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Improving meat tenderness using exogenous process: The consumer response

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ABSTRACT

The aim of this paper is to investigate purchase intention (PI) for meat obtained through a tenderization process based on a treatment with exogenous proteolytic enzymes. Particularly, perceived risks and perceived benefits on the consumer acceptance of tender meat produced through this emerging technology have been evaluated. In order to achieve the stated objective, a survey was conducted on a national representative sample of Italian consumers (N = 1006), who received information about the traditional and the emerging tenderization processes. Principal Component Analysis and Structural Equation Model were applied to the collected data. Results show that consumer purchase intention for meat treated with exogenous proteolytic enzymes was strongly influenced by perceived benefits and weakly influenced by perceived risks. Another important result is that perceived benefits are mainly affected by trust in science. Finally, a Cluster Analysis was performed to distinguish consumer segments with different response patterns.

1. Introduction

The complexity of interactions between consumers' preferences and the strategies of the industry to supply food produced using innovative or alternative technologies has stimulated the academic interest, particularly focusing on factors affecting consumer mindset to innovation in food processing, and on consumer response in terms of purchase intention (PI) for innovative foods. In recent years, meat consumption trends are evolving rapidly, undergoing significative changes driven by the decline of the influence of factors, such as price and income, and by the increasing relevance of health worries, ethical concerns and ecological issues (Troy, Ojha, Kerry, & Tiwari, 2016). Therefore, consumers' demand of meat has increasingly shifted towards products that are safe, of good eating quality, nutritious and produced through sustainable practices (Santeramo et al., 2018). In 2020, 328 million tons of meat were produced worldwide, equivalent to an annual per capita consumption of 35 kg, and meat consumption is estimated to rise by 12% between 2020 and 2029 (OECD-FAO). In the rising world meat market, understanding consumers' perception of meat quality is of paramount importance for the companies in order to increase their competitiveness. Consumer satisfaction (Oliver, 1980) and willingness to purchase the product again in the future are determined by the match or mismatch between expected quality (formed before and during the purchase) and experienced quality (assessed after the purchase and consumption), as indicated the Expectancy-Disconfirmation theory proposed by Lewin (1938). Before purchase, the formation of meat quality expectations is based on a few key cues which can be grouped into intrinsic (color, fat content, marbling) and extrinsic (price, origin, quality labels), while eating quality stands out as the most assessment criterion shaping satisfaction or dissatisfaction, and, consequently, future purchase (Henchion, McCarthy, & Resconi, 2017).

The tenderness attribute is one of the main indicators for assessing the quality of meat, and it is the primary sensory characteristic that consumers consider when they make a purchasing decision (Henchion et al., 2017). It has been widely verified that *post-mortem* aging is one of the most important meat processes for obtaining a satisfactory increase of meat tenderness due to the action of endogenous enzymes on myofibrillar proteins (Kim et al., 2018). However, the traditional aging of meat is time consuming (15–20 days of storage at 2–4 °C) and is also expensive; in addition, its effectiveness varies on the basis of different

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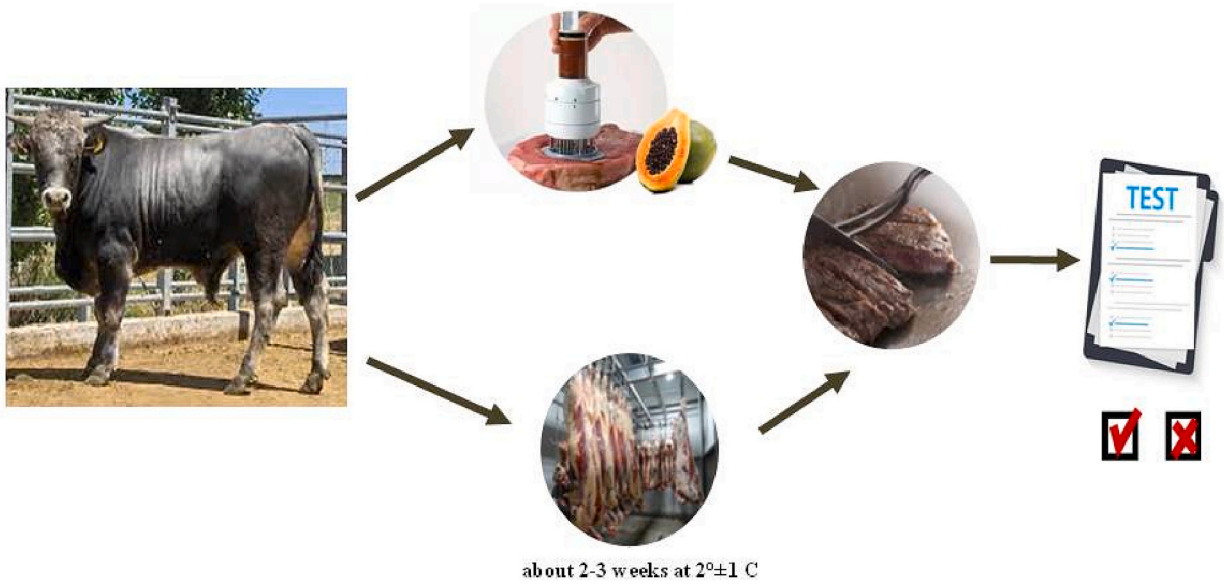

