lower C18:1 *trans*-10/C18:1 *trans*-11 ratio values. The MFAI index also discriminates between the 2 groups, showing greater values for the organic milk group in all the considered sub-pillars. The differences in the 10 selected individual FA, their sum, and the ratios of the retailed milk, split according to their certification concerning mountain origin and in reference to mountains on the label (name or image but no certification), as well as milk with no reference to mountains or certification, are reported in Table 6. The mountain-derived milk presents more favorable values than the samples with no reference to mountains, with higher C18:3n-3, n-

Table 3. Models (segmentations) provided by latent class analysis and the related indexes derived by individuals' preferences index stated for the 12 milk attributes[1]

Model	LL	BIC	Chi-squared	Relative chi-squared
2-cluster	−8,074.2	16,352.7	3,814.2	165.8
3-cluster	−7,920.0	16,150.9	4,122.6	117.8
4-cluster	−7,808.6	16,034.6	4,345.4	92.5
5-cluster[2]	−7,718.7	15,961.4	4,525.3	76.7

[1]LL = log-likelihood; BIC = Bayesian information criterion.

[2]The 5-cluster model was chosen in this research, corresponding to the minor values of LL, BIC, and relative chi-squared.

3/n-6 ratio, and total MFAI values. Milk that shows a reference to mountains but which is not certified presents intermediate values. The profiles of the 10 selected individual FA and their indexes and ratios of the retail milk, with reference to pastures or grazing cows on the label (pasture image), and milk with no reference to pastures, are reported in Table 7. Milk with a pasture image on the label has higher C18:3n-3, CLA *cis*-9,*trans*-11, branched-chain FA, and MUFA, and lower even-chain FA and C18:1 *trans*-10/C18:1 *trans*-11 ratio. The MFAI indexes are all higher in milk with pasture images on the label, except for MFAI dairy product sensory properties. The profiles of the 10 selected individual FA and their indexes and ratios of the retail milk available on the market in northern Italy are reported in Table 8 according to the country where the milk packaging took place. Most of the foreign milk sold in Italy was packaged in France and Austria, and only 6 were of generic EU origin. The Austrian and French samples present higher C18:3n-3, CLA *cis*-9, total n-3,

Table 4. Descriptive statistics of the main milk fatty acid (FA) composition of the sampled retail milk (n = 130)

Fatty acid (g/100 g of FA)	Mean	Median	Min	Max	SD
C4:0	3.38	3.28	2.79	4.68	0.40
C6:0	2.31	2.29	1.78	2.90	0.18
C10:0	2.85	2.88	1.91	3.43	0.20
C12:0	3.26	3.27	2.27	3.88	0.24
iso C14:0	0.11	0.11	0.08	0.26	0.03
C14:0	10.78	10.79	9.48	11.93	0.52
anteiso C15:0	0.45	0.44	0.34	0.82	0.06
C14:1 *cis*-9	0.93	0.92	0.79	1.17	0.07
C15:0	1.12	1.12	0.95	1.64	0.08
iso C16:0	0.25	0.25	0.20	0.39	0.03
C16:0	30.16	30.10	26.32	35.33	1.38
C16:1 *cis*-9	1.42	1.42	1.18	2.19	0.13
anteiso C17:0	0.43	0.42	0.35	0.61	0.04
C17:0	0.56	0.55	0.48	0.94	0.05
C18:0	9.58	9.58	6.96	11.14	0.73
C18:1 *trans*-10	0.36	0.37	0.14	0.68	0.12
C18:1 *trans*-11	1.13	0.94	0.54	2.57	0.43
C18:1 *cis*-9	18.97	18.94	16.61	22.32	0.99
C18:1 *cis*-11	0.61	0.61	0.43	0.87	0.06
C18:2n-6	1.89	1.95	0.98	3.00	0.49
C18:3n-3	0.47	0.43	0.23	0.95	0.15
CLA *cis*-9,*trans*-11	0.54	0.47	0.30	1.17	0.19
C20:4n-6	0.14	0.14	0.07	0.19	0.03
SFA	67.81	67.81	63.37	71.83	1.44
MUFA	26.87	26.90	23.77	30.37	1.16
PUFA	4.23	4.22	2.76	5.85	0.46
Even-chain SFA	63.86	63.90	58.34	67.73	1.50
Odd-chain FA	2.41	2.39	2.12	3.44	0.15
Branched-chain FA	1.88	1.86	1.46	2.63	0.22
Total n-6	2.22	2.29	1.14	3.39	0.55
Total n-3	0.71	0.67	0.36	1.40	0.21
n-3/n-6	0.36	0.31	0.15	0.98	0.18
Σ C18:1 *cis*	20.66	20.62	18.06	24.09	1.03
Σ C18:1 *trans*	2.49	2.46	1.57	3.76	0.37
Σ *trans* FA	3.92	3.79	2.70	6.34	0.65
C18:1 *cis*-9/C16:0	0.63	0.63	0.50	0.82	0.06
C18:1 *trans*-10/C18:1 *trans*-11	0.38	0.42	0.07	0.70	0.19
Σ de novo synthesized FA	23.87	23.91	19.29	26.43	1.06
Σ CLA	0.68	0.60	0.41	1.33	0.21
Atherogenicity index	2.58	2.57	2.03	3.26	0.22
Thrombogenicity index	2.97	2.99	1.69	3.60	0.26
MFAI HH[1]	0.24	0.16	0.00	1.81	0.40
MFAI SPDP	0.11	0.09	0.00	0.60	0.10
MFAI AW	0.80	0.83	0.56	1.25	0.19
MFAI ES	0.06	0.00	0.00	0.49	0.14
Total MFAI	1.21	1.00	0.56	4.10	0.75

[1]MFAI = milk FA index (Coppa et al., 2017); HH = human health pillar; SPDP = sensory properties of dairy products sub-pillar of dairy industry pillar; AW = animal welfare sub-pillar of dairy industry pillar; ES = environmental sustainability sub-pillar of dairy industry pillar.

