

CONSUMER PERCEPTION OF SUPPLEMENTING RABBIT DIETS WITH SEAWEED TO REDUCE ANTIBIOTIC USE IN RABBIT PRODUCTION IN SPAIN

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Abstract: Rabbit meat consumption has gradually decreased in Spain and rabbit production systems face some challenges related to high mortalities caused by gastrointestinal diseases, which are difficult to control owing to limitations on antibiotic use. The inclusion of seaweeds in the rabbit diet as prebiotics can potentially reduce the need to use antibiotics, as already observed in other types of livestock. The aim of this survey was to study the rabbit meat and seaweed consumption habits of the population of a municipality in Galicia (NW Spain) and the willingness of the population to choose seaweed-fed rabbit meat over other rabbit meat, to determine whether this new product would be accepted by consumers. Rabbit meat consumption, despite being minoritarian, is more frequent in the surveyed population compared to other regions in Spain, and great importance is attached to home-produced rabbit meat. Most respondents have a positive image of rabbit meat and highlighted its nutritional value. The acceptability of seaweed-fed rabbit meat was high, as two thirds of the respondents stated that they would choose this product over other types of rabbit meat. Most respondents agreed about the environmental benefits of this feeding strategy, highlighting the reduction in antibiotic use and the higher quality of the product as benefits. Nevertheless, this strategy should be properly communicated, to guarantee its success in attracting environmentally concerned consumers.

Key Words: rabbit meat, seaweed, antibiotics, consumer perception, willingness to consume.

INTRODUCTION

Rabbit meat is a minor but very valuable and highly appreciated product in Mediterranean countries such as Spain, Italy and France, due to its characteristic taste and its nutritional properties (high quality protein, low cholesterol and sodium, and valuable content of B group vitamins) (Cullere and Dalle Zotte, 2018). Nonetheless, rabbit production is facing a critical period caused by a large increase in mortality on farms, mainly due to the limitation on the prophylactic use of antibiotics, which makes control of some gastrointestinal diseases difficult (Solans *et al.*, 2019). Moreover, rabbit meat consumption in Mediterranean countries has gradually decreased in recent years (Cullere and Dalle Zotte, 2018). In Spain, total consumption has dropped by 51.4% in the last 10 yr (2012-2022), and the per capita consumption in Spain is currently only 0.74 kg/year (MAPA, 2023). The main reasons for the decline in consumption are the limited availability of processed products adapted to modern types of consumption, the perception of rabbits

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as pets, the lack of tradition of consumption and the intense taste of the meat, which some consumers do not like (Buitrago-Vera *et al.*, 2016; Cullere and Dalle Zotte, 2018). The rabbit farming sector therefore needs support and new marketing strategies to ensure its long-term future.

Dietary supplementation with marine macroalgae or seaweed has been well studied in some livestock species (Costa *et al.*, 2021; Morais *et al.*, 2020), especially in porcine, with very positive results on both gut health and meat quality. In rabbits, literature is scarce, although some studies have observed some benefits on gut health, both *in vitro* (Al-Soufi *et al.*, 2022, 2023) and *in vivo* (Abu Hafsa *et al.*, 2021), due to the potential prebiotic activity of some of the polysaccharides that seaweeds contain. Seaweed is a suitable ingredient for complete animal feed, as production is very sustainable and does not require fresh water or arable land, and in addition, seaweed acts as a carbon sink (Costa *et al.*, 2021). Seaweed production reaches very high levels in some regions of Spain, e.g. Galicia (NW Spain) (García Tasende and Peteiro, 2015). Seaweed-producing companies sustainably harvest or cultivate seaweed for human consumption in these regions, generating tonnes of discards that could potentially be revalorised if used for animal feed, in a circular-economy approach (Al-Soufi *et al.*, 2022).

The inclusion of seaweed in rabbit feed has also proven to have some benefits on rabbit meat quality (Rossi *et al.*, 2020) without any negative impact on the sensory properties of the meat (unpublished results). Therefore, consumer acceptability regarding the objective characteristics of this product should be positive, and this feeding strategy could also be used as a marketing tool to attract consumers and increase rabbit meat consumption. However, as far as we know, no previous studies have addressed consumer perception and acceptability of seaweed-fed rabbit meat or the willingness of consumers to choose this type of product. Consumers are generally concerned about animal welfare and sustainable livestock production systems and also demand functional food with adequate nutritional properties (Gunnarsson and Thulin, 2023), and they are therefore expected to accept these types of products. Nevertheless, consumption of rabbit meat is more dependent on some societal factors than consumption of other types of meat, which is in fact one of the main causes for the decrease in consumption (Petracci *et al.*, 2018). This makes it difficult to predict consumer response to different strategies.

Galicia is a suitable place to address this question, as the region is a top producer of marine macroalgae and is also one of the main rabbit meat producing regions in Spain (3rd position). Although the Atlantic diet is widely consumed in Galicia—with pork and beef being the main types of meat consumed—rabbits have traditionally been raised by smallholders as a complementary source of meat and manure (Botana and Novas, 2023). Although rabbit farming has gradually been industrialised and professionalised, rearing rabbits for home consumption is still very important in Galicia (MAPA, 2020; Botana and Novas, 2023). This sociohistorical feature, together with the food traditions in the area, must be considered in order to understand consumption habits and the willingness of individuals to consume new products (Fernández, 2008; Petracci *et al.*, 2018).

This study was conducted within a broader research project investigating the use of seaweed products in rabbit feed within intensive production systems, in order to improve rabbit gut health and reduce antibiotic use in rabbit production. The specific objective of the present study was to determine the willingness of consumers to buy seaweed-fed rabbit meat. In addition, rabbit meat and seaweed consumption habits were studied in relation to consumer perception of this novel product. The main interest was to determine whether the feeding strategy could be used as a marketing tool to increase rabbit meat consumption.