Fig. 1. Flow chart representing two different meat tenderization processes (endogenous or traditional and the exogenous or emerging).

commercial cuts and animal species. In particular, such method is inadequate in the case of cuts containing high amount of connective tissue and, in general, in the case of meat obtained from rustic breeds, which may present optimal nutritional properties but they are often characterized by low tenderness.

In the last years, several post-mortem processes have been implemented in order to improve meat tenderness and its variability amongst commercial cuts, and to reduce costs and time as well. Recently, Gagaoua et al. (2021) highlighted that the use of plant proteases is an emerging sustainable approach to enhance meat tenderness. In particular, proteolytic treatments with exogenous enzymes allow the improvement of tenderness and palatability of some cuts of beef that are generally underutilized and sold at lower price than primal cuts, giving the chance to reduce food industry waste in the frame of the circular economy (Campos, Gómez-García, Vilas-Boas, Madureira, & Pintado, 2020). The use of proteolytic treatments with exogenous enzymes could be a useful option to support meat industry in the effort to satisfy consumer expectations for product quality and, at the same time, it would allow the reduction of costs and the environmental impact compared to the traditional aging of meat. Although the use of plant proteases is a very promising technology with great potential in the meat sector, several recent examples, such as gene technology (GT), nanotechnology, cultured meat and food irradiation proved that consumers may not embrace innovative agri-food technologies as enthusiastically as hoped for at the times when the technologies were developed (Pakseresht, Kaliji, & Canavari, 2022; Siegrist & Hartmann, 2020). For example, De Barcellos et al. (2010) showed that while consumers may support the development of non-invasive processing technologies which improve healthiness and eating quality of meat, they are very reluctant towards manipulations and interventions that are perceived as excessive, invasive and non-natural in meat production process. Therefore, consumers are cautious about accepting new technologies applied to meat sector because of perceived risk. In particular the very limited knowledge about new technologies by the consumer results in an inability to decide whether new foods produced by such technologies are associated with possible risks (Bolumar, Enneking, Toepfl, & Heinz, 2013).

In the case of meat-based products, as in general in food industry, the success of an innovative process technology, as well as the commercialization of a new product, is influenced by the risk benefit perception which reflects the public acceptance of the innovation (Pakseresht et al., 2022). In condition of limited knowledge, people use heuristics, such as trust, to assess risks and benefits of a new technology (Siegrist & Hartmann, 2020). If the public trusts the institutions charged with the responsibility for the emerging technology, it tends to perceive lower risks and higher benefits (Siegrist & Cvetkovich, 2000). Another factor that can influence the perception of risks and benefits is the consumer attitude towards new technologies (Stampfli, Siegrist, & Kastenholz, 2010) which reflects an individual belief in the ability of technological progress to solve the world's problems in the future (Bredahl, 2001). So that, when the public holds a positive attitude towards a new technology, it will perceive more benefits and fewer risks from its application.

Several studies in the food domain have shown that healthiness is also an important predictor of product acceptance (Bimbo et al., 2017; Stampfli et al., 2010), while a great interest in sustainability could led to the rejection of technology (Cavaliere & Ventura, 2018). Furthermore, the way a food technology is perceived by consumers also depends on people's socio-demographic characteristics (Bryant & Barnett, 2018; Siegrist & Hartmann, 2020).

To the best of our knowledge, no data are available on consumers' perceptions of meat obtained with an emerging process which involves the use of exogenous proteolytic enzymes for tenderization process. In this frame, the purpose of the present study is to investigate the consumer purchase intention tender meat produced through exogenous enzymatic treatments as well as the perceived risk and perceived benefit associated with such innovation. In addition, attitude towards new technologies, attention to health, and trust in different institutions involved in the food domain are assessed as predictors for purchase intention meat treated with this innovative technology. Finally, a cluster analysis was performed to distinguish consumer segments with different response patterns.

