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# Impact of hedonic evaluation on the expected consumers' preferences for beef attributes including its enrichment with *n*-3 and CLA fatty acids


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# IMPACT OF HEDONIC EVALUATION ON THE EXPECTED CONSUMERS' PREFERENCES FOR BEEF ATTRIBUTES INCLUDING ITS ENRICHMENT WITH *n*-3 AND CLA FATTY ACIDS

**Abstract**

The impact of hedonic evaluation on the expected consumers' preferences towards beef attributes including its enrichment with polyunsaturated fatty acids (PFA) was evaluated. Six hundred and forty seven Spanish consumers were divided into two groups differentiated by the information received. Consumers assessed five beef attributes (origin, animal diet, amount of visible fat, meat colour and price) by conducting a discrete choice experiments (DCE) using the Generalized Multinomial Logit model (G-MNL). Subsequently, after a blind tasting of beef samples, consumers repeated the DCE. Results showed that the hedonic evaluation had a significant impact on consumer beef preferences, in particular, for the animal diet attribute. After tasting, the scale heterogeneity, which is the variation of the degree of randomness in the decision-making process and hence the degree of individuals' certainty, have decreased significantly. Results showed higher consumers' overall acceptability scores for beef enriched with PFA, and the information offered to consumers had no significant impact on their acceptability scores.

**Key Words**: n-3, CLA, beef meat, choice experiments, Generalized Multinomial Logit model.

## 1. Introduction

When health claims are presented on food package, purchase intentions are favourably influenced and consumers risks perception of certain diseases decrease (Kozup, *et al*., 2003). Consumers are more aware of the contribution of food to their health (Siró *et al*. 2008) and thus, health concerns are becoming a main determinant factor for food consumption. To meet today's health and wellness concerns, food/beverage demands has evolved towards new range of products often related to health-promotion and disease prevention. In United States, health influenced the food purchase decisions of 64% of consumers in 2013, up from 61% in 2012 (IFIC, 2013). However, consumer perception and purchase behaviour of functional ingredients is not one-dimensional, and the final food result from a variety of factors such as sensory, socioeconomic, attitudinal, risk perception, cultural and information issues among others (Hellyer *et al*, 2012; Siró *et al*., 2008; Urala and Lähteenmäki, 2004).

Cultural and attitudinal factors plays an important role in food choice. Siró *et al*. (2008) stated that there is a clear difference between western and eastern valuation of functional food. Western perception of maintenance of original food characteristics is more important for Europeans than North Americans. The Mediterranean consumers are the ones more concerned with the "natural" characteristic of food. Therefore, the balance between the valuation of health effects/benefits of specific functional ingredients and the preservation of the original food characteristics are key points for the acceptability of functional food. In this context, Franchi (2012) mentioned that beliefs and identity are influence preferences by indicating to individuals what foods are 'good' and 'right'.

Sensory attributes are also decisive factors for acceptance of food especially those dealing with health claims and well-being enhancement (Verbeke, 2005; Urala and Lähteenmäki, 2003 & 2004). Gabrielyan, *et al*. (2014) mentioned that the intrinsic cues such as taste are a primary basis for consumers' expectations of quality and decisions about whether to make repeat purchases of a product. Asioli *et al*. (2014) found that flavour and odour are the most important in driving consumers' choice for organic food. Annett *et al*. (2008) and Hobbs *et al*. (2006) verified that health and nutrition information together with sensory evaluation and eating experience are all relevant for a positive valuation of specific functional food (organic bread/functional meat). Combris *et al*. (2009) noticed that personal experience, derived from a blind tasting, was significantly more important than label information regarding "appellation of origin" of wines. That is, experience plays a very important role in defining individuals' perception and willingness to pay. Lange *et al*. (2002) and Noussair *et al*., (2004) compared hedonic ratings and experimental auctions to evaluate food preferences, stating that hedonic ratings provided similar aggregate results. Poole *et al*. (2006) employed an experimental auction to test fruit quality perceptions by evaluating consumers' willingness to pay (WTP) after three alternative sensory experiments (visual appearance, touching and peeling, and tasting). The authors concluded that "experience" modifies product quality perceptions and scoring behaviour, as well as it is likely to affect repurchase decisions. Lange *et al*. (1998) compared consumers' behaviour using two scenarios: just packaging exposure and packaging exposure and taste. The authors reported that tasting had an important role on consumers' purchase decisions. Respondents do consider different food attributes after tasting than before tasting with a modification on their purchase decisions.

