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A multi-criteria stated method to analyze consumers' preference and sensory evaluation towards omega-3 enriched eggs: The Analytical Hierarchy Process (AHP)

Abstract

The appropriateness of the Analytical Hierarchy Process (AHP) technique to analyze consumers' acceptance of eggs was assessed for the first time and compared with the traditional 9-point hedonic scale. In addition, the relative importance of egg attributes (egg type: regular, free-range, enriched with omega-3; egg size: small, medium, large; origin: local, regional, other Spanish origin; and price) on consumer purchasing decisions was evaluated in the Catalan market. Data were obtained from a face-to-face questionnaire (n=122) in a controlled environment. Subsequently, consumers conducted a hedonic test of three types of commercialized eggs (regular, free-range and enriched with n-3) using the AHP technique and a 9-point scale. The AHP approach seems to be a reliable tool to evaluate consumer hedonic preferences as well for purchasing decision study as contrasted with the traditional 9-point category scale. However, further testing of the technique applied to other food products using larger sample sizes is needed.

Keywords: Analytical Hierarchy Process, consumers' acceptance, eggs, omega-3

JEL codes: C00, C18, Q13.

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1. Introduction

Nowadays, factors affecting human health are gaining prominence in purchasing food products and thus, they are becoming one of the most relevant predictors for food consumption (Bayarri *et al*., 2010; Lusk *et al*., 2003; Roininen *et al*., 1999). Different strategies are available for food marketers for the production of healthier food products. Thus, a broad range of products are offered in the market such as low sugar, low salt, low fat content and fat-free products (i.e. light products portfolio) or the enrichment of food products with polyunsaturated fatty acids (PUFA).

Foods with reduced levels of total fat and increased levels of unsaturated fatty acids have gained market shares (Sloan 2008; Bower, *et al*., 2003). In Spain, the consumption of low-fat products such as the partially skimmed milk has increased from 1.8 l/capita in 2004 to 20.72 l/capita in 2012 (MAGRAMA, 2013), and the consumption of milk enriched with omega-3 (n-3) and other health additives have increased from 0.86 l/capita in 2004 to 5.73 l/capita in 2012 (MAGRAMA, 2013). Moreover, due to the perceived high content of cholesterol in eggs, its consumption in Spain has decreased from 155.64 eggs per capita in 2004 to 132.11 eggs per capita in 2012 even though the egg price decreased in the last years[1]. In contrast to the high penetration in Spanish households of enriched dairy products, the penetration is still limited in other food sectors, specifically, for poultry products.

Omega-3 fatty acids (n-3) play a major role in human health and are involved in the development of brain and retinal tissues and in the progression and prevention of human diseases, including heart disease (Connor 2000; Simopoulos 1999). In addition to the effects on cardiovascular health, n-3 fatty acids have been shown to prevent the development of dementia, reduce systemic inflammatory diseases, prevent prostate cancer, and possibly have a role in the treatment of depression and bipolar disorder (Fares *et al*., 2014). Nutritional recommendations suggest that the polyunsaturated /saturated fatty acid ratio for the diet as a whole should be 0.40 or higher, while the n-6/n-3 ratio should be 4.0 or lower (Department of Health 1994). Thus, modifying the type of fat in eggs through modifications in the animal diet, would offer the consumer a fatty acid profile closer to the current nutritional recommendations for a healthy diet and would improve the nutritional image of eggs. Consequently, animal feeding strategies have been successfully used to significantly increase polyunsaturated fatty acids in eggs (Lawlor *et al*., 2010; Parpinello *et al*., 2006). The usual practice of producing n-3 fatty acid-modified eggs is basically achieved by feeding flax seeds and marine

[1]The deflated egg price has decrease from 0.11€/egg (2004) to 0.09€/egg (2012) (MAGRAMA, 2013).

oils (fish oil, fish meal) to laying hens (Lawlor *et al*., 2010). Antioxidants are also added in order to minimize lipid oxidation (Qi and Sim, 1998).

Analyzing consumers' acceptance towards n-3 enriched eggs is not new and has been assessed decades ago (Adams, *et al*., 1989; Caston *et al*., 1994; Scheideler *et al*., 1997; Parpinello *et al*., 2006 and Lawlor *et al*., 2010 among others). In carrying out sensory analysis for food products in particular, the 9-point hedonic scale is widely used in measuring consumers' acceptance. Nevertheless, among the different sensory evaluation techniques, the comparative methods are also relevant (Meilgaard *et al*., 2006). In this context, the main objective of this research was twofold: First to verify the appropriateness of the Analytical Hierarchy Process (AHP) technique as a valid tool in the assessment of consumer acceptance of eggs by contrasting its results with the traditionally used 9-point hedonic scale. Second, to evaluate the relative importance of egg attributes including its enrichment with n-3 fatty acids on consumer purchasing decisions in the Catalan market.