Table 5. Fatty acid (FA) composition and milk fatty acid index (MFAI) of organic and nonorganic retail milk

Fatty acids (g/100 g of FA)[1]	Nonorganic (n = 113)	Organic (n = 17)	SEM	*P*-value
C18:3n-3	0.45	0.60	0.013	<0.001
CLA *cis*-9,*trans*-11	0.52	0.70	0.017	<0.001
Even-chain SFA	64.03	62.78	0.127	0.001
Branched-chain FA	1.86	1.99	0.019	0.022
MUFA	26.79	27.42	0.102	0.034
PUFA	4.17	4.66	0.040	<0.001
Total n-3	0.69	0.84	0.018	0.007
n-3/n-6	0.34	0.45	0.015	0.020
C18:1 *cis*-9/C16:0	0.62	0.67	0.005	0.001
C18:1 *trans*-10/C18:1 *trans*-11	0.39	0.30	0.017	0.066
MFAI HH	0.19	0.59	0.035	<0.001
MFAI DPSP	0.10	0.19	0.009	0.001
MFAI AW	0.78	0.94	0.017	0.001
MFAI ES	0.04	0.19	0.013	<0.001
Total MFAI	1.10	1.90	0.066	<0.001

[1]MFAI = milk FA index (Coppa et al., 2017); HH = human health pillar; SPDP = sensory properties of dairy products sub-pillar of dairy industry pillar; AW = animal welfare sub-pillar of dairy industry pillar; ES = environmental sustainability sub-pillar of dairy industry pillar.

n-3/n-6, and MFAI environmental sustainability values. No differences in the milk FA profile or MFAI were observed when the samples were categorized according to the retail price (Table 9). Moreover, no differences were observed when the samples were categorized on the basis of their brand (distributor, leading producers, local, and others; data not shown).

Table 10 reports the selected individual FA and MFAI of the retail milk composing the 5th and 95th percentiles of the MFAI distribution, together with label information about certification (organic or mountain-derived), label reference to mountains, label reference to pastures, packaging country, and retail price.

Consumer Preference Results

Details of the socio-demographic variables of the 502 milk-purchasing respondents are reported in Table 11. The considered sample was characterized by male and female proportions of 29 and 71%, respectively, with an average age of 59 yr. The stated preference level (RAS) of each milk attribute for milk purchasers is reported in Table 12. Consumers' choices when purchasing milk were first determined considering the following credence and extrinsic attributes: the origin of the product (with highest average RAS of 2.13), followed by product brand, and then the local origin. The expiration

Table 6. Fatty acid (FA) composition and milk fatty acid index (MFAI) of milk certified from mountain origin, milk with reference to mountain on the label (name or image but no certification), and milk with neither reference to mountain nor certification

Fatty acids (g/100 g of FA)[1]	Mountain certified (n = 12)	Mountain reference (just name or image; n = 25)	No reference to mountain (n = 93)	SEM	*P*-value
C18:3n-3	0.597[a]	0.518[ab]	0.443[b]	0.013	0.001
CLA *cis*-9,*trans*-11	0.746[c]	0.639[b]	0.494[c]	0.017	<0.001
Even-chain SFA	63.478	63.476	64.019	0.127	0.177
Branched-chain FA	2.109[a]	1.948[b]	1.834[b]	0.019	<0.001
MUFA	26.952	27.173	26.778	0.102	0.311
PUFA	4.188	4.302	4.222	0.040	0.695
Total n-3	0.845[a]	0.741[ab]	0.683[b]	0.018	0.029
n-3/n-6	0.482[a]	0.377[b]	0.332[b]	0.015	0.016
C18:1 *cis*-9/C16:0	2.034	1.982	1.982	0.005	0.496
C18:1 *trans*-10/C18:1 *trans*-11	0.178[c]	0.311[b]	0.419[a]	0.017	<0.001
MFAI HH	0.625[a]	0.378[b]	0.156[b]	0.035	<0.001
MFAI DPSP	0.119	0.132	0.103	0.009	0.458
MFAI AW	1.040[a]	0.832[b]	0.759[b]	0.017	<0.001
MFAI ES	0.169[a]	0.112[a]	0.026[b]	0.013	<0.001
Total MFAI	1.953[a]	1.454[b]	1.045[b]	0.066	<0.001

[a–c]Means within a row with different superscripts differ ($P < 0.05$) for Bonferroni post hoc test.

[1]MFAI = milk FA index (Coppa et al., 2017); HH = human health pillar; SPDP = sensory properties of dairy products sub-pillar of dairy industry pillar; AW = animal welfare sub-pillar of dairy industry pillar; ES = environmental sustainability sub-pillar of dairy industry pillar.

Table 7. Fatty acid (FA) composition and milk FA index (MFAI) of milk with reference to pasture or grazing cows on the label (image) and conventional retail milk

Fatty acids (g/100 g of FA)[1]	Pasture image (n = 62)	No pasture image (n = 68)	SEM	P-value
C18:3n-3	0.507	0.440	0.013	0.010
CLA *cis*-9,*trans*-11	0.600	0.495	0.017	0.001
Even-chain SFA	63.465	64.230	0.127	0.003
Branched-chain FA	1.957	1.813	0.019	<0.001
MUFA	27.138	26.626	0.102	0.011
PUFA	4.289	4.185	0.040	0.193
Total n-3	0.738	0.683	0.018	0.138
n-3/n-6	0.377	0.334	0.015	0.167
C18:1 *cis*-9/C16:0	1.991	1.982	0.005	0.713
C18:1 *trans*-10/C18:1 *trans*-11	0.330	0.417	0.017	0.009
MFAI HH	0.366	0.129	0.035	0.001
MFAI DPSP	0.126	0.096	0.009	0.103
MFAI AW	0.866	0.739	0.017	<0.001
MFAI ES	0.093	0.023	0.013	0.005
Total MFAI	1.450	0.986	0.066	<0.001

[1]MFAI = milk FA index (Coppa et al., 2017); HH = human health pillar; SPDP = sensory properties of dairy products sub-pillar of dairy industry pillar; AW = animal welfare sub-pillar of dairy industry pillar; ES = environmental sustainability sub-pillar of dairy industry pillar.

date and the product and process certifications were positively evaluated, with RAS of around 0.90. The price of the product was not considered as particularly important when choosing milk, with an average RAS of 0.085. The least important attribute considered when purchasing milk was organic certification (credence attributes). The other intrinsic and extrinsic factors (packaging material, fat content, visual and verbal label claims, nutritional value, and taste) were evaluated by most of the participants as not being very relevant when choosing milk.

