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Additional Information

1   **Perception of fat and other quality parameters in minced and burger**

2   **meat from Spanish consumer studies**

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9   **ABSTRACT**

11   This study examined Spanish consumer knowledge and perceptions of fat content in

12   minced meat products, as well as the most relevant aspects considered to accept or reject

13   these products. The majority of respondents overestimated the fat content of different

14   minced meat types. Most consumers would not detect fat variations between ± 2 g fat/100

15   g. The word association task evidenced different perceptions of minced meat according

16   to both meat types (beef-pork or chicken-turkey) and packaging (on trays, bulk). The

17   colour and appearance of the products were very important for consumers, who did not

18   attach much importance to the presence of additives. Unpackaged beef-pork meat was

19   perceived as more natural, but fattier and less healthy. Chicken-turkey meat was

20   associated with health and low-fat, but also with dislike. This study provides relevant

21   information to develop or reformulate new meat products.

23   *Keywords:* meat products; fat; word association; consumer perceptions.

1. Introduction

Fat content is a very important attribute for those consumers concerned about eating a healthy balanced diet (Banović, Chrysochou, Grunert, Rosa, & Gamito, 2016; Loebnitz & Grunert, 2018). The population is becoming increasingly aware of the relationship of various diseases with nutritional factors (Anders & Mőser, 2010; Saba et al., 2019). Faced with this growing consumer concern about the fat content and nutritional composition of food, the labelling law in Europe was updated in 2011. Regulation (EU) No. 1169/2011 of the European Parliament and Council, of 25 October 2011, obliges the food industry to provide information about the fat content of food. In Spain, the Spanish Agency of Consumption, Food Safety and Nutrition (AECOSAN) established the NAOS Strategy (Strategy for Nutrition, Physical Activity and Obesity Prevention) in which some strategic lines involved cutting fat, sugars and salt intake by reformulating food products, among other actions.

Consumers associate some meat products with high fat content (Peterson, Van Eenoo, & Preckel, 2001). This, among others (i.e., animal welfare, sustainability, environmental impact, etc.) might be one of the reasons why the meat industry has noted loss of sales in recent years. It is also important to point out the negative impact on meat consumption that the report published by the International Agency for Research on Cancer of the World Health Organization had (World Health Organization, 2015). In that document, eating red meat was classified as *probably carcinogenic to humans* (Group 2A) and processed meat was described as *carcinogenic to humans* (Group 1). According to a report on food consumption in Spain, in recent years the consumption of fresh meat has decreased by 1.7% in 2016 and by 2.2% in 2017 (Ministerio de Agricultura Pesca y Alimentación (MAPA), 2018). For this reason, companies are attempting to innovate by

49   creating new products or adapting those that they already make to meet consumer

50   demands and the new governmental requirements.

51   In order to properly respond to consumer demands, it is important for companies to

52   understand consumer opinions about the type of products they make, which attributes are

53   the most important ones for them, and both negatively and positively. In short,

54   understanding consumer preferences and attitudes is essential for food manufacturing and

55   distribution companies to be able to face the challenge of developing new products and/or

56   reformulating already existing ones so that they meet different consumer expectations.

57   For decades, low-fat diets have been associated with healthier diets but, currently,

58   researchers and public health authorities consider that the effect of total fat intake alone

59   on health does not make sense, and fat composition should be taken into account (Forouhi,

60   Krauss, Taubes, & Willett, 2018). Notwithstanding, there is a wide variability of attitudes

61   towards fat in food (Frank, Oytam, & Hughes, 2017). In general, fat content and the

62   perception of changes in fat content are negative attributes for consumers in some meat

63   products, such as burger meat. Guadalupe, Lerma-García, Fuentes, Barat, Bas, and

64   Fernández-Segovia (2019) reported that Spanish consumers were more interested in

65   information about saturated fat content than about total fat content in food. In the same

66   study, animal fat quality was chosen as one of the worst. Consumers' interest in low-fat

67   and healthier meat products is increasing. With minced meat and other meat products,

68   reducing the percentage of fat could be a good alternative to meet consumer demands. A

69   study about consumer evaluations of processed meat products reformulated to be

70   healthier (Shan et al., 2017) demonstrated that reducing salt and/or fat in processed meat

71   products positively influenced purchase intention and health perception. Koistinen et al.

72   (2013) reported that a low-fat content had a positive effect on minced meat product

73   choices. However, reducing the fat content in meat could have an adverse effect on food

satisfaction as this parameter directly affects the palatability, flavour and overall liking of meat (Fernández-Ginés, Fernández-López, Sayas-Barberá, & Pérez-Alvarez, 2005; Frank et al., 2016; Webb & O'Neill, 2008). For this reason, it is important to know if changes in percentages of fat are perceived by consumers because low-fat meat can be perceived as a healthier product, but if sensory features are negatively affected, the product will not succeed. It is also worth answering these questions: do consumers really know the fat content present in meat products? Do they notice lower fat contents on meat product labels?

The European legislation establishes maximum levels of fat in minced meat, ranging from 7 to 30%, depending on the type of meat (European Parliament, 2011). In Spain, fat content in burger meat can vastly vary depending on the meat type, and also on brand. In a previous study carried out in Spanish supermarkets (data not published), the fat content of burger meat ranged from 7-14% in beef, 8-18% in beef-pork mixtures, 13-16% in pork and 2.5-10% in poultry. The mean fat percentage values found in that study were 11%, 13%, 14% and 5.4%, respectively.

When consumers repeat the purchase of one same product, they expect the same properties to remain. According to European Commission (2012), tolerances in the variation of the amount of fat provided on labels is ± 1.5 g fat/100 g food when content goes below 10 g fat/100 g, with one of $\pm 20\%$ of fat content on labels for fat percentages within the 10-40 g fat/100 g range. Considering that products on markets can present fat variations of these magnitudes, it is worth asking if consumers are really capable of appreciating these differences.

