Consumer willingness to pay for catechin-enriched yogurt: Evidence from a stated choice experiment

Consumer Willingness to Pay for Catechin-enriched Yogurt: Evidence from a Stated Choice Experiment

Abstract

In recent years, food manufacturers have been devoting a large portion of their R&D budgets to the development of functional foods. Although functional foods exhibit a significant level of information asymmetry, consumers appear to be increasingly appreciative, recognising their role in preventing or reducing health risks and/or improving other physiological functions. This paper quantifies the willingness to pay of a representative sample of 600 Italian consumers for a hypothetical yogurt using a web-based stated choice experiment. The willingness to pay for two functional attributes (probiotics and catechin enrichment) was measured using the panel data version of a Random Parameters Logit model. The results show that respondents are willing to pay a premium for a catechin-enriched yogurt (0.38 €/jar), which is well above their willingness to pay for the probiotic attribute (0.21 €/jar). Averaging the across sample sub-groups indicates that the willingness to pay for catechin enrichment may be related to age, income, health status, lifestyle and education. [EconLit Classifications: C25, C93, D12].

1. Nutrition and health: the role of functional foods

Although the primary goal of a diet is to meet nutritional requirements and provide energy, its link with health is well established, as it is maintained that "diet may modulate various physiological functions and may play detrimental or beneficial roles in some diseases" (Koletzko et al., 1998 cited in Granato et al., 2010:455). Consumers have become increasingly aware that a balanced diet has significant positive effects on health, and thus eating "good" food might prevent the insurgence of diet-related pathologies and/or improve well-being and life expectancy.

In recent years, functional foods (FFs) have been proposed as an additional tool for a healthy life, and consumers appear to appreciate this extension of the food product basket. Although FFs may exhibit a level of information asymmetry between producers and consumers that is higher than in traditional food items (Zou & Hobbs, 2006), their demand has surged due to, for instance, rapid population ageing, health deterioration as a result of poor lifestyles, increased information to consumers, novelty, scientific progress in nutrition research and food technology. Moreover, the consumption of FFs may reduce the extent of malnutrition and the budget allocated to a publicly funded healthcare system addressing, *inter alia*, the negative externalities associated with unwise eating habits (for further details, please see Malla et al. (2007) and Doidge et al. (2012)).[1]

[1] On these issues, Lenoir-Wijnkoop et al. (2013) provide an interesting summary of the role of nutrition economics - a recently developed sub-branch of health economics - in informing the policy debate on, *inter alia*, "the role of nutrition and its impact in reducing the public health burden through […] enhancing the use of functional foods for health improvement and disease risk reduction" (Lenoir-Wijnkoop et al., 2013:778).

Therefore, knowledge of consumers' perceptions, motivations and evaluations of functional attributes in food products is crucial for drafting both marketing strategies and policy interventions (Siró et al., 2008; Annunziata & Vecchio, 2011).

Producing and commercialising FFs has been considered by food manufacturers to be a viable competitive strategy in food markets currently dominated by largely static demand, at least in quantitative terms. Moreover, as reflected in available data, FFs appear to be a market segment offering high returns for the significant associated R&D investments.[2] In fact, the 2010 sales of FFs and beverages in the United States are valued at 38 billion US$ (NBJ, 2011), with roughly one-fourth of the foods and beverages commercialised in 2010-11 carrying a functional claim regarding added nutrients, reduced calories or low-fat/fat-free/high fibre content (IRI, 2011). Other figures suggest that the world market for FFs amounted to 78.3 billion US$ in 2007, with the United States and Europe accounting for approximately 50% and 20%, respectively; this market was expected to increase to 128 billion US$ by 2013, with an annual growth rate of 8.4%.

The term FF was first promoted in Japan and is currently "used to describe a range of novel foods […] which are designed to deliver some other benefit beyond nutrition to the person consuming them" (Frewer et al., 2003:715). While there is not an established definition of FF, its numerous formulations can be classified according to the *health benefits*, the *nature of food*, the *level of function* and the *consumption pattern* (Doyon & Labrecque, 2008). A processed food is functional if it contains ingredients that aid/affect specific physiological functions in addition to being nutritious, thus having a role in disease prevention/reduction and health promotion. Further, as stated also in Poulsen (1999:1), the "product which has been modified or enriched with naturally occurring substances […] must also be part of the normal daily consumption of food/fluids". Regarding the characteristics of the functional property incorporated into the food product, Siró et al. (2008) distinguish among *fortified products* (addition of normal nutrients), *enriched products* (addition of new nutrients/components), *altered products* (removal, reduction or replacement of "bad" components) and *enhanced commodities* (natural enhancement of some components in agricultural commodities). Further, a classification based on their functional role (Siró et al., 2008) identifies products that *add good to your life*

[2] The cost of developing and marketing new food products is estimated to be between US$ 1 and 6 million, while Menrad (2003) reports that Unilever has invested in excess of US$ 50 million to develop two FFs.

(i.e., probiotics and prebiotics), *reduce an existing health risk problem* (i.e., addition of plant sterols to reduce cholesterol) and *make life easier* (i.e., lactose-free and gluten-free products).

Consumers are not necessarily fully aware of the functional attributes in a food item; therefore, the latter may be characterised by a potentially high level of information asymmetry regarding either the actual presence of the functional component or the credibility of the associated health claim (Zou & Hobbs, 2006). In turn, consumers' acceptance of FFs largely depends on subjective perception. Since manufacturers rely on consumer acceptance of the functional attributes to charge a premium price, labelling and brand advertising are crucial to the success of a new product. Nonetheless, public agencies, such as the EFSA in the European Union, are concerned with ensuring that the message delivered to the final consumer is legitimate, meaning that the causality between the consumption of the FF and the health benefit has a solid scientific basis.[3] If the functional attributes can be identified and the information asymmetry largely overcome, consumers may be willing to pay a (higher) price premium for the beneficial food (see also Markosyan et al., 2009). Therefore, the price premium also provides a measure of the value placed by consumers on the associated health risk. Empirical studies on consumer acceptance and valuation of FFs include West et al. (2002), Cox et al. (2004), Larue et al. (2004), Teratanavat & Hooker (2006), Ares & Gámbaro (2007) and van Trijp & van der Lans (2007).