2. Materials and methods

2.1. Participants and experimental design

The survey was carried out in Italy by a market research agency, specialized in consumer surveys, through a web-based interview conducted on a sample of 1006 participants by the administration of a questionnaire. The agency (a division specialized in the provision of Survey Management, Data Collection and Data Delivery), actively managed an on-line panel which is representative of the Italian population in terms of geographical area, age, gender, education and income. Participants have been selected from this panel on the basis of two inclusion criteria: i) being the household responsible for food purchasing;

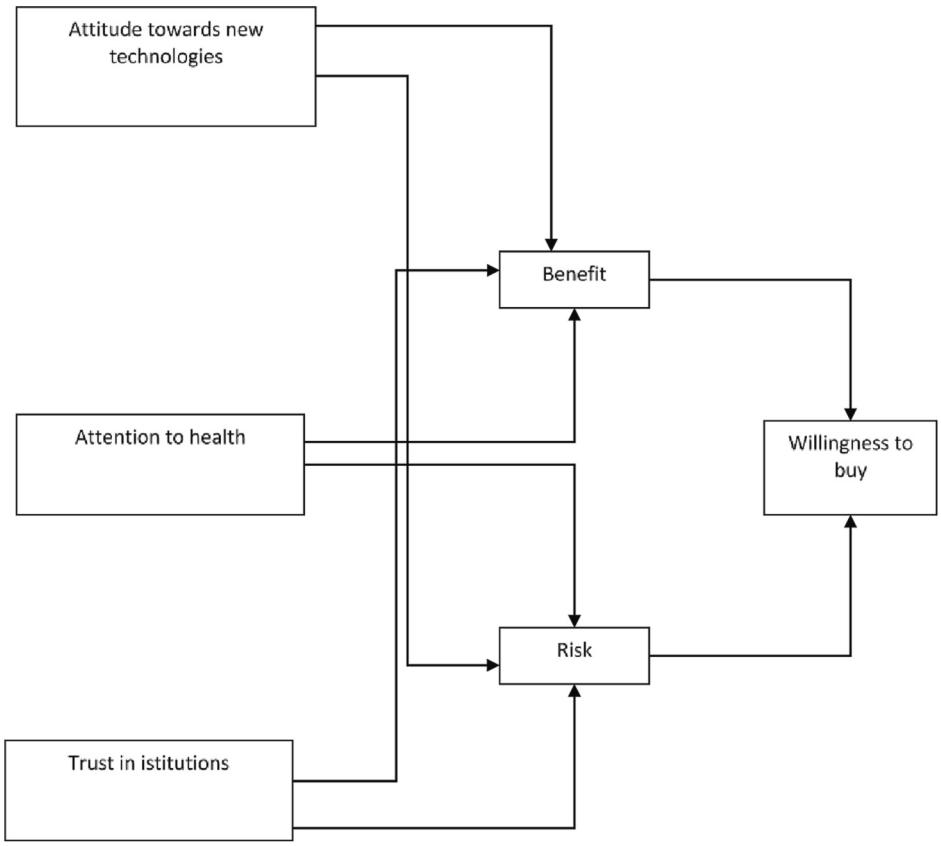

Fig. 2. The conceptual model hypothesized to examine factors that may influence the purchase intention of beef treated with exogenous tenderization process.

ii) being beef consumer. The questionnaire was structured in five sections. The first section aimed to collect information about food and beef purchasing habits in the household. The second section listed questions about: i) attitude towards new technologies and ii) attention to health. Attitude towards new technologies was measured by using items which were obtained by screening the Food-Related Lifestyle Instrument proposed by Scholderer, Brunsø, Bredahl, and Grunert (2004). Specifically, we selected and partially adapted those items that were deemed more suitable to measure both aversion towards new treatments applied on food (e.g. "I only buy and eat foods which are familiar to me", "I try to avoid food products with additives") and attraction for them (e.g. "I like to try new foods that I have never tasted before", "We use a lot of convenience foods in our household"). Attention to health was measured by using fifteen items which were obtained by screening the Health and Taste Attitudes Questionnaire developed by Roininen, Lähteenmäki, and Tuorila (1999). Specifically, we selected and partially adapted those items that were deemed more suitable to measure both attention to health in general (e.g. "I have regular medical check-up", "I regularly practice sports") and attention to health in choosing food (e.g. "I always follow a healthy and balanced diet", "It is important for me that my diet is low in fat"). Respondents were asked to indicate their level of agreement/disagreement on the proposed statements using a scale ranging from 1 (I strongly disagree) to 5 (I strongly agree). The third section of the questionnaire contained key statements for estimating perceived risks, perceived benefits and purchase intention (PI) of meat obtained through exogenous tenderization process. Following Stampfli et al. (2010), participants received a flow chart (Fig. 1) representing the endogenous (traditional) and the exogenous (emerging) meat tenderization processes together with the following description *"Some cuts of meat are particularly tough and require long storage time (aging) at 2–4 °C to become tender. This involves high energy costs that have a negative impact on the environment and on sales prices. It has recently been shown that by treating cuts of meat with substances extracted from plants, it is possible to obtain a more tender meat in a short time with reduced energy consumption.*

Perceived risks and perceived benefits were measured by the statement "I perceive this product as potential risky/beneficial", while purchase intention was measured by the statement "I would buy meat obtained through exogenous tenderization process". For both statements respondents were asked to indicate their level of agreement/disagreement using a scale ranging from 1 (I strongly disagree) to 5 (I strongly agree).

