Microwave-dried or air-dried? Consumers' stated preferences and attitudes for organic dried strawberries. A multi-country investigation in Europe

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ABSTRACT

Non-thermal food processing technologies are becoming more important in the organic food sector because, beyond preserving the organic feature, they could offer organic products with additional benefits in terms of enhanced nutritional content and healthiness as well as better sensory properties that could satisfy the more complex demands of organic consumers. Berries have a well-known health benefits and show increasing market shares in European markets while dehydration can increase the food convenience in terms of extended shelf-life. This study investigates for the first time organic consumers' stated preferences, attitudes and individual differences for a non-thermal organic processing technology. Specifically, we investigated consumers' preferences for organic dried strawberries varying in drying technology used, such as the most conventional (i.e. thermal) air drying and the most innovative (i.e. non-thermal) microwave drying, origin, price levels, and nutrient contents in three European countries: Norway, Romania and Turkey. Data from a total of 614 consumers were collected through an online choice experiment. Results show that on average consumers prefer organic dried strawberries produced with air drying technology that have national origin, with natural nutrient content and at low price, but country and individual differences are identified. Consumers who showed least rejection for microwave dried products are young, mostly from Norway and have higher positive attitudes towards new food technologies. Consumers who showed most rejection for microwave dried products are older, mostly from Turkey and have higher positive attitudes for organic, natural and ecological products. Organic producers who adopt microwave drying might better inform consumers about the characteristics, the process and highlight the nutritional benefits of such technology. Finally, this research informs policy makers about the need to define and regulate more clearly microwave drying as an organic technology, as well as to regulate labelling to ensure that consumers are not misled and correctly informed about the new technology.

1. Introduction

Nowadays, food consumption is increasingly affected by the three major trends of sustainability, health and convenience (Grunert, 2013). Sustainability is driven by the growing awareness of environmental effects caused by conventional agricultural practices which resulted, for example in an increasing expansion of organic agriculture and markets (Aschemann, Hamm, Naspetti, & Zanoli, 2007). Health attitudes are driven by consumer concerns, sparked by the increasing number of food and lifestyle related diseases (e.g. diabetes and obesity) (Kearney, 2010;

Weis, 2007) as well as allergies and intolerances towards some specific food products or components that drive consumers' preferences towards food products that report "clean labels" (Asioli et al., 2017). Convenience relates to easiness of food consumption (i.e. ready meals, extended shelf-life, home-delivered food, etc.) and food producers during the last decades have responded to this consumer demand by launching on the market an increasing number of convenient food products (Lachat et al., 2012).

The European organic food market is currently one of the most rapidly expanding market (+114% between 2006 and 2017) due to the

increasing consumer demand for potentially healthier and more environmental friendly food products (FIBL, 2017; IFOAM, 2015). In 2015 the market has been of 352 million Euros in Norway, 80 million Euros in Romania and 4 million Euros in Turkey (FIBL, 2017). However, organic consumers are not only looking for the 'organic' feature itself, which is perceived to benefit the environment and their health, but also increasingly demand convenient organic processed foods, for instance ready-to-eat food products, and products of extended shelf-life (Kretzschmar & Schmid, 2011). According to the guidelines stated on the EU regulations 834/2007 (European Commission, 2007) and 848/2018 (European Commission, 2018), organic processing methods should guarantee genuineness, authenticity and preservation of the natural properties of the raw materials and also follow the three principles: freshness, minimal processing, and careful treatment (Kahl et al., 2012).

From a balanced nutritional diet and healthiness point of view, fruits have a good image (Briz et al., 2008) and play a key role in the prevention of chronic disease and premature death (WHO, 2003). Among the different fruit species, berries are known to be rich in vitamins, fibre, antioxidants, polyphenols and minerals that consumers appreciate for a healthy diet (Schnettler et al., 2011). The presence of these nutritional compounds in the diet is suggested to potentially reduce the risk of cardiovascular disease, inflammation, obesity, diabetes, cancer and other chronic diseases (Jia, Kong, Liu, Diao, & Xia, 2012; Szajdek & Borowska, 2008; Wu, Frei, Kennedy, & Zhao, 2010).

Among the different types of berries available on the market, strawberries are of particular interest because with raspberries they dominate the berries market both in terms of value and volume (Invenire Market Intelligence, 2008). In addition, strawberries due to their valuable sensory (i.e. appearance and flavour) (Aday & Caner, 2014; Tanase et al., 2016) and nutritional properties (i.e. richness in vitamins, phenolic compounds and anthocyanins) (Basu, Nguyen, Betts, & Lyons, 2014) are highly appreciated by consumers (Häkkinen & Törrönen, 2000; Meyers, Watkins, Pritts, & Liu, 2003). However, one of the barriers to the consumption of fresh berries, is that they are highly perishable as they have relatively high physiological activity after harvest. This leads to a rapid deterioration of quality characteristics due to softening, shrinkage, discoloration, development of off-flavours and finally fungal decay, resulting in a short shelf-life (Wang et al., 2014; Wang & Gao, 2013). Indeed, if healthiness is one of the key motive that drives fruit consumption, the main barriers are represented by the perception of price, quality and convenience (Harker, Gunson, & Jaeger, 2003).

Drying is a very well-known and ancient food technology able to preserve food products (Moses, Norton, Alagusundaram, & Tiwari, 2014; Zielinska & Michalska, 2016). The dehydration process offers a better preservation of nutritional compounds of food products, extends shelf-life and reduces packaging, storage, handling and transportation costs; in addition, it offers the possibility of out-of-season availability (Orsat, Changrue, & Raghavan, 2006; Zielinska & Michalska, 2016). Technically, drying reduces the moisture content within food products and it is mainly used for food products with high moisture content (˜80%) such as fruits, vegetables and other food products considered highly perishable (Orsat et al., 2006). In a study of Jesionkowska, Sijtsema, Konopacka, and Symoneaux (2009), the interest of consumers in dried fruits was related to the high content of antioxidants in this type of food. Conventional drying technologies such as hot air and combustion gases use the heat as transfer medium (i.e. thermal technologies) (Zarein, Samadi, & Ghobadian, 2015). However, these technologies suffer from two major drawbacks, namely the large loss in nutritional, functional and sensory properties of treated fruit and vegetables (Aguilera, Chiralt, & Fito, 2003; Moses, Paramasivan, & Kumar, 2013; Vadivambal & Jayas, 2007) and the high energy consumption (Raghavan et al., 2005). Due to these limitations, during the last decades non-thermal (also called "mild" or "minimal") food technologies are gaining importance due to increased consumer demand for