Latent Class Cluster Analysis

Cluster analysis was performed considering the entire sample of consumers (n = 502), and 5 different clusters were identified (Table 13). The individuals belonging to each group had similar preferences and attitudes toward the 12 considered milk attributes. Analysis of socio-demographic variables showed an equal distribution between women (mean 70%) and men (mean 30%) in the 5 groups. However, some differences emerged when considering the median age of the individuals (Figure

Table 8. Fatty acid (FA) composition and milk FA index (MFAI) of retail milk available on the market of northern Italy according to the origin of the milk packaging company

Fatty acids (g/100 g of FA)[1]	Italy (n = 88)	France (n = 18)	Austria (n = 18)	Other (n = 6)	SEM	P-value
C18:3n-3	0.43[b]	0.56[a]	0.59[a]	0.45[ab]	0.013	<0.000
CLA *cis*-9,*trans*-11	0.49[b]	0.66[a]	0.70[a]	0.51[ab]	0.017	<0.000
Even-chain SFA	67.69	67.99	68.16	67.97	0.127	0.821
Branched-chain FA	1.83[b]	2.10[a]	1.91[b]	1.90[b]	0.019	<0.000
MUFA	26.93	26.76	26.60	27.12	0.102	0.636
PUFA	4.34	4.02	4.05	3.85	0.040	0.001
Total n-3	0.66[b]	0.83[a]	0.85[a]	0.67[ab]	0.018	<0.000
n-3/n-6	0.28[c]	0.53[ab]	0.55[a]	0.36[bc]	0.015	<0.000
C18:1 *cis*-9/C16:0	0.63	0.63	0.62	0.64	0.005	0.726
C18:1 *trans*-10/C18:1 *trans*-11	0.46[a]	0.23[b]	0.17[b]	0.28[b]	0.017	<0.000
MFAI HH	0.19	0.46	0.30	0.16	0.035	0.066
MFAI DPSP	0.12	0.09	0.09	0.13	0.009	0.457
MFAI AW	0.76[b]	0.95[a]	0.82[a]	0.83[ab]	0.017	0.002
MFAI ES	0.04	0.14	0.07	0.05	0.013	0.053
Total MFAI	1.11	1.63	1.27	1.17	0.066	0.063

[a–c]Means within a row with different superscripts differ ($P < 0.05$) for Bonferroni post hoc test.

[1]MFAI = milk FA index (Coppa et al., 2017); HH = human health pillar; SPDP = sensory properties of dairy products sub-pillar of dairy industry pillar; AW = animal welfare sub-pillar of dairy industry pillar; ES = environmental sustainability sub-pillar of dairy industry pillar.

1). The consumers who were more sensitive to the organoleptic characteristics of milk (*Organoleptic quality sensitive*) were under 45 yr (53%). *Brand sensitive* individuals were represented by older participants, 74% of whom were aged 46 yr and older. The *Loyal to local product* consumers were characterized by individuals of ages ranging from 36 to 55 yr. The family composition of each cluster is described in Figure 2. The 5 clusters are mainly represented by 2-component families; however, a higher number of couples can be observed in the *Brand sensitive* cluster, whereas consumers interested in the organoleptic characteristics and the national origin of the product are predominantly represented by families with 3 and 4 members.

The average annual incomes (€/yr) of the individuals belonging to the 5 clusters are reported in Figure 3. The lowest average income is linked to respondents sensitive to the organoleptic quality of milk, whereas the highest one is linked to consumers sensitive to local brand. The consumers in the different clusters are characterized by a medium educational level (holders of secondary school leaving certificate), although the *Attentive to product origin* consumers have mostly completed a master's degree (Figure 4).

Milk Purchasing Habits

Analysis of consumers' milk purchasing habits showed that 274 consumers were oriented only toward buying fresh milk and 174 toward purchasing UHT milk (Figure 5). Only 54 respondents declared that they bought both milk typologies. Investigation of the characteristics of individuals belonging to each cluster revealed that fresh milk was preferred by consumers who paid attention to the origin of the product, especially in the case of milk produced locally. Moreover, individuals who were attentive to national origin as well as to the expiration date preferred fresh milk. The *Organoleptic quality sensitive* and *Quality certified sensitive* clusters were characterized by most consumers oriented toward UHT milk. *Brand sensitive* individuals were represented by consumers equally distributed between UHT and fresh milk.

DISCUSSION

This study, combining results from 2 different surveys, intended to identify the main drivers of buyers at large retail market chains in northern Italy in choosing milk, and to evaluate and verify correspondence between milk quality, in terms of milk FA profile, and the visual and verbal claims reported on milk labels. Of the analyzed milk samples, 13.1% were certified as organic, 9.2% as mountain-derived, and over 50% showed images or messages linked to cow grazing (62 samples) or to a mountain environment (25 samples) on their labels. It has recently been shown that it is possible to link the FA profile to positive or negative effects on human health (Yu and Hu, 2018), to the sensory properties of dairy products, and to some aspects of animal welfare, in terms of ruminal functionality (Bauman and Griinari, 2003). The link to positive effects on environmental health are connected to a high correlation with the effect of the composition of the diets of dairy cows (Prache et al., 2020). The presence of high proportions of fresh herbage or of conserved forages, produced on grassland from both permanent and rotational meadows, in the diets of dairy cows is known to modify the

Table 9. Fatty acid (FA) composition and milk fatty acid index (MFAI) of retail milk according to price level

Fatty acids (g/100 g of FA)[1]	<1.0 €/L (n = 50)	Between 1.0 and 1.5 €/L (n = 58)	≥1.5 €/L (n = 22)	SEM	*P*-value
C18:3n-3	0.48	0.47	0.47	0.013	0.983
CLA *cis*-9,*trans*-11	0.55	0.55	0.52	0.017	0.863
Even-chain SFA	64.02	63.74	63.84	0.127	0.637
Branched-chain FA	1.87	1.89	1.86	0.019	0.922
MUFA	26.75	26.94	26.97	0.102	0.588
PUFA	4.17	4.29	4.23	0.040	0.482
Total n-3	0.72	0.71	0.68	0.018	0.833
n-3/n-6	0.38	0.34	0.33	0.015	0.392
C18:1 *cis*-9/C16:0	0.63	0.63	0.63	0.005	0.747
C18:1 *trans*-10/C18:1 *trans*-11	0.35	0.40	0.39	0.017	0.484
MFAI HH	0.20	0.26	0.30	0.035	0.586
MFAI DPSP	0.10	0.11	0.14	0.009	0.252
MFAI AW	0.77	0.81	0.83	0.017	0.333
MFAI ES	0.05	0.06	0.06	0.013	0.858
Total MFAI	1.11	1.24	1.33	0.066	0.460

[1]MFAI = milk FA index (Coppa et al., 2017); HH = human health pillar; SPDP = sensory properties of dairy products sub-pillar of dairy industry pillar; AW = animal welfare sub-pillar of dairy industry pillar; ES = environmental sustainability sub-pillar of dairy industry pillar.