Many studies have analysed consumers' preferences, attitudes and acceptance towards beef (Carpenter *et al*., 2001; Resurreccion, 2004; Verbeke *et al*., 2010; Font-i-Furnols & Guerrero, 2014 among others). However, literature that analyses the impact of hedonic valuation on consumers' purchasing decisions toward new developed meat products is still scarce and remains untreated for beef enriched with polyunsaturated fatty acids, particularly in Spain. In this context, we applied a methodological approach that attempts to mimic consumers' behaviour towards a novel product (enriched beef with beneficial fatty acids), which can be summarized in 3 main subsequent steps:

a) When consumers face a new product on the shelf stores, they generate expectations (expected or pre-sensory preferences) on the basis of their past experiences and available information related to the characteristics of the product or to similar products (Deliza & MacFie, 1996).
b) Tasting the new product (hedonic evaluation test) allow constructing a set of current experience information that is useful to decide for a repeated choice or not.
c) After tasting the new product, consumers' acceptance may result in agreement or disagreement with what they expected. These changes play an important role in the acceptance or rejection of the new product (Font-i-Furnols & Guerrero, 2014), and may affect the final choice of the consumers (final or post-sensory preferences).

In this context, the main objective of this paper was to analyse the impact of hedonic evaluation, for both informed and non-informed groups of consumers, on the expected preferences for beef attributes including its enrichment with polyunsaturated fatty acids (omega-3 and the conjugated linoleic acid, CLA). The analysis of the hedonic evaluation impact is carried out by comparing the consumers' preferences before and after the tasting experience. In addition, we analysed if the health information delivered to consumers had influenced the overall acceptability scores for beef. From one hand, empirically, this is the first paper that analysed the sensory impact on the expected preferences towards the enriched beef meat with polyunsaturated fatty acid. On the other hand, methodologically, this paper contribute to the literature of the Discrete Choice Modelling (DCM) using the recently developed Generalised Multinomial Logit Model (G-MNL) of Fiebig *et al*., (2010) allowing for both preference and scale heterogeneity. To our knowledge, this is the first application, in the literature of food and meat preferences studies that analyse the impact of sensory experience on consumers' preferences using the G-MNL and that analyses how the scale heterogeneity is affected.

## 2. Materials and methods

In accordance to the main objective, our methodological framework consisted of three main steps:

a) The first part focussed on analysing the expected consumers' preferences using discrete choice experiments (DCE) towards beef meat attributes and its enrichment with n-3 and CLA (expected or pre-sensory preferences step). In this initial step, consumers were divided into two groups. While the first one received information about the enrichment process and the health benefits of CLA and n-3 fatty acids, the second group did not receive any additional information.
b) The second part was based on a blind tasting of four types of beef samples (conventional, enriched with n-3, enriched with CLA and enriched with both n-3 and CLA) from animals fed one of four different diets (hedonic evaluation test step). In this second stage, consumers' overall acceptability was assessed using a 9-point hedonic scale (1 = dislike extremely to 9 = like extremely). After tasting of samples, all consumers were told what type of beef they have tasted in order to associate their score with the different types of beef meat.
c) In the third phase, we repeated the DCE carried out in the first step in order to analyse the potential impact of sensory evaluation on the expected consumers' preferences for beef attributes including its enrichment with n-3 and CLA (final or post sensory preferences step).

A summarized scheme of the methodological framework is presented in Figure 1. As can be seen, this approach allowed first to analyse the impact of health information on the expected preferences (point 1) that has been reported by Kallas *et al*. (2014). It also permitted analysing the hedonic evaluation regarding beef attributes in particular the n-3 and CLA attributes (point 2) that has been presented and discussed by Realini *et al*. (2014). Finally, the hedonic evaluation impact on the expected preferences of informed and non-informed consumers is assessed in this study.

### *3.1. Theoretical foundation of the Discrete Choice Experiments*

The preference analysis is based on the DCE that aims to identify the individual's indirect utility function associated with attributes of products by examining the trade-offs they make when making choice decisions. Thus, several alternatives that are described by several attributes with varying levels are presented to respondents in choice sets. The respondent is then asked to select its preferred alternative within each choice set, thereby revealing his/her preference for certain attributes and levels. Subsequently, the relative importance of the attributes can be indirectly recovered from respondents' choices.

