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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).

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

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

13 The term FF was first promoted in Japan and is currently “used to describe a range of novel foods [...]”
14 which are designed to deliver some other benefit beyond nutrition to the person consuming them” (Frewer et
15 al., 2003:715). While there is not an established definition of FF, its numerous formulations can be classified
16 according to the *health benefits*, the *nature of food*, the *level of function* and the *consumption pattern* (Doyon
17 & Labrecque, 2008). A processed food is functional if it contains ingredients that aid/affect specific
18 physiological functions in addition to being nutritious, thus having a role in disease prevention/reduction and
19 health promotion. Further, as stated also in Poulsen (1999:1), the “product which has been modified or enriched
20 with naturally occurring substances [...] must also be part of the normal daily consumption of food/fluids”.
21 Regarding the characteristics of the functional property incorporated into the food product, Siró et al. (2008)
22 distinguish among *fortified products* (addition of normal nutrients), *enriched products* (addition of new
23 nutrients/components), *altered products* (removal, reduction or replacement of “bad” components) and
24 *enhanced commodities* (natural enhancement of some components in agricultural commodities). Further, a
25 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.

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

3 Consumers are not necessarily fully aware of the functional attributes in a food item; therefore, the latter
4 may be characterised by a potentially high level of information asymmetry regarding either the actual presence
5 of the functional component or the credibility of the associated health claim (Zou & Hobbs, 2006). In turn,
6 consumers' acceptance of FFs largely depends on subjective perception. Since manufacturers rely on consumer
7 acceptance of the functional attributes to charge a premium price, labelling and brand advertising are crucial
8 to the success of a new product. Nonetheless, public agencies, such as the EFSA in the European Union, are
9 concerned with ensuring that the message delivered to the final consumer is legitimate, meaning that the
10 causality between the consumption of the FF and the health benefit has a solid scientific basis.³ If the functional
11 attributes can be identified and the information asymmetry largely overcome, consumers may be willing to
12 pay a (higher) price premium for the beneficial food (see also Markosyan et al., 2009). Therefore, the price
13 premium also provides a measure of the value placed by consumers on the associated health risk. Empirical
14 studies on consumer acceptance and valuation of FFs include West et al. (2002), Cox et al. (2004), Larue et al.
15 (2004), Teratanavat & Hooker (2006), Ares & Gámbaro (2007) and van Trijp & van der Lans (2007).

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

1 a trade-off between food characteristics. The major drawback of this method is the hypothetical nature of
2 choices such that consumers avoiding a monetary outlay may overstate their WTP. However, the joint
3 evaluation of multiple product attributes gives rise to welfare measures, of which WTP is arguably one, that
4 have generally smaller variances – relative to their means – compared to those obtained from CV (Adamowicz
5 et al., 1998). Moreover, considering different levels of attributes eliminates the part-whole bias (Hanley et al.,
6 1998).

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

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

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

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

4 Probiotics are live bacteria (i.e., lactic acid bacteria, bifidobacteria) that may augment consumers'
5 intestinal microbial population, providing some relief to intestinal inflammations, urogenital infections or
6 allergies. Catechins are natural phenolic compounds that can be found in tea, mainly green tea (Najgebauer-
7 Lejko et al., 2013), grapes and wine (Karaaslan et al., 2011), chocolate and a few fruits whose taste is neither
8 exactly astringent nor exactly bitter (Kielhorn & Thorngate Iii, 1999). While most of the catechin extracts
9 would be encapsulated into cyclodextrins to mitigate their effect on the taste of the carrier product (Kriz et al.,
10 2003), those extracted from vine grapes appear to have a milder taste. Relying on this source of catechins could
11 be instrumental to producing a cheaper functional yogurt and preventing the shifts in sensory characteristics
12 that sometimes occur for probiotic yogurts enriched with encapsulated bacteria (Kailasapathy, 2006). The
13 recommended daily allowance (RDA) of both probiotics and catechins (Williamson & Holst, 2008) may be
14 added, at least in a laboratory setting, to the “base” yogurt by means of a similar procedure: heating, high-
15 speed stirring and cooling (Kailasapathy, 2006; Karaaslan et al., 2011).

16 While several probiotic yogurts are already marketed in Italy (Boesso et al., 2009), and their popularity
17 among consumers has contributed to boosting the penetration of functional yogurts on the Italian market to
18 68% in 2010, it appears that food and beverages enriched with catechins are only vaguely considered by the
19 food industry.⁴ Nonetheless, several medical studies confirm that a regular daily intake of these components
20 may provide positive health effects (e.g., antioxidant, antidiabetic, antimutagenic, anticarcinogenic, antiviral,
21 antibacterial, antihypertensives, antiatherogenic), protect against progressive neurodegenerative disorders such
22 as Parkinson’s and Alzheimer’s diseases, and control the level of total and LDL cholesterol, triglycerides, free
23 fatty acids, and fat accumulation. Catechins can thus help individuals in reducing, *inter alia*, obesity,
24 cardiovascular problems and aging (e.g., Murase et al., 2008).