food processing technologies that have a reduced impact on nutritional content and overall food quality (i.e. largely retaining their nutritional qualities and better sensory characteristics) (Awsi, Monika, SA, & Tsering, 2017; Fellows, 2017). Examples of non-thermal food technologies are high hydrostatic pressures (HPP), ionising radiation, pulsed electric fields (PEF), pulsed light and UV light and ultrasound (Fellows, 2017). Specifically for drying technologies, due to the limitations of the conventional thermal air drying technology, significant advancements have been made in the recent years in terms of drying techniques (see Moses et al., 2014, for a review), pre-treatment and equipment (Dev & Raghavan, 2012) able to offer dried new products of higher quality features (Zielinska & Michalska, 2016). Microwave (MW) drying is a non-thermal technology that involves heating and mass-transfer where vapour is generated inside a food item and then spread through internal pressure gradient (Guo, Sun, Cheng, & Han, 2017; Wray & Ramaswamy, 2015). More specifically, MW drying translates the high frequency electromagnetic energy into heat, such that liquid moisture contained within the food item is intensively evaporated and transported towards the food material surface (Li, Wang, & Kudra, 2011). MW drying is suitable as an organic processing technology because it is a careful and minimal processing treatment. It is able to preserve a larger quantity of natural bioactive compounds, it better preserves sensory properties (Guo et al., 2017), it requires less energy consumption (Chandrasekaran, Ramanathan, & Basak, 2013; Guo et al., 2017; Moses et al., 2014), and it is also less time-consuming than the traditional air-drying process (Wojdyło, Figiel, & Oszmiański, 2009; Zhang, Tang, Mujumdar, & Wang, 2006). In particular, MW drying allows to retain large quantities of phenolic compounds, anthocyanins and antioxidant capacity compared to the conventional hot air convective drying and has been successfully used for dehydration of cranberries (Wojdyło, Figiel, Lech, Nowicka, & Oszmiański, 2014) and blueberries (Zielinska & Markowski, 2016; Zielinska, Sadowski, & Błaszczak, 2015). However, since the implementation of MW drying technology is expensive and challenging (e.g. non-uniform heating that results in the formation of hot/cold spots in the course of heating) (Chizoba Ekezie, Sun, Han, & Cheng, 2017; Dehghannya, Hosseinlar, & Heshmati, 2018; Moses et al., 2014), research should be conducted to investigate organic consumers' preferences for berry products treated with MW drying to better understand their preferences. In addition, the introduction of new food technologies, as MW drying, is at high risk since consumers might be suspicious with high risks of product rejections as literature report for new food technologies (Giordano, Clodoveo, Dev Gennaro, & Corbo, 2018; Lusk, Roosen, & Bieberstein, 2014; Siegrist, 2008a). This is linked with the increased consumer interest for food product technology (Grunert, Bredahl, & Scholderer, 2003) and thus it is important to investigate consumer attitudes towards new food technology at an early stage of product development (Siegrist, 2008b; Van Kleef, Van Trijp, & Luning, 2005). Therefore there is a need to get information from organic consumers' side to evaluate reactions towards this new non-thermal processing technology and ensure a successful introduction to market. To the authors' knowledge, there is no previous study in the literature that investigates consumers' preferences and attitudes for organic dried berries treated with MW drying.

This study uses an online choice experiment (CE) to investigate consumers' stated preferences, attitudes and individual differences for organic dried strawberries varying in drying technology, nutrient level, origin and price in three diverging European cultures: Norway, Romania and Turkey. The main objectives of this research are: (i) to investigate consumers' preferences for organic dried strawberries focusing on two drying processing technologies (i.e. air drying and MW) and compare across the different countries; (ii) to investigate individual technology preferences and characterize consumer profiles in terms of attitudes, habits and socio-demographics across the different countries investigated.

We decided to focus on the individual technology preferences because to support market research it is essential to understand consumer

segments that might react differently to a new technology introduction (Evans, Kermarrec, Sable, & Cox, 2010; Salgado-Beltrán, Beltrán-Morales, Velarde-Mendivil, & Robles-Baldenegro, 2018; Siegrist, 2008b).

2. Materials and methods

This methodological section introduces the choice experiment method, the chosen product attributes and levels, the experimental choice design and procedure, the consumer attributes investigated as well as the data analysis approaches.

2.1. The choice experiment method

Choice experiment (CE) is one of the most popular stated multi-attributes valuation method used to investigate consumers' preferences and willingness to pay (WTP) for market and non-market goods and services (Asioli, Næs, Øvrum, & Almli, 2016; Hensher, Rose, & Green, 2015; Jaeger & Rose, 2008; Lusk & Schroeder, 2004; Scarpa & Del Giudice, 2004; Van Loo, Caputo, Nayga, & Verbeke, 2014; Van Wezemael, Caputo, Nayga, Chryssochoidis, & Verbeke, 2014). CEs are based on the Random Utility Theory (RUT) (Thurstone, 1927) and Lancaster's consumer demand theory (Lancaster, 1966), implying that subjects derive utility from attributes of a good rather than from the good itself. In a CE framework, consumers are presented with a series of alternative choice scenarios and are asked to choose their most preferred option within each choice scenario (Almli & Naes, 2018; Louviere and Swait, 2000). The different alternatives are composed of different combinations of attribute levels which characterize the goods based on an experimental design (Hensher et al., 2015; Louviere and Swait, 2000).

2.2. Product attributes and levels

Due to the difficulty in finding real suitable dried strawberry products for the countries investigated, we chose to conduct an online CE. Thus, based on an experimental choice design we created a series of mock-up product images of dried strawberry packages varying in four attributes: origin, drying technology, nutrient content and price (Table 1).

We included origin because previous studies show that it is one of the most important attributes that consumers take into account when purchasing strawberry products (Bhat, Geppert, Funken, & Stamminger, 2015; Hinson & Bruchhaus, 2008; Panico, Del Giudice, Cicia, & Cembalo, 2011). In addition, given the fact that in many countries the demand of organic food is growing much faster than domestic production, the supply of foreign organic products is increasingly getting importance thus getting information about organic consumers' preferences for different products origins is relevant for organic producers for better targeting their marketing and business strategies and enrich

Table 1
: Attribute levels used in the study.

Attribute	Code and level
Origin	- 1 Europe
	+1 Own country (Norway, Romania or Turkey)
Technology	- 1 Air drying
	+1 Microwave drying
Nutrition content	- 1 Natural nutrients (Antioxidants, Vitamin C and Fibres)
	+1 More natural nutrients (Antioxidants, Vitamin C and Fibres)
Price	−10% (63 NOK in Norway; 20 Lei in Romania; 3.4 TL in Turkey)
	0 (70 NOK in Norway; 22 Lei in Romania; 3.8 TL in Turkey)
	+10% (77 NOK in Norway; 24 Lei in Romania; 4.2 TL in Turkey)

the lack of research (Thøgersen, Pedersen, Paternoga, Schwendel, & Aschemann-Witzel, 2017). The technology attribute was used to test two drying technologies: the most conventional air drying and the most innovative non-thermal MW drying. While air drying is the most used technology to dry berries products, MW drying is particularly interesting because it better preserves natural nutritional content. The nutrient content attribute was selected based on the fact that it is one of the main attributes that consumers take into account as criteria of purchasing organic foods (Bourn & Prescott, 2002) and berries (Farruggia, Crescimanno, Galati, & Tinervia, 2016; Tanase et al., 2016), and that the two technologies investigated have different effects on the natural nutrient content of the final product, where MW drying retains more natural nutrients than air drying technology. However, in order to distinguish whether consumer choices would be rather driven by technology or by nutrient content, we kept these two factors independent from each other in our factorial design. Finally, three price levels were tested varying from −10% to +10% of the average market prices in each target country for a 40 g package of dried strawberries, which is a typical size of selling. We used price percentage differences to be able to compare the three target countries in spite of differing mean market prices and currencies. The mean price levels were selected by researching the dried strawberries prices in different Norwegian, Romanian and Turkey stores where dried strawberries are typically sold. All conjoint attributes were integrated in the form of text or symbols in the mock-up package images. In addition, all packages included an organic logo (i.e. either EU or national logos depending on the product's origin in the factorial design), see Fig. 1 for example packages.

To make sure that respondents would be aware of all four conjoint attributes, an introduction screen showed an example product profile where arrows pointed at the relevant texts and symbols on the package. This technique has been recommended to help counterbalance possible inequalities in visual salience linked to the specific usage of colors and font size for the different attributes (Almli & Naes, 2018).

2.3. Choice experiment design

We used a D-optimal design for the choice experiment, using the software Ngene 1.1.1 (Choice Metrics, 2012). This design allows parameters to be estimated with the lowest possible number of asymptotic standard errors in the parameter estimates (i.e. the square roots of the diagonal elements of the asymptotic variance-covariance) (Jaeger & Rose, 2008). The design was based on 11 choice scenarios (i.e. choice sets) always offering two organic dried strawberry alternatives (called options "A" and "B") and an "opt-out" or no purchase option (called option "C") (Fig. 1). The chosen design was the one which had the lowest D-error (0.63) among the designs.