To know which parameters, attributes or aspects of meat products are relevant (positive or negative) for consumers, is very important for the meat industry to be able to adapt to new market trends. Different qualitative consumer research methods exist. Of

99   them all, it is worth mentioning the free word association (WA) task, which has been

100   widely used in different studies to understand consumers' perceptions of food (Ares &

101   Deliza, 2010; Ares, Giménez, & Gámbaro, 2008; Esmerino et al., 2017; Pontual et al.,

102   2017), and specifically in meat products (da Rosa et al., 2019; de Andrade, de Aguiar

103   Sobral, Ares, & Deliza, 2016; Raggio, Gámbaro, Teresa, Ana, & Garmendia, 2014).

104   Masson, Delarue, Bouillot, Sieffermann, & Blumenthal (2016) compared six qualitative

105   methods to identify consumer perceptions, and concluded that WA and the sentence

106   completion method might be one of the most comprehensive techniques to identify

107   subjective dimensions. The free WA technique allows information to be collected about

108   the most relevant attributes for a product to be accepted, common defects of products on

109   sale, reasons that affect the choice and attributes that could limit consumers' interest in a

110   product (Ares et al., 2008). The technique consists of presenting a series of images or

111   words to consumers and they must write down the first sentences or words that come to

112   mind. The written words/phrases are quite relevant to understand why and how

113   consumers make their choices because they are associated with their stimuli (Pontual et

114   al., 2017). The ideas expressed in this technique are spontaneous, with less influence than

115   in an interview or a closed questionnaire (de Andrade et al., 2016).

116   The aims of this work were to study the knowledge that consumers hold about the

117   percentage of fat present in minced meat, assess whether differences in the fat content

118   around ±2% in burger meat are perceptible, and determine the most relevant attributes or

119   features for this food type to be accepted or rejected.

120

121   **2. Materials and methods**

122

123   The work was done in three parts:

124   - Surveys to determine if consumers know what is the approximate percentage of fat

125   in minced meat.

126   - Triangular test to determine whether a 2% difference above and below the 12% fat

127   content target can be perceived.

128   - Applying the WA technique to evaluate which attributes have the most influence

129   on minced meat or burger meat being accepted or rejected, and may affect the purchase

130   choice of such products.

131   All the analyses were made by considering the IFST Guidelines for Ethical and

132   Professional Practices for the Sensory Analysis of Foods (Institute of Food Science and

133   Technology, 2015).

134

135   *2.1. Survey on the percentage of fat in minced meat*

136

137   In order to assess knowledge that consumers have about the approximate percentage

138   of fat in different types of minced meat, a consumer survey was conducted.

139   In the first part of the survey, the participants were asked for personal data (gender

140   and age) and the frequency with which they eat minced meat. In the second part, they had

141   to indicate the percentage of fat that they considered four types of minced meat have

142   (beef, beef-pork mixture, low-fat beef and low-fat beef-pork mixture). It is noteworthy

143   that beef and beef-pork mixture are two minced meat types widely consumed in Spain.

144   This part of the study was conducted in the cities of Valencia and Pamplona (Spain). A

145   total of 185 consumers participated in this study. The participants were randomly

146   recruited at universities, shopping areas and other public places. Surveys were conducted

147   face-to-face.

148   To process data, the range of variation of the fat present in the different products on

149   sale was taken as a reference for beef and the beef-pork mixture. According to a previous

150   study on the % fat of minced meat and meat derivatives for sale in the distribution chain

151   (data not published), variation in the percentage of fat in minced beef ranged from 7% to

152   14%, while these values went from 8% to 18% of fat in the beef-pork mixture. The

153   percentage of correct answers (responses within these ranges) was determined, as were

154   the percentages of responses below these ranges, and those that were above or far above

155   them.

156   For both the low-fat minced meat types, Regulation (EU) No. 1924/2006 of the

157   European Parliament and Council, of 20 December 2006, on nutrition and health claims

158   made on foods, was taken as a reference. This Regulation establishes that "*a claim that a*

159   *food is low in fat, …., may only be made when the product contains no more than 3 g of*

160   *fat per 100 g …*". The percentages of correct answers ($\leq 3\%$ of fat) were calculated, as

161   was the percentage of responses between $\geq 3\%$ and 6%, and those above 6%.

162

163   *2.2. Triangular test*

164

165   Two triangle tests were carried out according to ISO Standard 4120 (AENOR, 2008)

166   to test for similarity between meatballs prepared with beef burger meat with different

167   percentages of fat. Sensory evaluations were made during a single session in individual

168   booths at the Universitat Politècnica de València (UPV) in a tasting room with 58

169   untrained panellists.

170

171   *2.2.1. Sample preparation*

172   For this purpose, three types of burger meat were prepared in a factory whose target

173   fat content was 10 g fat/100 g, 12 g fat/100 g and 14 g fat/100 g. The fat content target

174   was achieved by mixing raw material (meat) which naturally contained different

175   percentages of fat, just as industry usually obtains homogeneous fat contents between

176   different production batches. These percentages were chosen according to a previous

177   study (data not published) on the fat percentages of the different burger meat brands found

178   in Spanish supermarkets. One of the burger meat brands was chosen, whose label

179   indicated 12% fat, and this value was taken as a reference to determine if consumers could

180   detect differences of around ± 2 g fat/100 g (approx. the fat variation tolerance allowed by

181   law). The burger meat ingredients were beef meat (82%), water, cereals (rice flour),

182   vegetal fibre (beans), aromas, antioxidants E-301 (sodium ascorbate) and E-330 (citric

183   acid) and preservative E-221 (sulphite), which simulated the formulation of burger meat

184   used in some industries. This raw material was characterised at the manufacturing point

185   by assessing the real percentage of fat, protein, moisture and collagen (Table 1) by a

186   FoodScan^{TM} 2 Meat Analyser (Foss Analytical, Denmark). Raw material was transported

187   refrigerated to the UPV laboratory, where meatballs were prepared by adding salt (1.5

188   g/100 g meat) and forming balls weighing 15 g, which were covered with wheat flour and

189   fried for 5 min in sunflower oil. Finally, samples were removed and mixed with fried

190   tomato (1.5 kg/kg meat). This preparation method was chosen because it is a typical way

191   to prepare and eat burger meat in Spain, and the objective of this part of the study was to

192   test if consumers could differentiate the fat content of burger meat in a cooked dish.