A large body of applied research has investigated the main determinants of consumers' behaviour to elicit preferences and to measure the economic value of food products' attributes in an attempt to determine consumers' willingness to pay (WTP) for, *inter alia*, the quality and health related attributes of food products. The WTP for food attributes is relevant for manufacturers developing new products because it provides insights into the likely price premium they can enjoy. Different approaches can be employed to obtain estimates of the WTP for the health attributes in a new (hypothetical) FF product (e.g., auctions, contingent valuation (CV), choice experiments (Enneking, 2004)). In valuing nonmarket goods and/or new products, the choice modelling approach, grounded in random utility theory, has gained relevance in recent years: individuals' responses to product characteristics can be assessed requiring consumers to choose from a hypothetical set of products differing in the level of their attributes (Quagrainie et al., 1998), thus stating their preferences and allowing for

[3] The European Union (EU) institution that is responsible for evaluating and approving proposed health claims is the European Food and Safety Authority (EFSA) under the mandate of Regulation (EC) No 1924/2006, which is the binding and current legal framework stipulating that permitted health claims, *inter alia*, "be based on and substantiated by generally accepted scientific evidence" (art. 6.1) and not "be false, ambiguous or misleading" (art. 3).

a trade-off between food characteristics. The major drawback of this method is the hypothetical nature of choices such that consumers avoiding a monetary outlay may overstate their WTP. However, the joint evaluation of multiple product attributes gives rise to welfare measures, of which WTP is arguably one, that have generally smaller variances – relative to their means – compared to those obtained from CV (Adamowicz et al., 1998). Moreover, considering different levels of attributes eliminates the part-whole bias (Hanley et al., 1998).

We contribute to the extant literature by evaluating the WTP for the health benefits from two functional attributes of a new and hypothetical, yet technically feasible, FF product: a yogurt enriched with probiotics and catechins. Our contribution, in addition to being one of the few studies on the WTP for FFs in Italy, aims to establish an economic valuation of the numerous and wide-ranging medical and clinical benefits of catechins. Therefore, consumers may be willing to pay a premium to have access to a product enriched with catechins. In turn, food manufacturers could amass higher revenues and profits provided that they are able to effectively communicate the functional benefits to the consumer through a health claim formulated in accordance with Regulation (EC) No 1924/2006. Because of the fairly restrictive nature of this Regulation, the frequently negative evaluations of health claims which have ensued from and the evidence that health claims determine consumer WTP for FFs (e.g., Leathwood et al., 2007; Williams & Ghosh, 2008), the present study may be considered an empirical evaluation of the monetary benefits that food manufacturers could receive from financing and collecting high quality medical research as well as from formulating appropriate and precise health claims leading to an EFSA approval. In turn, our results will reflect the WTP for the medical and clinical benefits of catechin intake but do not necessarily depend on the formulation of an EFSA-compliant health claim.

Yogurt has been adopted as the "carrier" food because it is an almost daily component of consumers' diets with a high degree of penetration among households (in Italy almost 95% in 2010), and it even qualifies as a FF because of the sole presence of live bacteria (Bonanno, 2012). Moreover, since medical studies suggest that the beneficial effects of catechins can be observed only after prolonged daily consumption, yogurt represents a suitable "candidate" food to deliver catechins to the human body. Yogurt consumption has been growing in Italy over recent years, with functional yogurt accounting for approximately 30% of consumption in volume and 35-40% in value. Empirical research has demonstrated the importance of health-related

attributes in shifting the demand for yogurt (Bonanno, 2012), reducing demand elasticity and increasing brand loyalty (Bonanno, 2013).

2. The potential health benefits of a yogurt enriched with probiotics and catechins

Probiotics are live bacteria (i.e., lactic acid bacteria, bifidobacteria) that may augment consumers' intestinal microbial population, providing some relief to intestinal inflammations, urogenital infections or allergies. Catechins are natural phenolic compounds that can be found in tea, mainly green tea (Najgebauer-Lejko et al., 2013), grapes and wine (Karaaslan et al., 2011), chocolate and a few fruits whose taste is neither exactly astringent nor exactly bitter (Kielhorn & Thorngate Iii, 1999). While most of the catechin extracts would be encapsulated into cyclodextrins to mitigate their effect on the taste of the carrier product (Kríz et al., 2003), those extracted from vine grapes appear to have a milder taste. Relying on this source of catechins could be instrumental to producing a cheaper functional yogurt and preventing the shifts in sensory characteristics that sometimes occur for probiotic yogurts enriched with encapsulated bacteria (Kailasapathy, 2006). The recommended daily allowance (RDA) of both probiotics and catechins (Williamson & Holst, 2008) may be added, at least in a laboratory setting, to the "base" yogurt by means of a similar procedure: heating, high-speed stirring and cooling (Kailasapathy, 2006; Karaaslan et al., 2011).

While several probiotic yogurts are already marketed in Italy (Boesso et al., 2009), and their popularity among consumers has contributed to boosting the penetration of functional yogurts on the Italian market to 68% in 2010, it appears that food and beverages enriched with catechins are only vaguely considered by the food industry.[4] Nonetheless, several medical studies confirm that a regular daily intake of these components may provide positive health effects (e.g., antioxidant, antidiabetic, antimutagenic, anticarcinogenic, antiviral, antibacterial, antihypertensives, antiatherogenic), protect against progressive neurodegenerative disorders such as Parkinson's and Alzheimer's diseases, and control the level of total and LDL cholesterol, triglycerides, free fatty acids, and fat accumulation. Catechins can thus help individuals in reducing, *inter alia*, obesity, cardiovascular problems and aging (e.g., Murase et al., 2008).

Although probiotic yogurt is extensively commercialised on the Italian market, the health claims related to probiotic enrichment have come under the intense scrutiny of the EFSA under the mandates of Regulation

[4] Unilever might be the most likely proponent of a food/beverage enriched with catechins. In fact, Unilever has sponsored research to explain the benefits of and to collect medical evidence for the use of green tea catechins for body shape management (Unilever, 2009).

(EC) No 1924/2006. All of the evaluations related to the submitted questions have been completed and have generally established the lack of a cause and effect relationship between the consumption of the food(s)/food constituent(s) subject of the claim(s) and the claim's content. Only a few scientific opinions regarding probiotics have been negative because of the general and non-specific reference to health effects. Similarly, the EFSA outputs concerning the assessment of the numerous health claims (and reformulations thereof over time) related to catechins have, so far, all been rejected on the basis of motivations similar to those for the probiotic enrichment. However, five questions related to the ability of, *inter alia*, catechins to foster toxin elimination, help maintain weight control and cardiovascular health as well as invigorate the body are still under consideration, suggesting that the food industry foresees significant potential applications for this enrichment.

