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Comparison of Acceptance and Preference Between Rabbit Burgers and Other Lean Meat Burgers by Young Consumers

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ABSTRACT
Burgers are proposed as an ideal way to increase rabbit meat consumption among young people in a context where it is declining in several countries, mainly due to less familiarity with and appetite for rabbit meat and greater demand for easy-to-cook preparations. This study compared the acceptance and preference of commercial rabbit burgers with those of pork, chicken and turkey using an untrained panel of 45 young Spanish consumers (23.5 years; 55.6% male). A first trial evaluated on cooked burgers: a) acceptance of organoleptic characteristics and overall assessment, using a 9-point hedonic scale and b) order of preference of burgers (1st to 4th position). For this purpose, the panellists were presented with a dish with 2 × 5 cm blind-coded samples of each of the four burgers, randomly placed and to be tasted and evaluated from left to right. Overall acceptance and sensory attribute ratings differed between cooked burgers, except for texture (6.9 points for rabbit burger). Odour was rated better in the cooked rabbit (6.8 points) and turkey burgers, worst in the pork burger, and intermediate in the chicken burger. The colour, appearance, juiciness and overall acceptance of the cooked rabbit (6.5, 6.8, 6.9 and 7.1 points, respectively), pork and turkey burgers were rated better than the chicken burger. The flavour of the cooked rabbit (7.2 points) and turkey burgers was better accepted than that of pork and chicken burgers. The elasticity of the cooked rabbit (6.6 points) and pork burgers was rated better than that of the chicken, while that of the turkey burger was intermediate. The cooked turkey burger was preferred first, followed by the rabbit (second position; average order 2.27) and pork burgers, while the chicken burger was ranked last. A second trial evaluated on raw burgers: a) acceptance of colour and visual appearance and b) order of preference for burgers. For this purpose, the panellists were presented with a dish containing a 3 × 3 cm blind-coded raw sample of each of the four burgers, arranged in random order, to be visually evaluated in a clockwise direction. The colour of the raw turkey burger was rated best, the chicken burger was rated worst, and the rabbit and pork burgers were rated in between. Visual evaluation of appearance scored best for raw turkey, rabbit and pork burgers and worst for chicken burger. The visual appearance of the raw turkey burger was ranked first, followed by the rabbit and pork burgers, while the raw chicken burger was ranked last. In both trials, the gender of the consumer had no effect, and there was no interaction with the type of cooked burger. In conclusion, rabbit burgers were rated at the same level as pork and turkey burgers and better than chicken burgers, showing the potential to increase rabbit meat consumption among young people, which would benefit from promotion using this presentation format targeted at this specific audience.

Keywords: Rabbit, Pork, Chicken, Turkey, Meat, Processed products, Consumer behaviour, Burgers

1. Introduction

Rabbit meat consumption, a traditional part of the Mediterranean diet and in other areas of the world, has experienced a significant decrease in Spain and other European countries in recent decades (Petracci et al. 2018; Ministerio de Agricultura, Pesca y Alimentación 2021). Among other causes, several factors have contributed to this decline in consumption, such as changes in lifestyle and food consumption habits that lead to less time spent for cooking traditional and home-made dishes (Montero 2015), changes in work habits and in the family size and structure (Ministerio de Agricultura, Pesca y Alimentación 2006), as well as a lower preference for the organoleptic characteristics and a progressive loss of contact with rabbit meat among some consumers, especially young people and children (González-Redondo et al. 2010; Montero 2015; Escribá-Pérez et al. 2019). Thus, rabbit meat consumption has been mainly concentrated among traditional older consumers (Escriba-Perez et al. 2017). This is in line with the current general food trends, characterised by increased demand for ready-to-eat and ready-to-cook food products with convenience features, as well as for healthier meats in terms of their nutritional value (Siddiqui et al. 2023). In this regard, rabbit meat has excellent nutritional properties, characterised by its low fat and cholesterol content, which makes it suitable for a sustainable human diet (Hernández & Gondret 2006).

Faced with this situation, for almost three decades in Spain, part of the processing industry's proposals to attract consumers to rabbit meat has consisted of market presentations alternatives to the whole carcass, such as cuts (half or quartered carcasses, thighs, loins, loin medallions, etc.) and processed products such as sausages and burgers (ASESCU 1996; De Santos 2019).

These formats and presentations simplify cooking, and some of them, such as sausages and burgers, are more attractive to younger consumers because they are familiar with their consumption when they are made with meat from other animal species that are more frequently consumed (Escribá-Perez et al. 2019). In Spain and other European countries, several companies market rabbit burgers (Fernández 2019; Priorelli 2019).