25 Although probiotic yogurt is extensively commercialised on the Italian market, the health claims related
26 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).

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

11 **3. The choice modelling approach**

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

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

$$1 \quad U_{ijt} = V_{ijt} + \varepsilon_{ijt} \quad (1)$$

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

$$7 \quad U_{ijt} > U_{iht} \quad \forall h \neq j \in J \quad (2)$$

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

$$9 \quad P_{ijt} = \Pr[U_{ijt} > U_{iht}] = \Pr[(V_{ijt} - V_{iht}) > (\varepsilon_{iht} - \varepsilon_{ijt})] \quad \forall h \neq j \in J$$

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

$$21 \quad P_{it}(j | \beta_i) \equiv L_{ijt}(\beta_i) = \frac{e^{V_{ijt}(\beta_i)}}{\sum_h e^{V_{iht}(\beta_i)}} \quad (3)$$

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

$$5 \quad P_i(j) = \int \prod_{t=1}^T L_{ijt}(\boldsymbol{\beta}_i) f(\boldsymbol{\beta}_i | \boldsymbol{\mu}_\beta, \boldsymbol{\sigma}_\beta) d\boldsymbol{\beta} \quad (4)$$

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

$$11 \quad \hat{E}_s [WTP_{i,k}] = \frac{\frac{1}{R} \sum_{r=1}^R -\frac{\hat{\beta}_{ikr}}{\hat{\beta}_{i,price,r}} L(\hat{\boldsymbol{\beta}}_{ir})}{\frac{1}{R} \sum_{r=1}^R L(\hat{\boldsymbol{\beta}}_{ir})} \quad (5)$$

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

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

19 4. The choice experiment

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

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

3 The questionnaire is composed of three parts. In the first part, catechins and their potential health effects
4 are briefly described and a definition of the term FF is given to provide the necessary preliminary information,
5 allowing consumers to make a “rational and informed choice”.⁶ The second part of the questionnaire collects
6 information on the respondents’ responsibility for food purchases, frequency of yogurt consumption and daily
7 lifestyle. Furthermore, in this section, the surveyed individuals make three choices (i.e., a panel dataset with
8 $T=3$ is obtained) selecting, each time, one product from a set of three alternatives (i.e., three products with
9 different levels of relevant attributes). Finally, in the third part, socio-demographic information is collected
10 (gender, age, geographic location, weight, height, employment status, education, marital status, household size,
11 presence of children, income and number of income recipients).

12 Choice sets have been constructed through an experimental design based on the product’s main
13 attributes. Six different attributes have been considered for a given product packaging (a 125 g jar): *type*,
14 *flavour*, *organic*, *probiotic (enriched with)*, *catechin (enriched with)* and *price*.⁷ Table 1 lists the attributes and
15 their levels. Probiotic enrichment has been added to the attribute space since it provides a functionality that the
16 consumer is familiar with. Thus, it should help respondents to make more consistent choices. Moreover, the
17 inclusion of the probiotic attribute is likely to reduce the potential for overestimating the health benefits of
18 catechins, attributing to the latter some of the health benefits of the former (i.e., giving rise to a halo effect
19 (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

1
2 **Table 1 about here**
3

4 The full factorial experimental design based on the attributes and levels in Table 1 produces
5 $2 \cdot 3 \cdot 4 \cdot 2 \cdot 2 \cdot 7 = 672$ alternative treatments. To reduce the dimension of the experiment while allowing the
6 consumers' responses to be identified, a D-optimal experimental design selects 29 alternatives, which are
7 constructed considering only the linear individual effects for the attribute variables. Moreover, a "baseline
8 alternative" is always included as the first alternative in each choice set administered to the respondents to help
9 to scale the utilities among the various choice sets. Often, the "baseline alternative" is specified as the "no
10 choice" option in market penetration studies. Because this is not the main focus of the present work, the
11 "baseline alternative" is defined according to retailing data: it is the type of yogurt most frequently purchased
12 by Italian consumers (i.e., whole, creamy fruit, non-organic, without probiotics, without catechins, priced at
13 0.70 €). Moreover, fully characterising the "baseline alternative" prevents respondents from providing no
14 information at all through the "no choice" option (Haaijer et al., 2001).