193

194   *2.2.2. Procedure*

195   Each panellist carried out two triangle tests. In one test they evaluated the meatballs

196   with 10 g fat/100 g and with 12 g fat/100 g. In the other test, the samples with 12 g fat/100

197 g and with 14 g fat/100 g were evaluated. In each triad, samples were coded with 3-digit

198 random numbers and placed on disposable plastic dishes. Samples were presented in

199 random order. Water was offered to the participants for palate cleaning between samples.

200 The followed procedure was forced election. The obtained data were analysed using the

201 tables included in ISO Standard 4120:2004 (AENOR, 2008).

202

203 *2.3. Word association task and study of health and nutrition attitudes*

204

205   To determine which attributes influenced consumer perceptions and purchase

206 intention of burger meat, and to check if meat type, presence of sulphites and meat being

207 packed on trays could influence consumer perceptions, a study using the free WA task,

208 together with a survey on health and nutrition attitudes, was performed.

209   Seventy-three consumers participated, which is considered an adequate number for a

210 qualitative method (Ares et al., 2008). This part of the study was conducted in the cities

211 of Valencia and Pamplona (Spain) with different consumers from those who participated

212 in the survey described in Section 2.1. The participants were randomly recruited at

213 universities, shopping areas and other public places. For this test, convenience sampling

214 was used, as in other similar studies (Ares & Deliza, 2010; de Andrade et al., 2016;

215 Pontual et al., 2017; Raggio et al., 2014). In convenience sampling, the sample

216 "represents" the target group insofar as it meets the characteristics defined by the

217 population, but it is important to note that it is not representative in a statistical sense

218 according to probability principles (Alonso et al., 2017). However, convenience sampling

219 does not imply that it is biased sampling as participants do not necessarily have to differ

220 from the rest of the population.

221   The questionnaire was divided into two parts: in the first part, the participants had to

222   perform the WA task. The second part consisted of personal questions and buying/eating

223   habits, as well as questions about health and nutrition, as explained below.

224

225   *2.3.1. Word association*

226   The stimulus consisted of four cards containing images of different types of minced

227   meat that were coded with 3-digit random numbers and shown with the meat type (code:

228   245. beef-pork; code 716: beef-pork; code 198: sulphite-free beef-pork; code 382:

229   chicken-turkey). All the samples were burger meat packaged on transparent trays under

230   film, except for sample 245, which was unpackaged minced meat corresponding to the

231   conventional bulk format sold by butchers. Images 716 and 198 were exactly the same,

232   and were used merely to check if the presence of additives could affect consumers'

233   opinions. Photographs were printed in colour and covered by adhesive transparent paper.

234   Fig. 1 shows an example of two cards. Images were presented monadically in a balanced

235   random order. The participants were asked to observe the images on the cards and write

236   down the first four words, thoughts or feelings that came to their minds, following the

237   procedure used in other studies (Ares et al., 2008; Pontual et al., 2017). As the answer

238   sheet did not contain images, a code corresponding to each sample was included.

239

240   *2.3.2. Health and nutrition attitudes*

241   After completing the WA task, consumers filled in a questionnaire of attitudes with

242   eight questions about nutrition and health in relation to diet to later check if the responses

243   influenced the consumer perceptions of minced meat observed in the WA test. The

244   respondents had to state their degree of agreement with each statement on a scale of nine

245   points anchored to three points: "Strongly disagree" on the left, "Neither agree nor

246 disagree" in the middle, and "Strongly agree" on the right. This questionnaire also

247 included personal data such as age, gender, level of education, purchasing habits, among

248 others. The questionnaire was based on those published by several authors (Ares et al.,

249 2008; Roininen, Lähteenmäki, & Tuorila, 1999) after modifying them.

250

251 *2.4. Data analyses*

252

253 *2.4.1. Qualitative analysis of the word association*

254 The words elicited in the WA task were grouped into different categories according

255 to their meaning. For this purpose, the triangulation method was carried out, as in other

256 studies (Ares et al., 2008; Guerrero et al., 2010). Three researchers individually classified

257 the terms into different categories. Afterwards the final classification into categories was

258 agreed by the three researchers reaching a consensus after taking into account the three

259 independent classifications they had previously made. The categories with terms

260 mentioned by more than 5% of the consumers were considered for further analyses. This

261 cut-off point was based on other studies (de Andrade et al., 2016; Esmerino et al., 2017).

262 The frequencies (number of terms and number of times mentioned) in each category were

263 calculated for each meat type. A Chi-square analysis was carried out to evaluate the

264 differences in consumer perceptions of the different minced meat types.

265

266 *2.4.2. Correspondence analysis*

267 A correspondence analysis was performed with the frequencies of the categories

268 obtained in the qualitative analysis of WA (Esmerino et al., 2017) to visualise the

269 relationship among the different categories and the various meat products on a two-

dimensional map. This is a descriptive/explorative technique that allows contingency tables to be examined.