2.4. Consumer attributes

In order to characterize consumer profiles related to different individual choice preferences, a number of consumer attributes were collected. These attributes include: (i) berry consumption habits (location of purchasing and purchasing frequency), (ii) dried fruits/berries consumption habits (importance of attributes for purchasing and location of consumption), (iii) attitudes to health and natural product interest using the items from the Health and Taste Attitude Questionnaire (HTAQ) (Roininen, Lähteenmäki, & Tuorila, 1999), (iv) attitudes to organic and ecological food using the items from the Food Related Lifestyle (FRL) model (Brunsø & Grunert, 1995) and, (v) food technology neophobia using the Food Technology Neophobia Scale (FTNS) (Cox & Evans, 2008). Finally, we collected a number of socio-demographic attributes. Consumer attributes were measured using both numerical and categorical variables. For the importance of attributes for choosing dried fruit/berries, the scale was anchored from 1 (Very unimportant) to 7 (Very important). Consumers' attitudes were collected

Fig. 1. : An example of choice set (English translation).

using scales anchored form (Strongly disagree) to 7 (Strongly agree). For the data analysis, all the categorical attributes have been coded using dummy variables where 0 represents the absence of the actual level while 1 represents the presence of the attribute level. The complete questionnaire is available upon request.

2.5. Data collection

A hypothetical web-based survey was carried out in Norway, Romania and Turkey. This type of web-procedure has been used in different research studies due to the low cost and time effectiveness to gather the answers. The information obtained through web-surveys and in-person surveys has been reported to be similar (Canavari, Nocella, & Scarpa, 2005). The company Userneeds (Copenhagen, Denmark) was responsible for the recruitment task and for the web-survey implementation. We recruited only consumers aged between 18 and 65 years, who like strawberries, purchase organic foods (at least once a month), as well as purchase and consume dried nuts, fruits and/or berries (at least once during the last three months). An overall sample of 13,070 consumers were invited by e-mail to participate to the web-survey, and of them 614 consumers (4.7% of the invited consumers) fulfilled the eligibility criteria and completed the survey. Note that the survey was closed once our target of minimum 200 consumers per country was reached. The questionnaire comprised an initial information screen, then (i) recruitment questions (in case of failure of selection criteria the respondents were not allowed to continue answering), (ii) choice tasks, (iii) consumer attributes questionnaire.

The survey development was executed in English, then translated in Norwegian, Romanian and Turkish by the local research teams, then carefully checked again against the English questionnaire. The global survey was pretested by 6 to 19 respondents (colleagues of the local teams) in each country. After adjustments, it was then pilot-tested ($n = 20$ per country), before the full data collection took place in February 2017.

2.6. Data analysis

2.6.1. Descriptive statistics

Consumer attributes were analyzed using statistical descriptive analysis, such as frequency and mean. Significant differences among the countries were tested with non-parametric Kruskall-Wallis and Dunn

tests for ordinal and Chi-Squared test for nominal variables. Cronbach's alpha was calculated for checking the internal consistency of attitudinal questionnaires. STATA 15.0 software (StataCorp LP, College Station, US) was used for the analyses.

2.6.2. Mixed logit model

Choice-based data are routinely analyzed within a random utility framework by so-called discrete choice models (DCMs) (Louviere and Swait, 2000; Train, 2009). The approach consists in modelling "Utility", that is to say the net benefit a consumer obtains from selecting a specific product in a choice situation, as a function of the conjoint factors. The utility of a product j for individual m in a choice occasion t is written:

$$U_{mjt} = \beta''_m \mathbf{x}_{mjt} + \varepsilon_{mjt} \tag{1}$$

where β_m is a vector of individual-specific parameters accounting for preference heterogeneity, $\mathbf{x}_{mjt}$ is a vector of conjoint factors, and ε_{mjt} is a random error term.

Among different DCMs, Mixed Logit (ML) models are widely applied due to their flexibility (Train, 2009) and since they allow models that may better match real-world situations. ML models have increased in usage within sensory and consumer science in recent years in parallel with the usage of choice and ranking approaches (Almli, Øvrum, Hersleth, Almøy, & Næs, 2015; Jaeger & Rose, 2008; Zhou, Hu, & Huang, 2016).

The main specification of the model included main effects and interactions of the conjoint variables for Origin, Technology, Nutrition content and Price. All variables were coded using effects coding (-1; 1) (Bech & Gyrd-Hansen, 2005), except price which was coded in three levels expressing the percentage deviations from the mean price (-10; 0; $+10$). The variables were coded as presented in Table 1.

The utility ML model for dried strawberries j for individual i in choice occasion t is written:

$$U_{ijt} = \beta_{1i} \text{Origin}_{ijt} + \beta_{2i} \text{Technology}_{ijt} + \beta_{3i} \text{Nutrition}_{ijt} + \beta_{4i} \text{Price}_{ijt}$$
$$+ B_{5i} (\text{Origin* Technology})_{ijt} + .$$

$$\beta_{6i} (\text{Origin*Nutrition})_{ijt} + \beta_{7i} (\text{Origin*Price})_{ijt}$$
$$+ \beta_{8i} (\text{Technology*Nutrition})_{ijt} + .$$

$$\beta_{9i} (\text{Technology*Price})_{ijt} + \beta_{10i} (\text{Nutrition*Price})_{ijt} + \varepsilon_{ijt} \tag{2}$$

The interaction effects are obtained by multiplying the columns in the data set for the corresponding main effects. The consumer effect is automatically incorporated here since all coefficients are considered random. The ML model used here assumes random parameters with normal distributions for all conjoint factors, consumer characteristics and two-way interactions. These random coefficients are further assumed to be independent. This model provides estimates of the mean and the standard deviation of the random conjoint parameters for main effects and their interactions. The ML model was estimated using the Stata module *mixlogit* (Hole, 2007) run in STATA 15.0 software (StataCorp LP, College Station, US). Two thousand Halton draws were used in the simulations. More details on estimation of ML models are found in Train (2009) and Hole (2007).

2.6.3. Principal component analysis (PCA)

The matrix of individual parameter estimates $\hat{\beta}_m$, extracted from the ML model (Eq. 3) by using the command *mixlbeta* in STATA, is submitted to Principal Component Analysis (PCA) in order to identify the main drivers of variation between individual choices. PCA was conducted in the multivariate statistical software package The Unscrambler X 10.4.1 (Camo Software AS, Norway).

2.6.4. Partial least squares regression (PLSR)

Cross-national and country-specific models were conducted with Partial Least Squares Regression (PLSR) by relating the individual parameter estimates $\hat{\beta}_m$ for technology (Ys) (i.e. dependent variable) to the consumer attributes (i.e. independent variables). A similar approach has previously been used by Asioli, Almli, and Næs (2016) and Endrizzi, Menichelli, Johansen, Olsen, and Næs (2011). We used a several-step procedure: to start with we included in the model all the consumer attributes (Xs) investigated to check which ones were significantly related to technology preferences. Then, several refined models were run successively by selecting as consumer attributes (Xs) only the significant ones from the former step. Such variable selection was repeated until stability in the significant consumer attributes was reached, to achieve model reduction and better visualisation of results. Interpretations are based on the final refined model only. In all models we used standardized X-variables, cross-validation with 20 random segments and significance testing by jack-knifing at 5% significance level (Martens & Martens, 2000) in The Unscrambler X 10.4.1 (Camo Software AS, Norway).

3. Results

3.1. Characteristics of the sample: Socio-demographics and attitudes

The socio-demographic and attitudinal attributes of the interviewed consumers are shown in Table 2. According to the quota restrictions settled up in the recruitment, the distribution of gender and age are similar among the three countries. Regarding the other socio-demographics attributes only employment and income were found to be statistical significant differences across the countries investigated. Specifically, in Norway and Turkey similar patterns were found with a bit more public-sector employees for Norway and retired people for Turkey, while for Romania half of the sample is represented by private-sector workers with fewer students. Education level is very high (i.e. more than ¾ consumers have done university studies) and it is similar across the three countries, with a bit larger number of Norwegian consumers that have medium school level (11–14 years) compared to Romania and Turkey. In terms of income level compared to the respective national mean incomes, the Norwegian and Romanian consumers tend to have better personal economy than the Turkish consumers.