Some research has been published around the world on the effects of various ingredients, processing techniques, packaging and storage treatments on aspects such as shelf life, oxidative status, physicochemical properties, and microbiological quality of raw or cooked rabbit burgers (Tavares et al. 2007; Cossu et al. 2012; Dal Bosco et al. 2019; Mancini et al. 2015; Mancini et al. 2016; Mancini et al. 2017a; García-Vázquez et al. 2020; Mancini et al. 2020a; Mancini et al. 2020b; Silva et al. 2022; Śmiecińska et al. 2022), including their sensory evaluation (Tavares et al. 2007; Cossu et al. 2012; Mancini et al. 2017b; Mancini et al. 2020b; Silva et al. 2022; Śmiecińska et al. 2022). However, little research has been done on the acceptance and preference of commercial rabbit burgers by young consumers compared to burgers made with other meats that are more commonly available on the market.

In this context, this study aimed to evaluate the acceptance and preference of commercially available rabbit burgers, both raw and cooked, by a panel of young consumers by comparing them with burgers made with other lean meats such as pork, chicken and turkey. The main hypothesis is that young consumers, a segment of the population that is less inclined to consume rabbit meat, will accept commercial burgers made with rabbit meat well, to the same extent as those made with other more commonly consumed meats, because this presentation format, which also better meets the demand of this consumer segment for ready-to-cook food products, eliminates, masks or neutralises some of the characteristics and attributes that prevent them from consuming this meat, such as the bone content or the taste, which they are not familiar with.

2. Material and Methods

2.1. Consumer panel

In May 2021, a panel of 45 untrained young consumers was recruited from undergraduate, master's and doctoral students of the Higher Technical School of Agricultural Engineering at the University of Seville (Spain). The panellists were recruited through advertisements on the school's bulletin boards and social networks and participated voluntarily and with informed consent.

On average, the panellists were 23.5±0.38 years old (mean ± standard error), varying between 20 and 30 years with a mode of 23 years. Of the young consumers, 55.6% (*n*= 25) were men, and 44.4% (*n*= 20) were women.

2.2. Burgers

Commercial rabbit, pork, chicken and turkey burgers, purchased in hypermarkets in Seville, were evaluated. The burgers were packaged in a modified atmosphere in transparent pet-tray packages. The nutritional values and ingredients of the burgers are shown in Table 1. The burgers were kept refrigerated at 3 ºC until they were used in the sensory evaluation panel.

Table 1 - Nutritional facts (per 100 g of edible portion) and ingredients of the commercial burgers evaluated (information from the manufacturers labelling)

	Burger			
	Rabbit	***Pork***	***Chicken***	***Turkey***
Nutritional value				
Calories (kJ/kcal)	570/136	823/198	428/102	350/92
Fat (g)	6.0	14.9	3.4	1.5
Saturated fat (g)	2.6	5.7	1.1	0.5
Carbohydrates (g)	6.0	1.5	<1.0	0.9
Sugars (g)	0.5	<0.5	<0.5	0.0
Protein (g)	14.4	14.5	16.8	18.9
Salt (g)	1.85	2.74	2.15	1.33
Ingredients	Rabbit meat (75%), water, salt, natural spices, starch, vegetal fibres, pea protein, dextrose, preservative (sodium sulphite), antioxidant (ascorbic acid) and colour (carminic acid)	Pork meat (78%), water, rice flour, salt, emulsifier (monoglycerides and diglycerides of fatty acids), natural fermentation extracts, antioxidant (sodium ascorbate), spice extracts, potato starch and vegetal fibre, onion, white pepper, spices and vegetable extracts	Chicken meat (85%), water, rice flour, salt, emulsifier (monoglycerides and diglycerides of fatty acids), natural fermentation extracts, antioxidant (sodium ascorbate), spice extracts, potato starch and vegetal fibre, onion, white pepper, spices and vegetable extracts	Turkey meat (90%), water, antioxidants (sodium lactate, sodium ascorbate), salt, starch, natural aroma, spices, vegetable extract, garlic and parsley

2.3. Preparation and sensory evaluation of cooked burgers

The burgers were cooked on electric griddles (Jata® model GR2017, Tudela, Spain) using a little extra virgin olive oil to prevent sticking. The burgers were then served hot to the panellists 1 minute after cooking.

The colour differences between the burgers were measured by determining the physical coordinates of colour L* (lightness), a* (redness) and b* (yellowness) (Table 2) (CIE 1976) using a Minolta CM-700d (Konica Minolta® Co., Japan) spectrophotometer with illuminant D65 and a standard observer of 10°. For each burger sample, three determinations were made at different points approximately 1 minute after cooking.