2. Materials and methods

In a first step, a pre-sensory questionnaire was applied to assess the factors that affect consumers' decisions when purchasing eggs using the Analytical Hierarchy Process (AHP) technique. Consumers were asked to make pairwise comparisons between attributes and levels that usually take into consideration in their decision to purchase eggs. The relative importance of the attributes and levels was then estimated following a hierarchy structure. In a second step, consumers' acceptance towards three commercial types of egg (regular, free-range and enriched with n-3) in the Catalan market was analyzed. Two different approaches were carried out for the sensory evaluation. On one side, the AHP technique was used by pairwise comparisons of the three products for each relevant sensory egg attribute. On the other side, a 9-point hedonic scale was also used to assess the sensory attributes among the three types of eggs. Results were contrasted between the AHP technique and the traditional 9-point hedonic scale. A summary of the methodological approach is presented in Figure 1.

2.1. Theoretical background: the Analytical Hierarchy Process

The Analytical Hierarchy Process (AHP) is a multi-criteria decision-supporting method that relies on mathematics and psychology and aims to organize and analyze complex decisions (Saaty, 1977; 1980). It helps decision makers (consumers) find a decision (purchase and consumption) that

best suits their goal (preferences) and their understanding of the problem (the best product). In this context, the AHP is based on decomposing the problem (best product) into a hierarchy of smaller constituent sub-problems (best attributes). Determining the individually most preferred product, from a set of them, is a decision problem where the hierarchy top level represents the final consumer decision. To reach this goal, the problem is decomposed into a predefined number of attributes on a second level and their corresponding levels on a third level as can be seen in Figure 1.

AHP allows to analyze individuals' preference for the attributes and their levels by eliciting the relative importance (w) (known also as priority) through pairwise comparison. In a survey, participants are asked to carry out all possible one way pairwise comparisons (the arrows in Figure 2) between attributes and between levels obtaining their weights (w_{A_m}, $w_{L_{m.n}}$ respectively) where; m ($1, \dots, m$) is the number of attributes and n ($=1, \dots, n$) is the number of levels of each attribute. In the pairwise comparison process, respondents have to indicate which of the two compared elements (attributes and levels) they prefer (Table 1), where the 9 points scale (Saaty scale) is used to measure the strength of the preference by means of verbal judgements as can be seen in Table 2.

After constructing the hierarchy of attributes and levels preferences, respondents are asked to make a pairwise comparison between the available products to assess their relative importance in describing each attribute and level as shown in Table 3. Then, the best product that better satisfies consumers' preferences is identified. From the answers provided, a matrix with the following structure is generated for each individual k (1, ... , K) known as Saaty matrix:

$$S_k = \begin{bmatrix} a_{11k} & a_{12k} & \dots & a_{1jk} \\ a_{21k} & a_{22k} & \dots & a_{2jk} \\ \dots & \dots & a_{ijk} & \dots \\ a_{i1k} & a_{i2k} & \dots & a_{NNk} \end{bmatrix} \qquad (1)$$

where a_{ijk} (known as judgement) represents the value obtained from the pairwise comparison between attribute/level/product i ($i \in$ M / $i \in$ N / $i \in$ S) and attribute/level/product j; ($j \in$ M / $j \in$ N / $i \in$ S) for each individual k. The fundamental properties of this comparison matrix are: a) reciprocal comparison: if $a_{ijk}=x$ then $a_{jik}=1/x$); b) homogeneity: if the element i and j are judged, they have an equal relative importance, thus, $a_{ijk} = a_{jik} = 1$; and c) all the elements of its main diagonal take a value of one ($a_{iik}=1 \ \forall \ i$).