MATERIAL AND METHODS

Interview design

This study adopted a quantitative method. Data were collected using a semi-structured questionnaire specifically designed for the study (Table 1). The questionnaire was divided into the following sections: 1) sociodemographic characteristics of respondents; 2) general consumption habits; 3) rabbit meat consumption habits; 4) seaweed consumption habits; and 5) willingness to buy seaweed-fed rabbit meat.

Table 1: Questions included in the survey.

Sections	Questions	Type of Question
Socio-demographic characteristics of respondents	-Do you live in Lugo?	-Close-Yes/No
	-What gender do you identify with?	-Close-Variou options
	-What age range are you in?	-Close-Variou options
	-Who do you live with?	-Close-Variou options
	-Indicate your educational level	-Close-Variou options
General consumption habits	-Indicate your annual income range	-Close-Variou options
	-Choose the type of establishment where you usually shop (most frequent)	-Close-Variou options
	-Choose the type of establishment where you usually shop (second most frequent)	-Close-Variou options
	-What are the factors that most influence you when purchasing a product?	-Close-Variou options (can choose 3)
	-How would you describe your diet?	-Close-Variou options
Rabbit meat consumption habits	-How often do you consume meat?	-Close-Variou options
	-How often do you consume rabbit meat?	-Close-Variou options
	-Where do you usually buy rabbit meat?	-Close-Variou options
	-What positive properties can you highlight about rabbit meat?	-Close-Variou options (multiple choice)
	-What negative properties can you highlight about rabbit meat?	-Close-Variou options (multiple choice)
Seaweed consumption habits	-How often do you consume seaweed?	-Close-Variou options
	-If you have never tried seaweed, would you be willing to try it?	-Close-Yes/No
	-Where do you usually consume seaweed?	-Close-Variou options
	-What positive properties do you highlight about seaweed?	-Close-Variou options (multiple choice)
	-What negative properties do you highlight about seaweed?	-Close-Variou options (multiple choice)
Willingness to buy rabbit meat fed with seaweed	-Read the following statement: rabbits were fattened with feed containing seaweed with the aim of reducing the need to use antibiotics in its production. Taking this factor into account, would you choose this meat over other rabbit meat products with similar characteristics but that were not fed this way?	-Close-Yes/No/No influence
	-Why not?	-Open (just for "No" answer in the previous question)
	-Would knowing that these rabbits received this diet make you consume more rabbit meat?	-Close-Yes/No/Don't know
	-Why not?	-Open (just for "No" answer in the previous question)
	-From your point of view, what benefits would there be to fattening rabbits with feed containing seaweed?	-Open
	-Indicate how closely you agree with the following statements: "The inclusion of seaweed in rabbit diets would...":	-Close-Agree/Don't know what to say/Disagree
	"...improve the meat quality".	
	"...provide environmental benefits".	
	"...improve their health".	

Research location and sample selection

The study was carried out in the municipality of Lugo (NW Spain), which is a medium-sized town of 97 211 inhabitants. It is a territory organised around an urban area —the city of Lugo— surrounded by small rural settlements, and it also borders other rural municipalities. The questionnaire was administered to inhabitants over 18 yr old, selected by non-probabilistic quota sampling based on gender and age in order to achieve a distribution representative of the population (Table 2). The sample size was calculated by applying an expected error of 5% and a confidence level of 95%, assuming that $p=q=0.5$. This yielded a sample size of $n=383$.

Table 2: Sampling by quota based on gender and age.

Age (yr)	Gender		Total
	Women	Men	
18-30	29	24	53 (13.7%)
31-64	123	102	226 (58.9%)
65 or more	57	48	105 (27.4%)
Total	209 (54.6%)	174 (45.4%)	383

Data collection

In total, 383 people completed the questionnaire, which was administered using two methods: a) computer-assisted web interviewing (CAWI) and b) face-to-face interviews. Initially, the methodology was designed to administer the questionnaire only online. However, the difficulty in obtaining responses from inhabitants over 65 yr old (owing to the digital divide) led us to carry out face-to-face interviews. The questionnaires were administered between March and June 2023.

Statistical analysis

Different analyses were performed. On the one hand, we employed univariate analysis to describe the data using basic statistics and frequency distributions. On the other, based on the frequencies of consumption of rabbit meat and seaweed

Table 3: Sociodemographic characteristics of respondents.

	N
Gender	
Woman	209
Man	174
Gender-diverse	0
Age (years)	
18-30	53
31-64	226
>65	105
Monthly income (Euros)	
Up to 999	24
1000 to 1499	73
1500 to 1999	60
2000 to 2500	80
2500 to 2999	39
3000 or more	100
NA	7
With whom do you live	
Family	205
Alone	54
Friends	14
Partner	108
Others	2
Educational level	
No studies	8
Primary Studies	33
Compulsory Secondary Education	59
Vocational training	74
University degree	209

of respondents, we identified three different types of consumers, creating two new variables: “profile of rabbit meat consumer” and “profile of seaweed consumer”. Both were elaborated with the following categories: a) non-consumer (never consumed either); b) sporadic consumer (consumed them “sporadically” or “several times a year”); and c) regular consumer (consumed them “at least once a week”, “once every two weeks” or “at least once a month”). To investigate the dependency relationships of these two new variables with others, we performed cross-tabulation with Chi-squared test, used to evaluate hypotheses about the relationship of two categorical variables (Hernández Sampieri *et al.*, 2014). The level of statistical significance was set at $P < 0.05$. This test was also performed to investigate the dependency relationship between the willingness of respondents to consume seaweed-fed rabbit meat with other variables. Data were analysed using Jamovi (version 2.3.21.0).

RESULTS AND DISCUSSION

Sociodemographic characteristics and general consumption habits

The sociodemographic characteristics of the respondents (Table 3) were homogeneous regarding gender and age due to the sampling quotas, and income level and educational level were representative of all sectors of the population.