2.4.3. Cluster and ANOVA analyses

A hierarchical cluster analysis was carried out with the answers in the health and nutrition attitudinal questionnaire to check if there were groups of consumers with different attitudes towards diet/health. The Euclidean distances between each pair of observations and Ward's aggregation method to group similar objects were used, according to other studies (Ares et al., 2008; da Silva et al., 2014). Next an analysis of variance (ANOVA) was performed for each survey question on diet and health to evaluate if the differences in responses among clusters were significant. The HSD (Honestly Significant Differences) of the Tukey test was used to test for differences at the 5% significance level.

Finally, to test if there were differences in the perception of meat products among clusters, a Chi-square analysis with the frequencies in each category (WA) for the different clusters was carried out for each minced meat type.

The employed statistical programme was XLSTAT (Long Island, NY, USA) (Addinsoft, 2019).

3. Results and discussion

3.1. Consumer knowledge of the total fat content of Spanish minced meat products

One hundred and eighty-five consumers (58% women, 42% men) participated in the survey, which was conducted to determine people's knowledge about the fat content of

295 different minced meat types. The age of most of the participants fell within the 18-29

296 years range (Table 2). Regarding consumption frequency, a high percentage of consumers

297 stated regularly eating minced meat (more than 60%), which is relevant for the

298 significance of the present study's results.

299 To analyse the obtained data, as explained in Section 2.1 of the Materials and

300 methods, they were grouped into four categories: <7%; 7-14%; 15-25% and >25% for

301 beef minced meat and <8%; 8-18%; 19-25% and >25% for the beef-pork mixture. The

302 data for both the low-fat minced meat types were classified into three categories: ≤3%;

303 4-6% and >6%.

304 The results are shown in Fig. 2. For beef meat, only 33% of the participants answered

305 correctly (data fell within the 7-14% range); 5% of the consumers stated that it had a

306 percentage of fat below 7%, while the rest (more than 60%) overestimated the fat content

307 of beef minced meat (Fig. 2a).

308 With the beef-pork mixture (Fig. 2b), 41% of the respondents gave the correct

309 percentage of fat (range 8-18%). Once again, most of the participants (56%) estimated

310 that the mixed minced meat type had a higher percentage of fat than it actually had, and

311 only 2.7% gave lower fat values than the real ones. This was because the population

312 generally thinks that beef is leaner than pork and, therefore, contains less fat, as some

313 studies conclude (Arana, Sagarnaga, & Martínez, 2012). This perception may be due to

314 that beef has less visible fat (Font-i-Furnols & Guerrero, 2014).

315 Regarding the low-fat minced meats, only 7% and 6% of the consumers gave a

316 correct value of the percentage of fat to low-fat beef and low-fat beef-pork meat,

317 respectively. More than 90% of the respondents considered that low-fat minced meat had

318 a percentage of fat above 3% (Fig. 2.c and 2.d). It was noteworthy that, in this case, people

319 also considered that beef-pork had a higher percentage of fat than beef.

14

320   The results show that most consumers have little knowledge of the true fat content in

321   minced meat products. Most consumers perceive that this product has a higher fat content

322   than it actually has. As percentages of fat are indicated on labels, these results indicate

323   that most consumers do not look at the fat content on labels, and assume higher fat values

324   than the real ones.

325   These results agree with those reported by other authors (Peterson et al., 2001), who

326   showed that individuals generally tend to overestimate the amount of fat contained in

327   meat products. As consumers consistently overestimate the amount of fat that minced

328   meat contains and consider it a high-fat product, the meat industry should do more to

329   educate consumers about true fat contents.

330

331   *3.2. Triangular test*

332

333   To check whether consumers could detect differences of 2% fat, a study was

334   conducted with the meatballs made with beef burger meat, and containing different

335   percentages of fat, as explained in Section 2.2 of the Material and Methods. Two

336   triangular tests were carried out with 58 tasters and correct answers were counted.

337   There were 23 correct answers for the test carried out with the samples containing

338   the target percentages of fat of 10-12%, with 22 correct answers for the samples with the

339   target percentages of fat of 12-14%. It is noteworthy that the actual percentage of fat in

340   the samples provided in Table 1 shows a difference of 1.73% of fat between the samples

341   with 10-12% (real percentages: 10.52% and 12.25%) and 2.28% between the samples

342   with 12-14% (real percentages: 12.25% and 14.53%). However, there was one more

343   correct answer for the samples that showed less differences in fat, which could be

344   because, as it is a forced election test in which tasters had to select the different sample

345 even if they did not detect any difference, some hits could have randomly occurred, as

346 some tasters stated.

347   In order to evaluate if the samples could be considered similar or not, a risk value β

348 of 0.05 and a value of p_d (the maximum allowed proportion of subjects who perceive a

349 difference) of 30% were set to represent a value of average size according to ISO Standard

350 4120 (AENOR, 2008). With the data acquired in this study, the maximum number of

351 correct answers to conclude that both samples were similar was 24, according to the

352 above-cited Standard. In neither case (10-12% or 12-14%) did the number of correct

353 answers reach this value, so it can be concluded that, with 95% confidence, the samples

354 in both pairs were considered similar. Notwithstanding, it is worth noting that a small

355 percentage of the population could detect variation in the amount of fat of burger meat,

356 which confirms the need to achieve the highest degree of homogeneity as possible in this

357 parameter when manufacturing this product. However in the meat industry, as already

358 mentioned, variations in fat margins do not generally reach 1%, so it can be concluded

359 from this part of the study that consumers would not perceive differences in this parameter

360 between products of different batches.

361

362 *3.3. Word association task and study of health and nutrition attitudes*

363

364 *3.3.1. Health and nutrition attitudes*

365   Table 3 shows the results of the survey on diet, nutrition and health attitudes. The

366 respondents stated that diet is very important to health (7.9) and they were aware that

367 foods high in fat and salt can be harmful for their health (7.8 and 7.7, respectively).