If respondents are consistent, then any two judgements obtained from any two pairwise comparisons that have a common element to be compared will automatically allow to obtain the third judgement. This means it should hold that $a_{ihk} \times a_{hjk} = a_{ijk}$ for all i, j and h (i, j, $h \in$M / i, j, $h \in$N / i, j, $h \in$S). This condition implies that values given for pairwise comparisons represent the relative importance (known also as weights or priorities) given to each element by a perfectly rational decision-maker $a_{ijk} = w_{ik}/w_{jk}$ for all i and j. Therefore, in perfect consistency the previous matrix can also be expressed in weight terms as follows:

$$S_k = \begin{bmatrix} \frac{w_{1k}}{w_{1k}} & \frac{w_{1k}}{w_{2k}} & \cdots & \frac{w_{1k}}{w_{Nk}} \\ \frac{w_{2k}}{w_{1k}} & \frac{w_{2k}}{w_{2k}} & \cdots & \frac{w_{2k}}{w_{Nk}} \\ \cdots & \cdots & \frac{w_{ik}}{w_{jk}} & \cdots \\ \frac{w_{Nk}}{w_{1k}} & \frac{w_{Nk}}{w_{2k}} & \cdots & \frac{w_{Nk}}{w_{Nk}} \end{bmatrix} \qquad (2)$$

Under such circumstances, K weights (w_{Mk}) for each attribute, for each level (w_{Nk}) and for each product (w_{Sk}) can be easily determined from the M×(M-1)/2, N×(N-1)/2 and S×(S-1)/2 values for a_{ijk}, respectively. Therefore, in the case of perfect consistency it should hold the verification that: $S_k \times \mathbf{W} = \mathrm{M} \times \mathbf{W}$ (for attributes), $S_k \times \mathbf{W} = \mathrm{N} \times \mathbf{W}$ (for levels) and $S_k \times \mathbf{W} = \mathrm{S} \times \mathbf{W}$ (for products), where **W** is a column vector in each case ($w = [w_1, \ldots, w_{m/n/s}]$). However, some degree of inconsistency exists in carrying out consumers' stated preferences through survey, since the personal subjectivity plays an important role in the pairwise comparison. Therefore, the original verification can be redefined to: $S_k \times \mathbf{W} = \lambda_{max} \times \mathbf{W}$, where λ_{max} is the maximum eigenvalue of matrix S_k that is determined by $\lambda_{max} = \sum_i \sum_j \hat{a}_{ijk} \hat{w}_{ik}$ where the quantity $\lambda_{max} - \mathrm{M}$ (attribute), $\lambda_{max} - \mathrm{N}$ (levels) and $\lambda_{max} - \mathrm{S}$ (product) is an indicator about the degree of inconsistency within the S_k. In this context, the Consistency Index (CI) can be defined as $CI = \frac{\lambda_{max} - M}{M-1}$ (for attributes), $CI = \frac{\lambda_{max} - N}{N-1}$ (for levels) and $CI = \frac{\lambda_{max} - S}{S-1}$ (for products).

The Consistency Ratio (CR) then is defined (Saaty, 1980) as CR=CI/RI where RI is a Random Index which denotes the consistence index for a randomly generated S_k matrix as can be seen in Table 4. Values of CR ≤ 0.1 are acceptable. For higher values, respondents are asked to revise their pairwise comparison to restrict for inconsistency.

The Row Geometric Mean (RGM) prioritization method (Saaty 1980 and 2003) is applied as valid procedure to estimate the real weights. Using this approach, weights assigned by the subject to each attribute and level are obtained using the following expression:

$$w_{ik} = \sqrt[N,P]{\prod_{i=1}^{i=N,P} a_{ijk}} \qquad \forall\ i, k \qquad (3)$$

From the individual weights (w_{ik}) we need to aggregate the values across subjects to obtain a synthesis for each attribute and level (w_i) for the whole sample. The aggregation process is carried out following Forman and Peniwati (1998), who consider that the most suitable method for aggregating individual weights (w_{ik}) in a social collective decision-making context is that of the geometric mean:

$$w_i = \sqrt[K]{\prod_{k=1}^{k=K} w_{ik}} \qquad \forall\ i \qquad (4)$$

Once the weights are estimated, the Kolmogorov-Smirnov test is applied to test for normality of the distribution. If the normality do not held, the Wilcoxon non-parametric test is used to test for differences between weights, otherwise the ANOVA test is applied.

2.2. Data collection

Data used in this analysis were obtained from a face-to-face questionnaire completed in a controlled environment followed by a sensory test. The sample consisted of 122 consumers over 18 years of age who purchase food and beverages regularly and having purchased eggs in the last month. Participants were recruited through the Centre for Agro-food Economy and Development (CREDA). Consumers were seated in individual booths of the test lab of the Agriculture Engineering School of Barcelona (ESAB) according to the UNE-ISO 8589: 2010.