Table 2 - Trichromatic coordinates characterising the colour of cooked rabbit, pork, chicken, and turkey burgers (n= 3; mean±standard error)

Trichromatic coordinates	*Burger*				*p-value*
	Rabbit	*Pork*	*Chicken*	*Turkey*	
L*	56.5 ± 0.76b	47.2 ± 3.01a	67.1 ± 1.41c	50.9 ± 2.89a	<0.001
a*	6.2 ± 0.45a	10.9 ± 1.19b	8.6 ± 0.80a	9.6 ± 1.53b	0.035
b*	12.7 ± 0.74a	18.7 ± 0.69c	17.9 ± 1.10b	21.2 ± 1.06c	<0.001

a–c: Means of the same trichromatic coordinate accompanied by different letters are different between cooked burgers (P<0.05)

The tasting sessions were carried out following standard methodologies for sensory evaluation with untrained consumers (Pagliarini 2002). The panellists were informed that they had to evaluate the burgers made of the four lean meats mentioned above, but the identification of the samples was blinded. The young consumers were provided with paper napkins, single-use cutlery sets, water and breadsticks. They were presented with a dish containing a 2 × 5 cm sample of each of the four burgers, blind-coded with three-digit random numbers, with the samples placed in random order for each panellist (Figure 1). They were instructed to taste and evaluate the burgers from left to right, and to eat breadsticks and drink water between each burger.

Figure 1 - Presentation of the cooked burger samples for tasting and evaluation by the panellists. From left to right: cooked chicken, pork, rabbit, and turkey burger samples

The panellists were first asked to rate the degree of acceptance of the organoleptic attributes (odour, colour, appearance, texture, flavour, juiciness and elasticity) and the overall acceptance for each type of burger using a 9-point hedonic scale (1= dislike extremely, 2= dislike very much, 3= dislike moderately, 4= dislike slightly, 5= neither like nor dislike, 6= like slightly, 7= like moderately, 8= like very much, 9= like extremely).

Secondly, using the same samples as for the previous evaluation, the young consumers were asked to rank them in order of preference, using a ranking scale of 1, 2, 3 and 4 for first, second, third and fourth preference, respectively.

The young consumers were also asked to indicate whether they could identify the type of meat used to make each burger.

2.4. Preparation and visual evaluation of raw burgers

Following the tasting and evaluation of the cooked burgers, in the same session, the panellists were asked to evaluate the visual appearance of the raw burgers in order to assess their attractiveness in a potential purchase decision. The raw burger samples were obtained from the same purchase lot as the cooked burger samples.

To this end, the young consumers were presented with a dish containing one 3 × 3 cm raw sample each of rabbit, pork, chicken and turkey burgers, blind-coded with a random letter and with the samples placed in random order for each panellist (Figure 2). The panellists were instructed to rate and evaluate the raw burgers in a clockwise direction.

For each raw burger sample, the panellists were first asked to rate their degree of acceptance of the visual appearance and colour of the burgers, using a 9-point hedonic scale (previously described).

Secondly, and on the same samples used for the previous evaluation, the young consumers were asked to rank them in order of preference by using the ranking scale of 1 to 4 for the preference in first to fourth position, respectively.

The colour differences between the raw burgers (Table 3) were evaluated using the same procedure and equipment as for the cooked burgers. For each raw burger sample, three determinations were made at different points approximately 1 minute after removing them from their packaging.

Table 3 - Trichromatic coordinates characterising the colour of raw rabbit, pork, chicken, and turkey burgers (n= 3; mean±standard error)

Trichromatic coordinates	*Burger*				*p-value*
	Rabbit	*Pork*	*Chicken*	*Turkey*	
L*	54.3 ± 1.59b	58.4 ± 1.24b	59.2 ± 1.90c	46.7 ± 1.51a	<0.001
a*	8.3 ± 0.39a	12.7 ± 0.56b	10.2 ± 0.97a	8.7 ± 0.89a	0.002
b*	11.0 ± 0.65a	15.0 ± 1.05b	9.6 ± 1.04a	10.2 ± 1.18a	0.005

a–c: Means of the same trichromatic coordinate accompanied by different letters are different between raw burgers (P<0.05)

2.5. Statistical analyses

For both cooked and raw burgers, differences in physical coordinates of colour between burgers were analysed by means of a one-way analysis of variance with burger type as a factor, followed by post-hoc Duncan's test to separate means.

Two generalised linear model (GLM) analyses were performed, with burger type and consumer gender as the factors, and the interaction between both factors was also assessed. The first was performed on the panellists' evaluation of the sensory attributes (odour, colour, appearance, texture, flavour, juiciness and elasticity) and overall acceptance of the cooked burgers, and the second was performed on the visual assessment of the colour and appearance of the raw burgers. Both GLM analyses were followed by the least significant difference post-hoc multiple comparison tests to identify differences in the ratings of sensory attributes and overall acceptance of the cooked burgers, as well as differences in the colour and appearance scores after visual assessment of the raw burgers. Two Friedman tests were carried out to analyse the preference ranking of the burgers; the first was performed on the cooked burgers and the second on the raw burgers. Both ranking analyses were followed by Nemenyi post-hoc multiple comparison tests to identify differences in burger rankings. Differences in the frequency of young consumers who correctly identified the type of meat in each cooked burger were analysed using contingency tables on which Pearson's χ^2 tests were performed.