368 However, it should be noted that despite this, the scores for the items about avoiding

369 consuming products that are high in fat, calories and additives were considerably lower

370 (5,8, 5.5 and 5.1, respectively). That is, the participants claimed that they knew about diet

371 affecting their health, but when it came to eating, this seemed to have no decisive

372 influence. This confirms that consumer intention differs from real behaviour.

373   Ares et al. (2008) reported similar results for the perceived importance of diet and

374 food on health. Another study also concluded that consumers tend to perceive that a

375 reduction in the consumption of foods high in fats and sugars helps prevent some diseases

376 (Shafie & Rennie, 2012).

377   The standard deviations of the data were relatively high, which reflects a wide

378 variability in the responses among the participants and possible consumer segmentation.

379 In order to check if in the population participating in the survey there were consumer

380 groups with different attitudes, a cluster analysis was carried out. Three clusters were

381 identified (Cluster 1=34 individuals, Cluster 2=17 individuals, Cluster 3=22 individuals).

382 Table 4 shows the average values obtained in the surveys for the different groups.

383   Significant differences were found in the evaluation of all the questionnaire items

384 ($p<0.01$). The Cluster 2 participants showed the most awareness that diet is an important

385 factor for health, and were those who were most concerned about eating a healthy

386 balanced diet, and ate low-calorie, fat-free products without additives. On the contrary,

387 the Cluster 3 members were those who give less importance to nutrition, showing much

388 lower scores. The Cluster 1 participants showed intermediate values. It was noteworthy

389 that in all three clusters, the item with the lowest score was "*I try to consume products*

390 *without additives*". Regarding the purchase option, the respondents in Cluster 2 affirmed

391 that the nutritive and healthy aspect of food greatly affects purchase intention (average

392 score of 8), while those of Cluster 1 only gave an average score of 4.2 to this item. These

393 results were coherent in all the answers in each cluster, which confirms that the

394 respondents could be divided into three groups.

Table 5 shows the respondents' personal data and purchasing habits separated into clusters. A much higher percentage of women (71%) than men (29%) were found in Cluster 2, while this difference was much smaller in Cluster 3 (54.5% women and 45.5% men), which could indicate a greater concern and more interest in nutrition and health among women. It should be noted that in Cluster 1, and especially in Cluster 3, the highest percentage of participants were aged between 18 and 29 years old, while the participants in Cluster 2 were older. The fact that Cluster 3 was composed mainly of young people could considerably influence the results of the above-mentioned attitudes because generally the younger a person is, the fewer their health concerns. They could also more accurately understand the real relation between diet and health.

Regarding consumption frequency, the level of studies or the frequency with which purchases are made, despite some differences appearing among the three groups, they did not seem to relate to the attitudinal questionnaire responses. In Cluster 2, the highest consumption frequency was recorded, followed by Cluster 3. The majority of respondents had a high level of education as many surveys were conducted at universities. In all the groups, the vast majority always or frequently makes the purchase. Finally, it should be noted that, when asked about the place where they bought minced meat, although people indicated buying it mostly in supermarkets in all the groups, a high percentage in Cluster 2 indicated that they bought minced meat in butcher's, which would correlate with the attitudes questionnaire responses as some consumers associate butcher's products with better quality. According to another study, consumers do not consider themselves good predictors when assessing food quality. Therefore when buying meat products, they prefer to delegate the purchase decision to an expert butcher (Font-i-Furnols & Guerrero, 2014).

419   Once the attitudes and importance attached by the respondents to the above-discussed

420   items were known, the data obtained in the WA technique were analysed.

421

422   *3.3.2. Word association*

423   All the answers obtained by the WA technique were collected and the terms were

424   grouped into different categories according to their meaning, as previously explained.

425   Twenty-one categories were obtained by a consensus reached by the three researchers

426   (triangulation method), but the category "price" was discarded as it obtained less than 5%

427   of mentions. The 20 final categories are shown in Table 6. Some of these categories are

428   similar to some identified in other studies conducted on meat (da Rosa et al., 2019; de

429   Andrade et al., 2016; Raggio et al., 2014).

430   The Chi-square analysis showed a relation between the categories and the different

431   products ($X^2 = 204$, p <0.001).

432   The most widely mentioned categories were: "culinary uses", "colour", "shape" and

433   "homogeneity". "Culinary uses" was more frequently mentioned in the beef/pork meat

434   on trays, followed by the same meat type, but without packaging, which could be related

435   to these meat types being more frequently consumed. The following three categories were

436   related directly to appearance and, therefore, to consumers' first impression that

437   influences purchase choice, which could determine the selection of one meat type or

438   another. Regarding "colour", the chicken/turkey was the meat that received the most

439   mentions. Some of these attributes were pink, white or too light, which could be because

440   consumers are used to beef or beef-pork minced meat being red and the colour of the

441   chicken-turkey meat may be so light that consumers do not like it as it is the meat type

442   that, despite being receiving the most terms in the "healthy and nutritious" and "low-fat"

443   categories, was also that which received more terms related to "disliking" (little tasty,

444   disgusting, rare, etc.). These results demonstrate the importance that consumers attach to

445   the colour and appearance of these products.

446   The categories "liking", "artificial/processed", "fatty" and "low-fat" obtained an

447   intermediate number of mentions. The first category includes attributes such as

448   appetising, good quality, delicious, etc. In this category ("liking"), the beef-pork meat

449   packaged on trays received the most mentions, followed by the same meat type without

450   sulphites. It is important to note that the images in both cases were exactly the same,

451   which demonstrated that consumers do not attach much importance to the fact that meat

452   is sulphite-free, which agrees with the survey results, where people gave the lowest score

453   to the sentence "*I try to consume products without additives*". In relation to fat content,

454   the turkey-chicken meat was considered by more respondents as being "low-fat",

455   although the sulphite-free meat and the beef-pork meat on trays received some mentions

456   in this category. Unpackaged beef-pork was not considered low-fat by any respondent

457   and, on the contrary, many consumers considered it a fatty meat. This meat type obtained

458   the fewest mentions in the "artificial/processed" category as consumers perceived the

459   unpacked meat to be more natural and less processed. However, this meat type also

460   received the most mentions in the "unhealthy" category, which is directly related with the

461   most mentions to fat. These results confirm that fat content is another of the key points to

462   be taken into account when developing new meat products.