After 20 minutes of the pre-sensory questionnaire (first step), seven sensory sessions were conducted with approximately 15-20 consumers per session (second step). Consumers evaluated in a blind condition, the acceptability of the three egg samples (regular, free-range and n-3) under white light in the order printed on the recording sheet, which was established to avoid the sample order effect (Macfie *et al.*, 1989). Consumers were presented with one plate of 3 samples coded with different 3-digit code in a balanced randomized order and asked to make a pairwise comparison of the three samples following the AHP approach. Unsalted crackers and room temperature filtered water were presented to each consumer to rinse their palate between samples.

In order to minimize the gap between the stated preferences (i.e. what consumers state in hypothetical scenario in questionnaires) and the revealed preferences (i.e. what consumers really did in markets), that is mainly associated with consumers motivation and the incentive compatibility of the questions used, a standard "*cheap talk*" procedure was used in our survey as proposed by Carlsson *et al*., (2005) and Bosworth and Taylor (2012). Thus, before starting the experiment the following paragraph was mentioned to the participants:

"*Previous studies indicate that individuals in general respond to surveys differently from the way they act in real life. It is quite common to find that individuals say they are willing to pay higher prices than those that they are really willing to pay or to select the product that are environmental friendly or committed with animal welfare. We believe that this is due to the difficulty in calculating the exact impact of these higher expenses on the household economy or because we would prefer to be more committed with environment but we do not do it. It is easy to be generous when in reality one does not need to pay more*".

2.3. The analysis of the purchasing preferences using the AHP

- *Attributes and levels for purchasing eggs*

The process of purchasing food products is in general a complex process which lies on a various number of cues that characterize the different products. Such complexity generates some difficulties when trying to determine the key factors that intervene in the consumer's decision making. To tackle this issue, in the case of the determinants factors for egg purchase we used results from previous literature. We identified various attributes that were subsequently discussed in a focus group involving university lecturers in the field of agro-food marketing as well as representatives from consumer associations in Catalonia.

Gracia *et al*. (2013) analysing the Spanish consumers' preferences when purchasing eggs, they used, the price as a commonly used determinants factors, the origin and the method of the production as the most relevant attributes. Mesías *et al*., (2011) in another Spanish case study used the following attributes: feed given to chickens, if enhanced or not with n-3, rearing conditions, egg size and price. Ness and Gerhardy (1994) focused on the freshness and quality as a determinants factor for purchasing eggs. They used the production method, origin, freshness information and price. Norwood and Lusk (2011), focused on the hen welfare such as barn space per hen, beak trimming as a potential attributes to infer animal welfare importance in the eggs purchasing

decision. Finally, the attributes and levels included in our experiment were: egg type (regular, free-range and enhanced with n-3), egg size (small, medium, large), origin (local, Catalonia and other Spanish region) and the price. These identified descriptors of the eggs were pairwise compared and their relative importance was estimated by the AHP procedure.

2.4. The sensory test

- *Egg collection and sample preparation*

Regular, free-range and enriched with n-3 eggs laid in the same day were collected from the same farm. The eggs were purchased within two days of the sensory study and kept under refrigerated storage (4°C) for the duration of the experiment. We followed Parpinello *et al*. (2006) for the preparation of the different types of egg samples. Eggs were cooked in separate pots in boiling water for 8 minutes, using six eggs per treatment, and later cooled using running water to an external temperature of about 40ºC. Next, they were shelled and divided longitudinally into 4 portions that contained approximately a similar content of yolk. A plate containing three samples corresponding to each egg type was presented to each consumer. Samples were prepared without salt addition and the portions were covered by aluminum foil to preserve odour compounds.

- *Attributes and levels for valuing egg acceptance*

The first step in measuring the acceptance is to clearly define the main sensory attributes of eggs. We first relied on prior research to identify the most used attributes in egg sensory studies. On the basis of the most used attributes in the literature (Sheideler *et al.*, 1997; Parpinello *et al*., 2006; Sedoski *et al.*, 2012; Caston *et al*., 1994; Lawlor *et al*., 2010) to evaluate the sensory characteristics of eggs, we selected: odour, colour and flavour in our study. These attributes, were used to evaluate consumer acceptance of the different types of eggs using the AHP method and also the traditional 9-point hedonic scale. Hedonic scales were defined for the egg odour (1: non-typical egg odour to 9 typical egg odour), for the yolk colour of the eggs (1: non-typical egg colour to 9 typical egg colour), for egg flavour (1: non-typical egg flavour to 9 typical egg flavour), and for global acceptance of eggs (1: dislike extremely to 9 like extremely).