3. The choice modelling approach

In the choice modelling approach, respondents are asked to choose one product within a (finite) set of (hypothetical) alternatives that differ in terms of the levels of their attributes (including price). Contrary to CV, consumers do not directly provide a measure of their WTP for the relevant attribute but, rather, their stated choices can help infer WTP. A number of applications of choice modelling in agricultural and food marketing studies have emerged in recent years (e.g., Burton et al., 2001; Burton & Pearse, 2002; West et al., 2002; James & Burton, 2003; Lusk et al., 2003; Alfnes, 2004; Enneking, 2004; Rigby & Burton, 2005; Alfnes et al., 2006; Mtimet & Albisu, 2006; Loureiro & Umberger, 2007; Jaeger & Rose, 2008; Gracia et al., 2009). When products are not available (i.e., new hypothetical products), as is the case for a yogurt enriched with catechins, a stated choice (SC) experiment is arguably the best available approach for investigating consumer preferences.

Functional (health-related) attributes can be interpreted as food "characteristics". The choice modelling approach relies on Lancaster's consumer theory (Lancaster, 1966), which posits that goods are bundles of characteristics and that consumers' preferences are stated over characteristics. McFadden (1974) has developed an econometric framework for treating discrete choice models in the context of random utility theory. The (indirect) utility that individual *i* obtains from good (alternative) *j* in choice situation *t*, U_{ijt}, can be decomposed into a deterministic part, V_{ijt}, related to the *K* observed good's characteristics (including its price), and a stochastic part, ε_{ijt}, also accounting for unobserved individual characteristics:

$$U_{ijt} = V_{ijt} + \varepsilon_{ijt} \tag{1}$$

The deterministic (observable) component V_{ijt} can be modelled as $V_{ijt} = \sum_k x_{jkt}\beta_{ik}$, that is, the observed utility can be expressed as a linear function of the x_{jkt} level of attribute k in good j in choice situation t, according to the individual preference parameters β_{ik}. The choice rule is utility maximisation: good (alternative) j is chosen in choice situation t by individual i, from all mutually exclusive finite alternatives within an exhaustive choice set J, iff

$$U_{ijt} > U_{iht} \qquad \forall h \neq j \in J \tag{2}$$

and the probability P_{ijt} that individual i will choose alternative j in choice situation t can be written as

$$P_{ijt} = \Pr\left[U_{ijt} > U_{iht}\right] = \Pr\left[\left(V_{ijt} - V_{iht}\right) > \left(\varepsilon_{iht} - \varepsilon_{ijt}\right)\right] \qquad \forall h \neq j \in J$$

Different assumptions for the structure of the stochastic component ε_{ijt} lead to a variety of models. We employ the Random Parameter Logit (RPL) model allowing the set of preference parameters $\boldsymbol{\beta}_i$ to be distributed across individuals according to a statistical distribution $\boldsymbol{\beta}_i \sim f\left(\boldsymbol{\beta}_i \middle| \boldsymbol{\mu}_{\boldsymbol{\beta}}, \boldsymbol{\sigma}_{\boldsymbol{\beta}}\right)$ characterised by mean $\boldsymbol{\mu}_{\boldsymbol{\beta}}$ and variance-covariance matrix $\boldsymbol{\sigma}_{\boldsymbol{\beta}}$. The RPL model has become the reference model in SC studies because of its ability to account for preference heterogeneity, both measured and unmeasured, and its flexibility in accommodating a variety of model specifications (McFadden & Train, 2000; Jain et al., 1994). The RPL specification does not require the Independence of Irrelevant Alternatives (IIA) property. Thus, it does not restrict substitution patterns as in the Multinomial Logit (MNL) model, such that the ratio of the probability of choosing between alternatives j and h also depends on alternatives other than j and h and their attributes. The conditional probability that individual i with preference parameters $\boldsymbol{\beta}_i$ will choose alternative j in choice situation t is given by

$$P_{it}\left(j \middle| \boldsymbol{\beta}_i\right) \equiv L_{ijt}\left(\boldsymbol{\beta}_i\right) = \frac{e^{V_{ijt}(\boldsymbol{\beta}_i)}}{\sum_h e^{V_{iht}(\boldsymbol{\beta}_i)}} \tag{3}$$

Furthermore, since the RPL specification can also be generalised to panel data (i.e., each sampled individual *i* makes more than one choice (Train, 2003)) assuming that the parameters are constant over time/choices, integration of the conditional probability leads to the unconditional probability of individual *i* choosing alternative *j* in choice situation *t* (Greene et al., 2005)

$$P_i(j) = \int \prod_{t=1}^{T} L_{ijt}(\boldsymbol{\beta}_i) f\left(\boldsymbol{\beta}_i \left| \boldsymbol{\mu}_{\boldsymbol{\beta}}, \boldsymbol{\sigma}_{\boldsymbol{\beta}} \right.\right) d\boldsymbol{\beta} \tag{4}$$

To evaluate consumers' WTP for the two health attributes (probiotic (prob) and catechins (catec)), consider that in the random utility model, each preference parameter represents the marginal utility of the attribute, that is $\partial U / \partial x_k = \beta_k$. Nonetheless, given the individual-specific nature of the preference parameter vector $\boldsymbol{\beta}$, the individual (simulated) unconditional estimate of the WTP for any attribute *k* is given by (Greene et al., 2005)

$$\hat{E}_s\left[WTP_{i,k}\right] = \frac{\frac{1}{R}\sum_{r=1}^{R} -\frac{\hat{\beta}_{ikr}}{\hat{\beta}_{i,price,r}} L\left(\hat{\boldsymbol{\beta}}_{ir}\right)}{\frac{1}{R}\sum_{r=1}^{R} L\left(\hat{\boldsymbol{\beta}}_{ir}\right)} \tag{5}$$

where $\hat{\beta}_{ik}$ is the (simulated) conditional mean of the individual preference parameter β_{ik} corresponding to the r^{th} draw – out of the total number of replications *R* – of β_{ikr}.