In the fourth section, trust in institutions was measured by using fifteen items which were obtained by expanding the items used in Stampfli et al. (2010) for measuring the same variable of interest, namely social trust. In particular, we have included all the items used in Stampfli et al. (2010) for measuring the level of trust in different institutions that are directly and indirectly involved with the issues of food quality and safety (such as public health bodies, scientific institutions, certification bodies, food industry, large retailers). We also included additional items for discerning the level of trust for national and foreign institutions and for capturing the level of trust in food labelling, brand and private label. Participants were asked to express their level of agreement/disagreement on a five-point scale from 1 (I strongly disagree) to 5 (I strongly agree). Finally, in the fifth section, standard socio-demographic questions such as age, gender, education, family income, were included.

The empirical model depicted in Fig. 2 was hypothesized with the aim to examine factors that may influence the purchase intention beef treated through exogenous tenderization process. It assumes that perceived risks and perceived benefits influence the purchase intention (Siegrist, Stampfi, & Kastenholz, 2009), and that they, in turn, are influenced by the attitude towards new technologies, the attention to health and the trust in institutions (Stampfli et al., 2010; Verneau, Caracciolo, Coppola, & Lombardi, 2014).

Table 1
Perceived Benefit, Perceived risk and Purchase intention-PI. (five-point Likert scale: 1 = I strongly disagree; 5 = I strongly agree).

	Perceived Benefit score mean 2.93 ± 0.95 S.D.		Perceived Risk score mean 2.58 ± 0.97 S.D.		PI score mean 2.65 ± 0.97 S.D.	
	n	%	N	%	n	%
I strongly agree	61	6.1	53	5.3	37	3.7
I agree	177	17.6	100	9.9	130	12.9
Neither agree nor disagree	454	45.1	319	31.7	397	39.5
I disagree	254	25.2	438	43.5	325	32.3
I strongly disagree	60	6	96	9.6	117	11.6
Total	1006	100	1006	100	1006	100

2.2. Data analysis

Information collected through the questionnaire were used for a multi-level data analysis.

Information on the scales related to: i) attitude towards new technologies, ii) attention to health and iii) trust in institutions, have been summarized using a Principal Component Analysis with a Varimax rotation. This analysis was performed for each of the above scale with the aim to extract components that are highly correlated and, thus, to obtain more easily interpretable factors. Extracted components with Eigenvalue >1 were introduced in the Structural Equation Model (SEM) which has been used to estimate the empirical model proposed in Fig. 2. The SEM includes simultaneously the measurement of structural parameters in a full latent variable model approach. The measurement model is related to the within-construct relationship, which regards the relation between measured variables, such as item scales, and related latent construct. The structural model allows to assess the magnitude and direction of the relations amongst the set of measured constructs, and it is used to verify whether the hypothesized relationships take place in the tested model. A Chi-Square test was applied with the aim to assess socio-demographic and environmental awareness differences in consumer PI.

Finally, a hierarchical cluster analysis, using the Ward's method, was performed in order to verify the existence of different groups of consumers on the basis of perceived risks-benefits and their PI The socio-demographic characteristics of consumers have been used as descriptive variables. The resulting clusters merge individuals sharing similar (stated) values of perceived benefits and perceived risks as well as PI for the new technology. Then, each cluster has been profiled according to socio-demographic variables: gender, age, education, employment, income, geographical area, household size, children under 14 years in the family.

All reported analyses were conducted through SPSS 16.0 except the SEM model which was estimated in STATA 16.0 software (StataCorp LLC, College station, TX, USA).

3. Results

Table 1 shows descriptive statistics (mean, standard deviation, and percentage distribution) that were calculated on individual scores expressed by participants for purchase intention, perceived benefits and perceived risks. It is possible to observe that 16.6% of respondents clearly reveals to appreciate meat tenderized through the use of exogenous enzymes by expressing agreement (I agree/I strongly agree) on the purchase intention. Conversely, 43.9% of respondents clearly reveals aversion towards the innovative product by expressing disagreement (I disagree/I strongly disagree) on the purchase intention. However, a large amount of respondents (39.5%) revealed uncertainty, and they were not able to clearly and directly express an intention to buy or not to buy the tested product (neither agree nor disagree). This preliminary analysis, also shows that the perception of benefits is different from the perception of risks. In particular, it is worth to highlight that 23.7% of respondents expressed agreement (I agree/I strongly agree) that meat tenderized through the use of exogenous enzymes is a beneficial product, whereas only 15.2% of respondents expressed agreement (I agree/I

Table 2
Component loading matrix for attitudes towards new technology.