Table 10. Fatty acid (FA) composition and milk fatty acid index (MFAI) of the retail milks composing the 5th and 95th percentiles of the MFAI distribution

	5th percentile						95th percentile					
Fatty acids (g/100 g of FA)[1]	1	2	3	4	5	6	125	126	127	128	129	130
C18:3n-3	0.33	0.48	0.31	0.37	0.42	0.25	0.73	0.93	0.68	0.95	0.76	0.88
CLA *cis*-9,*trans*-11	0.37	0.31	0.41	0.37	0.33	0.38	0.87	0.98	0.92	0.95	1.17	1.09
Even-chain SFA	65.15	66.19	64.90	65.19	65.32	65.37	61.30	61.95	60.75	61.01	59.51	58.75
Branched-chain FA	1.50	2.13	1.55	1.83	1.67	1.89	2.28	2.35	2.22	2.22	2.39	2.25
MUFA	26.49	24.23	26.24	25.87	25.80	26.11	28.41	26.94	28.91	28.46	29.84	29.63
PUFA	3.96	4.04	4.08	4.11	4.14	3.70	4.42	4.88	4.48	4.71	5.03	5.85
Total n-3	0.51	0.67	0.49	0.64	0.62	0.42	1.07	1.24	0.99	1.27	1.04	1.15
n-3/n-6	0.21	0.28	0.19	0.26	0.24	0.18	0.73	0.86	0.66	0.98	0.56	0.46
C18:1 *cis*-9/C16:0	0.59	0.51	0.60	0.59	0.57	0.57	0.75	0.66	0.75	0.74	0.78	0.76
C18:1 *trans*-10/C18:1 *trans*-11	0.60	0.62	0.58	0.55	0.62	0.56	0.11	0.07	0.13	0.12	0.11	0.12
MFAI HH	0.00	0.00	0.00	0.00	0.00	0.00	1.30	1.38	1.39	1.55	1.48	1.81
MFAI DPSP	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.14	0.23	0.23	0.36	0.55
MFAI AW	0.56	0.56	0.56	0.56	0.56	0.56	1.25	1.25	1.25	1.25	1.25	1.25
MFAI ES	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.49	0.49	0.49	0.49	0.49
Total MFAI	0.56	0.56	0.56	0.56	0.56	0.56	3.23	3.26	3.36	3.52	3.58	4.10
Organic								x		x	x	x
Mountain certified							x		x		x	
Mountain reference (just name or image)	x											x
Pasture image							x	x	x	x	x	x
Packaging country[2]	IT	IT	IT	IT	AT	IT	FR	FR	FR	FR	IT	IT
Price (€/L)	1.50	0.75	1.25	0.99	1.39	1.05	0.85	1.11	0.86	1.17	1.45	1.70

[1]MFAI = milk FA index (Coppa et al., 2017); HH = human health pillar; SPDP = sensory properties of dairy products sub-pillar of dairy industry pillar; AW = animal welfare sub-pillar of dairy industry pillar; ES = environmental sustainability sub-pillar of dairy industry pillar. x indicates that terms or images were present on the milk label.

[2]IT = Italy; AT = Austria; FR = France.

FA profile to a great extent, by increasing n-3 FA, C18:3n-3, and PUFA. Therefore, through selection of a few FA and some of their sums and ratios, it is possible to link milk to its beneficial effects on human health (Coppa et al., 2017), as well as to verify the veracity of packaging labels. In the present investigation, the range of variation of the different FA proved to be very high and comparable with the greater variations observed in bulk tank milk over different dairy farming systems throughout Europe (Coppa et al., 2013). The FA profile was significantly different for organic and mountain certified origin, and provided a better profile than that of noncertified milk. Delley and Brunner (2020), studying the milk buying choices of Swiss consumers, reported that mountain milk is primarily a marketing concept that capitalizes on the affection that the consumers have for a mountain lifestyle and imagery and, by extension, for mountain products. However, milks belonging to the certified organic or mountain-derived groups, when ranked on the basis of MFAI, presented great variability and bimodal distribution (Figure 6), with several samples in each group showing values

Table 11. Socio-demographic variables of consumers interviewed in the choice experiment (n = 502)

Characteristic	%
Sex	
Female	71
Male	29
Number of family members	
1	15
2	41
3	23
4	16
>4	5
Educational level	
Primary school	8
Lower secondary school	22
Upper secondary school	47
Master's degree	23
Household average annual income (€/yr)	
<25,000	33
25,000–40,000	48
40,000–60,000	15
>60,000	4
Age ranges (yr)	
18–25	5
26–35	12
36–45	19
46–55	19
56–65	15
66–75	17
>75	11
Employment	
Homemaker	8
Unemployed	4
Employed	44
Self-employed	9
Retired	31
Student	4

Table 12. Raw average score (RAS) for each milk attribute considering the entire sample of respondents (n = 502)

Rank	Milk attributes	RAS	SD
1	Origin indication (national or abroad)	2.129	1.983
2	Brand	1.169	2.568
3	Locally farmed	1.042	1.622
4	Certification (both of process and of product)	0.909	1.514
5	Expiration date	0.873	1.680
6	Price	0.085	1.567
7	Taste	−0.477	1.700
8	Nutritional value	−0.683	1.184
9	Label claims (visual and verbal)	−0.968	1.191
10	Fat content (skimmed, partially skimmed, or whole)	−0.985	2.163
11	Package type (plastic jug, cardboard carton, glass)	−1.456	1.559
12	Organic certification	−1.636	2.037

close to those reported for intensive farming systems in northern Italy (Borreani et al., 2013). These findings indicate that, even though the milk FA profile and MFAI of organic or mountain-derived milk presented greater average values than those observed for noncertified milk, certification alone does not guarantee that buying a certified milk corresponds to a real difference in quality and healthiness of the product, in terms of FA profile. These findings are in agreement with results reported by O'Donnell et al. (2010), who, surveying FA profiles of retail milk samples obtained from conventional or organic production processes in the UK, reported higher average CLA values for organic milk than for conventional milk, but with more than half of the organic milk samples having CLA values comparable to those observed for conventional milk. Differences in the FA profiles of milk were also observed when the label reported images referring to cows grazing or eating fresh forage, compared with milk with labels without any reference to cow grazing or pastures. In a survey in Northern Ireland, Hollywood et al. (2013) reported that, for the majority of consumers, the presence on the milk package of such images as a picture of a cow or pictures of the countryside reinforced their belief in the origin and naturalness of the product. However, even for this category, the sample distribution showed that the majority of the milk samples reporting images of cow grazing or herbage on their label had FA profiles comparable to those observed for milk from intensive farming systems (Borreani et al., 2013). As a consequence, the presence on the label of this kind of image (cow grazing, pasture, fresh forage), was not a useful indication for consumers who want to buy better-quality milk in terms of FA profile. However, these images, if accompanied by simple information that stated that the actual quality of milk is better,