To mitigate the order effect, we followed a design based on ordering change between techniques (i.e. between sensory AHP and sensory hedonic scale) as advised by Charzan (1994). We split our sample into two sub-samples, generating two versions of the survey differentiated by different orders between methods. Thus, for the consumers' acceptance test, we used a quota sampling procedure by allocating 50% of the samples to start with the AHP questions and the other

half with the hedonic scale. In all other aspects, such as wording of questionnaire, the two versions were identical.

3. Results and discussions

3.1. Relative importance of egg attributes in purchasing decisions

The relative importance of the attributes when purchasing eggs is shown in Figure 3. Results showed that the egg type and the price had similar and higher importance than the origin which had higher importance than the egg size in purchasing decisions. The Wilcoxon non-parametric test indicated that the egg type and the price did not differ between them, while the origin and size of eggs differed from the other attributes.

Focusing on the levels of the attributes, for the egg type, consumers showed a preference for the free-range type followed by the enriched with n-3 and regular eggs. As in the case of the attributes, the Wilcoxon test showed that the differences were statistically significant between the free-range and the other types of eggs, being the most preferred egg type. However, revealed data in Spain have shown that consumers purchase regular eggs most frequently. To better understand these results, it is relevant to take into account the price importance in the purchasing decision. The divergence between the stated and revealed preferences in this case is likely to be associated with price effect between both types of eggs. Statistical data regarding food price in Spain showed that on average the free-range eggs are at least two times more expensive than the regular ones (MAGRAMA 2009, Mesías *et al*, 2011), bringing consumers to choose the regular eggs over other types of eggs.

Regarding the preferences for egg size, results confirmed what we expected. Consumers prefer medium and big egg sizes compared to the small size. The Wilcoxon test showed statistical difference between the small size and the other egg sizes. These results are in accordance to the results obtained by Mesías *et al*., (2011) where the highest utility (most preferred) of the attributes was for the extra-large size egg (>73 g) against the standard size (53–73 g). Finally, analysing the origin attribute and levels, results agreed with literature data showing a preference for the local origin of eggs for Spanish consumers (Gracia *et al*., 2013). Thus, consumers preferred the local origin followed by the regional origin and finally the other Spanish regions. This preference pattern is especially pronounced in Catalonia where the feeling of belonging and the value of locality is rooted in the society in general.

3.2. Hedonic evaluation of egg attributes: AHP and 9-point scale results

The results of comparing the three egg types according to the selected sensory attributes using AHP are shown in Figure 4. For the typical egg odour, results showed that the regular eggs received the highest weight, which means that it had the best score on this attribute than the other egg types. However, the statistical Wilcoxon test showed no odour differences between the regular and the free-range eggs, which had higher odour scores than the n-3 enriched eggs. These results reflect consumers' unfamiliarity with the odour of the n-3 enriched eggs, which is probably associated to its low frequency of consumption as well as the possible oxidation and subsequent development of off-odours and off-flavours as previously reported in this type of eggs. Parpinello *et al*. (2006) indicated that the off-flavours that are usually present in this type of enriched eggs are considered to be a major undesirable side-effect when incorporating high n-3 levels in diets fed to hens.

Regarding the colour attribute, results showed that the regular eggs had the most typical colour score followed by the free-range and enriched with n-3. Results showed statistical differences between regular eggs and both free-range and enriched eggs which were not significantly different. These results reflect consumers' habits towards the familiar colour they face when consuming regular eggs. Finally, for the flavour attribute, results indicated that the regular and the free-range eggs had similar and higher scores than the n-3 enriched eggs. Flavour scores were significantly lower for the enriched eggs with n-3 than the other egg types in agreement with results reported in literature. Karahadian and Lindsay (1989) indicated that the enrichment with n-3 may cause off-flavours in eggs, mainly due to the oxidative damage of yolk lipids which may affect the sensorial quality of eggs (Caston *et al*., 1994).

Results of the sensory egg valuation using the 9-point hedonic scale are shown in Table 5. Analysing the odour attribute, results show that regular eggs had higher typical odour score than free-range and n-3 enriched eggs, however, non-significant differences were found among the three types of eggs for the odour attribute. In contrast, results from the AHP approach (Figure 4) showed significant differences between regular and free-range eggs and the n-3 enriched eggs. This discrepancy may show the capacity of the AHP, and thus the comparative technique, to better detect differences in the odour attribute between the different egg types in the hedonic evaluation in comparison to the 9-point hedonic scale in our exploratory study.