For all comparisons, statistical significance was accepted at P<0.05. Quantitative results are presented as the mean and standard error. All statistical analyses were performed using the SPSS 15.0 statistical package (SPSS Inc. 2006).

3. Results and Discussion

To the best of our knowledge, this is the first study to investigate the acceptance and preference of rabbit meat burgers by a young consumer panel compared to burgers made with other lean meats. Indeed, there are previous works that have carried out sensory evaluations of rabbit meat burgers with trained assessors or consumer panels but without comparing them with burgers made with other types of meats and focusing on the effects of several ingredients (Mancini et al. 2017b; Mancini et al. 2020b; Silva et al. 2022; Śmiecińska et al. 2022), packaging or storage conditions (Cossu et al. 2012; Śmiecińska et al. 2022), or processing (Tavares et al. 2007) on aspects such as shelf life, oxidative status, physicochemical properties, and microbiological quality of raw or cooked rabbit burgers. Furthermore, this study was carried out using commercial burgers, while the literature reports investigations using burgers prepared *ad hoc* for the experiments. This means that practical implications for improving the marketing of processed rabbit meat products can be more easily derived from the present study than from most studies reported in the literature, which were carried out with experimental burgers instead of commercial ones. Another relevant aspect is that this study was conducted with young adult consumers, some of whom are emancipated and, as a whole, have the ability to buy and make purchase decisions for food products.

Table 4 shows the effects of burger type and consumer gender, as well as their interaction, on the assessment by young consumers of the sensory attributes of cooked rabbit, pork, chicken and turkey burgers. The burger type influenced (P<0.05) the assessment by young consumers of all sensory attributes and the overall assessment of the cooked burgers, except for texture

(P>0.05). The gender of the consumers did not influence this sensory assessment (P>0.05), nor was there any interaction between consumer gender and burger type (P>0.05). Table 5 shows the comparison of the acceptance of the sensory attributes, as well as the overall acceptance of the cooked pork, chicken and turkey burgers, evaluated by the young consumers.

In general terms, all the sensory attributes evaluated and the overall acceptance of the cooked burgers made with the four lean meats received medium-high average scores from the young consumers, varying between 5.6 and 7.4 out of 9 points. Odour was rated higher for the cooked turkey and rabbit burgers and lower for the pork burger, with the chicken burger being intermediate in acceptance between the rabbit and pork burgers. Colour, appearance and juiciness were equally accepted in the cooked rabbit, pork and turkey burgers, and worst valued in the chicken ones. The flavour of the cooked rabbit and turkey burgers was rated at a similar level and was better accepted than that of the pork and chicken burgers. The elasticity of the cooked rabbit and pork burgers was rated best at the same level, while it was rated worst in the chicken and at an intermediate level in the turkey. Texture showed a marginal tendency (P<0.1) to be better accepted for the cooked rabbit burger and the worst for the chicken burger, with turkey and pork burgers rated intermediate. Overall acceptance was similar for the cooked rabbit, pork, and turkey burgers and worst for the chicken burger.

Table 4 - Effects (p-value) of the factors Burger and Consumer gender on the assessment of odour, colour, appearance, texture, flavour, juiciness, elasticity, and overall assessment of cooked rabbit, pork, chicken, and turkey burgers (n= 45)

Factor	*Odour*	*Colour*	*Appearance*	*Texture*	*Flavour*	*Juiciness*	*Elasticity*	*Overall assessment*
Burger	0.035	<0.001	0.001	0.057	0.003	0.002	0.010	0.001
Consumer Gender	0.588	0.119	0.255	0.140	0.460	0.633	0.476	0.859
Burger × Consumer Gender	0.695	0.248	0.356	0.081	0.394	0.437	0.667	0.111

Table 5 - Comparison of acceptance (*) of sensory attributes of cooked rabbit, pork, chicken and turkey burgers by young consumers (n= 45; mean±standard error)

Sensory attribute	*Burger*			
	Rabbit	*Pork*	*Chicken*	*Turkey*
Odour	6.84 ± 0.22a,b	6.27 ± 0.21c	6.33 ± 0.19b,c	6.91 ± 0.18a
Colour	6.53 ± 0.20a	6.64 ± 0.20a	5.56 ± 0.22b	7.00 ± 0.20a
Appearance	6.82 ± 0.20a	6.78 ± 0.19a	5.91 ± 0.24b	7.02 ± 0.18a
Texture	6.87 ± 0.22	6.62 ± 0.22	6.04 ± 0.23	6.69 ± 0.22
Flavour	7.24 ± 0.17a	6.60 ± 0.28b	6.44 ± 0.21b	7.36 ± 0.17a
Juiciness	6.87 ± 0.23a	6.98 ± 0.24a	5.73 ± 0.28b	6.56 ± 0.24a
Elasticity	6.60 ± 0.23a	6.93 ± 0.22a	5.82 ± 0.23b	6.38 ± 0.23a,b
Overall assessment	7.07 ± 0.16a	6.82 ± 0.26a	6.13 ± 0.19b	7.16 ± 0.17a