Most of the respondents had similar consumption habits (Table 4), as they mainly shopped in supermarkets, specialist shops or local markets. Regarding the factors

that most influenced the consumers, a wide range of answers were given, but most people appeared to be concerned about the product quality, its origin and its freshness, and although price was also an important factor, it was not considered as important as quality. The frequent consumption of local, seasonal, fresh and low processed products is considered a characteristic feature of the traditional Galician diet, i.e. the so-called Atlantic diet (Trabazo *et al.*, 2019).

The Atlantic diet is also characterised by moderate meat consumption —especially pork and beef— among other products (Trabazo *et al.*, 2019). Most people surveyed consumed meat two or three times a week, while a substantial proportion consumed meat every or almost every day. Low meat consumption was quite frequent, as almost one quarter of respondents consumed meat only once a week or less.

Profile of rabbit meat consumers

Based on the frequency of rabbit meat consumption, the main types of consumers were sporadic consumers (41.3%), followed closely by regular consumers (38.6%). Non-consumers of rabbit meat accounted for 18.0% and vegetarians represented 2.1% of respondents.

Regarding the sociodemographic characteristics of rabbit meat consumers (Figure 1), no significant differences were observed in relation to gender or income level. However, rabbit meat consumption differed significantly depending on the age of the respondents ($P < 0.001$). In this respect, consumption of rabbit meat was significantly higher in people older than 65 yr, while both young (18-30) and middle-aged respondents (31-64 yr old) were predominantly sporadic consumers. Non-consumers of rabbit meat were more frequent in the middle-aged group than in the young group, although vegetarians were predominantly young people. Regular consumers were more common in people between 31-64 yr than in the younger participants. As expected, people who consumed more meat in general also consumed more rabbit meat ($P < 0.001$).

Regarding the most frequent place of purchase of rabbit meat (Figure 1), both sporadic and regular consumers had different preferences ($P < 0.001$), which help to explain the different types of consumption. Supermarkets were the most common place of purchase in both groups.

Table 4: General consumption habits of respondents

	%
Type of establishment where you usually shop (most frequent)	
Supermarket/hypermarket	83.8
Specialised shops	12.3
Local market	1.6
Organic grocery	1.6
Local grocery shop	0.5
No answer	0.3
Type of establishment were you usually shop (2 nd most frequent)	
Supermarket/hypermarket	24.8
Specialised shops	39.4
Local market	12.0
Organic grocery	5.7
Local grocery shop	5.2
I always buy at the same type of establishment	12.3
Self-supply	0.3
No answer	0.3
Factors that most influence you when purchasing a product? ¹	
Quality	32.0
Price	20.7
Local production	18.2
Fresh product	17.7
Sustainable production	5.52
Establishment	2.48
Brand	1.80
Others	1.58
How would you describe your diet? ¹	
I try to eat everything in a balanced way	57.4
I look for food with a low cholesterol content	8.4
I look for food with a healthy fatty acid profile	11.7
High in protein	6.5
Low content of salt	9.3
Vegetarian diet	1.8
I include prebiotics and probiotics in my diet	2.1
Others	2.8
How often do you consume meat?	
Every/almost every day	17.5
Two or three times a week	58.7
Once a week	18.8
Once or twice a month	2.9
Less than once a month	0.3
Never	1.8

¹ multiple responses.

Variable	N	% Non consumers	% Sporadic	% Regular	% Vegetarian	p
N	383	69	158	148	8	
Gender						NS
Woman	209	19.6	37.3	40.7	2.4	
Man	174	16.1	46.0	36.2	1.7	
Age (years)						**
18-30	53	15.1	58.5	18.9	7.5	
31-64	225	20.4	44.4	33.3	1.8	
>65	105	14.3	25.7	60.0	0.0	
Income level						NS
Up to 999	24	25.0	33.3	41.7	0.0	
1000 to 1499	73	17.8	38.4	42.5	1.4	
1500 to 1999	60	20.0	31.7	45.0	3.3	
2000 to 2499	80	21.3	43.8	31.3	3.8	
2500 to 2999	39	10.3	48.7	38.5	2.6	
3000 or more	100	15.0	49.0	35.0	1.0	
NA	7	28.6	0.0	71.4	0.0	
Frequency of meat consumption						**
Every/almost every day	67	6.0	52.2	41.8	0.0	
2-3 times a week	225	19.1	40.4	40.4	0.0	
Once a week	72	22.2	40.3	37.5	0.0	
Once or twice a month	11	54.5	27.3	18.2	0.0	
Never or <1/month	8	25.0	0.0	0.0	75.0	
Place of purchase of rabbit meat¹						**
Supermarket	117		47.9	52.1		
Home-reared	104		51.9	48.1		
Butcher shop	40		40.0	60.0		
Does not buy it	21		95.2	4.8		
Local market	15		60.0	40.0		
Others	9		50.0	50.0		

Figure 1: Profile of rabbit meat consumers considering different sociodemographic and consumption habits. ¹Only rabbit meat consumers.

Nevertheless, one third of rabbit meat consumers did not buy rabbit meat but raised rabbits themselves (or their relatives did). This type of purchase was almost equal in all age groups, and it was not directly linked to elderly people as might have been expected.

The frequency of rabbit meat consumption determined in the present study differed from that reported for the whole of Spain, as non-consumers and regular consumers were less frequent, while a higher proportion of the population consumed the meat sporadically. Escribá-Pérez *et al.* (2017) studied the consumption of different types of meat in Spain (whole territory) among the meat consuming population (age 25-75 yr) and observed that 34.6% of these people did not consume rabbit meat, whereas regular consumers accounted for about 50% of the population. Another study conducted in Spain (Buitrago-Vera *et al.*, 2016) reported similar proportions of rabbit meat consumption (38% of non-consumers, 49% regular consumers). Nevertheless, both studies included the whole territory of Spain, which is very diverse and therefore some differences in findings are expected. Lugo is a small municipality (approx. 100 000 inhabitants), like many others in Galicia and Spain (58% of the cities in Spain have less than 100 000 inhabitants, Montero-Vicente *et al.* (2018), which are still closely linked to rural areas and therefore to livestock production systems. This fact might affect the consumption habits and could explain the lower number of non-consumers of rabbit meat.