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

19 **5. Results and discussion**

20 Table 2 presents the summary statistics for the sample of Italian consumers who responded to the
21 questionnaire.⁹ Our sample features a percentage of overweight/obese people consistent with national statistics
22 (45.7%), while over 50% of the surveyed individuals are trying to lose weight, and a large proportion (86.5%)
23 pays attention to nutritional labels on food products. Lastly, 73% of the respondents report consuming yogurt
24 more than once a week.
25

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 5.0¹⁰ 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

$$U_{ijt} = \beta_{i,ty_B} ty_DuB_t + \beta_{i,ty_C} ty_DuC_t + \beta_{i,fl_B} fl_DuB_t + \beta_{i,fl_C} fl_DuC_t + \beta_{i,fl_D} fl_DuD_t + \beta_{i,or} or_Du_t + \beta_{i,pb} pb_Du_t + \beta_{i,ca} ca_Du_t + \beta_{i,pr} pr_t + u_{ijt} \quad (6)$$

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.

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

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

14

15 **Table 3 about here**

16

17 Further insights on consumer responses to product attributes can be gained by inspecting the estimated
18 spread coefficients (i.e., standard deviations (σ_β) or scale parameters) for the attributes' preference
19 parameters. Aside from the spread coefficient for the "other flavours" attribute being significant only at the
20 10% level, all of the remaining spread coefficients are statistically significant at the 1% level. This evidence
21 reveals the existence of strong heterogeneity among respondents.

22 The estimation of consumers' evaluation of the health risks associated with the functional attributes,
23 that is, their WTP to obtain a FF, is instrumental to quantify a price premium for the FF. Given the assumption
24 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).

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

4 The sample average WTP for the addition of catechins is 0.38 €/jar. Because a jar of the hypothetical
5 catechin-enriched yogurt would contain the RDA of these polyphenols, we can assume that this value is a good
6 approximation of the absolute value of the premium a consumer is willing to pay to obtain the functional
7 benefits associated to this enrichment. The calculated average WTP indicates roughly a 42% price premium
8 on the 0.90 €/jar average price recorded in the experiment, a value that exceeds the ones estimated by
9 Teratanavat & Hooker (2006) for the presence of single, multiple health benefits and naturalness in a
10 hypothetical tomato juice containing soy. Somewhat similarly, the price premium measured in this contribution
11 exceeds that for the heart-healthy property of a conventional chicken breast (Larue et al., 2004). Nonetheless,
12 this premium is consistent with that found for the anti-cancer property of a can of conventional tomato sauce
13 and yet is smaller than that associated with the heart-healthy property of a bag of potato chips (Larue et al.,
14 2004).

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

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

1 (0.46 - 0.48 €/jar), while differences due to gender are much smaller (in fact, females have a slightly higher
2 WTP than males, most likely because they generally appear to be more concerned with personal health status).
3 People in the North-East and Centre of Italy and who earn an income in the second lowest and second highest
4 classes show particularly large WTP. Furthermore, the highest WTPs pertain to individuals who have
5 completed the middle and tertiary education levels, are married or widowed (with the one for the latter group
6 reaching 0.60 €/jar) and are part of a two or more than four person household, with larger households reporting
7 a WTP of 0.45 €/jar.

8 9 **Table 4 about here**

10

11 Respondents consuming yogurt every day and, somewhat strangely, once every 15 days also report a
12 WTP for catechins higher than its sample average. This result may be related to consumer awareness that only
13 the frequent consumption of a functional yogurt enriched with catechins is instrumental to ensuring the full
14 benefits of this enrichment. In fact, the probiotic enrichment – which is capable of delivering its health benefits
15 with the (occasional) consumption of a more limited number of daily servings – enjoys a higher than its sample
16 average WTP whenever the respondent consumes the yogurt once a month and more than once a week.¹⁴
17 Individuals with non-extreme values for BMI report a WTP for catechins that is consistently higher than the
18 sample average, signalling that a weight management-related claim for catechins might indeed resonate with
19 consumers and induce purchases at above-average prices. This effect seems to disappear when severely obese
20 respondents are considered: in fact, they have a very low WTP for both catechins and probiotics. Finally, the
21 respondents' lifestyle may also induce differences in the WTP: those who are trying to maintain their current
22 weight or lose some (0.44 - 0.40 €/jar), workout more than three times a week (0.61 €/jar) and do not smoke
23 (0.40 €/jar) show higher values of WTP.

24 Trying to explore the different market segmentations for the probiotic enrichment, we unveil that
25 markedly large values of WTP are expressed by respondents in the 20,000 – 40,000 € and top income class
26 (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).

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

6 **6. Concluding remarks**

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

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

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

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

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

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