Regarding the colour attribute, significant differences were found among the different egg types. As expected, the yolk of the regular eggs was perceived as a more typical egg colour, followed by the n-3 enriched eggs and finally the free-range eggs. Colour results are associated to the different feeding regimes, as it is well known that the free-range hens have in general the opportunity to eat more pigmented foods and the pigment is then transferred to the yolk, conferring its more orange colour. This tendency was also found in the n-3 enriched eggs but with a relatively lower incidence. This is due to some ingredients used for the egg enrichment with n-3, which are natural sources of carotenoids and thus the yolk shows greater pigmentation (Barbosa *et al*., 2011). Comparing these results with those obtained from the sensory AHP regarding the colour attribute, both methods founded higher scores for the regular eggs compared with the free-range and the n-3 enriched eggs, showing the capacity of the AHP approach to detect major differences in the odour attribute obtained from hedonic valuation. However, results obtained using the 9-point scale showed significant differences in egg odour between the free-range and n-3 enriched eggs, while the AHP technique did not show significant differences between these egg types.

For the flavour attribute, results (Table 5) showed that the free-range and the regular eggs received higher values with more typical egg flavour than the n-3 enriched eggs. These hedonic results using the 9-point scale are in agreement with those obtained using the AHP technique that also found significant differences between the flavour of the regular and the free-range eggs and the flavour of the n-3 enriched eggs. Finally, In line with literature data regarding the sensory valuation of enriched eggs with n-3 (Lawlor *et al*., 2010), results showed that there are still some potential adverse effects on the sensory attributes of enriched eggs that are currently being commercialized in the Catalan market. The global acceptance scores assigned by consumers using the 9-point scale also indicates that the n-3 enriched eggs have a lower sensory rating than the regular and the free-range eggs. Recommendations should be offered to egg producers to revise their feeding mixture for laying hens to minimize the negative impact that the enrichment may have on sensory properties of eggs, including the use of antioxidants among other approaches.

4. Conclusions

The most important cue driving the majority of consumers' egg purchase decisions were the type and the egg price followed by the origin and finally the egg size. For the egg type, consumers showed a preference for the free-range egg followed by the enriched with n-3 and regular eggs. Regarding the preferences for egg size, consumers preferred medium and big egg sizes compared

with the small size. Finally, for Catalan consumers analysing the origin attribute and levels, results showed preference for the local origin of eggs followed by the regional origin and lastly other Spanish origin.

Regarding consumers' hedonic evaluation, results showed agreement between the AHP technique and the 9-point scale showing that n-3 enriched eggs had lower flavour acceptance, regular eggs had higher colour acceptance, and regular and the free-range eggs had similar and higher odour acceptance than the other egg types. In addition, the AHP technique detected odour differences between the n-3 enriched eggs and the other 2 types of eggs, while the 9-point scale detected colour differences between the n-3 enriched eggs and the free-range eggs.

The AHP approach seems to be a reliable tool to evaluate consumer hedonic preferences as contrasted with the traditional 9-point category scale. In addition, this approach shows its ability to analyse consumers preference. However, further testing of the technique applied to other food products using larger sample sizes is needed to validate the AHP as a comparative method adapted to sensory analysis and to be compared woth other staed prefernece approaches.

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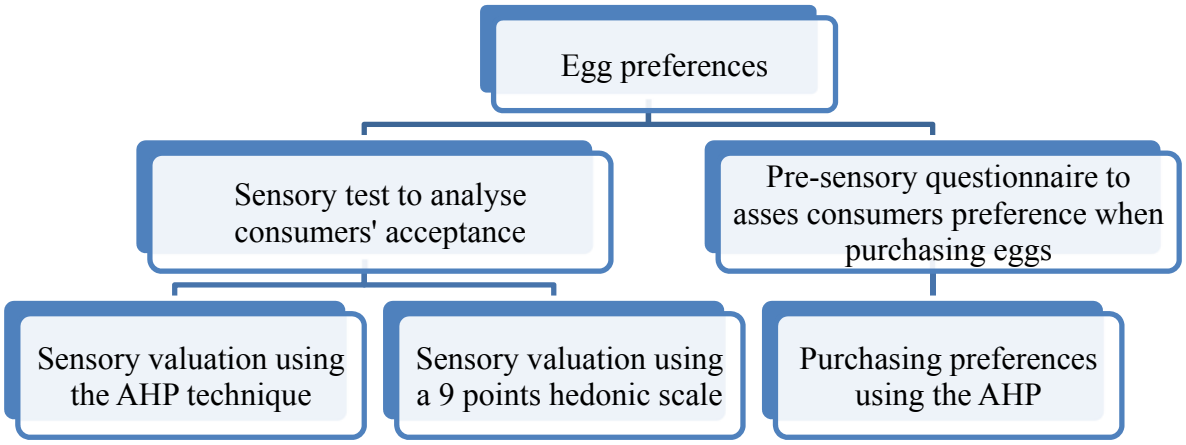