In other Mediterranean countries like Italy, where rabbit meat is part of the gastronomic tradition, consumption was similar to that in the whole of Spain, as around 30% of the population does not consume this meat, whereas 38% are regular consumers (Crovato *et al.*, 2022). Similar consumption rates to those obtained in the present study were reported in France (Gomant and Beddiar, 2018), as only 20% of the population did not consume rabbit meat. In other countries such as Romania (Petrescu and Petrescu-Mag, 2018) and Hungary (Bodnar and Horvath, 2008), consumption was low and mostly sporadic. In Spain and in most mentioned countries, consumption of rabbit meat was higher in middle-aged or elderly people than in younger people (Escribá-Pérez *et al.*, 2017; Szendrő *et al.*, 2020).

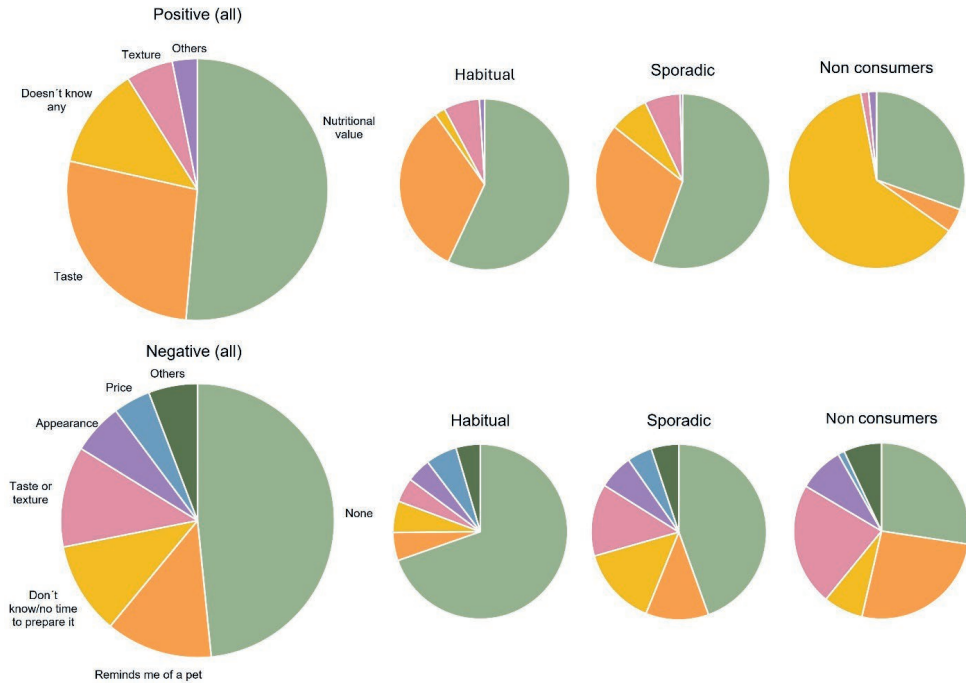


Figure 2: Positive and negative characteristics of rabbit meat highlighted by (all) respondents and by type of rabbit meat consumer.

The place of purchase of rabbit meat varies widely between countries and regions: supermarkets are preferred in countries like Italy (Crovato *et al.*, 2022) or Romania (Petrescu and Petrescu-Mag, 2018), whereas in Hungary most consumers buy the meat directly from the farmer or produce the meat themselves (Bodnar and Horvath, 2008). In Spain, most rabbit meat consumers buy rabbit meat in local butcher shops (46.6%) or in supermarkets (33.3%), while people who rear rabbits or buy the meat directly from farms account for only 4.8% (Buitrago-Vera *et al.*, 2016), although in some butcher shops the meat comes directly from producers or from the butchers themselves. In our study, the number of rabbit meat consumers whose families still breed rabbits themselves was remarkable, and therefore the availability of the meat is very important in relation to maintaining consumption. Family farming (smallholding) is very important in Galicia —the region of Spain with the largest area of family farming spaces (MAPA, 2022)— and generates an alternative economy and home consumption that may not be contemplated in the official indicators of this meat and probably others. This type of supply of some products like rabbit meat is likely to occur in other similar small municipalities in Galicia and in Spain, whose close contact with rural areas may encourage consumption of this type of meat.

The findings show the importance of informal food distribution networks produced by older relatives who live in the countryside and who provide food to their descendants living in the city (Botana and Novas, 2023), in relation to rabbit meat and also to vegetables. A high proportion of the population rely on the supply of rabbit meat from their family and habitually consume rabbit meat. There therefore appears to be an opportunity to attract these niche consumers to buy a high quality product that would enable them to maintain their rabbit meat consumption if they cease to have this family supply in the future.

Positive and negative characteristics of rabbit meat

When respondents were asked which positive and negative characteristics of rabbit meat they would highlight (Figure 2), most of them appeared to have a very positive image of this product. They especially highlighted its nutritional value (healthy fatty acids, good quality protein, antioxidants, low cholesterol content, etc.) and half of them did not highlight any negative property of rabbit meat.

The perception of rabbit meat differed significantly between types of consumers (Figure 2). Most habitual and sporadic consumers appreciated the nutritional value and taste of rabbit meat, while most non-consumers did not report any positive property of meat. The same applied to the negative properties of rabbit meat, as most habitual consumers did not highlight any, while some sporadic consumers thought of rabbits as pets, did not know how to prepare the meat or disliked its texture. Many non-consumers viewed rabbits as pets, although others did not highlight any negative properties or they disliked the intense taste of the meat.