Items	Component 1	Component 2	Communalities	Total Variance explained	Kaiser-Meyer-Olkin measure [1]	Bartlett's Test [2]	*P*-value
Usual purchase of innovative food products seen for the first time	**0.63**	0.09	0.42				
Belief that new technologies enable the improvement of the food sensory quality	**0.66**	0.03	0.45				
Importance of convenience when choosing food	**0.66**	0.17	0.48				
Usual preference of unprocessed over processed food	−0.07	**0.61**	0.47				
Usual preference in buying food products already tried in past occasions	0.31	**0.5**	0.4				
Usual preference of food that can be stored for a short period of time over long-life food	−0.01	0.33	0.43				
Belief that food can be enriched with vitamins, minerals and other nutrients in order to have a balanced diet	**0.67**	−0.02	0.47				
Usual preference of packaged foods over those sold in bulk (not packaged)	**0.57**	−0.12	0.35	54.6%	0.81	2.43	***
Belief that the use of additives such as preservatives, thickeners, dyes and flavour enhancers worsen the quality and safety of food	−0.1	**0.66**	0.47				
Importance of packaging in choosing food	0.45	−0.03	0.34				
Consumption of organic products	0.2	0.08	0.51				
Use of food supplements (vitamins, minerals, fiber, etc.)	**0.52**	−0.15	0.47				
Importance of genuine and natural ingredients in choosing food	0.05	**0.71**	0.52				
Use of natural herbal products rather than drugs in case of minor illnesses such as colds, intestinal disorders, skin irritations, etc.	0.07	0.2	0.45				
Preference for food obtained by traditional processing techniques	−0.01	**0.46**	0.38				

Loading greater than 0.45 are shown in bold
[1] Kaiser-Meyer-Olkin Measure of Sampling Adequacy
[2] Bartlett's Test of Sphericity. ***=P<0.001

Table 3
Component loading matrix for attention to health.

Items	Component 1	Component 2	Communalities	Total Variance explained	Kaiser-Meyer-Olkin measure [1]	Bartlett's Test [2]	P-value
Consumption of alcoholic beverages	0.02	**0.78**	0.6				
Sedentary lifestyle	0.08	0.33	0.78				
Smoking habit	−0.04	**0.75**	0.57				
Health concerns requiring special diets (hypertension, gastritis, diabetes or other)	0.36	**0.57**	0.5				
Practice of sport activity	0.41	0.33	0.63				
Routine of regular health check-ups	0.43	0.28	0.37				
Regularly and carefully reading information on food labels	**0.47**	0.06	0.48				
Importance of flavour in food choice	−0.06	**0.56**	0.41	58.75%	0.83	2.76	***
Belief that eating habit affects a person's health	0.16	−0.26	0.64				
Effort to follow doctors' recommendations when choosing food	**0.57**	0.19	0.4				
Effort to follow a balanced diet	**0.69**	−0.01	0.6				
Effort to follow a low-calorie diet	**0.8**	0.01	0.63				
Effort to follow a low-fat diet	**0.83**	0	0.69				
Effort to follow a low-salt diet	**0.73**	0.01	0.53				
Effort to follow a vegetarian diet	**0.5**	0.36	0.45				

Loading greater than 0.45 are shown in bold
[1] Kaiser-Meyer-Olkin Measure of Sampling Adequacy
[2] Bartlett's Test of Sphericity. ***=P<0.001

Table 4
Component loading matrix for trust in institutions.