DCE rely on Lancaster's Theory of Value (Lancaster, 1966) which proposes that utility of a product is decomposed into separable utilities for their characteristics or attributes. It is also based on the Random Utility Theory (RUT) laid out by Thurstone (1927). This theory propose that subjects choose among alternatives according to a utility function with two main components: a systematic (observable) component and a random error term (non-observable):

$$U_{jn} = V_{jn}(X_j, S_n) + \varepsilon_{jn} \qquad (1)$$

where $U_{jn}$ is the utility of alternative $j$ to subject $n$, $V_{jn}$ is the systematic component of the utility, $X_j$ is the vector of attributes of alternative $j$, $S_n$ is the vector of socio-economic characteristics of the subject $n$ and $\varepsilon_{jn}$ is the random term.

### *3.2. Choice Experiments modelling*

To predict the subjects' preferences for attributes (k), we need to define the "probability of choice" that an individual *n* chooses the alternative *i* rather than the alternative $j$ (for any $i$ and $j$ within choice sets, $T$). McFadden (1974) developed an econometric model that formalized respondents' decision making process. This model is often referred to as the multinomial logit (MNL) model, which is considered the base model for DCE. According to MNL model the utility to person *n* from choosing alternative *j* on choice scenario *t* is given by:

$$U_{njt} = \beta x_{njt} + \varepsilon_{njt} / \sigma_n \qquad n = 1, \ \ldots, \ N \quad j = 1, \ \ldots, \ J \quad t = 1, \ \ldots, \ T \qquad (2)$$

Where, $x_{njt}$ is a vector of observed attributes of alternative *j*, $\beta$ is a vector of mean attribute utilities (utility weights) and $\varepsilon_{njt}$ is the "idiosyncratic" error term that follows independent and identically distributed (i.i.d.) Type 1 extreme value distribution with scale parameter $\sigma_n$.

The probability $(P_j | X_{nt})$ that an individual *n* will choose alternative $j$ among other alternative of an array of choice set $\mathrm{T}$ is formulated as follows:

$$(P_j | X_{nt}) = \frac{\exp(\beta x_{njt})}{\sum_{j=1}^{J} \exp(\beta x_{njt})} \qquad \forall j \in T \qquad (3)$$

Where $X_{nt}$ is the vector of attributes of all alternatives $j = 1, \ \ldots, \ J$ . In the case of estimating a MNL, the scale parameter $\sigma_n$ is normalized to one for identification.

The MNL impose homogeneity in preferences for observed attribute. Thus, only average attributes' utilities are estimated which is often unrealistic as consumers' preferences are, by nature, heterogeneous. Therefore, the mixed or *heterogeneous* logit models (MIXL) (in the literature is also referred to as Random Parameter Logit model, RPL) have been introduced to investigate such heterogeneity. This model extend the MNL allowing for unobserved heterogeneity by allowing random coefficients on attributes (Ben-Akiva *et al*., 1997).

In MIXL the utility to person *n* from choosing alternative *j* in choice set *t* is given by:

$$U_{njt} = \beta_n x_{njt} + \varepsilon_{njt} / \sigma_n \quad n = 1, \ \ldots, \ N \ \ j = 1, \ \ldots, \ J \ \ t = 1, \ \ldots, \ T \qquad (4)$$

Where, $\beta_n = \beta + \eta_n$ and where $(\eta_n)$ is the vector of person *n* specific deviations from the mean value of the $\beta$s. The $\eta_n$ is described by an underlying continuous distribution for the attributes defined by the researcher. In most applications the multivariate normal distribution is the most used, MVN (0, Σ). In this case, $\sigma_n$ is also assumed to be one for identification. This model has been used in the analysis regarding the information impact on expected preferences (point 1 in Figure 1). However, Louviere and Mayer (2007) and Louviere *et al*. (2008) argued that much of the preference heterogeneity captured by random parameters can be better captured by the scale term; and thus known as "scale heterogeneity". Therefore, they considered that the MIXL turns to be likely a poor approximation to stated data if scale heterogeneity is not accounted for (Fiebig, *et al*., 2010).

The scale heterogeneity is the variation of the degree of randomness in the decision-making process over respondents and hence is the degree of individuals' certainty. It is based the differences of the variance of the error term $(\varepsilon)$ across individual-decision-makers. In this context, the analysis of the scale heterogeneity is important, especially for the stated preference studies (i.e. based on questionnaire). In this context, Feibig *et al*. (2010) developed the Generalized Multinomial Logit model (GMNL). Within this approach, the $\sigma_n$ is no longer set to be one, and a particular specification of this term is assumed. Feibig *et al*. (2010) identified that the utility to person *n* from choosing alternative *j* on choice set *t* is given by:

$$U_{njt} = [\sigma_n \beta + \gamma \eta_n + (1-\gamma)\sigma_n \eta_n] X_{njt} + \varepsilon_{njt} \quad (5)$$

where $\gamma$ is a parameter between 0 and 1. It is a mixing parameter, and its value determines the level of mixing or interaction between the scale heterogeneity coefficient $\sigma_n$ and the parameter heterogeneity coefficient $\eta_n$. $\sigma_n$ is a scaling factor that proportionately scales the $\beta$ up or down for each individual *n*. Finally, because $\sigma_n$ only enters the model as a product of $\sigma_n \beta$ (equation 5), Fiebig *et al*. (2010) proposed $\sigma_n = \exp(\bar{\sigma} + \tau \upsilon_n)$ and $\tau$ is estimated[1].