Further, the consumers investigated generally shows high health, natural and organic/ecological attitudes. Turkish and Romanian

consumers have significantly larger health and natural product interest compared to Norwegian consumers, and in turn Romanian consumers have significantly larger organic and ecological attitudes compared to Turkish and Norwegian consumers. Romanian consumers also show a significantly higher food technology neophobia compared to Turkish and Norwegian consumers.

3.2. Choice data analysis: Estimation results

The parameter estimates of the ML models for the main and interaction effects of the conjoint variables are presented in Table 3 for the three countries separately and for the pooled sample. For each ML model, the average parameter values and their significance levels are presented to the left while the corresponding standard deviations and significance levels are presented to the right. The latter values give an indication of the individual variability, also called preference heterogeneity, around the mean parameter value. The null hypothesis that all coefficients are zero is rejected by a Wald test (*p*-value < .0005) for all the models, which implies that the attributes investigated in this research were considered relevant by the respondents.

3.3. Main effects

On average for the pooled sample, consumers prefer organic dried strawberries produced with conventional air-drying technology that have national origin, with natural nutrient content and at low price. In terms of magnitudes, technology is the most important factor followed by origin, nutrients and price. Specifically, we can notice that different national patterns arise for technology and origin, while for price the magnitudes are similar across countries. MW drying technology is more strongly rejected in Turkey followed by Romania and Norway. National origin is more strongly preferred in Norway, followed by Romania and Turkey. Turkish consumers reject high prices more strongly than Norwegian and Romanian consumers. Interestingly, the nutrient content factor is not significant in any country, but is significant at the overall level (pooled sample). The opt-out option has negative sign at pooled sample and individual country level meaning that on average consumers prefer one of the alternative products over the opt-out option. The standard deviations for all main effects are strong and significant both at overall level and for each country (with the exception of nutrients for Turkey), indicating the presence of a large preference heterogeneity across individuals.

3.4. Interaction effects

The model for the pooled sample does not present any significant interaction effect among conjoint variables, but several interactions are significant in the national models (Fig. 2).

The interaction between Technology and Origin is significant for Norway and Turkey with opposite signs: in Norway, microwaved products are chosen significantly more often if they are of national origin compared to European origin, while choice of air-dried products, which are globally preferred, does not really depend on origin. In Turkey, air-dried products are chosen significantly more often if they are of national origin compared to European origin, while acceptance of microwaved products, which are globally rejected, does not really depend on origin. Further, the interaction effect Technology*Nutrients is significant in Romania, where MW drying is more strongly rejected in the case of basic nutrient content; in the case of more nutrients, technology doesn't really matter in this country. Last, the effect Nutrients*Origin is significant for Turkey, where national origin has a stronger positive effect on the choice of products with more natural nutrients than on the choice of products with basic natural nutrient content.

Table 2

: Socio-demographic and attitudinal characteristics of the consumers in Norway, Turkey and Romania.

Attributes	Norway (n = 204)	Romania (n = 206)	Turkey (n = 204)	Pooled (n = 614)
Socio-demographics: number (%)				
Gender				
Male	102 (50.0%)	104 (50.5%)	102 (50%)	308 (50.2%)
Female	102 (50.0%)	102 (49.5%)	102 (50%)	306 (49.8%)
Age				
18–29 yr	53 (26.0%)	53 (25.7%)	53 (26%)	159 (25.9%)
30–41 yr	53 (26.0%)	53 (25.7%)	53 (26%)	159 (25.9%)
42–53 yr	50 (24.5%)	47 (22.8%)	45 (22%)	142 (23.1%)
54–65 yr	48 (23.5%)	53 (25.7%)	53 (26%)	154 (25.1%)
Employment				
Student	28 (13.7%)	3 (1.5%)	20 (9.8%)	51 (8.3%)
Independent worker	13 (6.4%)	11 (5.3%)	15 (7.4%)	39 (6.4%)
Private-sector worker	65 (31.9%)	101 (49.0%)	60 (29.9%)	226 (36.8%)
Public-sector worker	60 (29.4%)	51 (24.8%)	42 (20.6%)	153 (24.9%)
Retired	15 (7.4%)	25 (12.1%)	40 (19.6%)	80 (13.4%)
Unemployed	23 (11.3%)	7 (3.4%)	22 (10.8%)	52 (8.5%)
Other	0 (0.00%)	8 (3.9%)	5 (2.3%)	13 (2.1%)
Education				
Elementary school (6–10 yr)	0 (0.00%)	1 (0.49%)	0 (0.00%)	1 (0.16%)
Medium school (11–14 yr)	10 (4.90%)	1 (0.49%)	0 (0.00%)	11 (1.79%)
High school (15–18 yr)	47 (23.04%)	37 (17.96%)	32 (15.69%)	116 (18.89%)
University (+18 yr)	174 (72.06%)	167 (81.07%)	172 (84.31%)	486 (79.15%)
Monthly household income after tax[1]				
< 0.5*average	20 (9.8%)	30 (14.6%)	69 (33.8%)	119 (19.4%)
Between 0.5*average and average	67 (32.8%)	79 (38.3%)	95 (46.6%)	241 (39.3%)
Between average and 1.5*average	60 (29.4%)	63 (30.6%)	21 (10.3%)	144 (23.5%)
> 1.5*average	30 (14.7%)	26 (12.6%)	7 (3.4%)	63 (10.3%)
I don't know/I don't want to disclose	27 (13.2%)	8 (3.9%)	12 (5.9%)	47 (7.7%)
ATTITUDES[2][a,b,c]: Mean, *(SD)*, Cronbach's alpha				
Health attitude (HTAQ)	4.64 [a]*(0.79)*	4.94 [b]*(0.93)*	5.07 [b]*(0.93)*	4.89 *(1.00)*
	0.74	0.77	0.75	0.75
Natural attitude (HTAQ)	4.44 [a]*(1.16)*	5.26 [b]*(0.96)*	5.31 [b]*(1.03)*	5.00 *(1.12)*
	0.77	0.57	0.66	0.71
Organic and ecological attitudes (FRL)	4.15 [a]*(1.40)*	5.64 [b]*(1.11)*	5.35 [c]*(1.25)*	5.05 *(1.42)*
	0.78	0.80	0.73	0.80
Food technology neophobia (FTNS)	4.18 [a]*(0.91)*	4.60 [b]*(0.78)*	4.43 [c]*(0.91)*	4.40 *(0.89)*
	0.86	0.78	0.79	0.79

[a,b,c] Significant differences based on Chi-squared and Pearson Chi-squared tests. Same letter indicates that there is no statistical significant difference at 5% level.

[1] In Norway: *< 23,000 NOK/23000–46,999 NOK/47000–71,000 NOK/ > 71,000 NOK;* In Romania: *< 21,000 RON/2100–4199,99 RON/4200–6300 RON/ > 6300 RON;* In Turkey: *< 3750 TL/3750–7499 TL/7500–11,250 TL/ > 11,250 TL.*

[2] Seven-point Likert scales ranging from *1 = strongly disagree* to *7 = strongly agree* were used to measure consumer attitudes.