Figure 1: Diagram of the methodological approach

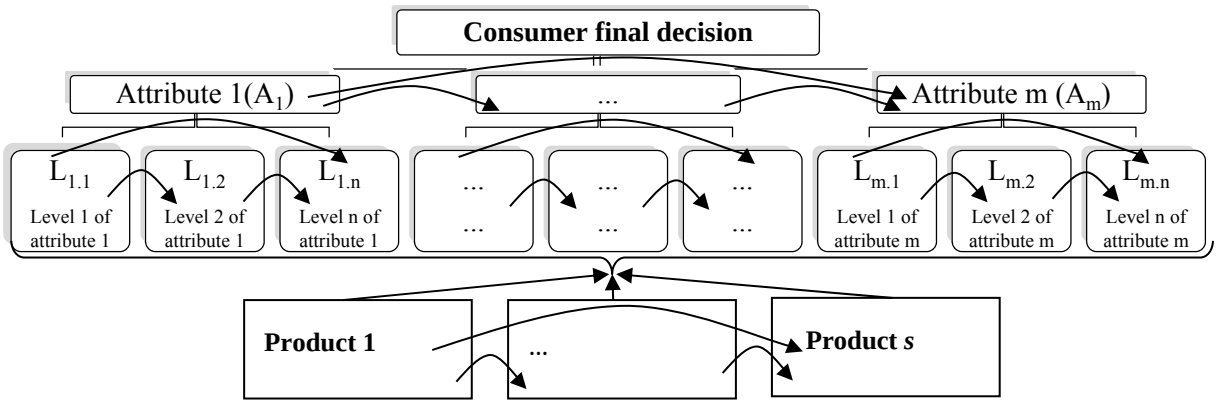
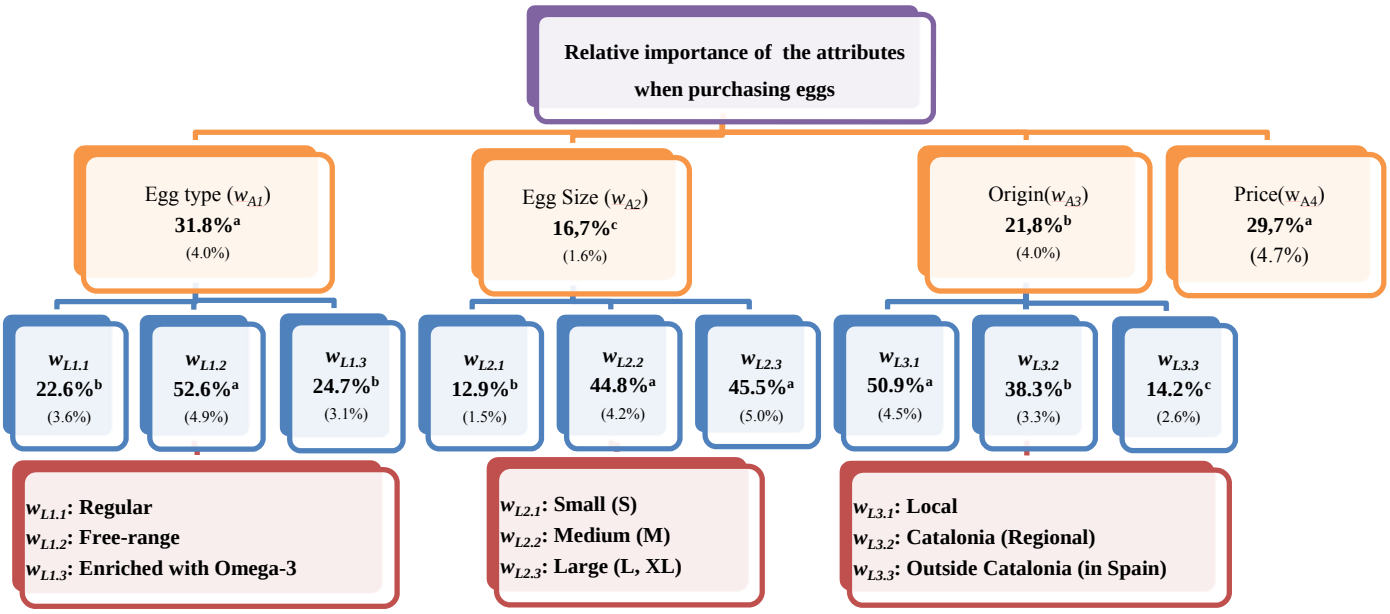
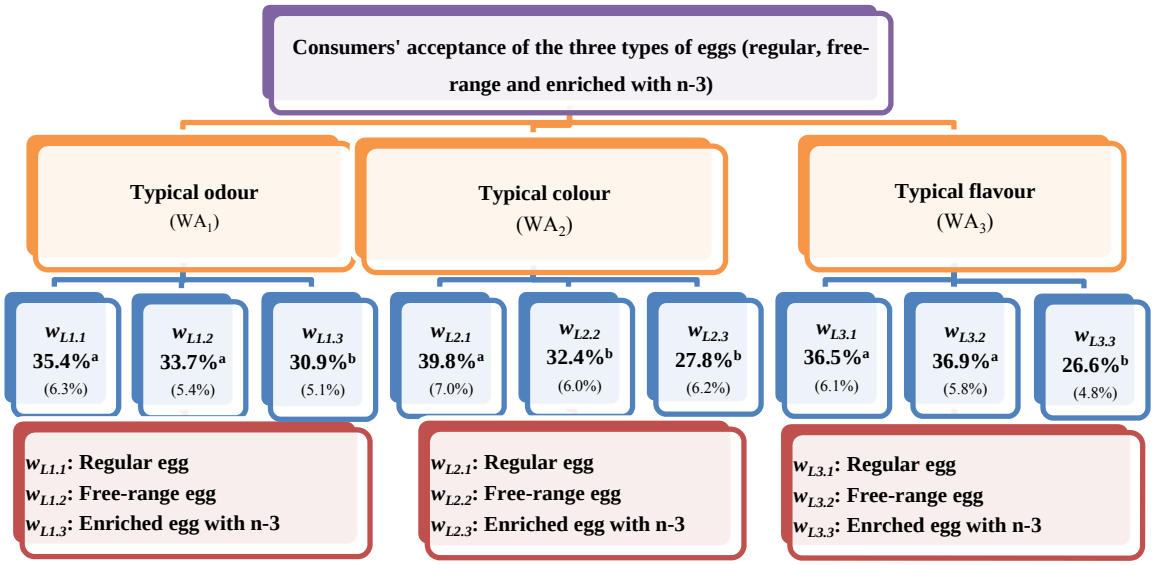