The GMNL model is specified by default to consider the $\eta_n$ as uncorrelated. That is mean the covariance matrix of $\eta_n$ is constrained to be a diagonal matrix (a matrix in which all values above and to the right of the diagonal are equal to zero). However, the GMNL can be specified to allow for correlated parameters. The presence of multiple observations on stated-choice responses for each sampled individual means that the potential for correlated responses across observations can be the product of many sources including the sequencing of offered choice situations that results in mixtures of learning and inertia effects, among other possible influences on choice response as commented by Hensher *et al*., (2005). Thus, discrete choice data with a repeated choice situations containing the same attributes and levels may have unobserved effects that are correlated among alternatives in a given choice situation. When the random parameter are correlated the model reports the diagonal value of the Cholesky matrix that represent the true standard deviation for each random parameter once the cross-correlated parameter terms have been unconfounded. The below –diagonal elements in Cholesky decomposition matrix are the

[1] More details about the GMNL model can be found in Fiebig *et al*., (2010) and Louvier *et al*. (2008).

covariances (cross-correlation) among the random parameter estimates. In this study, we estimated a correlated random parameter within the G-MNL model due to its best goodness of fit. For the estimation, we used the GMXLOGIT procedure in NLOGIT 5 with the “correlated” option.

Once the model is estimated, we calculate the relative importance $(I_k)$ of each attribute. Thus, the ratio of a particular attribute utility to the sum of all attributes’ utilities is used to reveal its relative importance by the following equation (Smith, 2005):

$$I_k = \frac{\left(\max \beta_k - \min \beta_k\right)}{\sum_{k=1}^{K}\left(\max \beta_k - \min \beta_k\right)} \qquad (4)$$

where $(I_k)$ is the relative importance of the attribute $(k)$, $(\max \beta_k)$ is the maximum utility of the attribute (i.e. the most preferred level) and $(\min \beta_k)$ is the minimum utility (i.e. the least preferred level).

### *3.3. Empirical application*

The first step in the application of the DCE is the identification of the attributes that best describe the product of interest. For this study, on the basis of the literature review presented in Kallas *et al*., (2014) and Realini *et al*., (2014) we defined five attributes: the animal diet with four levels were evaluated which corresponded to the type of beef assessed in the hedonic evaluation (conventional, enriched with omega-3, enriched with CLA and enriched with omega-3 plus CLA). Origin attribute with two levels as ‘locally produced’ and ‘other Spanish origin’. Two meat colour levels were evaluated as ‘pale red’ or ‘bright red’, and two fat levels of beef steaks were considered as ‘moderate visible fat’ or ‘slight visible fat’. Finally, beef price was included as another key attribute with four levels: 6.6 € high, 5.7 € medium–high, 4.8 € medium–low and 3.9 € low meat price. The second step is to carry out an experimental design that allow for creating the different situation of choice (choice sets). We followed the Dual Response Choice Experiments (DRCE) design (Kallas *et al*., 2012). An orthogonal fractional factorial design was used, obtaining 16 choice sets. Finally, factorial blocking arrangement was carried out obtaining 2 blocks, each with 8 choice sets presented to individual respondents so that the number of profiles would be low enough to be easily handled by consumers.

The data were obtained from a sample consisted of two different consumer groups. The first sample consisted of 322 consumers that did not receive any information about the enriched meat presented in the choice sets. The second group comprised 325 consumers who received extensive information about the enrichment process of the beef meat and the advantages of this product to human health. Regarding the beef sampling procedure for hedonic evaluation, the meat sample preparation for consumer liking assessment were obtained from forty-eight Holstein entire males fed with one of four dietary treatments. All animal diets had similar composition but differed in the content of whole linseed and conjugated linoleic acid (CLA): CONV (conventional commercial ration, 0% linseed and 0% CLA), OME3 (conventional ration enriched with omega-3 fatty acids through the addition of 10% linseed), CLA (conventional ration enriched with CLA through the addition of 2% CLA), and OME3-CLA (conventional ration enriched with omega-3 and CLA fatty acids through the addition of 10% linseed plus 2% CLA)[2].