These results are consistent with those of previous surveys conducted in Spain and other European countries, where rabbit meat is considered a healthy, "low fat" tasty meat (Buitrago-Vera *et al.*, 2016; Montero-Vicente *et al.*, 2018; Petrescu and Petrescu-Mag, 2018), although a lack of information about the nutritional properties of rabbit meat was also observed in previous studies (Szendrő *et al.*, 2020; Gunnarsson and Thulin, 2023). Promoting the nutritional value of the meat has been proposed by numerous authors in order to enhance consumption (Cullere and Dalle Zotte, 2018; Petracci *et al.*, 2018; Petracci and Cavani, 2013; Gunnarsson and Thulin, 2023), not only among health-conscious consumers and consumers who need to maintain a low-sodium or low cholesterol diet, but among meat consumers in general.

Although half of the respondents did not report any negative attributes of rabbit meat, the other half reported several disadvantages of this meat. A high proportion of people think of rabbits as companion animals and do not consider them as meat production animals, as previously observed in Spain (Buitrago-Vera *et al.*, 2016; Camps, 1996; González-Redondo and Rodríguez-Serrano, 2012) and in other countries (Gomant and Beddiar, 2018; Petracci *et al.*, 2018; Szendrő *et al.*, 2020; Crovato *et al.*, 2022; Gunnarsson and Thulin, 2023). It is unlikely that this group of people will ever consume rabbit meat, since it is no longer part of their usual diet. The taste is another barrier to the consumption of rabbit meat, as some people consider the intense taste a negative rather than a positive characteristic (Cullere and Dalle Zotte, 2018). These opposing views were previously observed in Spain (Buitrago-Vera *et al.*, 2016; Montero-Vicente *et al.*, 2018) and some thought may be required to develop preparations in which the flavour is hidden or less predominant, so that more people would eat rabbit meat. Other obstacles to rabbit meat consumption are the lack of know-how or the lack of time required to cook the meat and also the predominant presentation or appearance of this meat and the format in which it is sold. These issues were also observed in previous studies (Crovato *et al.*, 2022; González-Redondo and Rodríguez-Serrano, 2012; Szendrő *et al.*, 2020), as rabbit meat is commonly sold as a whole carcass, usually with the head (Cullere and Dalle Zotte, 2018). This type of presentation is related to the traditional preparation of rabbit meat and associated with social or family meals and long cooking times (Cullere and Dalle Zotte, 2018); it is contrary to the modern types of cooking, which look for quick and easy to cook preparations, adapted to everyday life (Szendrő *et al.*, 2020). The fact that the carcass is usually sold with the head is also a negative factor for many consumers (Petracci *et al.*, 2018). Some actions that can be taken in order to address these problems have already begun to be developed in Spain (Camps, 1996; González-Redondo and Rodríguez-Serrano, 2012) and other countries (Petracci *et al.*, 2018) in order to provide a wider variety of rabbit meat products that are better adapted to the current forms of consumption: smaller portions of the carcass that do not need long cooking times and other innovative products (Petracci *et al.*, 2018; Gunnarsson and Thulin, 2023).

In summary, the inhabitants of this municipality appear to have quite a positive image of rabbit meat, which may be related to the fact that a high portion of the population has close links with rural areas where rabbits are raised, or the rabbits are raised by their family or relatives (Botana and Novas, 2023). These findings appear to be consistent with the conclusions of Montero-Vicente *et al.* (2018), who observed that people living in cities in Spain with up to 100 000 inhabitants had a much more positive image of rabbit meat than people living in larger cities. These results may indicate that smaller cities and municipalities with close links to rural areas could be considered target regions for promotion of rabbit meat consumption.

Variable	N	% Non consumer	% Sporadic	% Regular	p
N	383	230	137	16	
Gender					NS
Woman	209	62.2	33.5	4.3	
Man	174	57.5	38.5	4.0	
Age (years)					**
18-30	53	52.8	43.4	3.8	
31-64	225	52.9	42.2	4.9	
>65	105	79.0	18.1	2.9	
Highlights positive properties of seaweed					**
No	167	88.0	12.0	0.0	
Yes	216	38.4	54.2	7.4	

Figure 3: Profile of seaweed consumers in relation to different variables.

Seaweed consumption

Respondents were classified into three groups in relation to seaweed consumption (Figure 3). Most respondents declared that they never consumed seaweed, while one third consumed it sporadically and very few people consumed it regularly. Differences in seaweed consumption were not related to the gender of the respondents, but some significant differences were observed regarding the age of the respondents ($P < 0.001$). Both the young and the middle-aged groups had similar patterns of seaweed consumption, while most of the respondents aged more than 65 yr were non-consumers.

When respondents were invited to select the positive and negative aspects that they would highlight about seaweed (Figure 4), some barriers to their consumption were observed. Regarding the positive aspects, many respondents did not know of any, which indicates the lack of information about these novel products among consumers. Meanwhile, almost half of the respondents highlighted the nutritional value of seaweed, including the high content of healthy fatty acids, minerals, dietary fibre and antioxidants, as well as its prebiotic effects, which indicates that those people who do consume seaweed are probably aware of the associated health benefits (Figure 3). Only a few respondents highlighted the taste, which may indicate that some people would consume seaweed because of the health benefits rather than because they particularly like the taste. Previous studies pointed that the healthy and nutritious characteristics were the most important reasons for consuming seaweed (Young *et al.*, 2022), and therefore that promotion of these attributes was the key to attracting new consumers (Losada-López *et al.*, 2021).