*: Nine-point hedonic scale; 1 = dislike extremely, 2 = dislike very much, 3 = dislike moderately, 4 = dislike slightly, 5 = neither like nor dislike, 6 = like slightly, 7 = like moderately , 8 = like very much, 9 = like extremely. a–c: Means of the same attribute accompanied by different letters are different between cooked burgers (P<0.05)

The acceptance test based on an assessment of sensory attributes, in which the young consumers in this study participated, revealed that the cooked rabbit burger was rated favourably and, overall, at the same level as turkey and pork burgers and better than chicken burger. On the one hand, the young consumers gave high average scores, which varied between 6.53 and 7.24 out of 9 points, to all the sensory attributes and to the overall acceptance of the cooked rabbit burger (Table 5). On the other hand, the cooked rabbit burger was rated by the young consumers as follows: i) it was rated at the same level as the turkey burger (the highest scoring burger) for all sensory attributes and for overall acceptance; ii) it surpassed the pork burger in odour acceptance; iii) it was rated better than pork and chicken burgers in flavour acceptance; and iv) it surpassed the chicken burger in the acceptance of colour, appearance, juiciness and elasticity, as well as overall assessment (Table 5). With respect to colour assessment, Figure 1 shows that the cooked rabbit burger looked similar to the turkey and pork burgers and that the chicken burger had a paler colour. In fact, the trichromatic coordinates (Table 2) showed that the lightness (L*) of the cooked rabbit burger was intermediate between that of the chicken burger (which was the palest; Figure 1), on the one hand, and that of the turkey and pork burgers on the other. The redness (a*) of the cooked rabbit and chicken burgers was lower than that of the turkey and pork burgers, and the yellowness (b*) was lowest in the rabbit burger compared to the other cooked burgers. The different acceptance of the colour of the burgers by the young consumers was therefore due to the different colour of the meat used in them. In fact, colour is considered the most important attribute of meat quality perceived by consumers (Tomasevic et al. 2021). Indeed, even though they are all white or lean meats, there are differences in the colour of rabbit, pork, chicken and turkey meat (Tapp et al. 2011). Rabbit meat is considered one of the meats with the highest values of lightness and a relatively low saturation colour, and it resembles poultry meats, although its colour is deeper and brighter (Maj et al. 2012).

The fact that the young panellists did not indicate differences in texture between the cooked burgers prepared with the of the four different types of meat (Table 5) may be because the meat and the other ingredients are minced and mixed to give the burgers their typical shape and consistency (Tavares et al. 2007; Mancini et al. 2020a), thus acquiring a similar homogeneous texture. This fact can be considered favourable for the acceptance of rabbit meat by young consumers in this presentation format,

as it is known that the differences in texture between different meats influence consumers' acceptance of processed products (Lee et al. 2018). In fact, sensory evaluations reported in the literature have shown that the texture of frankfurters made from rabbit meat is similar to that of beef and superior to that of chicken meat (Whiting & Jenkins 1981). The texture of rabbit meat may therefore benefit from this presentation format.

Table 6 shows the ranking of overall preferences, based on organoleptic characteristics, expressed by consumers for cooked rabbit, pork, chicken, and turkey burgers, by consumer gender and together. The ranking test revealed that young consumers, considering both genders together, preferred the cooked turkey burger the first place, followed by the rabbit and pork burgers (with no difference between them), while the chicken burger was ranked last. When considering the gender of the consumer, men did not show significant differences between the cooked rabbit, turkey and pork burgers, while they ranked significantly lower for the chicken burger. Women, however, ranked the turkey burger first, with an average rank significantly higher than the chicken and pork burgers. Women ranked the cooked rabbit burger with no significant difference from the turkey and pork burgers.

Table 6 - Friedman test for ranking (*) of overall preference of cooked rabbit, pork, chicken, and turkey burgers by young consumers (mean range)

Gender	***Burger***				***p-value***
	Rabbit	***Pork***	***Chicken***	***Turkey***	
All panellists(*n*= 45)	2.27b (2^{nd})	2.29b (3^{rd})	3.27a (4^{th})	2.18b (1^{st})	<0.001
Men (*n*= 25)	2.36b	1.96b	3.32a	2.36b	0.002
Women (*n*= 20)	2.15bc	2.70ab	3.20a	1.95c	0.009

Ranking scale of 1, 2, 3, and 4 for preference in first, second, third, and fourth position, respectively. The ranking of the cooked burgers is indicated in parentheses. a–c: Values accompanied by different letters are different between cooked burgers (P<0.05)

The Friedman ranking test (Table 6) confirmed the panellists' preference for the cooked rabbit burger in second place after the turkey burger and also that the preference scores for the cooked turkey, rabbit and pork burgers were similar between them (P< 0.05) and significantly better than the chicken burger, ranked in last place. This reinforces the favourable acceptance of rabbit meat by young consumers under this presentation format.