Items	Component 1	Component 2	Communalities	Total Variance explained	Kaiser-Meyer-Olkin measure [1]	Bartlett's Test [2]	P-value
Trust in food labelling	0.32	0.26	0.47				
Importance of brand in food choosing	0.12	0.19	0.66				
Importance of advertising in food choosing	0.14	0.18	0.73				
High confidence in food produced using a technology authorized by the European Food Safety Authority (EFSA)	**0.8**	0.22	0.74				
High confidence in food produced using a technology authorized by the Italian Ministry of Health	**0.73**	0.13	0.67				
High confidence in food produced using a technology declared totally risk free to human health by international scientific findings	**0.82**	0.18	0.74				
High confidence in food produced using a technology declared totally risk free to human health by an Italian university	**0.82**	0.18	0.75				
High confidence in food produced using a technology declared totally risk free to human health by a foreign university	**0.82**	0.22	0.74	53.51%	0.9	7.41	***
Belief that Italian food is safer than food imported from EU countries	0.13	0.1	0.7				
Belief that industrial food is safer compared to artisan food	0.2	**0.78**	0.69				
Belief that food purchased in big retailers is safer than in small shops	0.19	**0.81**	0.73				
Belief that big food brands ensure higher health and hygiene standard	0.22	**0.79**	0.75				
Belief that private labels ensure higher health and hygiene standard	0.21	**0.76**	0.71				
Belief that Italian food is safer than food imported from non-EU countries	0.14	0.18	0.75				
Belief that certified food is safer than food not bearing any certification	0.3	0.27	0.54				

Loading greater than 0.45 are shown in bold
[1] Kaiser-Meyer-Olkin Measure of Sampling Adequacy
[2] Bartlett's Test of Sphericity. ***=P<0.001

strongly agree) that the tested product is risky. In addition, 31.2% of respondents expressed disagreement (I disagree/I strongly disagree) that the innovative product is beneficial, but a large amount of respondents (53.1%) also clearly expressed disagreement (I disagree/I strongly disagree) that the innovative product is risky.

The items used for measuring "attitude towards new technologies", "attention to health", and "trust in institutions" have been undergone to a Principal Component Analysis (Tables 2-4), and the results of the Kaiser-Meyer-Olkin test and Bartlett's sphericity test showed adequacy of the analysis. The Principal Component Analysis revealed, for each scale, a two factors solution based on the correlation between the items. The factors explained 54.6%, 58.7% and 53.51% of the variance for "attitude toward new technology", "attention to health" and "trust in institutions", respectively. Referring to the attitude towards new technologies (Table 2), the items related to the interest for innovation, convenience, packaging and food supplements had high loadings on the first component, while the preference for natural ingredients, not processed foods and no additive, food products tried in the past and

Table 5
Three-stage least square regression.

	Parameters	Coefficient	S.E.	*P* value
WTB	*Benefit*	1.08	0.04	***
	Risk	−0.06	0.05	*
	Constant	0.49	0.22	**
Benefit	*Positive attitude to Innovative technology*	0.13	0.03	***
	Positive attitude to Traditional technology and naturalness	−0.04	0.03	***
	Healthy food choice	−0.009	0.02	NS
	Unhealthy Behaviour and hedonism	0.13	0.03	***
	Trust in Science[1]	0.41	0.02	***
	Trust in industry and retail	0.14	0.02	***
	Constant	2.93	0.02	***
Risk	*Positive attitude to Innovative technology*	0.02	0.03	NS
	Positive attitude to Traditional technology and naturalness	0.1	0.03	**
	Healthy food choice	0.18	0.03	***
	Unhealthy Behaviour and hedonism	0.25	0.03	***
	Trust in Science[1]	−0.33	0.03	***
	Trust in industry and retail	−0.12	0.03	***
	Constant	2.58	0.03	***
	R2	**Likelihood Ratio Chi** [2]	**RMSE**	**P value**
WTB	0.44	708.69	0.07	***
Benefit	0.35	543.45	0.08	***
Risk	0.22	281.01	0.09	***

Significance: NS = not significant.
* $P < 0.05$.
** $P < 0.01$.
*** $P < 0.001$.
[1] It is related to Italian and foreign universities, international scientific institutions, the European Food Safety Agency (EFSA) and the Italian Ministry of Health

traditional processing techniques, had high loadings on the second component. For the characteristics described above, the first component could be defined as "positive attitude toward innovative technology" and the second component as "positive attitude toward naturalness and traditional technology". Thus, two new rating scales, corresponding to each two components, were set up. Reliability analysis showed that the set of items is consistent for the two components: Cronbach's indicator is respectively $\alpha = 0.77$ for the first component, and $\alpha = 0.76$ for the second component. As concerns "attention to health" (Table 3), the items related to diets (low-fat, low-calories, low-salt, balanced, vegetarian), medical advices and attention to information on the label, had high loadings on the first component, while consumption of alcohol, smoking, special diets and importance of flavour in the food choice had high loadings on the second component. For the characteristics described above, the first component could be defined as "healthy food choice", and the second component as "unhealthy behaviour and hedonism", so that the two new rating scales, corresponding to each two components, were set up. Cronbach's alpha indicated that the scales had good internal consistency: $\alpha = 0.80$ for the first component, and $\alpha = 0.78$ for the second component. With regards to "trust in institutions" (Table 4), the items related to Italian and foreign universities, international scientific institutions, the European Food Safety Agency (EFSA) and the Italian Ministry of Health, had high loadings on the first component, while those related to large retailers, large food companies and their brands, had high loadings on the second component. Consequently, it was possible to define the first component as "trust in science" (related to the above mentioned institutions) and the second as "trust in industry and retail" leading to setting up two new rating scales, corresponding to each two components; the Cronbach's alpha was high for both the scales with a value of $\alpha = 0.90$.