## 3. Results and discussion

### *3.1. Impact of hedonic evaluation on expected preferences*

Focusing on how sensory experience from the hedonic evaluation affect the expected preferences generated for both informed and non-informed consumers, results of the full GMNL model showed the relative importance of the attributes (Table 1). Regarding the pre sensory test results, the order of the relative importance of the attributes was slightly different for both groups of consumers, showing that the information provided had an impact on their expected beef meat preferences as reported by Kallas *et al*. (2014). Thus, for non-informed consumers, fat content was the most important attribute while it was less important for the informed ones. There is a clear substitution effect between the diet and the fat content showing the significant impact of information on consumers' preferences. It is evident that consumers are less concerned about the amount of visible fat in beef as long as it is enriched with beneficial fatty acids.

In this context, diet was not important in the beef purchasing decisions of uninformed consumers before tasting the product, but it was one of the most important factors for informed consumers and after the hedonic evaluation. These results show that producing enriched beef meat may lead consumers to give less importance to its fat content, assuming that the beneficial compounds (omega-3 and CLA) may counteract the negative effect of the amount of fat. The improvement of the fatty acid composition of beef through modifications in the animal diet would provide consumers with a product that is closer to current nutritional recommendations for a healthy diet, favouring consumers' purchasing decisions regarding enriched meat. In addition,

[2] More details about the attributes' selection, the experimental design, the procedure of sample selection and the meat sample preparation can be found in Kallas *et al*. (2014) and Realini *et al*., (2014).

consumers would be less concerned about the amount of fat present in enriched meat, which is also positively related with the sensory properties of meat.

Analysing preferences before and after the sensory test within each group, results show significant modifications in the relative importance of the attributes for the non-informed consumers, while minor changes occurred for the informed ones in their beef purchasing preferences. Results showed that after beef tasting, a significant change resulted in the diet preference which has moved from a non-significant preference to the most important one. In addition, the relative importance of the fat attribute decreased significantly.

Results from Table 2 reports the marginal utilities of the attributes, the attribute heterogeneity terms and the scale parameters[3]. As commented, behaviourally, the advantage of the G-MNL is that it allows respondents to have different utility function scales that describe a different uncertainty levels with respect to the choices they make. Focusing on the scale parameters, the information and the hedonic evaluation have had a significant impact. Results shows that moving from models for non-informed consumers to informed one, the average error scales decreased significantly. This may indicate that when the consumers are informed they make more reliable choices. In addition, for the informed consumers both the $\gamma$ and the $\tau$ parameter were not significantly different from zero. Thus the unobserved heterogeneity in this case is better described by the normally distributed deviations from mean coefficients, but there is no additional value in describing it with a scaling factor. It is also relevant that the hedonic evaluation for both informed and non-informed consumers showed some evidence of a shift in the scaling factor across choice ($\tau$ turns to be insignificant) showing that consumers after tasting experience tended to be more reliable about their choice exhibiting non-significant scale heterogeneity.

Focusing on each attributes levels, results show those preferences for informed and non-informed consumers before and after tasting beef samples from animals fed different diets intended to improve the fatty acid profile of meat. To better understand the attribute preferences, the utilities of the different levels of each attribute from the GMNL estimation were obtained. Utilities for the amount of visible fat were higher for the uninformed consumers, which indicates that consumers that do not receive information about the benefits of omega-3 and CLA fatty acids or their role in human health are more concerned about the amount of fat in meat. There is a reduction in the

[3] Results of the estimated covariances of the attributes from the Cholesky matrix (45 parameters) are available upon request.

utilities for the fat attribute after tasting for non-informed consumers since the relative importance of this attribute decreases. After the blind tasting of the different beef samples, consumers were told about the type of beef that they have tasted. Thus, for the non-informed consumers the relative importance of other attributes and their utilities such as the animal diet increased significantly compared with the fat content which decreased. Enriched beef had similar or slightly higher hedonic scores compared with conventional beef (Table 2). Many authors indicated that consumers are not willing to compromise on taste of functional foods for eventual health benefits (Augustin, 2001; Cox, Koster & Russell, 2004; Gilbert, 2000; Verbeke, 2006). Results from this study indicate that consumers may be less concerned about the amount of fat in meat, if they become aware that sensory properties are not compromised when meat is enriched with beneficial fatty acids.