3.5. Preference heterogeneity

3.5.1. Drivers of individual choice differences in each country

In order to investigate individual choice differences, four PCA models, respectively for Norway, Romania, Turkey and pooled sample were run on individual parameter estimates from the ML model above (i.e. model including only main effects and interactions of the conjoint factors). In the PCA models the coefficients are not standardized to preserve the original scale variations. Fig. 3 shows the respective correlation loadings plot for each country and for the pooled sample. In Norway (Fig. 3a), the first four principal components (PCs) indicate that the largest individual variations are linked to the No-buy option (on PC-1, explaining 65% of the variance), followed by Origin (PC-2, 18%), Technology (PC-3, 15%) and Nutrients content (on PC-4, 1%). In Romania (Fig. 3b), the largest individual variations are linked to Technology (PC-1, explaining 52% of the variance), followed by No-buy option (PC-2, 31%), Origin (PC-3, 15%) and Nutrients*Origin (PC-4, 2%). In Turkey (Fig. 3c), the largest individual variations are linked to Technology (on PC-1, explaining 41% of the variance), followed by Origin (PC-2, 32%), No-buy option (PC-3, 27%) and Nutrients content (PC-4, 1%). In the pooled sample (Fig. 3d), the largest individual variations are linked to No-buy option (on PC-1, explaining 44% of the variance), followed by Technology (PC-2, 36%), Origin (PC-3, 19%) and Nutrients content (PC-4, 1%). It is also interesting to note that factor Price nearly does not contribute to consumer variance at all in

these models, indicating a strong consumer agreement on preference for low price levels.

3.5.2. Consumer attributes for air or microwave-drying technology preferences for the pooled sample

Consumer attributes typical of air-drying or microwave-drying technology choices across the three countries were identified through a PLSR model relating the consumer attributes to the individual parameter estimates for factor Technology obtained from the mixed logit (ML) model. The final model explains 17% of the variation in Technology preferences with one PLS factor, indicating that the selected significant characteristics only partially explain consumers' technology choices. Out of 106 original variables, 27 show significant relationships to technology choices (Fig. 4).

Consumers who most typically selected MW-dried products live in Norway, were in the age range 18–29 years old, agreed to the statements that "*New food technologies are unlikely to have long term negative health effects*" (AFTNS6) and "*New products using new food technologies can help people have a balanced diet*" (AFTNS8), purchase frozen conventional and organic berries (PurFroBer, PurFroBerOrg), purchase dairy products, drinks and jams based on berries (PurDaiBer, PurDrinkBer, PurBerJam), were often unemployed and often selected dried strawberries of national origin in the choice task.

Consumers who most typically selected air-dried products were Turkish in the age range 54–65 years old, presented high scores on the

Table 3

Estimated parameters for ML models with conjoint variables' main effects and interactions for Norway, Romania and Turkey and the pooled sample.

Effects	Norway (n = 204)		Romania (n = 206)		Turkey (n = 204)		Pooled sample (n = 614)	
	Estimate (p)	SD (p)	Estimate (p)	SD (p)	Estimate (p)	SD (p)	Estimate (p)	SD (p)
Price (low, medium, high)	−0.225*** (< 0.001)	0.228*** (< 0.001)	−0.046*** (< 0.001)	0.093*** (< 0.001)	−0.570*** (0.009)	0.100** (< 0.001)	−0.110*** (< 0.001)	0.148*** (< 0.001)
Origin (European, vs. National)	4.061*** (< 0.001)	3.021*** (< 0.001)	2.918*** (< 0.001)	2.284*** (< 0.001)	2.638*** (< 0.001)	3.117*** (< 0.001)	2.156*** (< 0.001)	1.786*** (< 0.001)
Technology (Air-dried, vs. Microwave-dried)	−3.537*** (< 0.001)	2.723*** (< 0.001)	−3.722*** (< 0.001)	2.990*** (< 0.001)	−4.208*** (< 0.001)	3.518*** (< 0.001)	−2.471*** (< 0.001)	2.514*** (< 0.001)
Nutrients (Natural, vs. More natural)	0.033 (0.923)	0.933*** (0.003)	0.051 (0.820)	0.707*** (0.001)	−0.381 (0.113)	0.363 (0.313)	−0.141** (0.007)	0.500*** (< 0.001)
Opt-out (Buy vs. No Buy)	−5.702*** (< 0.001)	6.530*** (< 0.001)	−3.553*** (< 0.001)	2.892*** (< 0.001)	−4.765*** (< 0.001)	3.174*** (< 0.001)	−2.993*** (< 0.001)	2.835*** (< 0.001)
Price*Origin	−0.014 (0.768)	0.156*** (0.001)	−0.057 (0.065)	0.034 (0.335)	−0.015 (0.641)	0.074 (0.011)	0.012 (0.299)	0.061*** (< 0.001)
Price*Technology	0.005 (0.898)	0.009 (0.867)	0.048 (0.102)	0.109** (0.002)	0.042 (0.889)	0.022 (0.597)	0.009 (0.404)	0.422 (0.021)
Price*Nutrients	−0.017 (0.554)	0.039 (0.371)	−0.027 (0.166)	0.080** (0.001)	−0.007 (0.715)	0.026 (0.574)	0.002 (0.783)	0.033 (0.014)
Technology*Origin	1.934** (0.005)	3.744*** (< 0.001)	−0.561 (0.209)	2.152*** (< 0.001)	−0.999* (0.023)	1.255 (0.051)	0.027 (0.738)	0.387** (0.007)
Technology*Nutrients	−0.332 (0.468)	1.900*** (< 0.001)	−0.728* (0.041)	0.346 (0.352)	−0.268 (0.474)	1.293** (0.001)	−0.119 (0.059)	0.018 (0.932)
Nutrients*Origin	0.145 (0.791)	1.004 (0.184)	0.634 (0.126)	0.952** (0.003)	0.860* (0.036)	0.381 (0.387)	0.027 (0.703)	0.248 (0.193)

*** $p < .001$.
** $p < .01$.
* $p < .05$.

health interest (AGHI), natural interest (ANPI), organic and ecological attitudes (AFRLI) and food technology neophobia scales (FTNS), purchase dry and fresh berries in organic shops (DriBerOrSh, FreBerOrSh), stated that when purchasing dried fruits or berries it is important to them that the products are free from genetically modified organisms (NoGMOs), health-harming substances (NoHarmSub) and additives (NoAdditives, LeastAdditives) and pay attention to shelf life as a purchase criterion (ShelfLife), were often retired and often selected dried strawberries of high prices in the choice task. Note that attributes such as Romanian, gender or income do not appear in Fig. 4 as these were neither significantly associated to microwave nor to air-drying technology preferences.

3.5.3. Consumer attributes for air or microwave-drying technology preferences within each country

Consumer attributes typical of air-drying or microwave-drying technology choices within each of the three countries were identified through country-specific PLSR models according to the same approach as for the cross-national model above. The final one-factor models explain 9%, 13% and 18% of the variation in Technology preferences for Norway, Romania and Turkey, respectively. This indicates that the selected significant attributes only partially explain consumers' technology choices. Out of 106 original variables, 8, 18 and 23 variables show significant relationships to technology choices in Norway, Romania and Turkey, respectively.

Fig. 5 shows that Norwegian respondents who most systematically selected microwave-dried strawberries in the choice task differed from those who most systematically selected air-dried products in that they adhered to the pro-technology statements "*New food technologies give people more control over their food choices*" (AFTNS7) and "*New products using new food technologies can help people have a balanced diet*" (AFTNS8) as well as rejected higher price levels in the choice task. On the contrary, air-dried organic strawberry choosers scored high on natural interest (ANPI) and organic attitudes (AFRLI) scales. They also stated that it is important to them that berry products are free from genetically modified organisms (NoGMOs), additives (LeastAdditives) and environment-friendly (EnvironmentallySound), and showed better acceptance for higher price levels in the choice task. No socio-demographic characteristics were significantly related to technology choices in this country.