The six components resulting from the Principal Component Analysis ("positive attitude toward innovative technology", "positive attitude toward naturalness and traditional technology", "healthy food choice", "unhealthy behaviour and hedonism", "trust in science" and "trust in industry and retail") are the variables that have been tested for their influence on the perception of risks and benefits which, in turn, are assumed to influence the purchase intention of meat treated with the innovative tenderization process as shown in the conceptual model described in Fig. 2.

Such model has been tested using the Structural Equation Model (SEM) through a three-stage least square regression in order to solve simultaneously multiple, related equations and to determine parameter estimates (Table 5) (Ullman & Bentler, 2012). The root-mean-square error RMSE showed values ranged between 0.07 and 0.09 that is an acceptable goodness of fit of data to the model.

As expected, because of the large size of the sample, the model showed a significant Chi-Square value ($\chi^2 = 708.69$; $p < 0.001$). Standardized path coefficients for the final model are shown in Fig. 3. The R^2 value for estimated equations in the SEM showed that perceived risks and perceived benefits explained 44% of the variance for the purchase intention. On the other hand, the other variables ("positive attitude towards innovative technology", "positive attitude towards naturalness and traditional technology", "healthy food choice", "unhealthy behaviour and hedonism", "trust in science, "trust in industry and retail") explained 35% of the variance for the perceived benefits, and 22% of the variance for the perceived risks.

The Chi-Square test also revealed that the PI significantly varied according to the groups of respondents as shown in Table 6. Male respondents showed a higher PI (61%) compared to females (52%) and, considering age, young people revealed to be more inclined to purchase meat tenderized through exogenous enzymes (62% for respondents under 33), while older classes of age showed similar answers (53% for those in the 34–49 age range, and 54% for those over 50). It is worth to highlight that the PI also increases with the level of education and income (in the first case, it ranges from 51%, corresponding to a low level of education, to 66.7% of a high level of education; in the second case, it ranges from 50% of low level of income to 69% of high income). Families with children evidence a higher PI (62%) compared with those with no children. Considering the issues of sustainability and attention to environment, the PI is >57% for respondents who are driven by sustainability in their food choice, and it is almost 66% for those who have declared to care of the environment.

A Cluster Analysis was applied to classify respondents of the sample in three consumer segments on the basis of three main variables: perceived benefits, perceived risks and PI (Table 7).

Results show that moving from the first consumer segment to the third, the perceived benefits decrease, whereas the perceived risks increase. Coherently, the PI decreases reaching the lowest value in the third consumer segment.Each segment was described by highlighting some socio-demographic characteristics of respondents, and their purchase and consumption habits The first consumer segment, representing 35% of the sample, is characterized by a relatively high presence of males, young people, with high level of education and income, living in a big family size (4 or > 5) with the presence of children under 14 years. The second segment (41% of the sample) consists of relatively older respondents with lower levels of education and income. Finally, the third segment (24% of the sample) is prevalently composed by females with medium levels of education and income, and limited presence of children under 14 years.