463   The least mentioned categories were those related to additives ("additives"

464   "additives-free"), so it was possible to infer that the respondents did not attach much

465   importance to the fact that this product type contained sulphites or any other additive, or

466   not. This once again confirms the relation found between the results obtained in this WA

467   technique and those mentioned in the attitudes survey, as explained above.

468   Fig. 3 depicts the map obtained in the correspondence analysis ~~this analysis~~. The first

469   two dimensions explained 78.5% of the inertia (factor 1, 53.11% and factor 2, 25.38%).

470   There was a clear separation of the four evaluated meat types. The turkey-chicken meat

471   type was directly related to the attributes "healthy", "low-fat", "colour" and "disliking",

472   probably because of its paler colour, as already mentioned.

473   Conversely, the unpackaged beef-pork type was related to the categories "fat" and

474   "place of purchase", where the term "butcher's" was frequently collected. This meat type

475   was perceived as being more natural, but less healthy, as explained above.

476   Finally, the beef-pork mixture on trays was related to the "artificial/processed"

477   attributes, "additives", "culinary uses" and "liking".

478   Given the differences among the respondents in each cluster, as mentioned in Section

479   3.3.1, a Chi-square analysis was carried out for each meat type by taking into account the

480   three clusters to check if the different attitudes towards the diet/health of each cluster

481   were reflected in the mentions given in the WA. In all cases, $p > 0.05$ values were

482   obtained, which indicates that there was no relation between the associations made for

483   one meat type and the Cluster; that is, the differences in the associations were independent

484   of cluster type. However, the biggest difference went to the categories of "additives" or

485   "additives-free", where Cluster 3 practically did not mention either of these two

486   categories, while there were mentions of additives in the two remaining groups (data not

487   shown).

488

489   **4. Conclusions**

490

491   The participants estimate that minced meat has a higher fat content than it actually

492   has, even when meat is labelled "low fat", which demonstrates the lack of Spanish

493   consumer knowledge about this issue. This indicates that the meat processing industry

494   should establish strategies to improve the image that consumers hold of its products.

495   The majority of consumers do not perceive fat differences of about ± 2% in burger

496   meat.

497   The participants consider the influence of diet on health important, and are aware of

498   the negative effect of foods that are high in fat and salt. However, all this does not have a

499   strong impact when consuming food.

500   The odour, appearance and fat content of minced meats are very important attributes

501   for the Spanish consumer. Additives are not a determining factor for accepting such

502   products, so their elimination or substitution would not be a priority in reformulating or

503   designing new products. Meat that is not packaged is perceived as being more natural,

504   but is also perceived as fatter and less healthy. Minced chicken-turkey meat is associated

505   with healthy and low-fat food, but is also the most related to disliking given its

506   colour/appearance, which indicates that it would be interesting to modify this product to

507   improve both parameters.

508   The information provided herein can be used as a basis for the meat processing

509   industry to develop new strategies to encourage Spanish consumers to increase the

510   consumption of these types of products.

511

512   **Conflict of interests**

513

514   There is no conflict of interests.

515

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Code: 382. Chicken and turkey

Code: 716. Beef and pork

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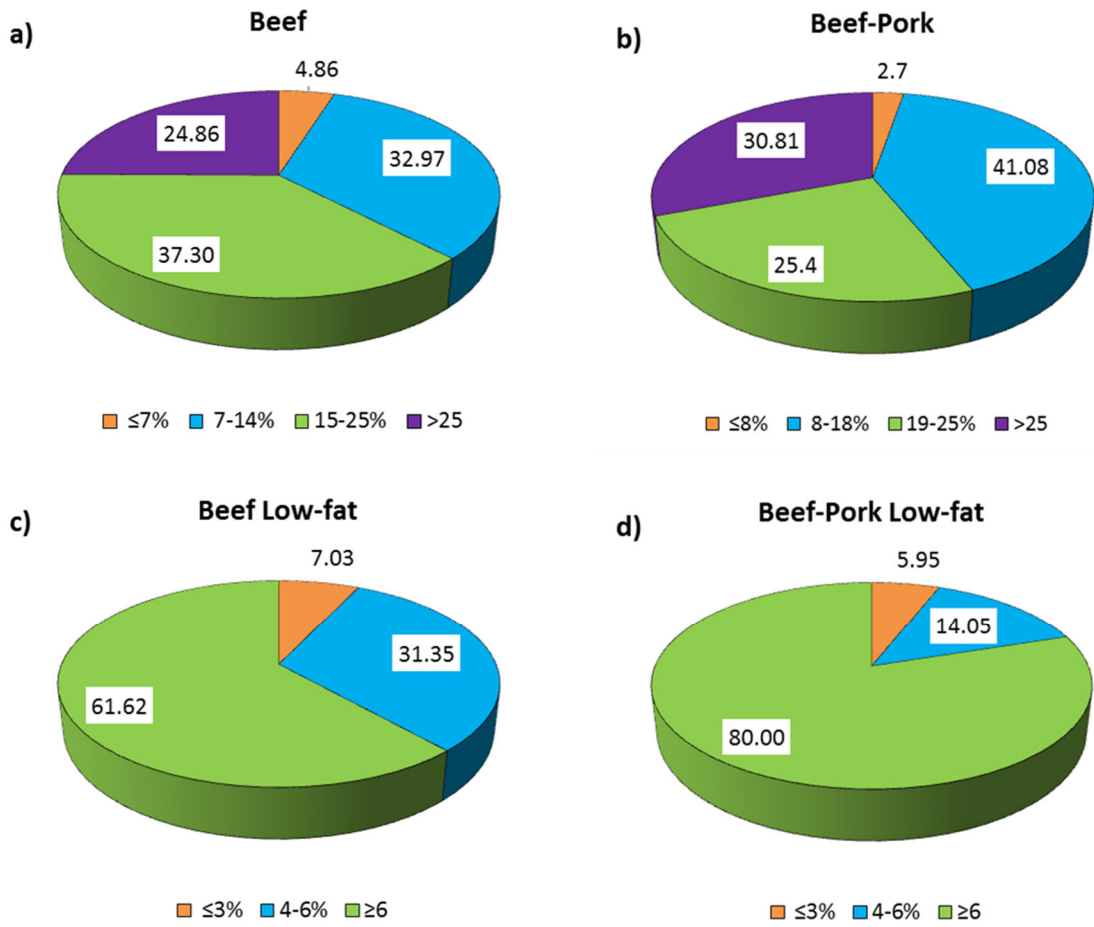632 **Fig. 1.** Example of two images used in the study of word association.