To provide useful insights into which socio-demographic variables may be fruitfully employed to segment the potential market in order to secure the highest price premium, the average $WTP_{k|g}$ for each socio-demographic group *g* can be calculated by averaging $WTP_{i,k}$ over the number of individuals in each group. Similarly, to obtain a synthetic measure of the WTP_k, the sample mean estimate is obtained by averaging $WTP_{i,k}$ across all individuals in the sample.

4. The choice experiment

In June 2011, a SC experiment was conducted on a sample of 600 Italian consumers to evaluate their perception of the potential health benefits related to two functional attributes of yogurt (enrichment with catechins and probiotics). Using a structured questionnaire, Lightspeed Research Ltd. administered a web-

based survey to a random sample of consumers selected according to given quotas from a wider representative sample of the Italian population.[5]

The questionnaire is composed of three parts. In the first part, catechins and their potential health effects are briefly described and a definition of the term FF is given to provide the necessary preliminary information, allowing consumers to make a "rational and informed choice".[6] The second part of the questionnaire collects information on the respondents' responsibility for food purchases, frequency of yogurt consumption and daily lifestyle. Furthermore, in this section, the surveyed individuals make three choices (i.e., a panel dataset with $T=3$ is obtained) selecting, each time, one product from a set of three alternatives (i.e., three products with different levels of relevant attributes). Finally, in the third part, socio-demographic information is collected (gender, age, geographic location, weight, height, employment status, education, marital status, household size, presence of children, income and number of income recipients).

Choice sets have been constructed through an experimental design based on the product's main attributes. Six different attributes have been considered for a given product packaging (a 125 g jar): *type, flavour, organic, probiotic (enriched with), catechin (enriched with)* and *price*.[7] Table 1 lists the attributes and their levels. Probiotic enrichment has been added to the attribute space since it provides a functionality that the consumer is familiar with. Thus, it should help respondents to make more consistent choices. Moreover, the inclusion of the probiotic attribute is likely to reduce the potential for overestimating the health benefits of catechins, attributing to the latter some of the health benefits of the former (i.e., giving rise to a halo effect (Roe et al., 1999; Street et al., 2005)).[8]

[5] Since the latter sample is representative at the national level and because our empirical sample has been extracted from this sample respecting the given quotas, we are reasonably confident that our findings can be used to describe patterns that concern all Italian consumers. When commenting on the evidence of this study, we occasionally exploit this generalisation.

[6] These preliminary statements are reported in Appendix A. The information that is provided is primarily the scientific evidence related to the health benefits associated with the intake of catechins and does not represent the communication of any health claim associated with catechin enrichment.

[7] A referee of this journal highlighted that brand (image) is an important factor communicating the health value of a FF to consumers who are in the process of making food choices/purchases (e.g. Chrysochou, 2010). Moreover, SC experiments have confirmed that brand is one of the most important attributes in product choice (e.g., Annunziata & Vecchio, 2013) and is related to significant differences in the WTP for credence attributes (e.g., Enneking, 2004). Nonetheless, it is difficult to speculate whether, and how, our findings would have been different if we had included brand in the attribute space. Given the referee's suggestion and the aforementioned literature, future research efforts in this field will definitely consider brand as one of the attributes in the SC experiment. Therefore, we may caution the reader that the empirical evidence provided here might still suffer from, *inter alia*, an omitted variable bias.

[8] The experimental evidence in Roe et al. (1999) confirms the possibility that the presence of a given health claim, possibly associated with a particular type of enrichment, does not prevent consumers from attributing a health benefit to the product of interest that is not associated with the health claim presented (in our case, the claim associated with catechin enrichment) but that is associated with the enrichment(s) that they are more familiar with (in our case, the claim associated with probiotics). We believe that excluding the

Table 1 about here

The full factorial experimental design based on the attributes and levels in Table 1 produces $2 \cdot 3 \cdot 4 \cdot 2 \cdot 2 \cdot 7 = 672$ alternative treatments. To reduce the dimension of the experiment while allowing the consumers' responses to be identified, a D-optimal experimental design selects 29 alternatives, which are constructed considering only the linear individual effects for the attribute variables. Moreover, a "baseline alternative" is always included as the first alternative in each choice set administered to the respondents to help to scale the utilities among the various choice sets. Often, the "baseline alternative" is specified as the "no choice" option in market penetration studies. Because this is not the main focus of the present work, the "baseline alternative" is defined according to retailing data: it is the type of yogurt most frequently purchased by Italian consumers (i.e., whole, creamy fruit, non-organic, without probiotics, without catechins, priced at 0.70 €). Moreover, fully characterising the "baseline alternative" prevents respondents from providing no information at all through the "no choice" option (Haaijer et al., 2001).

Three choice sets were submitted to each participant, and thus three choices were made, providing a balanced panel of observations. In each of the three choice sets administered, the respondent chose from three alternatives: the first was always the "baseline alternative", while the other two were randomly selected, without replacement, within the set of the 29 possible treatments.

5. Results and discussion

Table 2 presents the summary statistics for the sample of Italian consumers who responded to the questionnaire.[9] Our sample features a percentage of overweight/obese people consistent with national statistics (45.7%), while over 50% of the surveyed individuals are trying to lose weight, and a large proportion (86.5%) pays attention to nutritional labels on food products. Lastly, 73% of the respondents report consuming yogurt more than once a week.

probiotic enrichment from the attribute space of this experiment would have generated the halo effect described by Roe et al. (1999) and, previously, by Ford et al. (1996).

[9] Note that respondents who are not responsible for their household's grocery shopping and who have either never gone shopping or never consumed yogurt have been removed from the sample.

Table 2 about here

The empirical model was estimated using the econometric software NLOGIT 5.0[10] assuming that all of the attribute parameters are random in nature: the parameters for the attributes *type, flavour, organic, probiotic (enriched with) and catechin (enriched with)* are modelled following a normal distribution, while the one for *price* follows a triangular distribution. Moreover, we constrain the triangular distribution for the price coefficient to spread over positive values in order to limit the possibility that, upon calculating the WTPs for the product's attributes, the distributions of WTPs are not well behaved because 0 is in the domain of the triangular distribution (Daly et al., 2012).[11] All attributes, except *price*, have been introduced in the model using sets of mutually exclusive dummy variables.