Regarding the levels of meat colour and origin, results show a convergence of preferences for both types of consumers. Moreover, the sensory test had no impact on consumer preferences maintaining the order of the preferred colour (bright red) and the preferred origin (locally produced). For the diet attribute, the utility for the enriched meat with omega-3 increased and the preference for the conventional one decreased for both groups of consumers, but especially for non-informed consumers. However, there is a consensus to reject the CLA enriched beef for expected preference before tasting and that obtained after the sensory analysis. Consumer preferences regarding the diet attribute may be explained by the fact that most consumers are familiar with omega-3 fatty acids and with some commercial products enriched with these fatty acids, in contrast to CLA and the enrichment of food products with CLA. Siró *et al*. (2008) also indicated that well-known compounds are more accepted than less-known components in food products.

Finally, after the tasting experience, there is a reduction of the utility associated with the higher and average prices and a slight increase with the lower price for informed consumers. Focusing on the lower price level, informed consumers showed the highest utility increase. This may indicate that the sensory experience of the enriched meat was not enough to justify per se that the price of the meat have to be more expensive as a results of the enrichment. Regarding the opt-out option, results show that the utility associated with it was not significant for informed consumers, showing that more consumers did not select the opt out option in comparison to the non-informed one. In this later case, the utility of the opt-out was positive and significant which is an indicator that without information some products do not convince consumers, mainly the enriched with CLA and those with high prices.

### *3.2. Impact of information on consumers' beef acceptability*

Overall acceptability scores for beef from animals fed the different diets is shown in Table 3. Comparing the overall acceptability of the four types of beef meat, results show a non-significant impact of the information at 95%. This indicates that the information provided to one group of consumers about the benefits of omega-3 and CLA fatty acids did not have an influence on their hedonic preferences for beef. In contrasts to our results, Morales *et al*. (2013) showed that information about beef production systems generated positive expectations and increased acceptability ratings for beef from grazing animals. This may indicate that the impact of information on hedonic preferences by consumers may depend on the type of information provided. Since there were no differences in our study in hedonic scores depending on information, we will focus on the values obtained for the whole sample (all consumers) for the interpretation of the sensory scores. Results showed that enriched beef with omega-3 fatty acids had higher acceptability scores than beef from the other treatments. Beef enriched with CLA had similar acceptability scores to beef enriched with both omega-3 and CLA which in turn was similar to conventional beef. It should be noted, however, that the differences among acceptability scores are within 0.5 in a 9 point scale using a high number of consumers (n=642). Results indicate that differences in beef acceptability among dietary treatments, although statistically significant, are not large.

## 4. Conclusion

Results showed that hedonic evaluation had a significant impact on defining consumer beef preferences, especially for non-informed consumers, and thus, their expected preferences were affected by the sensory evaluation. Focusing on the animal diet attribute, utilities for *n*-3 enriched beef increased significantly after tasting, particularly for non-informed consumers, while utilities for CLA enriched beef were still not significant after tasting for all consumers. In this context, after the hedonic evaluation, there was a positive disagreement between the expected preference for *n*-3 enriched meat and the final preference. Provided information about the enrichment process and the health benefits of *n*-3 and CLA fatty acids had no significant impact on overall acceptability scores of beef.

After the hedonic valuation results showed that the unobserved heterogeneity is better described by the normally distributed deviations from mean coefficients and there is no additional value in describing it with a scaling factor. Thus, the beef tasting exhibit for both informed and non-informed consumers evidence of a shift in the scaling factor across choice. Comparing preferences before and after beef tasting results also shows significant changes in the relative importance of some attributes. In this sense, the heterogeneous scale identified before the sensory test tended to be more homogeneous after tasting. The GMN-L model was first estimated with uncorrelated coefficients. Compared to this, the correlated version provide a better fit to the data. Beside preference heterogeneity, we also find statistically significant scale heterogeneity; therefore the assumption of identical scales across individuals is rejected. Results also showed that the full version of the GMN-L (including correlation between random parameter and between taste and scale preferences) had the best goodness of fit (AIC, Pseudo $R^2$). Analysing the attributes non-attendance before and after sensory are proposed for further research.

ACKNOWLEDGEMENTS

This research was supported by the National Institute of Agrifood Research (project RTA2009-00004-CO2).