633

Fig. 2. Percentage of participants who gave a response within the different ranges of fat

for **a)** minced beef meat (<7%, 7-14%, 15-25%, 25% of fat); **b)** minced beef-pork meat

(<8%, 8-18%, 19-25%, 25% of fat); **c)** minced beef meat low-fat (≤3%, 4-6%, >6%); **d)**

minced beef-pork meat low-fat (≤3%, 4-6%, >6%).
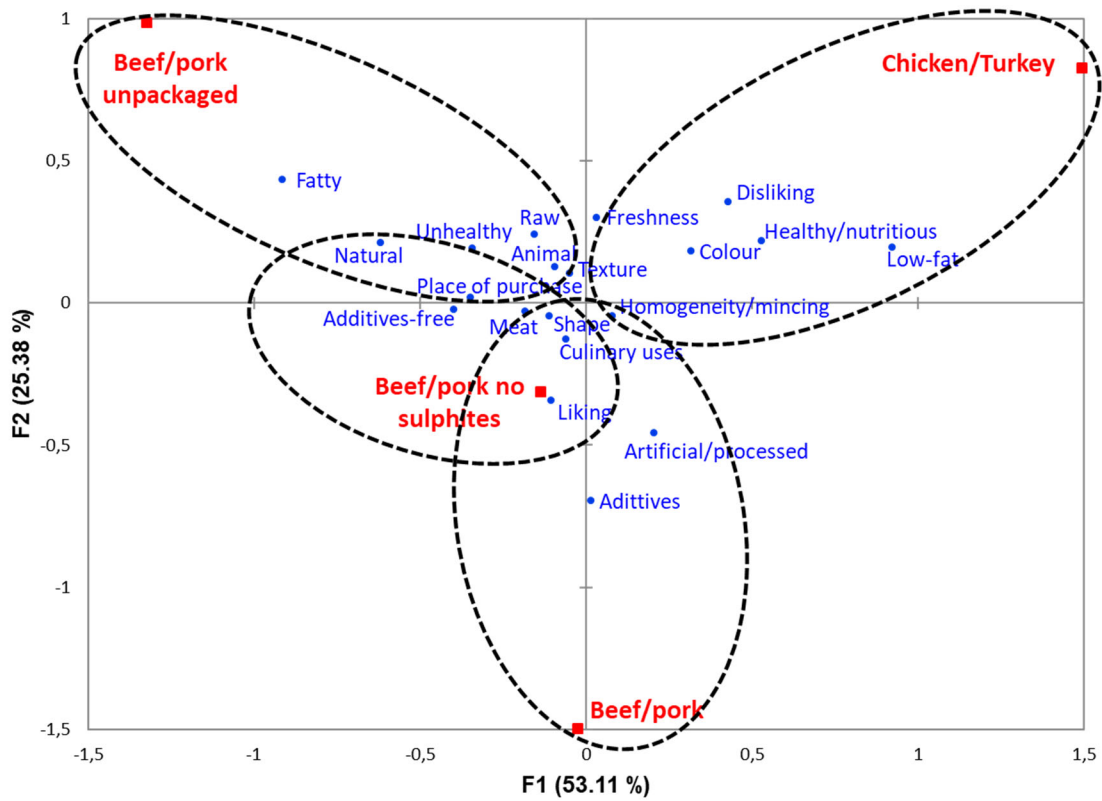
Fig. 3. Correspondence analysis bidimensional map of the categories associated with the different meat products in the word association task. Square symbols represent the stimulus (images of: beef-pork on trays; beef-pork unpackaged; sulphite-free beef and pork on trays; chicken-turkey on trays). Round symbols represent the different categories.

649 **Table 1**

650 Characterisation of the burger meat used to prepare meatballs.

	Target fat content		
	10 g fat/100 g	12 g fat/100 g	14 g fat/100 g
Fat (g/100 g)	10.52	12.25	14.53
Protein (g/100 g)s	17.83	17.32	16.94
Moisture (g/100 g)	68.62	67.72	66.13
Collagen (g/100 g)	1.50	1.90	2.16

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654 **Table 2**

655 Gender, age and consumption frequency of the participants in the survey on the

656 percentage of fat in minced meat.

		n	%
Total participants		185	100
Gender	Female	78	42.2
	Male	107	57.8
Age	18-29	104	56.2
	30-49	31	16.8
	50-65	36	19.5
	>65	14	7.6
Frequency of consumption	Several times/week	24	13.0
	Several times/month	88	47.6
	Once/month	36	19.5
	Rarely	37	20.0

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659   **Table 3**

660   Mean, standard deviation and median values of the scores given by participants in the

661   survey of the health and nutrition attitudes questionnaire (n = 73).