Table 13. Latent class analysis results showing the rescaled scores (relative preference index) for each milk attribute, resulting in the obtained 5 consumer clusters

	Average raw score				
Cluster name	Quality-certified sensitive	Loyal to local product	Brand sensitive	Organoleptic quality sensitive	Attentive to product origin
Cluster size	29.40% (n = 149)	20.70% (n = 102)	20.10% (n = 100)	19.50% (n = 98)	10.30% (n = 52)
Attribute					
Indication of origin (national or foreign)	15.436[c]	16.581[b]	24.412[a]	5.289[d]	20.888[b]
Brand	3.852[d]	16.951[b]	25.087[a]	7.832[c]	8.429[c]
Locally farmed	13.326[b]	16.863[ab]	8.522[c]	4.794[d]	16.166[a]
Certification (both of process and of product)	16.295[a]	13.612[b]	8.476[c]	7.616[c]	3.171[d]
Expiration date	12.367[b]	8.232[c]	3.331[d]	17.532[a]	16.954[a]
Price	4.319[b]	11.833[a]	9.077[a]	11.426[a]	2.342[b]
Taste	8.253[b]	3.274[c]	1.293[d]	11.492[a]	9.468[b]
Nutritional value	6.688[a]	3.053[c]	6.433[a]	4.882[ab]	2.785[c]
Label claims (visual and verbal)	5.595[a]	4.077[b]	1.852[c]	4.872[ab]	5.815[ab]
Fat content (skimmed, partially skimmed, or whole)	1.854[c]	1.380[c]	6.583[b]	12.99[a]	10.344[b]
Package type (plastic container, cardboard carton, glass)	2.234[c]	2.119[c]	4.645[b]	6.904[a]	1.818[c]
Organic certification	9.781[a]	2.016[c]	0.289[d]	4.372[b]	1.819[c]

[a–d]Preference averages (rescaled scores) within a row with different superscripts differ ($P < 0.05$) for Tukey post-hoc test.

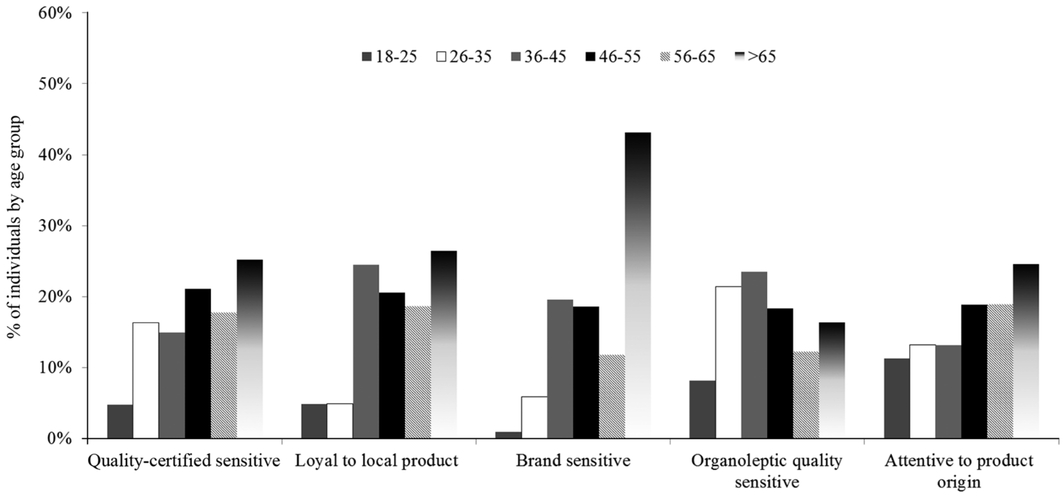

Figure 1. Share of individuals belonging to different age groups (in years) for each consumer cluster.

could be used to reinforce the concept of higher-quality milk. The 95th-percentile samples (Table 10), ranked on the basis of the MFA index, presented values that are typical of animals fed with diets based mainly on fresh forage from grasslands (Revello-Chion et al., 2010). All 6 milks belonging to this group were certified (4 organic and 3 mountain-derived, with 1 being both organic and mountain-derived), and all showed an image on the package that connects the milk to cow grazing or herbage fed to animals. This means that the companies that sell these milks aim to direct the consumers toward a more informed choice, based on the good characteristics that may be obtained when producing milk according to organic standards or rearing cows in a mountain environment. By contrast, the 5th percentile presented FA profiles typical of diets based on concentrates and corn silage, as reported by Borreani et al. (2013). None of the milks belonging to this group were certified (as either organic or mountain-derived), and none of the milk producers reported references to grazing or mountains on their packages, except for one reference that could be linked to a mountain environment through the name of the producer. As a result of the willingness of certain groups of consumers to buy milk because of its quality, having a clear index that gives clear information about the FA profile, quality, and healthiness of the product, and which is linked to sustainability of farming systems, could be an interesting tool to improve buyers' awareness. It is also clear that no correspondence existed between

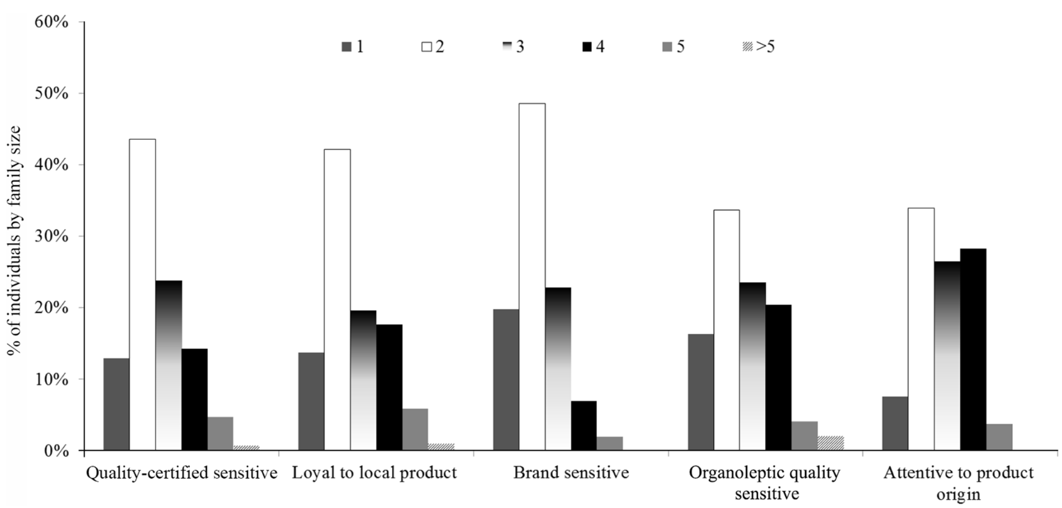

Figure 2. Share of individuals belonging to different family size (number of family members) for each consumer cluster.