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**Figure**

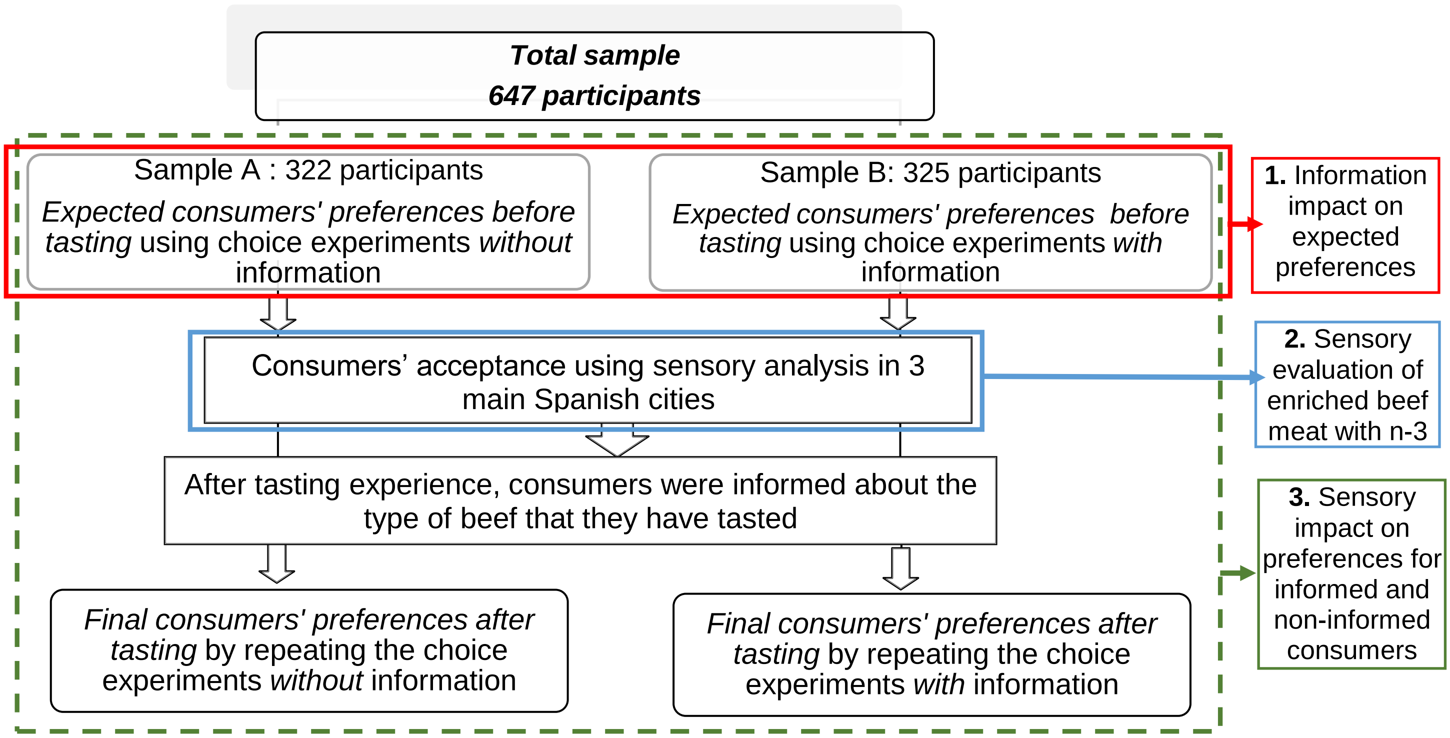


Figure 1: Scheme of the methodological framework

**Table**

Table 1: Relative importance of beef attributes (%) from the G-MNL model

| $\beta$ | Generalized Multinomial Logit model | | | |
|---|---|---|---|---|
| | *Without information* | | *With information* | |
| | *Pre Sensory* | *Post sensory* | *Pre Sensory* | *Post sensory* |
| **Fat content** | **36.74$^{***a}$** (25.1; 48.4) | **19.46%$^{***b}$** (12.2; 26.7) | **19.62$^{**b}$** (7.7; 31.6) | **16.45%$^{***a}$** (9.4; 23.5) |
| **Colour** | **21.88$^{***a}$** (13.1; 30.6) | **11.78%$^{***b}$** (7.2; 16.2) | **16.92$^{***a}$** (10.3; 23.6) | **10.57%$^{***b}$** (6.5; 14.6) |
| **Origin** | **19.34$^{***a}$** (12.7; 25.9) | **7.14%$^{***b}$** (3.2; 11.0) | **15.07$^{***a}$** (9.1; 21.0) | **8.62%$^{***b}$** (4.8; 12.4) |
| **Diet** | **1.72$^{b}$** (-7.6; 11.0) | **35.98%$^{***a}$** (26.9; 45.1) | **22.73$^{***b}$** (15.4; 30.0) | **34.79%$^{***a}$** (25.8; 43.8) |
| **Price** | **20.33$^{***a}$** (11.1; 29.5) | **25.66%$^{***a}$** (19.3; 31.9) | **25.67$^{***a}$** (17.4; 33.9) | **29.57%$^{***a}$** (23.4; 35.8) |

Significance levels: *** p<0.01; **p<0.05; * p< 0.10
$^{a,b}$: Differences between preferences (pre sensory and post sensory) within each group at 95%.