Table 7 shows the frequency of young consumers who correctly identified the type of meat in the cooked burgers. The proportion of panellists who correctly identified the meat used to make the cooked burgers was low, showing no differences between burger types (P>0.05). Therefore, the presentation in the form of a burger also hinders young consumers' ability to identify the type of meat in each burger. Indeed, only between 13.3% and 28.9% of the panellists were able to correctly identify the type of meat in each cooked burger, with no difference between burger types (Table 7). This fact, which is partly due to the mincing of the meat and its mixture with spices and other ingredients during preparation (Tavares et al. 2007; Mancini et al. 2020a), may also favour the consumption of rabbit meat in this presentation format in the case of consumers who do not like the flavour and other organoleptic characteristics of rabbit meat under conventional presentations or cooked as traditional dishes. This circumstance that has already been reported, especially among young people (González-Redondo et al. 2010) and children (Escribá-Pérez et al. 2019).

Table 7 - Contingency table of young consumers that identified correctly the animal species of meat ingredient of cooked rabbit, pork, chicken, and turkey burgers (n= 45)

Meat ingredient identification	***Burger***				***p-value***
	Rabbit	***Pork***	***Chicken***	***Turkey***	
Correct identification, *n* (%)	10 (22.2)	12 (26.7)	13 (28.9)	6 (13.3)	0.304

Table 8 shows the effects of the factors of burger type and consumer gender, as well as their interaction, on young consumers' visual assessments of the colour and appearance of raw rabbit, pork, chicken and turkey burgers. Burger type influenced (P< 0.05) young consumers' visual assessment of the colour and appearance of the raw burgers. The gender of the consumer did not influence this visual assessment (P>0.05), nor was there any interaction between the gender of the consumer gender and burger type (P>0.05). Table 9 shows the comparison of the visual assessment of the colour and appearance of the raw rabbit, pork, chicken and turkey burgers evaluated by young consumers.

Table 8 - Effects (p-value) of the factors Burger and Consumer gender on the visual assessment of colour and appearance of raw rabbit, pork, chicken, and turkey burgers (n= 45)

Factor	***Colour***	***Appearance***
Burger	<0.001	<0.001
Consumer Gender	0.570	0.942
Burger × Consumer Gender	0.725	0.282

Table 9 - Comparison of visual evaluation of colour and appearance (*) of raw rabbit, pork, chicken and turkey burgers by young consumers (n= 45; mean±standard error)

Visual characteristic	*Burger*			
	Rabbit	*Pork*	*Chicken*	*Turkey*
Colour	7.00 ± 0,20b	6.89 ± 0.22b	4.80 ± 0.25c	7.64 ± 0.17a
Appearance	7.20 ± 0.17a	6.78 ± 0.21a	5.00 ± 0.23b	7.29 ± 0.20a

* Nine-point hedonic scale: 1 = dislike extremely, 2 = dislike very much, 3 = dislike moderately, 4 = dislike slightly, 5 = neither like nor dislike, 6 = like slightly, 7 = like moderately , 8 = like very much, 9 = like extremely. a–c: Means of the same visual characteristic accompanied by different letters are different between raw burgers (P<0.05)

In the young consumers' visual assessment, the colour and appearance of the raw burgers made from the four lean meats received medium to high average scores, ranging from 4.8 to 7.6 out of 9 points. The young consumers rated the colour of the raw turkey burger as the best and the chicken burger as the worst, with the rabbit and pork burgers scoring in the middle. Young consumers' visual evaluation of appearance scored best for the raw turkey, rabbit and pork burgers and worst for the chicken burger.

In this second part of this trial, the acceptance and preference of young consumers for the visual appearance of raw burgers, as these can be seen through the transparent packaging at the time of purchase, were evaluated. It was decided to carry out this evaluation based on the premise that the visual appearance of the raw burger may influence the purchase decision and subsequent consumption of the product. In fact, it is well known that the consumer's purchase decision depends on the appearance and colour quality of rabbit meat on meat shelves (Sanah et al. 2020). In this regard, the acceptance test based on the visual assessment of colour and appearance by the young consumers revealed differences between the raw burgers (Table 8) and a favourable evaluation of the rabbit burger (Table 9). Thus, the visual assessment of the appearance was rated higher for the raw turkey, rabbit and pork burgers (average scores ranging from 7.29 to 6.78 out of 9 points), while it was perceived as significantly worse (P<0.05) for the chicken burger (scoring only 5 points on average).