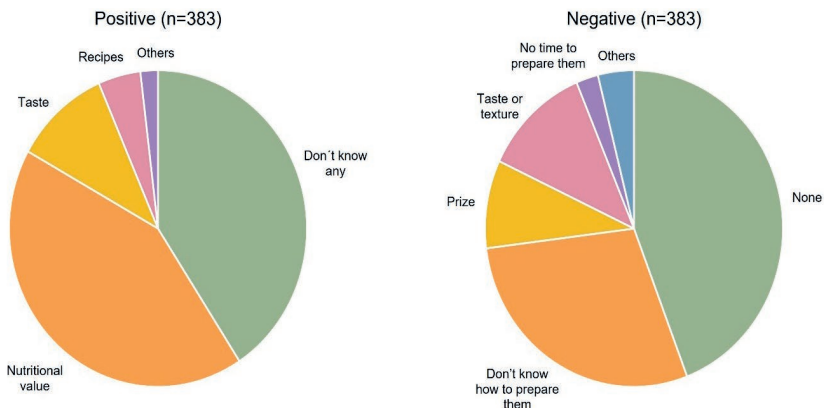


Figure 4: Positive and negative aspects respondents highlighted about seaweed.

The most remarkable negative aspect of seaweed was that the respondents did not know how to cook seaweed, indicating a lack of information among consumers who may be willing to consume this product but do not have enough information to do so; this also indicates that there are many potential consumers of seaweed. Among this group of people, it is likely that many of them only consume seaweed outside of their homes, in restaurants or other establishments (or ordered it at home).

Most respondents who had never consumed seaweed, across all age groups, were willing to try the product (68%). Therefore, the general perception of seaweed seemed to be positive, and the high level of willingness to try the product may be important in relation to the willingness of consumers to try other related products, such as seaweed-fed rabbit meat.

Willingness to consume seaweed-fed rabbit meat

Most of the respondents (66%) stated that they would be willing to buy seaweed-fed rabbit meat in preference to other similar rabbit meat products (Figure 5). This tendency was not influenced by age or gender ($P>0.05$), but some significant differences were observed regarding the type of consumer ($P<0.001$). Most respondents who would buy the product were sporadic rabbit meat consumers. Remarkably, almost half of non-consumers would choose this product, which is important since that could increase rabbit meat consumption. The place of purchase of rabbit meat did not seem to influence the decision of the respondents ($P>0.05$) (only considering rabbit meat consumers), which may indicate that people who rear rabbits would also buy this meat if they did not have this supply route.

When respondents were asked if they would increase their consumption of rabbit meat if they knew that rabbits were fed a diet containing seaweed, the answers were not clear (Figure 6). One third of habitual and sporadic consumers

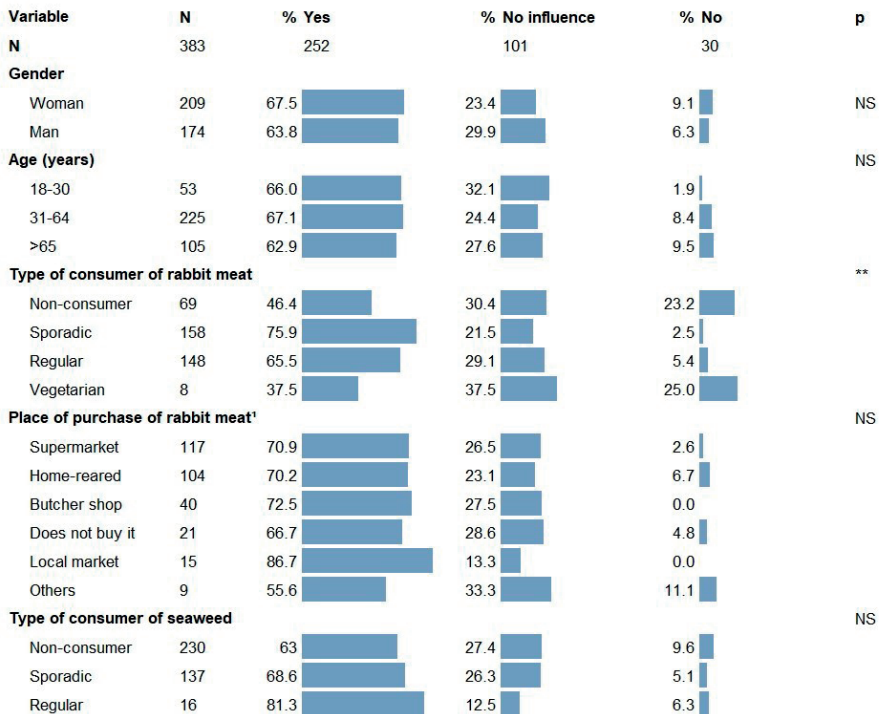


Figure 5: "If you knew that rabbits had been fed a diet that included seaweed, with the aim of reducing antibiotic use, would you choose this meat over other rabbit meat products?". ¹Only rabbit meat consumers (306 respondents)

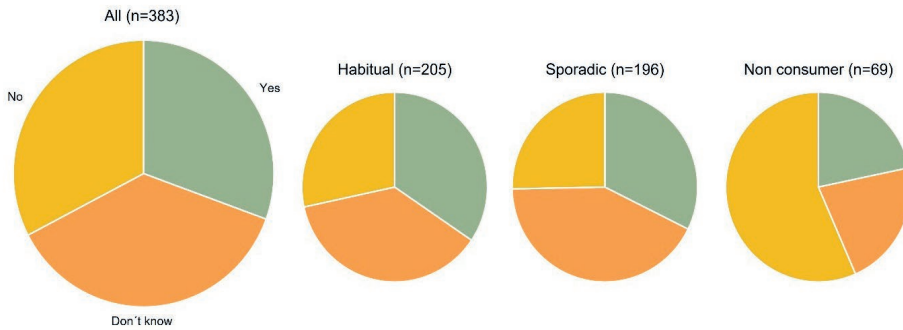


Figure 6: Response to the question: "If you knew that rabbits were fed a diet including seaweed, would you eat more rabbit meat?"

would eat more rabbit meat, while among non-consumers, more than half would not do so, and around a quarter of them would eat more seaweed-fed rabbit meat (Figure 6). These results indicate that rabbit meat consumption would increase slightly if rabbits were fed this diet and if the product were appropriately explained and marketed. In any case, consumers would have to taste this product before declaring that they would repeat or even increase their rabbit meat consumption.