To account for heterogeneity among consumers, the empirical treatment of discrete choice models suggests to also include socio-demographic characteristics in the set of explanatory variables assumed to affect V_{ijt} in (1). We have estimated the RPL model including all the socio-demographic variables in Table 2, one at a time and sometimes in pairs. Every unrestricted specification has been tested against the restricted specification featuring only the product's attributes. The associated Likelihood Ratio Test statistics, for the unrestricted model being superior to the restricted one, have recorded insignificant p-values, at conventional levels, except for the role of marital status, which is significant at the 5% level.[12] Due to the very limited evidence that socio-economic variables can capture additional individual deterministic heterogeneity, consistently with some of the existing literature (Hu et al., 2012), our final specification of consumer utility only includes the product's attributes

$$\begin{aligned} U_{ijt} = {} & \beta_{i,ty\_B} ty\_DuB_t + \beta_{i,ty\_C} ty\_DuC_t + \beta_{i,fl\_B} fl\_DuB_t + \beta_{i,fl\_C} fl\_DuC_t \\ & + \beta_{i,fl\_D} fl\_DuD_t + \beta_{i,or} or\_Du_t + \beta_{i,pb} pb\_Du_t + \beta_{i,ca} ca\_Du_t + \beta_{i,pr} pr_t + u_{ijt} \end{aligned} \quad (6)$$

[10] NLOGIT 5.0 fits this model employing a maximum simulated likelihood estimator. Crucial features of the estimator include the nature and number of the discrete points in the integration space. Following best practice, Halton sequences are selected, and 1000 draws are employed. The latter have been selected by following the estimates' "robustness checks" suggested in Hensher & Greene (2003), which consist in verifying the stability of the ratio of the estimated mean to the standard deviation of the model's random parameters when the model is estimated with 25, 50, 100, 250, 500, 1000 and 2000 points.

[11] Imposing this constraint implies that a model with correlated random parameters cannot be estimated and that the scale parameter for the price coefficient is set to be equal to the absolute value of the related β coefficient (mean) (Greene, 2012:N-545). While ignoring the correlation between random parameters has been suggested to lead to correlation among the implied WTP distributions (Scarpa et al., 2008), we maintain the constraint to obtain better-defined WTPs.

[12] Additional results for the testing procedure are available from the authors upon request.

The estimated model performs quite well. The McFadden Pseudo R-squared (R^2), which is a measure of the goodness-of-fit in discrete choice models, is very high (0.7160); as a consequence, the χ^2 test (with 17 degrees of freedom) of the explanatory power of the model strongly rejects the null that the model does not explain respondents' choices.

Estimates of the model parameters (mean and spread coefficients) are reported in Table 3. Looking first at the β coefficients (means), it appears that, on average, product attributes play a relevant role in consumers' choices. The price coefficient is highly significant and negative, as expected, while a "drinkable" yogurt appears to be less favoured by respondents, compared to a yogurt made out of whole milk. Similarly, "other flavours" and "white" yogurts have lower probabilities of being selected compared to a "creamy fruit" alternative. The positive coefficients for the presence of probiotics and catechins suggest that these functional attributes increase the probability of a product being selected. On the contrary, the organic nature of the milk employed in production does not influence, in a statistically significant manner, the mean probability of a given yogurt being chosen, on average and ceteris paribus.[13]

Table 3 about here

Further insights on consumer responses to product attributes can be gained by inspecting the estimated spread coefficients (i.e., standard deviations (σ_β) or scale parameters) for the attributes' preference parameters. Aside from the spread coefficient for the "other flavours" attribute being significant only at the 10% level, all of the remaining spread coefficients are statistically significant at the 1% level. This evidence reveals the existence of strong heterogeneity among respondents.

The estimation of consumers' evaluation of the health risks associated with the functional attributes, that is, their WTP to obtain a FF, is instrumental to quantify a price premium for the FF. Given the assumption of random parameters and of the $T = 3$ repeated choices introduced above, we can compute a WTP for each

[13] A referee of this journal was concerned with "organic" being a credence attribute for which no preliminary information was given to the survey respondent, such that a partial-knowledge bias could have arisen. Indeed, no explanatory information regarding the attribute "organic" was presented to the respondent, primarily because of consumer familiarity with this concept. Moreover, we note that other comparable studies focus only on the explanation of the nature and benefits of the concerned enrichment(s) (Teratanavat & Hooker, 2006).

of the individuals in the sample according to (5) and then average it out across the sample and socio-demographic groups. Attention is focused on the WTP for the functional attributes (catechin (catec.) and probiotic (prob.) enriched with).

The sample average WTP for the addition of catechins is 0.38 €/jar. Because a jar of the hypothetical catechin-enriched yogurt would contain the RDA of these polyphenols, we can assume that this value is a good approximation of the absolute value of the premium a consumer is willing to pay to obtain the functional benefits associated to this enrichment. The calculated average WTP indicates roughly a 42% price premium on the 0.90 €/jar average price recorded in the experiment, a value that exceeds the ones estimated by Teratanavat & Hooker (2006) for the presence of single, multiple health benefits and naturalness in a hypothetical tomato juice containing soy. Somewhat similarly, the price premium measured in this contribution exceeds that for the heart-healthy property of a conventional chicken breast (Larue et al., 2004). Nonetheless, this premium is consistent with that found for the anti-cancer property of a can of conventional tomato sauce and yet is smaller than that associated with the heart-healthy property of a bag of potato chips (Larue et al., 2004).

We have also computed the WTP for the probiotic attribute to compare the evidence obtained for a novel attribute with the premium associated with a (supposedly) well-established one. Consumers have experienced the probiotic attribute for quite a long time, such that we expect them to be acquainted with it. Therefore, including the probiotic enrichment in the attribute space of the experiment may help respondents to reduce their tendency to overestimate their evaluation for a single and novel attribute. In fact, we expect the WTP for probiotics to represent a sort of lower bound of the WTP for catechins, while the difference between the two WTPs will allow us to gauge the respondents' evaluation of different health-related attributes. Further, this WTP should prevent respondents from mistakenly attributing the functional benefits of catechins to the other, more generic, functional properties of yogurt, including the otherwise non-specified probiotic effect (Roe et al., 1999). The sample average WTP for the probiotic functionality is 0.21 €/jar, which is less than 1/4 of the average price and slightly more than 1/2 of the WTP for catechins.