	Mean	Standard deviation	Median
Diet is important for my health	7.9	1.4	8
Consuming food with a high salt content could increase the risk of some diseases	7.7	1.8	8
Consuming food with a high fat content could increase the risk of some diseases	7.8	1.6	8
I try to follow a healthy balanced diet	7.2	1.7	7
I try to consume low-calorie food	5.5	2.0	5
I try to consume low-fat food	5.8	1.9	6
I try to consume additive-free food	5.1	2.3	5
The nutritional value and health that I consider a food has strongly influences my purchase option	6.4	2.1	7

662
663

664 **Table 4**

665 Average scores and standard deviation values given by the participants in the survey of

666 the health and nutrition attitudes questionnaire of the three clusters (Cluster 1 n = 34;

667 Cluster 2 n = 17; Cluster 3 n = 22).

	Cluster 1	Cluster 2	Cluster 3	
Diet is important for my health	8.2(0.8)[b]	8.9(0.3)[b]	6.6(1.8)[a]	***
Consuming food with a high salt content could increase the risk of some diseases	7.4(1.6)[a]	8.9(0.2)[b]	7.0(2.3)[a]	**
Consuming food with a high fat content could increase the risk of some diseases	7.8(1.2)[a]	8.9(0.3)[b]	6.9(2.1)[a]	***
I try to follow a healthy balanced diet	7.6(1.1)[a]	8.6(0.7)[b]	5.5(1.6)[c]	***
I try to consume low-calorie food	5.6(1.6)[a]	7.2(1.6)[b]	4.0(1.9)[c]	***
I try to consume low-fat food	5.8(1.3)[a]	8.0(0.8)[b]	4.1(1.7)[c]	***
I try to consume additive-free food	5.1(2.1)[a]	7.0(1.3)[b]	3.6(2.2)[c]	***
The nutritional value and health that I consider a food strongly influences my purchase option	7.0(1.3)[a]	8.0(1.1)[a]	4.2(1.8)[b]	***

668 Different letters in the same row indicate significant differences in the scores among the different clusters
669 according to the Tukey test.
670 ** $p<0.01$; *** $p<0.001$
671
672
673

674 **Table 5**

675 Average scores and standard deviation given by participants in the survey of the health

676 and nutrition attitudes questionnaire of the three clusters.

		Cluster 1		Cluster 2		Cluster 3	
		n	%	n	%	n	%
Total		34	100	17	100	22	100
Gender							
	Female	21	61.8	12	70.6	12	54.5
	Male	13	38.2	5	29.4	10	45.5
Age							
	18-29	19	55.9	7	41.2	14	63.6
	30-49	13	38.2	4	23.5	6	27.3
	50-65	2	5.9	4	23.5	1	4.5
	>65	0	0	2	11.8	1	4.5
Frequency of consumption							
	Several times/week	5	14.7	3	17.6	4	18.2
	Several times/month	15	44.1	9	52.9	10	45.5
	Once/month	7	20.6	2	11.8	5	22.7
	Rarely	4	11.8	2	11.8	3	13.6
	Never	3	8.8	1	5.9	0	0
Level of education							
	No studies	0	0	1	5.9	1	4.5
	Primary school	1	2.9	0	0	0	0
	High school	4	11.8	4	23.5	6	27.3
	University degree	29	85.3	12	70.6	15	68.2
Frequency of purchasing food							
	Always	14	41.2	9	52.9	10	45.5
	Very often	12	35.3	3	17.6	5	22.7
	Sometimes	3	8.8	2	11.8	2	9.1
	Rarely	3	8.8	2	11.8	5	22.7
	Never	2	5.9	1	5.9	0	0
Place of purchase							
	Butcher's	7	20.6	6	35.3	2	9.1
	Supermarket	24	70.6	10	58.8	20	90.9
	Other	3	8.8	1	5.9	0	0

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Table 6

Categories, examples of terms and number of mentions in each category, for the four

stimuli considered in the word association task.

Category	Example of the most relevant terms	Beef-pork on trays	Beef-pork sulphite-free on trays	Beef-pork unpackaged	Chicken-turkey on trays
Culinary uses	Spaghetti, macaroni, burgers, ...	51	34	40	33
Colour	Pink, pale, pale red, ...	22	25	23	48
Shape	Brain, worms, wool skein, ...	26	39	29	21
Homogeneity	Homogeneous, mixture, compact, ...	20	18	16	20
Texture	Soft, sticky, viscous, ...	10	8	13	11
Place of purchase	Butcher's, supermarket, brand of supermarket, ...	6	6	9	3
Artificial/processed	Artificial, packaged, industrial, ...	27	21	4	15
Natural	Natural, normal, less artificial, ...	3	18	18	1
Fatty	Fatty, greasy, ...	6	2	23	1
Low-fat	Lean, light, low-fat, ...	4	4	0	14
Healthy/nutritious	Healthy, nutritious, proteins, ...	6	13	5	22
Unhealthy	Unsafe, unhealthy, distrust, ...	5	4	10	4
Freshness	Fresh, freshly minced, ...	2	2	4	4
Additives	Additives, sulphites, ...	4	0	1	1
Additive-free	Preservative-free, contains nothing strange, ...	0	7	2	0
Animal	Pork, beef, farm, ...	6	3	8	6
Liking	Good appearance, good, quality, delicious, ...	30	17	16	11
Disliking	Tasteless, bad aspect, unappetising, ...	5	7	8	19
Meat/minced meat	Meat, minced meat, normal meat, ...	12	12	14	8
Raw	Raw	1	3	3	2