The panellists' visual assessment of colour also showed differences between the raw burgers (P<0.05), with the rabbit and pork burgers scoring well (7 out of 9 points) and being considered intermediate between the best-rated turkey burger, and the worst-rated chicken burger. This result is consistent with the differences in colour between the raw burgers that can be seen in Figure 2, where the colour of the raw rabbit and pork burgers seems similar, and the colour of the turkey and chicken burgers appears very different. In fact, the trichromatic coordinates (Table 3) were characterised by the fact that the lightness (L*) of the raw rabbit and pork burgers was intermediate between that of the chicken burger (which was the palest; Figure 2), on the one hand, and that of the turkey burger, which was the darkest, on the other hand. The redness (a*) and yellowness (b*) of the pork burger were higher than those of the other three raw burgers, which did not display differences among them for these two trichromatic coordinates. As previously discussed for the cooked burgers, the different acceptance of the colour of the raw burgers by the young consumers was due to the differences in the colour of the meat used as the main ingredient.

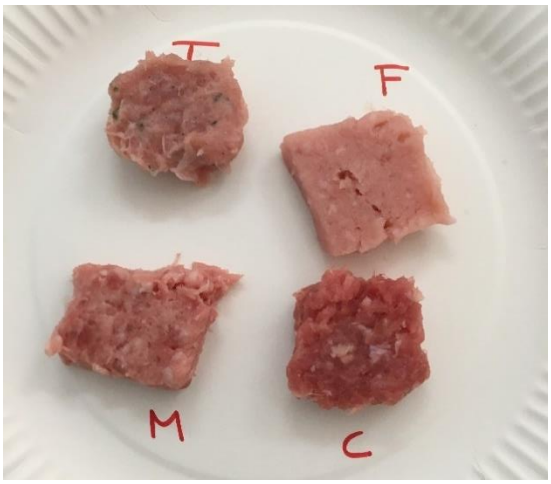

Figure 2 - Presentation of the raw burger samples for visual evaluation by the panellists. Raw chicken (F), pork (M), rabbit (T), and turkey (C) burger samples

Table 10 shows the ranking of overall preferences, based on visual appearance, expressed by consumers for raw rabbit, pork, chicken and turkey burgers, by consumer gender and together. The ranking test showed that young consumers, considering both genders together, preferred the visual appearance of the raw turkey burger first, followed by the raw rabbit and pork burgers (with no difference between them), while the raw chicken burger was ranked last. In general terms, this ranking pattern was maintained when analysing the gender of the panellists separately, with the only differences being that, on the one hand, men

ranked the raw pork burger as intermediate and no different from the raw turkey and rabbit burgers and, on the other hand, women ranked the raw rabbit burger as intermediate and no different from the raw turkey and pork burgers.

Table 10 - Friedman test for ranking (*) of overall preference of visual appearance of raw rabbit, pork, chicken, and turkey burgers by young consumers (mean range)

Gender	*Burger*				*p-value*
	Rabbit	*Pork*	*Chicken*	*Turkey*	
All panellists (*n*= 45)	2.29b (2^{nd})	2.29b (3^{rd})	3.69a (4^{th})	1.73c (1^{st})	<0.001
Men (*n*= 25)	2.44b	2.08bc	3.76a	1.72c	<0.001
Women (*n*= 20)	2.10bc	2.55b	3.60a	1.75c	<0.001

*: Ranking scale of 1, 2, 3, and 4 for preference in first, second, third, and fourth position, respectively. The ranking of the raw burgers is indicated in parentheses.a–c: Values accompanied by different letters are different between raw burgers (P<0.05)

The Friedman ranking test (Table 10) confirmed the preference of the young consumers for the raw rabbit burger in second place after the turkey burger and also that the preference scores of the raw rabbit and pork burgers were similar among them (P>0.05) and significantly higher than the chicken burger, which ranked in the last position. These findings confirm the favourable acceptance of rabbit meat by young consumers in this presentation format. This fact may favour the decision to purchase rabbit burgers when young consumers see them on the shelves of points of sale, as their raw appearance is well accepted compared to other types of meat burgers that are more common in the market.

Both in the sensory evaluation of the cooked burgers and in the visual evaluation of the raw burgers, the gender of the young consumers did not affect their acceptance and preference for rabbit meat burgers when compared to pork, chicken and turkey burgers. This is an interesting finding, because it is generally well known that women (Santos & Booth 1996; Kubberød et al. 2002a; Kubberød et al. 2002b; Kiefer et al. 2005), especially the youngest ones (Santos & Booth 1996; Kubberød et al. 2002a; Kubberød et al. 2002b), are less likely to eat meat than men, as has also been reported specifically for rabbit meat in several countries (Hui & McLean-Meyinsse 1996; McLean-Meyinsse 2000; González-Redondo et al. 2010). This phenomenon, which is more pronounced for red meat, is due to the fact that women tend to associate meat with unpleasant concepts, such as dead animals or blood, more frequently than men (Santos & Booth 1996). The presentation of rabbit meat in the form of a burger helps to avoid these associations and therefore makes it easier for women to make purchase and consumption decisions for rabbit meat, at least to the same extent as for burgers made with other types of meat.