In Table 4, the average WTPs for socio-demographic groups are reported. Trying to summarise the results, we focus on those representing larger deviations with respect to the sample average and establish that markedly large values of WTP for catechins are expressed by respondents in the 45 to 64 years of age range

(0.46 - 0.48 €/jar), while differences due to gender are much smaller (in fact, females have a slightly higher WTP than males, most likely because they generally appear to be more concerned with personal health status). People in the North-East and Centre of Italy and who earn an income in the second lowest and second highest classes show particularly large WTP. Furthermore, the highest WTPs pertain to individuals who have completed the middle and tertiary education levels, are married or widowed (with the one for the latter group reaching 0.60 €/jar) and are part of a two or more than four person household, with larger households reporting a WTP of 0.45 €/jar.

Table 4 about here

Respondents consuming yogurt every day and, somewhat strangely, once every 15 days also report a WTP for catechins higher than its sample average. This result may be related to consumer awareness that only the frequent consumption of a functional yogurt enriched with catechins is instrumental to ensuring the full benefits of this enrichment. In fact, the probiotic enrichment – which is capable of delivering its health benefits with the (occasional) consumption of a more limited number of daily servings – enjoys a higher than its sample average WTP whenever the respondent consumes the yogurt once a month and more than once a week.[14] Individuals with non-extreme values for BMI report a WTP for catechins that is consistently higher than the sample average, signalling that a weight management-related claim for catechins might indeed resonate with consumers and induce purchases at above-average prices. This effect seems to disappear when severely obese respondents are considered: in fact, they have a very low WTP for both catechins and probiotics. Finally, the respondents' lifestyle may also induce differences in the WTP: those who are trying to maintain their current weight or lose some (0.44 - 0.40 €/jar), workout more than three times a week (0.61 €/jar) and do not smoke (0.40 €/jar) show higher values of WTP.

Trying to explore the different market segmentations for the probiotic enrichment, we unveil that markedly large values of WTP are expressed by respondents in the 20,000 – 40,000 € and top income class (0.26 and 0.28 €/jar, respectively). Consistently with previous expectation, the highest WTP for the probiotic

[14] This evidence is consistent and is interpreted in line with the evidence for the purchase of natural, organic or health-promoting/disease-fighting food in Teratanavat & Hooker (2006).

enrichment is associated with fairly infrequent consumption: consuming yogurt more than once a week or, even more rarely, once a month is enough to elicit the highest WTP for this socio-demographic characteristic. Lastly, consumers who are trying to gain weight have a higher, than the sample average, WTP for the probiotic enrichment (0.27 €/jar) probably because proper intestinal regularity is required to gain weight in a healthy manner.

6. Concluding remarks

Consumer concern that an unbalanced diet may have detrimental effects on health has been growing over recent decades and FFs have been introduced to provide a response. Devoting large budgets to their R&D and marketing functions, food manufacturers and marketers have been devising and promoting new food items with functional attributes. These investments can be considered to be sustainable and profitable only upon their successful introduction into the market. Thus, knowledge of consumers' attitudes towards FFs and of individuals' evaluation of the related attributes is a key factor informing firms' strategies. Several contributions in the literature have provided insights regarding the determinants of consumers' attitude and acceptance towards these novel foods. Only a few contributions have estimated consumers' WTP for the functional attributes in food items and the related health benefits.

This paper has contributed to the extant literature on WTP for food attributes, computing the WTP for a new hypothetical product, a yogurt enriched with catechins that also features the addition of probiotics, on a unique dataset of Italian consumers. Based on a choice experiment, our findings show that the WTP for catechins provides, on average, roughly a 42% price premium to the experiment's average price and is approximately twice the WTP for probiotics. Considering both functional attributes allows for a better estimate of the true WTP for catechins because we have tried to control for a possible bias stemming from consumers confounding or extending the positive effects of catechins to other product characteristics (i.e., the halo effect), thus providing valuable information for inferring the possible development of similar new products.

Employing a random parameter model of consumer choice also accounts for strong heterogeneity among consumers, which is important information for devising market segmentation and promotional strategies. The results from our experiment and the computation of the WTP for population segments confirm that some of the established findings in the literature regarding the socio-economic factors instrumental to segmenting the market for FFs also apply to Italy: income, age, education, geographical area, household size, health status and

lifestyles are the candidate variables. Moreover, the two functional attributes appear to be associated with different segmentations of the potential market, especially with respect to income levels, the frequency of yogurt consumption and habits towards weight. This information may be valuable to individual firms that are willing to develop marketing and promotional strategies because a yogurt featuring both enrichments is likely to appeal to a broader consumer base than a yogurt enriched with catechins only.

7. References

Adamowicz, W., Boxall, P., Williams, M. & Louviere, J. (1998). Stated Preference Approaches for Measuring Passive Use Values: Choice Experiments and Contingent Valuation. *American Journal of Agricultural Economics*, 80, 64–75.

Alfnes, F. (2004). Stated preferences for imported and hormone-treated beef: application of a mixed logit model. *European Review of Agricultural Economics*, 31, 19–37.

Alfnes, F., Guttormsen, A.G., Steine, G. & Kolstad, K. (2006). Consumers' willingness to pay for the color of salmon: a choice experiment with real economic incentives. *American Journal of Agricultural Economics*, 88, 1050–1061.

Annunziata, A. & Vecchio, R. (2011). Factors affecting Italian consumer attitudes toward functional foods. *AgBioForum*, 14, 20–32.

Annunziata, A. & Vecchio, R. (2013). Consumer perception of functional foods: A conjoint analysis with probiotics. *Food Quality and Preference*, 28, 348-355.

Ares, G. & Gámbaro, A. (2007). Influence of gender, age and motives underlying food choice on perceived healthiness and willingness to try functional foods. *Appetite*, 49, 148–158.

Boesso, G., Davcik, N.St. & Favotto, F. (2009). "Health-enhancing" Products in the Italian Food Industry: Multinationals and SMEs Competing on Yogurt. *AgBioForum*, 12, 232–243.

Bonanno, A. (2012). Some like it healthy: demand for functional and conventional yogurts in the Italian market. *Agribusiness An International Journal*, 28, 67–85.

Bonanno, A. (2013). Functional foods as differentiated products: the Italian yogurt market. *European Review of Agricultural Economics*, 40, 45–71.

Burton, M., Rigby, D., Young, T. & James, S. (2001). Consumer attitudes to genetically modified organisms in food in the UK. *European Review of Agricultural Economics*, 28, 479–498.