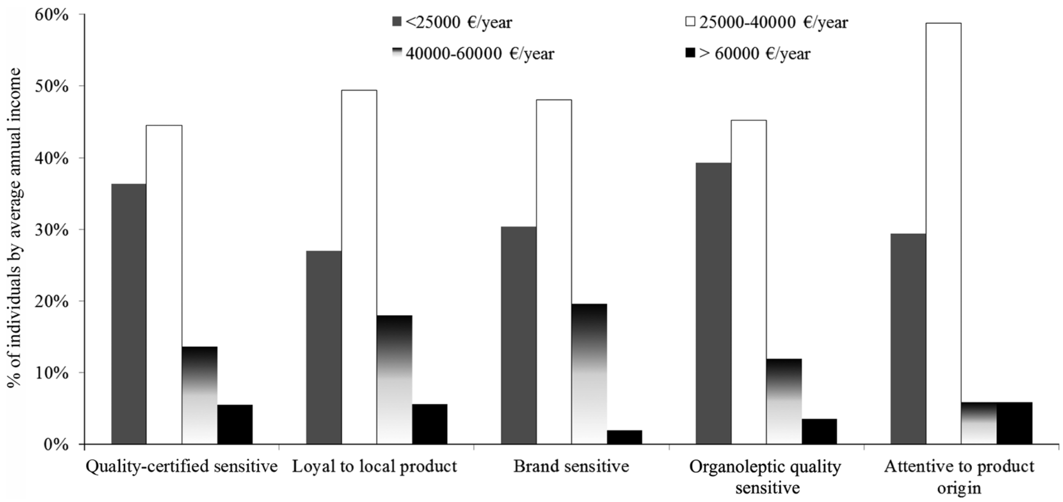

Figure 3. Share of individuals belonging to different ranges of average annual income for each consumer cluster.

the retail price of milk and quality, in terms of FA profile and MFA indexes, which means that the price should not be considered as a criterion to guarantee the quality or healthiness of a product. A study that examined the relationship between consumers' country of origin (Denmark, the United Kingdom, and the United States) and their knowledge and perceptions of milk fat (Vargas-Bello-Pérez et al., 2020) reported that most respondents (about 45%) would be willing to pay more for milk with a healthier fat content, whereas only a minority of respondents would not. Having the possibility of verifying the actual characteristics of milk, not on the basis of misleading claims or images on the package but through simple and easily understandable information, would allow consumers to make more informed choices and perhaps even pay more for milk that delivers the health benefits claimed on the label. This could represent an improvement for the national dairy sector, which is characterized by problems related to the low price of milk at the origin, as it could lead to an enhancement of the quality of the product on the market and therefore to the introduction of a premium price that would be accepted by consumers.

The socio-demographic characteristics of the considered sample well represented the macro area of northern Italy and were representative in terms of percentages of individuals belonging to different age groups and to the sexes of the national population of cow milk purchasers,

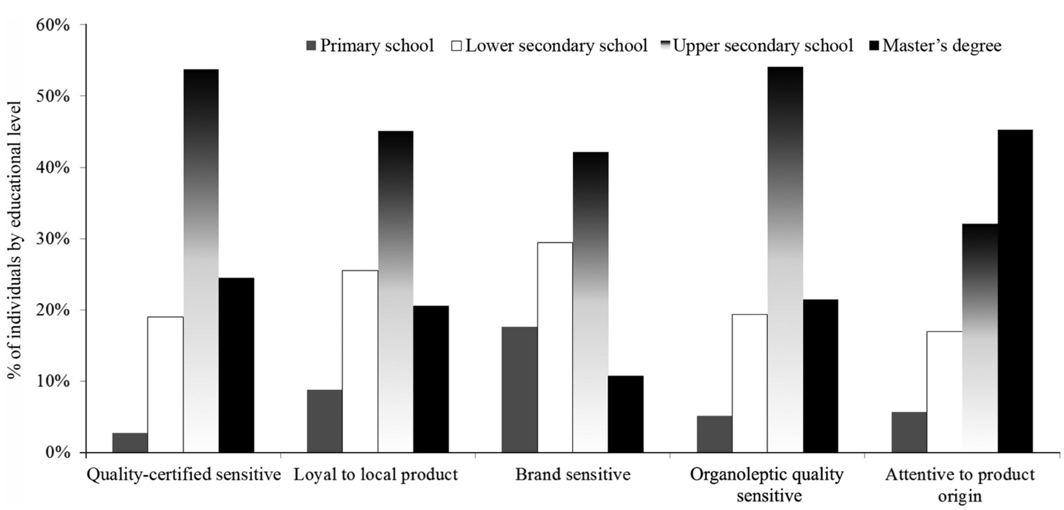

Figure 4. Share of individuals belonging to different educational levels for each consumer cluster.

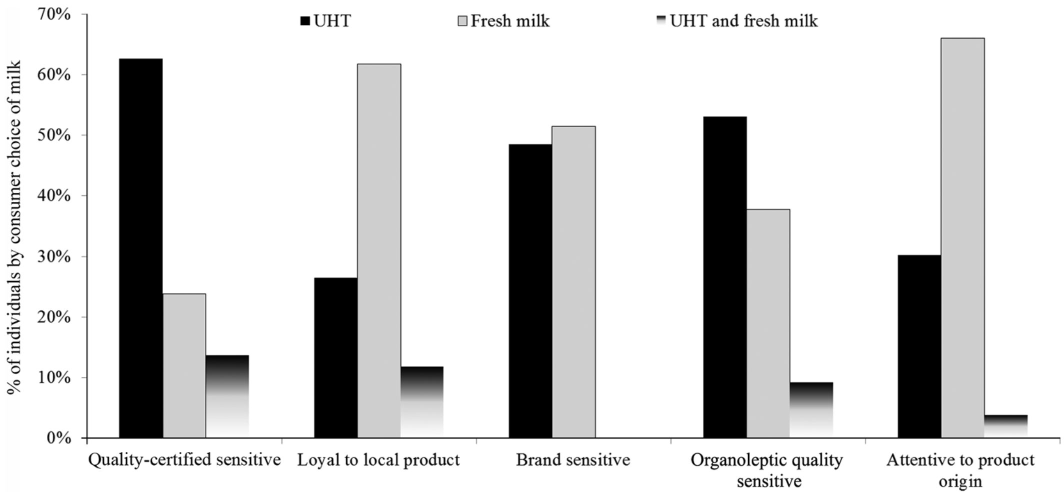

Figure 5. Share of individuals choosing UHT, fresh, or both types of milk for each consumer cluster.