In order to obtain more information about the willingness to choose this product over other rabbit meat products, respondents who declared that they would not choose it were asked for their reasons (Table 5). Many of them would not choose it since they do not consume rabbit meat frequently or because they do not eat meat. Some people considered that it was not an appropriate diet for rabbits, as they should be fed in a "natural" way, and others distrusted the beneficial effects of this feeding strategy or of industrial feed in general.

Respondents were also asked why they would not eat more seaweed-fed rabbit meat (Table 6). For one third of the respondents, the reason was just that they did not like rabbit meat or they do not consume it. Other people would not be influenced by this strategy or consider that they already eat enough rabbit meat. Other people preferred the "home-raised rabbit" or rabbit fed in a "traditional way", with a diet based on vegetables; and they dislike the meat sold in supermarkets (usually intensively reared).

Regarding feeding strategies, many respondents differentiated between two types of rabbit rearing and had a clear opinion about them. On the one hand, they related the rabbit meat sold in supermarkets to intensive breeding practices whereby rabbits received a diet based on industrial feed and with excessive use of antibiotics; they considered this low-quality meat with a poor taste. On the other, rabbit meat bought directly from farmers or raised at home or by their relatives was associated with "natural and traditional" breeding, where no industrial feeds or antibiotics were used and rabbits were fed only with vegetables of local origin. This second type of production would produce rabbit meat of very high quality and good organoleptic properties, and was therefore favoured by many people. This dichotomy has been observed in previous studies (Petracci *et al.*, 2018; Crovato *et al.*, 2022; Gunnarsson and Thulin, 2023), although there was also some contradiction, as consumers also believed that rabbit meat sold in supermarkets was safer than home-produced rabbit meat (Crovato *et al.*, 2022). This study, which was conducted in Italy, concluded that consumers were willing to pay more for rabbit meat that was produced without routine use of antibiotics (Crovato *et al.*, 2022), as in the present study. Other authors have also stated that these types of characteristics of rabbit meat are not visible to consumers, and it is therefore essential to include information regarding breeding and feeding strategies on the product label, which could influence the choice (Crovato *et al.*, 2022; Gunnarsson and Thulin, 2023). Nonetheless, most people will probably have to first taste this meat and personally check the benefits (or at least not disadvantages) regarding its quality, in order to favour it over other rabbit meat products.

Our results indicate that consumers are concerned about the feeding strategies and use of antibiotics in rabbit production. Previous studies have already found that these factors have a strong influence on consumers' purchasing choice regarding rabbit meat, both breeding without routine use of antibiotics (Gomant and Beddiar, 2018; Crovato *et al.*,

Table 5: Open question: “Why would you not choose to buy seaweed-fed rabbit meat?” (%).

Reasons for not choosing seaweed-fed rabbit meat	%
Do not eat rabbit meat	43.3
Not an appropriate diet for rabbits	20.0
Distrust of the beneficial effects of the diet	13.3
Distrust of rabbit meat due to diseases	6.67
Distrust of industrial feed	6.67
Do not like seaweed	3.33
NA	6.67

n=30.

Table 6: Responses to the open question: “Why would you not consume more rabbit meat if you knew the rabbits were fed seaweed?”

Reasons for not consuming more rabbit meat	%
Don't like it	20.0
Don't eat rabbit meat	12.8
Would not influence	12.8
Already eat enough	12.0
Only consume home-produced rabbit	8.0
Lack of habit	8.0
Consider that it is not an appropriate diet for rabbits	6.4
Not enough information	4.0
Rabbit considered a pet	4.0
Difficult to cook	2.4
Price	2.4
Don't know	3.2
Other reasons	4.0

n=125.

Table 7: Frequency of answers to the open question: “What benefits do you think there would be to including seaweed in rabbit diets?”

Benefits of including seaweed in rabbit diets	%
Don't know	21.9
Reduction in antibiotic use	16.7
Healthier meat	11.3
Higher meat quality	5.48
More sustainable	3.92
More natural	4.0
More nutritious meat	2.61
None	2.61
Use of local products	1.83
Seaweed valorisation	1.57
Not enough information	1.31
Mineral-enriched meat	1.04
NA	25.8

n=383.

2022) and feeding systems (Gomant and Beddiar, 2018; Petrescu and Petrescu-Mag, 2018; Szendrő *et al.*, 2020; Gunnarsson and Thulin, 2023). These studies also noted other factors that influence this choice, such as the local origin of the meat and cruelty-free rearing (Kallas and Gil, 2012; Petracci *et al.*, 2018; Szendrő *et al.*, 2020; Crovato *et al.*, 2022; Gunnarsson and Thulin, 2023).

Altogether these results indicate that the acceptance of these new type of products will be highly dependent on the sociocultural aspects of the population, which affect the decisions regarding food (Fernández, 2008). Therefore, for promotion of food, in this case of rabbit meat, to be successful, it should take all these of these factors into account and adapt to the target population.

Benefits of including seaweed in rabbit feed

In this survey, respondents were first asked —through an open question— what benefits they thought feeding rabbits with seaweed would have (Table 7). Although almost half of the respondents did not answer or did not know of any benefits, many people were aware of the benefits on the reduction of antibiotic use and pointed out that this strategy could be healthier for both rabbits and humans. Some people stated that the meat would be more nutritious and of higher quality. For some respondents, it would be an opportunity to revalorise seaweeds as a local ingredient, making rabbit meat production more sustainable.