Table 2: Results from model estimations for consumer data with and without information

| | The Generalized Multinomial Logit model | | | |
|---|---|---|---|---|
| | Without information | | With information | |
| | Pre sensory | Post sensory | Pre sensory | Post sensory |
| | **Random Parameters in utility functions (β)** | | | |
| Moderate visible fat | -0.50*** | -0.41*** | -0.31*** | -0.35*** |
| Pale red | -0.30*** | -0.25*** | -0.27*** | -0.22*** |
| Other Spanish origin | -0.26** | -0.15** | -0.24*** | -0.18*** |
| Enriched with n-3 | 0.03 | 0.58*** | 0.19*** | 0.42*** |
| Enriched with CLA | -0.01 | 0.12 | 0.01 | 0.10 |
| Enriched with n-3 & CLA | 0.11 | 0.22* | 0.33*** | 0.49*** |
| Price 6.6€ (high) | -0.52*** | -0.69*** | -0.67*** | -0.87*** |
| Price 5.7€ (medium-high) | 0.11*** | -0.07 | 0.20*** | 0.02 |
| Price 4.8€ (medium-low) | 0.37*** | 0.38*** | 0.32*** | 0.41*** |
| Opt-Out | 0.48*** | 0.44*** | -0.15 | 0.16 |
| | **Independent standard deviations of parameters distribution obtained from Diagonal values in Cholesky matrix** | | | |
| Moderate visible fat | 1.63*** | 1.58*** | 2.14*** | 1.82*** |
| Pale red | 0.94*** | 0.10** | 0.89*** | 0.11* |
| Other Spanish origin | 0.12* | 0.08 | 0.16*** | 0.26*** |
| Enriched with n-3 | 0.30*** | 0.05 | 0.02 | 1.33*** |
| Enriched with CLA | 0.02 | 1.06*** | 0.01 | 0.28** |
| Enriched with n-3 & CLA | 0.21** | 0.81*** | 0.15 | 0.25** |
| Price 6.6€ (high) | 0.30** | 0.90*** | 0.17 | 1.48*** |
| Price 5.7€ (medium-high) | .42*** | 0.24** | 0.25** | 0.20 |
| Price 4.8€ (medium-low) | 0.06 | 0.14** | 0.28** | 0.03 |
| Opt-Out | 1.27*** | 0.42*** | 1.65*** | 1.71*** |
| | **scale parameters** | | | |
| Variance parameter in scale parameter $\tau$ | 0.56*** | 0.08 | 0.12* | 0.11 |
| Weighting parameter $\gamma$ | 0.34*** | 0.31*** | 0.10 | 0.10 |
| | | | | |
| Log-Likelihood (θ) | -2,658.67 | -2705.29 | -2656.7667 | -2801.51 |
| Log-Likelihood (0) | -3,571.09 | -3,571.09 | -3,604.36 | -3,604.36 |
| LL ratio test | 1,824.84 (0.000) | 1,731.60 (0.000) | 1,895.19 (0.000) | 1605.69 (0.000) |
| Pseudo $R^2$ | 0.255 | 0.242 | 0.262 | 0.227 |
| AIC/N | 2.124 | 2.160 | 2.103 | 2.214 |

*Si*gnificance levels: *** p<0.01; **p<0.05; * p< 0.10

Table 3. Overall acceptability scores of beef from animals fed different diets assigned by consumers.

| Type of beef meat | **Overall acceptability** *Without* information | *With* information | *P value*[*] | *Whole Sample* |
|---|---|---|---|---|
| **Conventional** | 5.73 | 5.70 | *0.858* | 5.71[c] |
| **Enriched with omega-3** | 6.17 | 6.10 | *0.611* | 6.14[a] |
| **Enriched with CLA** | 6.04 | 5.76 | *0.051* | 5.90[b,d] |
| **Enriched with omega-3 & CLA** | 5.74 | 5.79 | *0.712* | 5.76[c,d] |

[*] Differences between mean scores assigned by consumers with and without information.
[a, b, c, d] Statistical differences among types of beef meat for all consumers at 95 %.