in accordance with Nielsen surveys (ISMEA, 2017). In terms of sex, as well as income, education, work activity, and number of household members, the considered sample was representative of large-scale retail milk purchasers identified in northern Italy by a nationwide study conducted by the international firm Growth for Knowledge, a leader in data analytics on markets and consumers, published by GS1 Italy in 2017 (Zanibon and Lucchi, 2017). The socio-demographic characteristics were comparable with data reported by other milk consumer preference surveys conducted in Italy (Tempesta and Vecchiato, 2013; Lanfranchi et al., 2017; Naspetti et al., 2021). As reported by Delley and Brunner (2020), the recruitment method used in the current survey, which requires participants to be responsible for the milk supply, led to over-representation of women and under-representation of the youngest age groups. The preferences of milk consumers for 12 quality attributes were investigated to determine the degree of importance of each milk characteristic and to verify

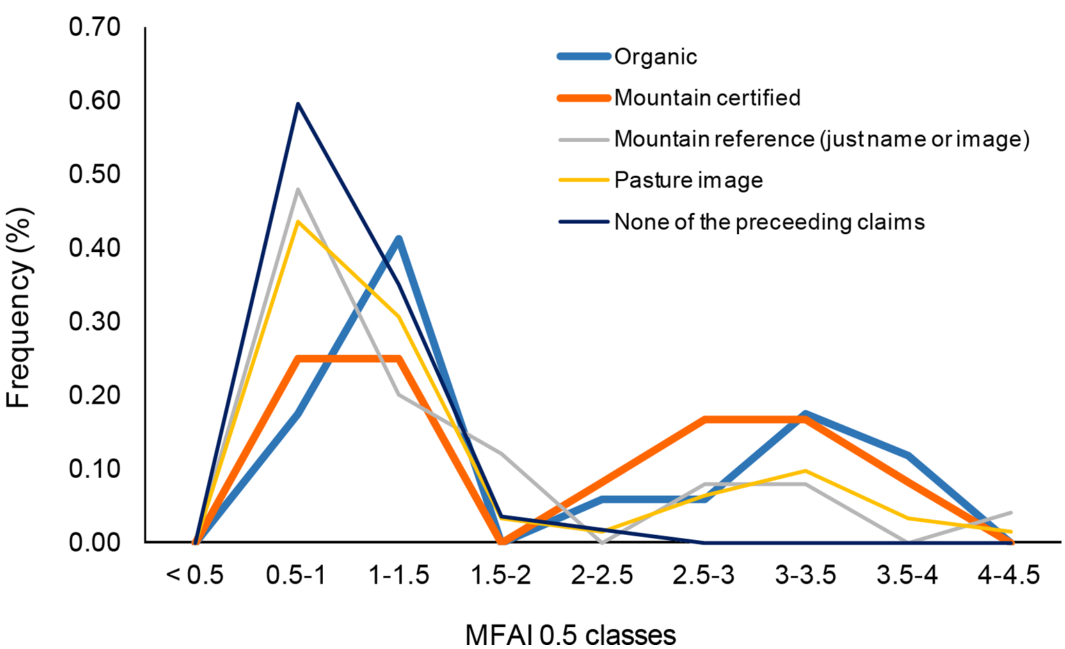

Figure 6. Frequency distribution of the milk fatty acid index (MFAI) of retail milk of northern Italy according to their label claims.

correspondence between consumer needs (demand) and what is stated by or could be perceived based on images or claims on the labels of milk packages. The preference analysis showed that the 3 most important attributes when choosing milk were the origin of the milk, the product brand, and the local production of milk. The simultaneous evaluation of these attributes by a consumer could be defined as an attitude of loyalty to the national product, especially if it is of local origin and linked to a brand the consumer knows and trusts (Tempesta and Vecchiato, 2013). Delley and Brunner (2020), analyzing the segmentation of fluid milk consumers in Switzerland, reported that more than half of the participants belonged to the “Locavores” segment, which meant that they primarily consumed milk of local origin, sought products from controlled supply chains, were not interested in fat-reduced milk, and were less sensitive to prices. In a survey of the milk market of Northern Ireland, Hollywood et al. (2013) found that the majority of participants positively perceived the regional brand and affirmed that they were familiar with and trusted the product, as the brand name ensured that the milk was produced locally, whereas they were uncertain about national or international milk brands, as they did not know the origin of the milk or the distance the product had traveled. The results of the present work presuppose that knowledge of the brand, especially if it is local, creates a relationship of loyalty between the consumer and product, as well as between the consumer and the producer, the value of which may be assessed indirectly through the evaluation of the trademark itself. These consumers probably choose local products as a result of their search for a sustainable product, with a low environmental impact, but also as support for the economy of the territory of origin (Berti and Mulligan, 2016; Harwood and Drake, 2018). Furthermore, Feldmann and Hamm (2015), reviewing the scientific literature on local food from the consumer’s perspective, suggested that the perception of locally produced milk offering a greater level of safety and better health perspectives probably orients consumers in their choice. However, Merlino et al. (2021), assessing the assortment depth and size of conventional cow milk in different retail formats of 2 metropolitan cities in Italy, reported a mismatch between consumers’ needs and the composition of the milk offered. The latter authors, in particular, showed differences between the 2 areas pertaining to the width and depth of the assortment of the milk offered and in retailers’ development of composition offerings, which are not always in agreement with consumers’ preferences, in terms of products of local origin.