Romanian respondents who most systematically selected microwave-dried strawberries in the choice task differed from those who most systematically selected air-dried products in that they purchase dried organic berries (PurDriOrgBer), berry drinks and jams (PurDrinkBer, PurBerJam), and frozen berries in online stores (PurFroBer, FroBerOnl) (Fig. 6). They were typically from larger households (Hous-18, Hous + 18) and in the age-range 18–29 yr. On the contrary, air-dried strawberry choosers scored high on health (AGHI), natural interest (ANPI) and organic attitudes (AFRLI) scales. They also stated that it is important to them that berry products are free from genetically modified organisms (NoGMOs), additives (NoAdditives, LeastAdditives) and without health-harming substances (NoHarmSub), and pay attention to shelf life as a purchase criterion (ShelfLife). These respondents were in the age-range 54–65 years old or retired.

Turkish respondents who most systematically selected microwave-dried strawberries in the choice task differed from those who most systematically selected air-dried products in that they purchase dried organic berries (PurDriOrgBer), berry drinks (PurDrinkBer) and conventional and organic frozen berries (PurFroBer, PurFroBerOrg) in particular in organic shops (FroBerOrSh) (Fig. 7).

They adhered to the pro-technology statements "*New food technologies are unlikely to have long term negative health effects*" (AFTNS6) and "*The media usually provides a balanced and unbiased view of new food technologies*" (AFTNS13), were typically males and in the age-range 18–29 years old.

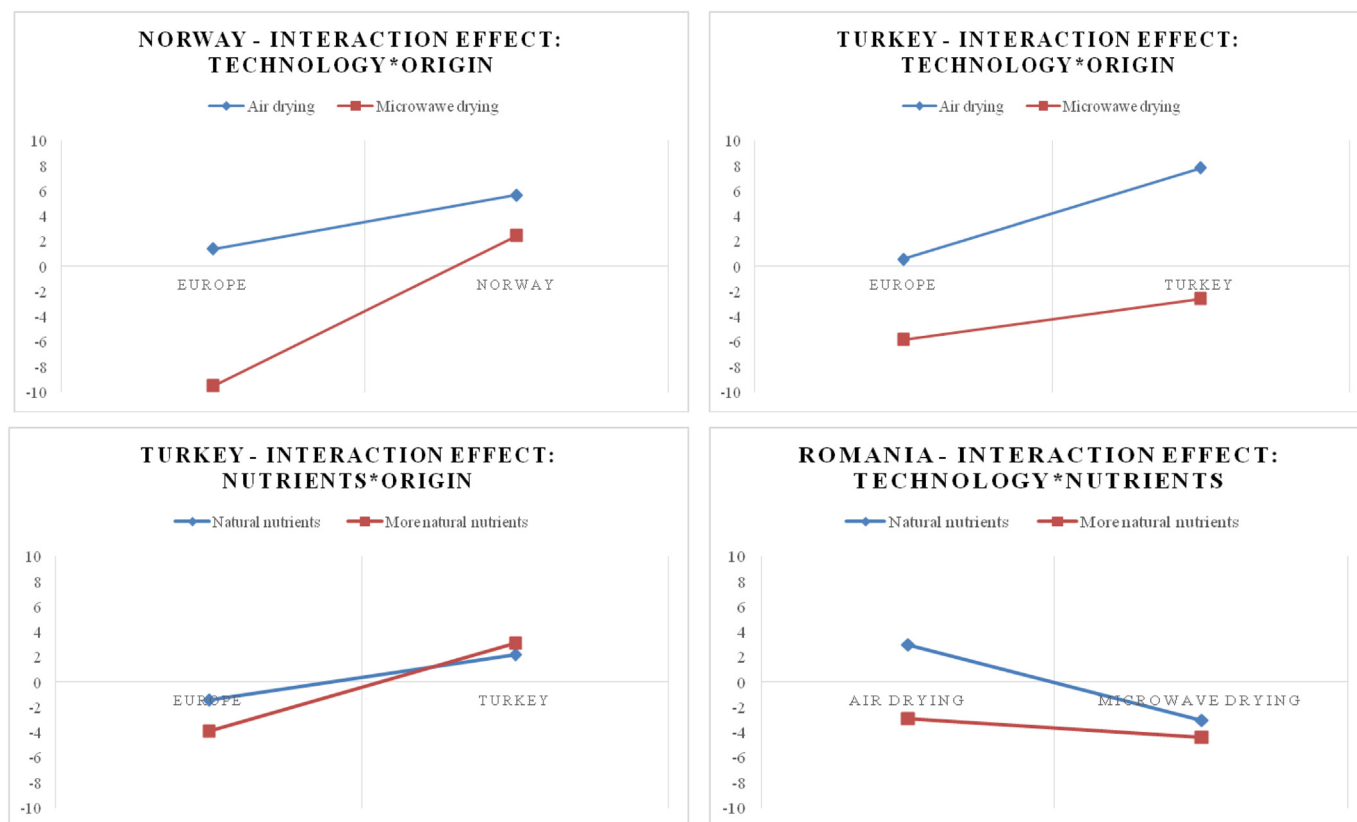On the contrary, air-dried strawberry choosers scored high on the

Fig. 2. : Significant interactions between conjoint factors at country levels.

natural interest (ANPI) and food technology neophobia (FTNS) scales, adhering in particular to the statement "*Society should not depend heavily on technologies to solve its food problems*" (AFTNS11). They also stated that it is important to them that berry products are free from genetically modified organisms (NoGMOs), additives (NoAdditives, LeastAdditives), health-harming substances (NoHarmSub), and environment-friendly (EnvironmentallySound). They pay attention to shelf life (ShelfLife), convenience (Convenience), visibility of the product in the packaging (VisibleProduct) and origin (Imp_Origin) as purchase criteria for dried-berry products. These respondents were typically consumers of dried berries for snacking purposes (ConBerSnack) and females (Fig. 7).
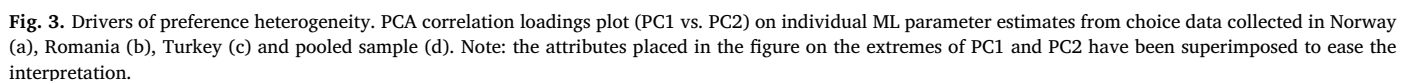
4. Discussion

This paper aimed to two main objectives. First, we aimed to investigate consumers' preferences for organic dried strawberries focusing on two drying processing technologies, such as the conventional thermal air-drying and the innovative non-thermal MW drying and compare them across the countries investigated such as Norway, Romania and Turkey. We found that on average consumers prefer organic dried strawberries produced with the air-drying technology with national origin, natural nutrient content and low price. One possible explanation of the rejection of MW technology is that organic consumers who are particular sensitive to sustainable issues (i.e. organic, natural and ecological attitudes) might perceive the technology "unnatural". These findings are corroborated by previous research which found that in general consumers prefer food products produced with conventional food technologies (Lusk et al., 2014) while more specifically Hemmerling, Asioli, and Spiller (2016) found that in several European countries organic consumers have preferences for conventional and traditional processing technologies. However, in general non-thermal food processing technologies are relatively well accepted

by consumers (Fischer, van Trijpe, Hofenk, Ronteltap, & Tudoran, 2012), but some differences between specific technologies exist. Sonne et al. (2012) found that while high pressure pasteurisation (HPP) is quite accepted by consumers because it is easy to explain and linked to natural and healthy aspects, other technologies such as pulsed electric field (PEF) have led to a more sceptical response from consumers. It is possible that the rejection of MW might be linked to the lack of perceived naturalness and familiarity especially for organic consumers who might be more sensitive towards new food technologies. Concerning origin, several authors found that organic consumers have preferences for food products of national origin (Krystallis & Chryssochoidis, 2009; Newman, Turri, Howlett, & Stokes, 2014; Peterson, Bernard, Fox, & Peterson, 2013). Gürhan-Canli and Maheswaran (2000) found that collectivist cultures[1] prefer national origin products over foreign products. Regarding the nutrient content, even if naturalness is perceived to be an important factor that drives consumer acceptance of new food technologies (Siegrist, 2008b), consumers prefer the natural nutrient content.