After this open question, respondents were again asked about how strongly they agreed with some statements related to the benefits that the inclusion of seaweed in rabbit diets would have (Figure 7). Only a small proportion of the respondents disagreed with the statements, while most people agreed or were hesitant to do so. Among the possible benefits of this strategy, respondents mostly agreed about the environmental benefits, while the other benefits such as improvements in meat quality or rabbit health were not clear to many people. These findings are not surprising, as the environmental benefits are easier to see and to relate to the feeding strategy, as consumers are already informed about the circular economy, the local production of ingredients or the reduction of antibiotics. This can be extrapolated to any animal production system in which seaweed could be included, as the potential benefit to health is applicable to other livestock species and even for people, who would benefit from incorporating these ingredients in their own diet. As seaweed is a relatively new dietary ingredient in our culture, it requires an effort to transmit this information to all of society.

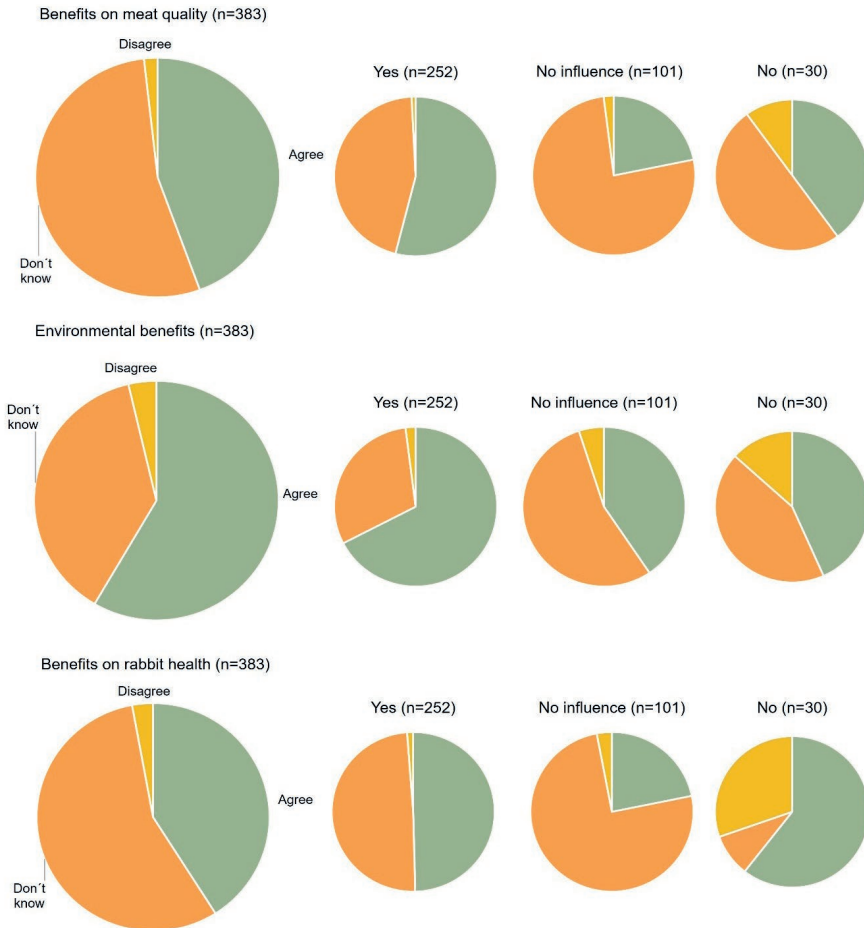


Figure 7: Level of agreement of respondents with the following statements: “The inclusion of seaweed in the rabbit diet would 1) improve the meat quality 2) provide environmental benefits 3) improve rabbit health”, and answers related to the willingness to choose seaweed-fed rabbit meat in preference to other rabbit meat products.

When the level of agreement with the statements was related to the willingness to choose seaweed-fed rabbit meat rather than other rabbit meat (Figure 7), significant differences were observed in all cases, as expected. In general, those people who would choose this meat agreed more strongly with the statements, as they may be more sensitive to these issues and more convinced of the strategy. In contrast, those respondents who would not be influenced by this feeding strategy were more hesitant about its benefits.

CONCLUSIONS

Rabbit meat consumption in the municipality of Lugo seems to be in a better situation than in other areas, possibly due to the maintenance of family smallholdings and the informal food distribution networks this creates. Nevertheless, this type of production is disappearing and the consumption of some of the derived products —like rabbit meat— is also at risk of disappearing, especially in the younger population. Our results show that a high proportion of the surveyed population in Lugo would be willing to consume seaweed-fed rabbit meat (65%); these findings may be extrapolated to other similar animal products and other similar populations. One of the keys to ensuring the success

of this type of products in the market seems to be the correct communication of the reasons for this feeding strategy. The circular-economy approach and the environmental benefits of this strategy could be used as marketing points to attract environmentally responsible consumers and to increase rabbit meat consumption. Rabbit meat products will also have to be adapted to modern types of cooking and information about how to cook the products provided, so that the meat can be included in the daily diets of people of all ages. The nutritional benefits were also identified as key points for increasing the consumption of rabbit meat, and the same applies to seaweed. Promoting the combination of both foods as functional foods has great potential but requires some effort to be made in developing marketing campaigns that include relevant information.

Overall, the complete analysis of this area and the preferences of its inhabitants, allows us to affirm that the use of seaweed in rabbit feed would be accepted by consumers, and that it would be an interesting strategy to increase the consumption of this meat among environmentally conscious people. However, this study is limited by its geographical location and should therefore be replicated in other regions in order to obtain more consistent results.

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Authors contribution: Al-Soufi S.: conceptualization, formal analysis, investigation, writing – original draft and writing – review & editing. Vivero-Saavedra C.: conceptualization, data curation, formal analysis, methodology, investigation and writing – review & editing. Pernas A.M.: conceptualization, data curation, formal analysis, methodology, investigation and writing – review & editing. Miranda M.: investigation, methodology and writing – review & editing. López-Alonso M.: conceptualization, funding, investigation, methodology, resources, supervision and writing – review & editing.

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