A lack of interest in organic certification, packaging type and features, and fat content of milk was observed for the majority of the consumers. Even though conflicting opinions have been highlighted in other studies about organic milk by consumers (Kiesel and Villas-Boas, 2007), the respondents involved in this study stated that they are not influenced by organic certification when choosing milk. Consumers probably do not associate this certification with superior quality characteristics of milk, as reported in other studies (Lee and Hwang, 2016; Harwood and Drake, 2018) and probably associate local milk with high-quality prerequisites that might not necessarily be certified by organic labeling. Another attribute that was evaluated as not being important by consumers was the packaging, thus confirming the results reported by Merlino et al. (2020), who found that consumers are not interested in milk packaging per se but expressed a willingness to pay a premium price for improved packaging, especially in terms of the materials used and recyclability. In the present work, most participants declared that they did not consider the fat content or label claims when buying milk. An explanation for the absence of interest in the fat content, as observed in the present study, or for the differences in concern about fat and its perceived healthfulness, could be a result of the food policies that have been adopted in each country in the last few decades, which could have influenced consumers’ perceptions, expectations, and decisions related to the fat content of milk and other foods (Vargas-Bello-Pérez et al., 2020). The observed lack of interest in label claims is consistent with the results of Hollywood et al. (2013), who reported that consumers generally did not read package labeling, as they considered milk as a commodity and expected the nature of the product to remain unchanged; therefore, reading claims was unnecessary when purchasing milk. However, the same authors (Hollywood et al., 2013) reported that a small minority of participants read the nutritional labeling on milk and focused on verifying its fat content. In the present study, the visual and verbal claims communicated through the label to the consumer probably do not represent one of the main attributes that motivate consumers to purchase milk. As reported by Stampa et al. (2020), information on the labels should be simple and comprehensible; otherwise it can be perceived as unreliable.

Evaluation of the consumer clusters allowed detection of some differences in individual preferences and attitudes, compared with the whole sample. The most representative, the *Quality certified sensitive* cluster, deviates from the total sample as a result of the low preference value attributed to brand. However, these consumers were attentive to the origin of milk: they preferred it to be local and probably assessed it positively, as the origin is considered a certified quality indication of the production process as well as of the product. This result is also consistent with the positive evaluation of organic certification, which showed the highest RAS level among the clusters. Individuals belonging to this cluster did not consider attributes related to the intrinsic quality of the product as being important, probably because, having chosen a certified milk (local, organic, or both), they considered quality as a guaranteed prerequisite. These consumers are mainly represented by families with children, who focus on the quality and safety of the product, which are guaranteed by its origin and certification. However, in contrast with their declared preferences, these individuals preferred UHT milk, thus highlighting a mismatch between their beliefs and real intentions of purchasing a milk of superior quality.

The least representative cluster (*Attentive to product origin*) was represented, by more than 50%, by respondents with families with 1 or more children, who declared they were interested in label indications about milk origin. This cluster attributed a higher level of importance to the claims on the label than did the other clusters. This attention could be linked to their purchasing habits concerning fresh milk products. Therefore, it is possible to state that many consumers look at the label, but almost exclusively to verify the origin of the product, the local production, and the type of milk. This aspect is confirmed by the limited interest of these individuals in the other verifiable characteristics printed on the label, such as the nutritional value and fat content.

By analyzing these first 2 consumer targets, it is possible to state that, even though both clusters consider origin as a discriminating attribute for the choice of milk, the *Quality certified sensitive* individuals assess it by analyzing the product brand (which should appear to be local, thereby recalling the territory), whereas the latter individuals (*Attentive to product origin*) assess the origin by reading the label on the product.

The *Brand sensitive* cluster represented 20% of the respondents, who declared an interest in the product brand and, in particular, in the national brand. In this case, the preference values for brand and origin indication attributes differed greatly from the rest of the raw scores attributed to other milk attributes, thereby highlighting a strong consumption attitude linked to brand loyalty. Moreover, the *Brand sensitive* cluster considered the price of the milk as an attribute worthy of attention when buying milk, whereas the milk price had an intermediate position for all the other clusters, confirming that, for the majority of consumers, milk is considered as a commodity whose price has little or no influence on their purchasing choices. Although these individuals showed very clear ideas about origin and brand, as far as the choice of fresh or UHT milk was concerned, this cluster proved to be divided equally into 2 distinct parts. In agreement with Kühl et al. (2017), these consumers consider the brand name when purchasing food and thus do not bother reading the information presented on the packaging. As suggested by Kühl et al. (2017) for pasture-based milk, this consumer segment could be an interesting target group for milk with better FA profile, offered in combination with a brand name. The consumers belonging to the *Attentive to product origin* cluster assess the origin of milk by evaluating the label, whereas the *Loyal to local product* individuals evaluate the local origin of the milk by referring to the trademark. This result confirms the importance of the brand as a communication tool for consumers, not only for product identification purposes but also for brand values and familiarity. Again, in this case, the preferred product is, above all, fresh milk, which is chosen by a cluster that is mainly represented by middle-aged couples. However, the higher annual average income that characterizes this cluster probably points to a local brand purchasing habit, and perhaps even of higher-priced niche products.

About 20% of the participants were clustered as *Organoleptic quality sensitive*. These consumers mainly chose milk by looking at the expiration date, taste, and, unlike the other clusters, fat content. Analysis of the purchasing habits of these individuals revealed that they mainly buy UHT milk but also, albeit to a lesser extent, fresh milk. These consumers probably consume milk because they like it and are aware of the link between the taste of the product and the fat content. Therefore, respondents belonging to this cluster would probably be the most receptive about the FA content of milk, especially if it is produced locally.

The results of the survey on the FA profiles of milk revealed a large amount of variation in FA profile across milk types sold in Italy and pointed out that, in most cases, images or claims on the milk package do not correspond with the actual FA quality of the milk, being a misleading factor for consumer choice. The study of consumer preferences divided the respondents into different clusters and showed that most consumers do not consider fat content, taste, and nutritional claims as important milk attributes, whereas about 20% of the consumers had a high propensity to buy milk on the basis of its quality and sustainability characteristics, which, however, are often poorly indicated on the milk label. Nevertheless, the lack of attention to the label declared by the majority of consumers means that a great deal of work is required by producers and retailers to improve communication strategies about positive aspects of milk, especially in term of FA profile, to make it more attractive and to aid buyers in making more informed choices.

The results of the present study could be useful for the industries and retailers involved in the milk production and selling chain, as well as for the public health sector. It has been suggested that the dairy industry should focus on the nutritional value of milk, in terms of FA profile, by finding a communication pathway, such as MFAI, that can easily be understood by consumers. The trade sector may identify drivers that motivate milk consumption on the basis of its fat content and may pay more attention to translating health benefits into more accurate labeling information to aid consumers make healthier food choices. Finally, information from the present study may be useful for the public health sector, to foster consumer education about certain misconceptions regarding dairy milk and to make them aware of the possibility of consuming milk characterized by healthier FA profiles.

CONCLUSIONS

The results of these 2 surveys provide useful feedback for all stakeholders involved in the milk production chain and in the retail sector, and could contribute to fostering information initiatives in the public health sector on the beneficial perspectives offered when choosing milk on the basis of their FA profiles. In this context, the availability of a clear and simple-to-read index, which offers information about the FA profile, healthiness of the product, and sustainability of the production process, would be an interesting tool to improve buyer awareness about healthy food choices and to valorize and differentiate milk products in large retail chains.

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