The burger-shaped preparation and presentation also has some advantages over other commercial presentations of rabbit meat, which may contribute to its good acceptance, as confirmed in this trial. Among the main advantages, it is worth highlighting the absence of bones or the standardisation of flavour, thus eliminating or masking some characteristics of other presentations of this meat for which some young people and children under the age of 18 years claim not to consume (bone content, flavour, etc.; González-Redondo et al. 2010; Escribá-Pérez et al. 2019). Indeed, the production of rabbit burgers requires deboning (Petracci & Cavani 2013), and, on the other hand, the characteristic flavour of rabbit meat is modified by mixing it with other ingredients (Tavares et al. 2007), among which spices, salt, starch and vegetable fibres and extracts stand out (Table 1). The good performance of rabbit meat in the production of burgers was shown in a study on the inclusion of oat bran in rabbit burgers, which has reported even greater acceptability of the flavour, texture and overall quality of burgers with higher levels of rabbit meat and lower levels of oat bran (Silva et al. 2022).

The results of the present study, derived from the sensory evaluation of cooked burgers and of the visual assessment of raw burgers, show that this presentation format, in which the rabbit meat is deboned, minced, mixed with other ingredients and homogenised to achieve the typical shape, consistency and appearance of this product (Tavares et al. 2007; Petracci & Cavani 2013), makes it as attractive to young consumers as burgers from other more widespread white or lean meats with which they are familiar. The good evaluation and acceptance of rabbit burgers in this study are in line with what has been found in previous studies (Tavares et al. 2007; Mancini et al. 2017a; Silva et al. 2022). Furthermore, rabbit meat has excellent nutritional quality; it is healthy because it is lean and rich in protein with a high biological value, a low cholesterol content and a good lipid profile, as well as high phosphorus and low sodium content, among other nutritional properties favourable for the human diet (Hernández & Gondret 2006). Policy makers can use such characteristics of rabbit meat to propose it as a desirable, healthy diet component to be achieved at a population level for the general population or specific groups (EFSA Panel on Dietetic Products, Nutrition, and Allergies 2010) and also to propose using it to replace other types of meats high in nutrients of public health concern, such as saturated fat and sodium, in processed products such as burgers (Cocking et al. 2020).

One of the potential limitations of this study is that comparing commercially available burgers may have the drawback that rabbit, pork, turkey and chicken burgers differ in several factors, from the meat content to other ingredients such as the type and amount of seasoning, which may influence the choice. In this regard, it would be interesting for further research to compare the acceptance and preference of burgers made from rabbit meat with those made from other types of meat, using the same percentage of meat and other ingredients. Regardless, the meat content of the four commercial burgers evaluated in this study was high and relatively similar (range 75–90%; Table 1), so the type of meat in each burger essentially determined its evaluation.

At least in Spain, the marketing rabbit meat in processed formats alternative to the whole carcass, such as burgers, has been advocated for almost three decades (ASESCU 1996) as a way to increase the consumption of this meat among non-traditional consumer segments, young consumers, children and small family nuclei (Trocino & Xiccato 2000; Escribá-Pérez et al. 2019; Fernández 2019). In fact, several rabbit meat producers include rabbit burgers in their product portfolios. However, their presence at points of sale is sometimes irregular and often scarce because the distribution chains do not keep them on the shelves of hypermarkets and supermarkets due to their low turnover (Fernández 2019). Moreover, their price is higher than that of burgers made with other meats, in part due to the complexity of the deboning process, which is not automated as in the case of other types of meat (Petracci & Cavani 2013). These factors contribute to hindering the spread of their consumption, which could be increased with adequate promotion to make them known through promotional campaigns specifically aimed at young audiences (Fernández 2019). In fact, when segmenting Spanish consumers according to cooking styles at home, it has been proposed that rabbit burgers could fit well into the group of easy cooking styles, which includes the "ready to eat", “easy cooking” and “unconcerned” segments comprising a third of consumers (Montero et al. 2015), among which many young people are included.

4. Conclusions

Young consumers rated the colour, appearance, juiciness and elasticity of the cooked rabbit burger better than the chicken burger, its odour better than the pork burger, and its flavour better than the pork and chicken burgers. Overall, both in its raw and cooked form, rabbit burger is accepted at the same level as pork and turkey burgers and better than chicken burger, being the second most preferred burger by young consumers after visual assessment and sensory evaluation, with no difference between genders. These results reveal the potential of the burger presentation format to increase rabbit meat consumption among young people, which would benefit from promotion targeted at this specific audience.

Data availability: Data are available on request due to privacy or other restrictions.

Authorship Contributions: Concept: P.G.-R., Methodology: P.G.-R., E.L.-R., Investigation: P.G.-R., E.L.-R., Resources: P.G.-R., E.L.-R., Data curation: P.G.-R., E.L.-R., Writing: P.G.-R., E.L.-R. All authors have read and agreed to the published version of the manuscript.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

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