Burton, M. & Pearse, D. (2002). Consumer attitudes towards genetic modification, functional foods, and microorganisms: A choice modeling experiment for beer. *AgBioForum*, 5, 51–58.

Chrysochou, P. (2010). Food health branding: The role of marketing mix elements and public discourse in conveying a healthy brand image. *Journal of Marketing Communications*, 16, 69-85.

Cox, D.N., Koster, A. & Russell, C.G. (2004). Predicting intentions to consume functional foods and supplements to offset memory loss using an adaptation of protection motivation theory. *Appetite*, 43, 55–64.

Daly, A., Hess, S. & Train, K. (2012). Assuring finite moments for willingness to pay in random coefficient models. *Transportation*, 39, 19–31.

Doidge, J.C., Segal, L. & Gospodarevskaya, E. (2012). Attributable Risk Analysis Reveals Potential Healthcare Savings from Increased Consumption of Dairy Products. *The Journal of Nutrition*, 142, 1772–1780.

Doyon, M. & Labrecque, J.A. (2008). Functional foods: a conceptual definition. *British Food Journal*, 110, 1133–1149.

Enneking, U. (2004). Willingness-to-pay for safety improvements in the German meat sector: the case of the Q&S label. *European Review of Agricultural Economics*, 31, 205–223.

Ford, G.T., Hastak, M., Mitra, A. & Ringold, J.D. (1996). Can Consumers Interpret Nutrition Information in the Presence of a Health Claim? A Laboratory Investigation. *Journal of Public Policy & Management*, 15, 16–27.

Frewer, L., Scholderer, J. & Lambert, N. (2003). Consumer acceptance of functional foods: issues for the future. *British Food Journal*, 105, 714–731.

Gracia, A., Loureiro, M.L. & Nayga Jr., R.M. (2009). Consumers' valuation of nutritional information: a choice experiment study. *Food Quality and Preference*, 20, 463–471.

Granato, D., Branco, G.F., Cruz, A.G., Faria, J.A.F. & Shah, N. (2010). Probiotic dairy products as functional foods. *Comprehensive Reviews in Food Science and Food Safety*, 9, 455–470.

Greene, W.H. (2012). *NLOGIT 5 Reference Guide*, Econometric Software, Plainview, New York.

Greene, W.H., Hensher, D. & Rose, J. (2005). Using classical simulation-based estimators to estimate individual WTP values. In Scarpa, R. & Albertini, A. (Eds.), *Applications of simulation methods in environmental and resource economics* (pp. 17–34). Dordrecht, The Netherlands: Springer Publisher.

Haaijer, R., Kamakura, W. & Wedel, M. (2001). The 'no-choice' alternative in conjoint choice experiments. *International Journal of Market Research*, 43, 93–106.

Hanley, N., MacMillan, D., Wright, R.E., Bullock, C., Simpson, I., Parsisson, D. & Crabtree, B. (1998). Contingent Valuation Versus Choice Experiments: Estimating the Benefits of Environmentally Sensitive Areas in Scotland. *Journal of Agricultural Economics*, 49, 1–15.

Hensher, D.A. & Greene, W.H. (2003). The Mixed Logit model: The state of practice. *Transportation*, 30, 133–176.

Hu, W., Batte, M.T., Woods, T. & Ernst, S. (2012). Consumer preferences for local production and other value-added label claims for a processed food product. *European Review of Agricultural Economics*, 39, 489–510.

IRI (2011). IRI New product pacesetters. Time & Trends. SymphonyIRI Group, Chicago, Illinois. http://www.iriworldwide.com/

Jaeger, S.R. & Rose, J.M. (2008). Stated choice experimentation, contextual influences and food choice: a case study. *Food Quality and Preference*, 19, 539–564.

Jain, D., Vilcassim, N. & Chintagunta, P. (1994). A random-coefficients logit brand choice model applied to panel data. *Journal of Business & Economic Statistic*, 12, 317–328.

James, S. & Burton, M. (2003). Consumer preferences for GM food and other attributes of the food system. *Australian Journal of Agricultural and Resource Economic*s, 47, 501–518.

Kailasapathy, K. (2006). Survival of free and encapsulated probiotic bacteria and their effect on the sensory properties of yoghurt. *LWT - Food Science and Technology*, 39, 1221–1227.

Karaaslan, M., Ozden, M., Vardin, H. & Turkoglu, H. (2011). Phenolic fortification of yogurt using grape and callus extracts. *LWT - Food Science and Technology*, 44, 1065–1072.

Kielhorn, S. & Thorngate Iii, J.H., (1999). Oral sensations associated with the flavan-3-ols (+)-catechin and (−)-epicatechin. *Food Quality and Preference*, 10, 109–116.

Koletzko, B., Aggett, P.J., Bindels, J.G., Bung, P., Ferré, P., Gil, A., Lentze, M.J., Roberfroid, M. & Strobel, S. (1998). Growth, development and differentiation: a functional food science approach. *British Journal of Nutrition*, 80, S5–S45.

Kríz, Z., Koca, J., Imberty, A., Charlot, A. & Auzély-Velty, R. (2003). Investigation of the complexation of (+)-catechin by β-cyclodextrin by a combination of NMR, microcalorimetry and molecular modeling techniques. *Organic & Biomolecular Chemistry*, 1, 2590–2595.

Lancaster, K.J. (1966). A new approach to consumer theory. *The Journal of Political Economy*, 74, 132–157.

Larue, B., West, G.E., Gendron, C. & Lambert, R. (2004). Consumer response to functional foods produced by conventional, organic, or genetic manipulation. *Agribusiness An International Journal*, 20, 155–166.

Leathwood, P.D., Richardson, D.P., Sträter, P., Todd, P.M. & van Trijp, H.C. (2007). Consumer understanding of nutrition and health claims: Sources of evidence. *British Journal of Nutrition*, 98, 474–484.

Lenoir-Wijnkoop, I., Jones, P.J., Uauy, R., Segal, L. & Milner, J. (2013). Nutrition economics – food as an ally of public health. *British Journal of Nutrition*, 109, 777–784.

Loureiro, M.L. & Umberger, W.J. (2007). A choice experiment model for beef: what US consumer responses tell us about relative preferences for food safety, country-of-origin labeling and traceability. *Food Policy*, 32, 496–514.