At national level we found interesting differences: Norwegian consumers show higher preferences for organic dried strawberries produced using MW technology than Romanian and Turkish consumers. A possible explanation is that in our sample, Norwegian consumers in general show a slightly lower food technology neophobia compared to Romanian and Turkish consumers. Another possible explanation of this behaviour is offered by Parrott, Wilson, and Murdoch (2002) who claimed that two main food cultures exist that divide northern and southern European countries: while northern European countries give

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[1] A collectivistic culture (e.g. Japan) is a culture when people feel they belong to larger in-groups or collectives which care for them in exchange for loyalty—and vice versa while the on the contrary an individualistic culture (e.g. US) is a culture where people are concerned with themselves and close family members only (Hofstede & Bond, 1984).

Fig. 3. Drivers of preference heterogeneity. PCA correlation loadings plot (PC1 vs. PC2) on individual ML parameter estimates from choice data collected in Norway (a), Romania (b), Turkey (c) and pooled sample (d). Note: the attributes placed in the figure on the extremes of PC1 and PC2 have been superimposed to ease the interpretation.

great emphasis on functionality-driven commodities and economic efficiency in food production, southern European countries provide more value to local, traditional, and artisanal production. Interestingly, origin plays a role in the acceptance of MW: Norwegians accept MW products if they are of national origin, while Turks accept air-dried products if they are of national origin. In this study, nutrients content was an important driver of choice at global level, but not in individual countries. It is possible that dried berries are considered as a healthy and nutritious food to start with, such that nutrients information is not a search attribute for this type of products. We also found significant consumer heterogeneities both at global level and within each country, which indicates that different consumer segments could be characterized.

Drying technology was the main driver of individual differences in Romania and Turkey, but not in Norway where MW-drying was widely accepted in combination with national production. This indicates that in Norway, organic production and national production may be cues of safety, reducing consumers' reluctance to new food technologies. It also illustrates that Norwegian consumers prefer national product origin and trust the Norwegian food industry (Asioli & Alfnes, 2016).

Second, we investigated individual technology preferences and

characterized consumer profiles in terms of attitudes, habits and socio-demographics across the different countries. We found that at global level consumer attributes only partially explain the attitude towards technology. Respondents who showed a least rejection for MW dried organic strawberries are young, live in Norway and have positive attitudes towards new food technologies. On the other hand, consumers who preferred air-drying products are typically older, live in Turkey and have pro-attitudes for organic, natural and ecological behaviour. Results show that younger consumers were more positive towards MW-dried products than older consumers. This finding is corroborated by Tuorila, Lähteenmäki, Pohjalainen, and Lotti (2001). Norwegians who prefer dried organic strawberries produced with MW drying show positive attitudes for new food technologies, while consumers who prefer air drying products show interest for organic and natural food products, and show a willingness to pay (WTP) higher prices as well as prefer to buy berries that are GMO-free, do not contain additives and are environmental-friendly produced. A similar path has been identified for Romanian consumers as well as for Turkish consumers.
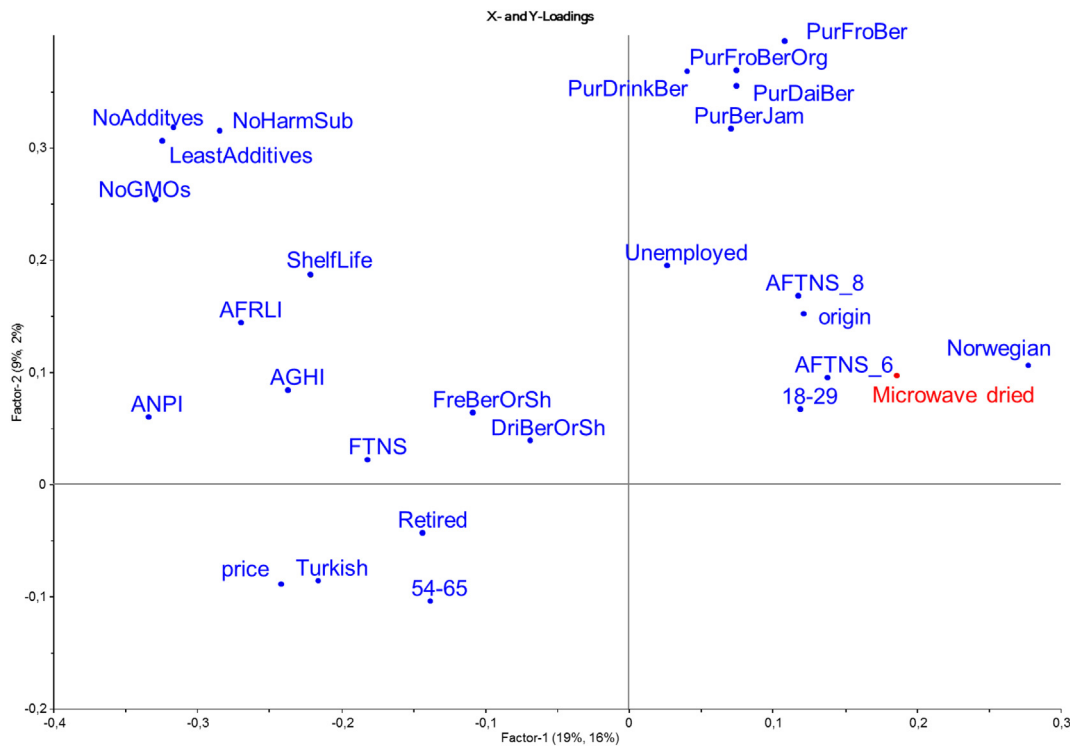
Fig. 4. : Consumer profiles for technology preferences. PLSR loadings plots (PLSC1 vs. PLSC2) on consumer attributes and Mixed Logit parameter estimates for Technology from the pooled sample.