Figure 2: Hierarchical structure used to value the product, its attributes and their levels.



a,b,c: Differences among attributes and levels at 95%. Variances are between brackets.

Figure 3: Results of the hierarchical structure of the attributes when purchasing eggs.



a,b,c: Differences among participants at 95%. Variances are between brackets.

Figure 4: Results of the hedonic valuation of the different types of eggs using AHP

Table 1: Example of the AHP pairwise comparison for attributes and levels

Attribute *1*									**Attribute *m***							
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
Level *1*									**Level *n***							
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9

Table 2: The AHP comparison scale

Degree of importance rating	***Definition of the scale***
1	The two elements have the same importance
2	The first element has an importance between 1 and 3 against the compared element
3	The preferred element is slightly more important
4	The first element has an importance between 3 and 5 against the compared element
5	The preferred element is moderately more important
6	The first element has an importance between 5 and 7 against the compared element
7	The preferred element is strongly more important
8	The first element has an importance between 7 and 9 against the compared element
9	The preferred element is absolutely more important

(Saaty, 1980)

Table 3: Example of the AHP pairwise comparison of the products that better satisfy a specific attribute or level

Which product better satisfies the attribute/level m/l?																
Product *1*									**Product *s***							
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9

Table 4: RI values

n	1	2	3	4	5	6	7	8	9	10
RI	0,00	0,00	0,58	0,90	1,12	1,24	1,32	1,41	1,45	1,49