Lusk J.L., Roosen, J. & Fox, J.A. (2003). Demand for beef from cattle administered growth hormones or fed genetically modified corn: a comparison of consumers in France, Germany the United Kingdom and the United States. *American Journal of Agricultural Economics*, 85, 16–29.

Malla, S., Hobbs, J.E. & Perger, O. (2007). Valuing the Health Benefits of a Novel Functional Food. *Canadian Journal of Agricultural Economics*, 55, 115–136.

Markosyan, A., McCluskey, J.J. & Wahl, T.I. (2009). Consumer response to information about a functional food product: apples enriched with antioxidants. *Canadian Journal of Agricultural Economics*, 57, 325–341.

McFadden, D. (1974). Conditional logit analysis of qualitative choice behaviour. In Zarembka, P. (Ed.) *Frontiers in Econometrics* (pp. 105–142). New York: Academic Press.

McFadden, D. & Train, K. (2000). Mixed MNL models of discrete response. *Journal of Applied Econometrics*, 15, 447–470.

Menrad, K. (2003). Market and marketing of functional food in Europe. *Journal of Food Engineering*, 56, 181–188.

Mtimet, N. & Albisu, L.M. (2006). Spanish wine consumer behavior: a choice experiment approach. *Agribusiness An International Journal*, 22, 343–362.

Murase, T., Haramizu, S., Ota, N. & Hase, T. (2008). Tea catechin ingestion combined with habitual exercise suppresses the aging-associated decline in physical performance in senescence-accelerated mice. *American Journal of Physiology. Regulatory, Integrative and Comparative Physiology*, 295, R281–R289.

Najgebauer-Lejko, D., Zmudzinski, D., Ptaszek, A. & Socha, R. (2013). Textural properties of yogurts with green tea and Pu-erh tea additive. *International Journal of Food Science & Technology*, 49, 1149-1158.

NBJ (2011). Sales data sheets 2011. Nutrition Business Journal, Boulder, Colorado. http://newhope360.com/nutrition-business-journal

Poulsen, J. (1999). Danish consumers' attitudes towards functional foods. MAPP working paper, 62. Aarhus School of Business. http://pure.au.dk/portal/files/32297714/wp62.pdf

Quagrainie, K.K., Unterschultz, J. & Veeman, M. (1998). Effects of product origin and selected demographics on consumer choice of red meats. *Canadian Journal of Agricultural Economics*, 46, 201–219.

Rigby, D. & Burton, M. (2005). Preference heterogeneity and GM food in the UK. *European Review of Agricultural Economics*, 32, 269–288.

Roe, B., Levy, A.S. & Derby, B.M. (1999). The Impact of Health Claims on Consumer Search and Product Evaluation Outcomes: Results from FDA Experimental Data. *Journal of Public Policy & Marketing*, 18, 89–105.

Scarpa, R. & Albertini, A. (eds.) (2005). *Applications of simulation methods in environmental and resource economics*. Dordrecht, The Netherlands: Springer Publisher.

Scarpa, R., Thiene, M. & Train, K. (2008). Utility in Willingness to Pay Space: A Tool to Address Confounding Random Scale Effects in Destination Choice to the Alps. *American Journal of Agricultural Economics*, 90, 994–1010.

Siró, I., Kápolna, E, Kápolna, B & Lugasi, A. (2008). Functional food. Product development, marketing and consumer acceptance – A review. *Appetite*, 51, 456–467.

Street, D.J., Burgess, L. & Louviere, J.J. (2005). Quick and easy choice sets: constructing optimal and nearly optimal stated choice experiments. *International Journal of Research in Marketing*, 22, 459–470.

Teratanavat, R. & Hooker, N.H. (2006). Consumer Valuations and Preference Heterogeneity for a Novel Functional Food. *Journal of Food Science*, 71, S533–S541.

Train, K.E. (2003). *Discrete choice methods with simulation*. Cambridge: Cambridge University Press.

Unilever (2009). *Green tea catechins and body shape*, mimeo, Lipton Institute of Tea, http://www.unilever.cl/Images/iv-icn09_Green-tea-catechins-and-body-shape_tcm54-189192.pdf

van Trijp, H.C.M. & van der Lans, I.A. (2007). Consumer perceptions of nutrition and health claims. *Appetite*, 48, 305–324.

West, G.E., Gendron, C., Larue, B. & Lambert, R. (2002). Consumers' valuation of functional properties of foods: results from a Canada-wide survey. *Canadian Journal of Agricultural Economics*, 50, 541–558.

Williams, D. & Ghosh, P. (2008). Health claims and functional foods. *Nutrition & Dietetics*, 65, S89–S93.

Williamson, G. & Holst, B. (2008). Dietary reference intake (DRI) value for dietary polyphenols: are we heading in the right direction? *British Journal of Nutrition*, 99, S55–S58.

Zarembka, P. (ed.) (1974). *Frontiers in Econometrics*. New York: Academic Press.

Zou, N.N. & Hobbs, J.E. (2006). Modelling Functional Food Choice and Health Care Impacts: A Literature Review. Research Project Number CMD-06-02, Department of Agricultural Economics, University of Saskatchewan.

8. Appendix A – Preliminary information for the questionnaire for the Stated Choice experiment

Catechins are a type of polyphenol with a diphenyl propane structure, and they are present in green and black tea. In lower concentrations, catechins feature in other food items such as wine, chocolate and some fruits. Catechins are most efficiently and effectively extracted from green tea because it is usually dried immediately after harvesting. A significant quantity of catechins is lost during the fermentation of black tea. Catechins intake has several positive outcomes: anti-oxidant, anti-inflammatory, anti-hypertensive, anti-diabetic, anti-mutagenic, anti-bacterial, and anti-viral. Moreover, the consumption of catechins helps to reduce the overall and bad cholesterol level of the body, the level of fat accumulated in the abdominal area, and the levels of triglycerides and free fatty acids. A daily catechin intake of between 100 and 600 mg is guaranteed to have a positive effect on the reduction of body weight and on the overall and abdominal fat level. The presence of catechins in food items allows them to be called “functional”, which implies that the product has sufficient positive influence on specific physiological functions. To be qualified as “functional”, these foods must significantly improve consumer’s health status and/or reduce the risk of falling ill while making a contribution to daily diet. Functional foods need to remain a food item while manifesting their effects when consumed in a quantity recommended by a balanced diet.