5. Conclusion

The results of this research show that producers aiming to produce and sell organic dried strawberries using MW drying should carefully identify specific consumers segments to target their marketing strategies. For example, it appears that an initial focus towards younger consumers as early adopters, in particular in Norway, would help the launch of MW products before extending to other consumer segments. To increase consumer acceptance of MW berries products, it is very important to inform consumers about the process and benefits of such technology and its characteristics (i.e. non-thermal and organic) since being a credence attribute it cannot be directly experienced by
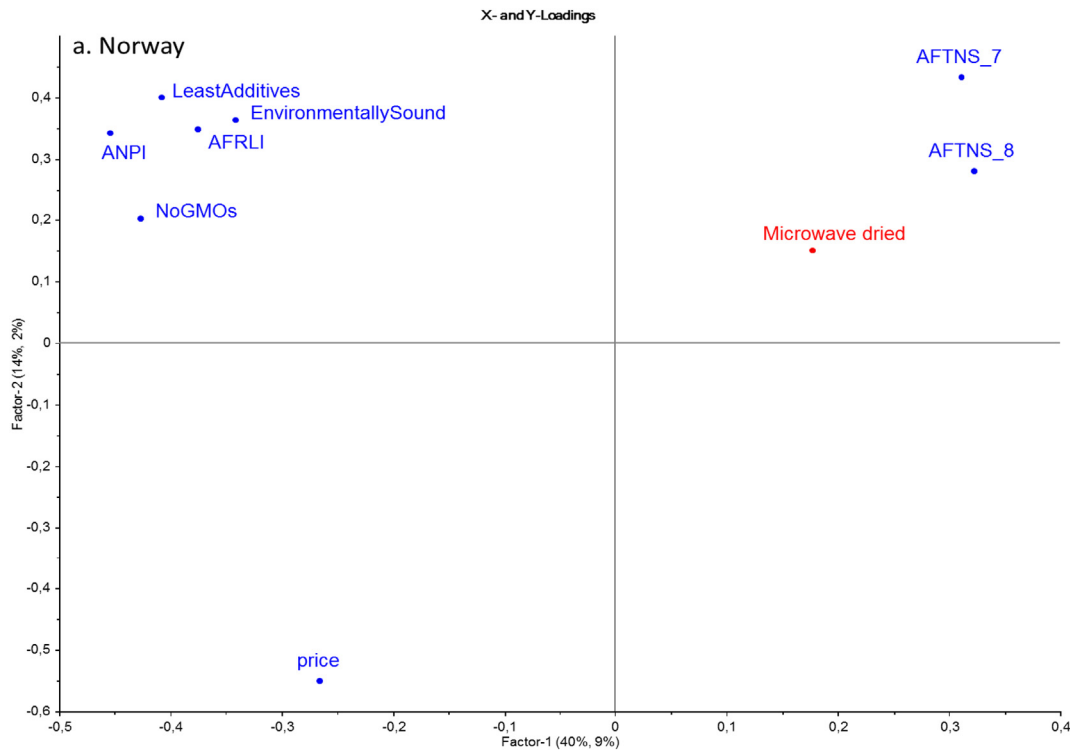
Fig. 5. : Consumer attributes for technology preferences in the country-specific models. PLSR loadings plots for Norway.
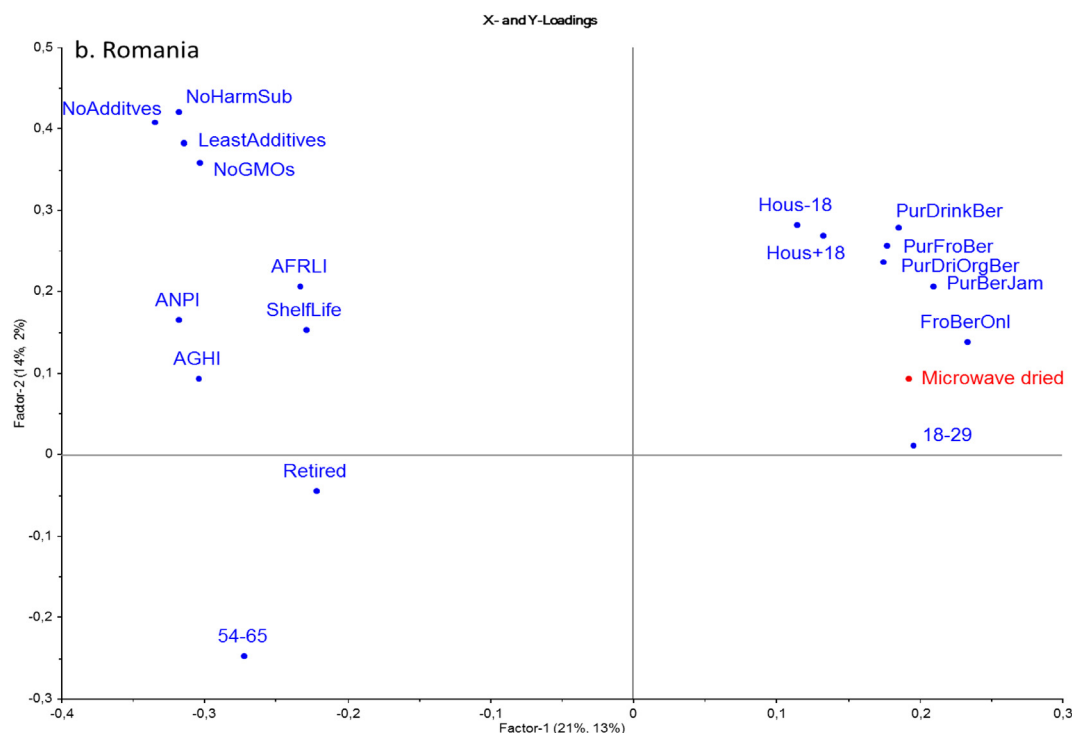
Fig. 6. Consumer attributes for technology preferences in the country-specific models. PLSR loadings plots for Romania.

consumers. The benefits and the process of MW should be communicated by the industry and/or by independent scientist or consumer organizations to increase consumer trust (Siegrist, 2008b). Special attention should be brought on how to frame the communication since organic consumers are more sensitive to health, environmental and ecological issues than non-organic consumers. For policy makers it is important to define and regulate more clearly the microwave drying as

organic technology as well as regulate the labeling to ensure that consumers are not mislead and correctly informed about the new technology.

Future research avenues could be addressed in several directions. First, investigations of different product communication framings may allow to verify which ones are more accepted by consumers and best reinforce consumers' trust in non-thermal processing technologies of
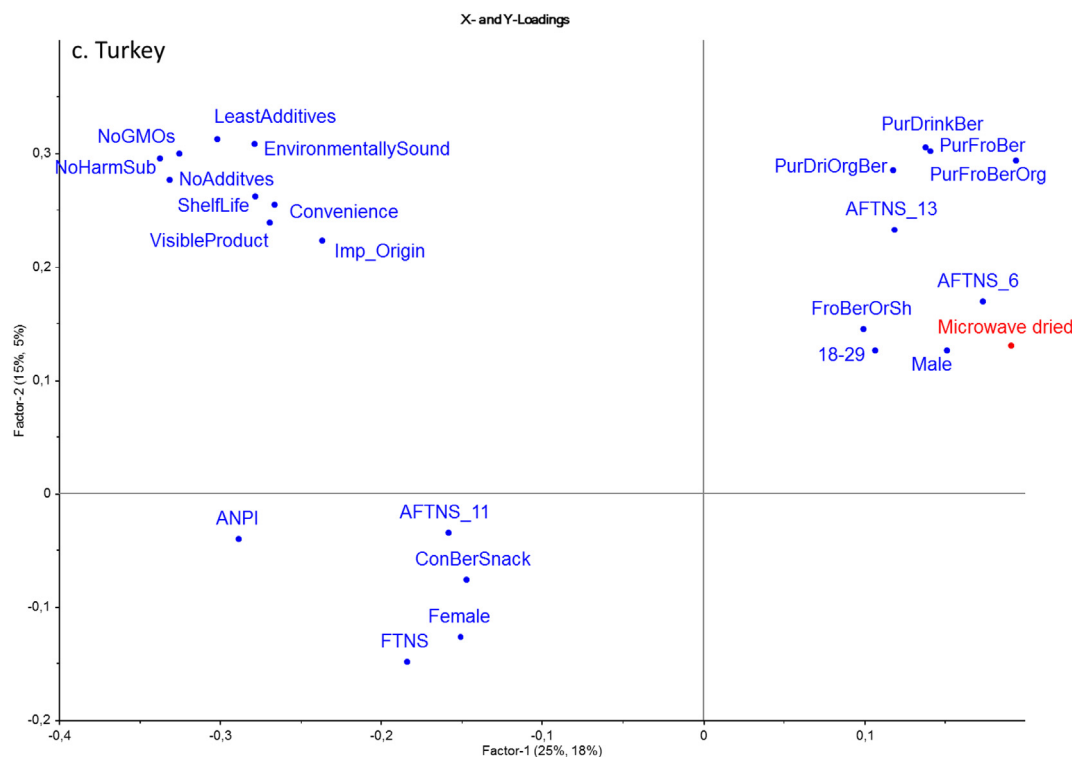

Fig. 7. Consumer attributes for technology preferences in the country-specific models. PLSR loadings plots for Turkey.

organic products. Second, the investigation of additional non-thermal processing technologies and labeling strategies would enrich the knowledge about organic consumers' acceptance towards those technologies. Last, the replication of this study in other countries by using organic products of different levels of processing and in non-hypothetical buying scenarios, would be useful to further investigate consumers' perception for organic processed products.

Finally, the results from this study show that consumers who have stronger ecological and environmental attitudes are more reluctant to adopt MW drying even if it is an organic processing technology. As expressed by Cavaliere and Ventura (2018), consumers with high sustainable concerns fail to recognize in science and technology a possible contribution towards a more sustainable world.

Acknowledgments

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