4. Discussion

4.1. Main factors affecting purchase intention

The estimated Structural Equation Model showed that *perceived*

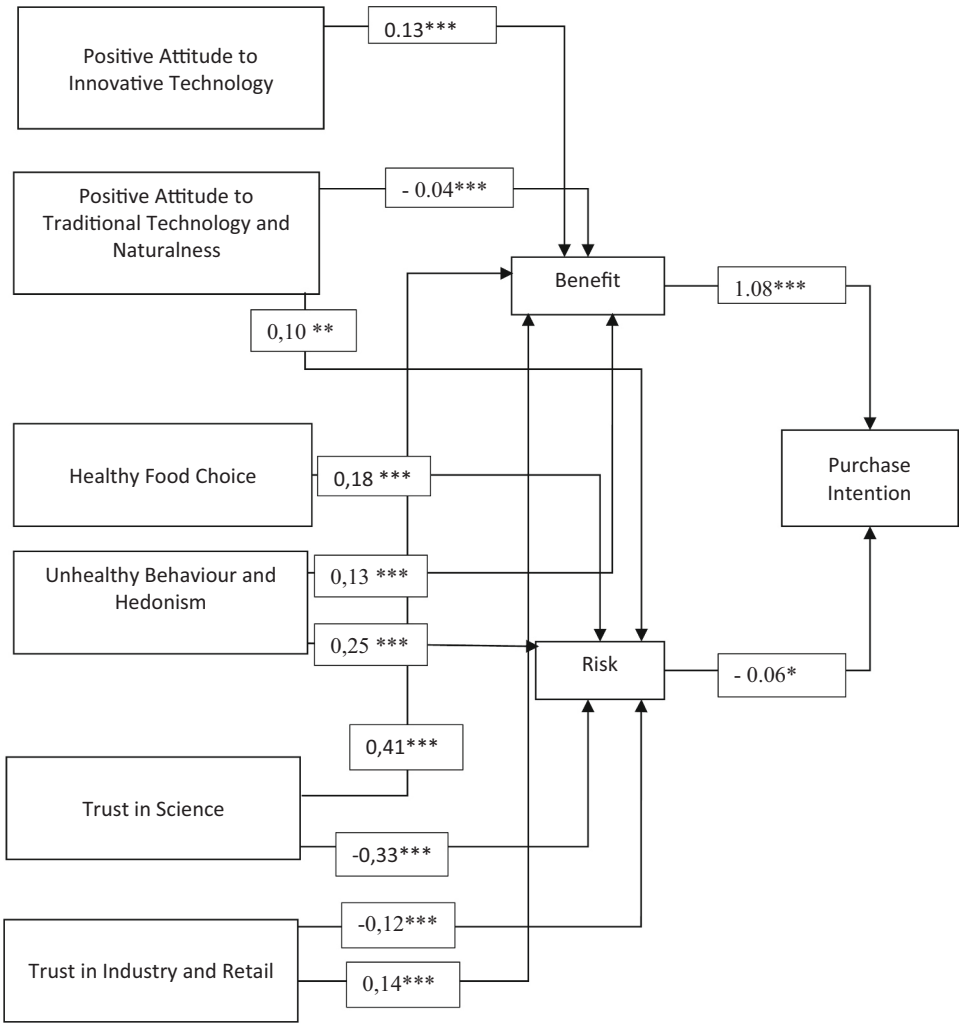

Fig. 3. The estimated Structural Equation Model, only significant results are reported * = $P < 0.05$; ** = $P < 0.01$; *** = $P < 0.001$.

benefits prevail over *perceived risks* for the acceptance of meat obtained through exogenous tenderization process, in agreement with the findings of other studies about consumer acceptance of food innovations (Bearth & Siegrist, 2016; Stampfli et al., 2010).

The variable "*trust in science*" was the strongest variable in explaining the variance of perceived risks and perceived benefits of meat treated with exogenous tenderization process. It means that as confidence in institutions involved in scientific research and food regulation increases, the perception of benefits related to such technology is higher while the perception of risks is lower.

Furthermore, the variable "*trust in industry and retail*" had a positive effect on perceived benefits and the opposite for risks. In the case of products for which it is not possible to directly experience all the benefits and/or risks, consumers must rely on promises made by the industry and retail. Therefore, considering both variables together, "*trust in institutions*" may play an important role in the acceptance of meat treated with the innovative tenderization process. This finding is in agreement with Siegrist and Hartmann (2020) who showed that consumer acceptance of novel food technologies is influenced by trust heuristic. In particular, trust is important in situations where people lack knowledge for assessing benefits and risks of technology and, therefore, they have to rely on third parties (Siegrist & Cvetkovich, 2000). If consumers trust in the institutions charged with the responsibility for the emerging technology, they tend to perceive lower risks and higher benefits (Roosen et al., 2015).

The variable "*attention to hedonism and unhealthy behaviour*" affects significantly both perceived risks and perceived benefits, even if the latter with less impact. This result could be explained considering that respondents of the sample leading a predominantly hedonistic and unhealthy lifestyle, even though recognizing and appreciating the possible benefits of exogenous enzymatic treatments on sensory properties, fear that meat produced with such new technology may have potential negative effects on human health. Such concern could overcome the beneficial aspects on a sensory level deriving from the new technology as proven by the higher coefficient related to the risk. These findings suggest that, in the meat sector, as in the food domain, the risk perception related to the use of technologies could outweigh the sensory enjoyment driven benefits perceptions (De Barcellos et al., 2010). In addition, the consumer perception of sensorial issues in the meat sector may be strongly associated with the idea of 'ancient naturalness', which could be in conflict with innovative technology.

The variable "*healthy food choice*" impacts significantly with perceived risks but not with perceived benefits, meaning that there is an increasing probability that consumers following a healthy diet could perceive such innovative technology as bearing risks. This result is in agreement with the findings of some studies (Hocquette, Liu, Ellies-Oury, Chriki, & Hocquette, 2022; Verbeke et al., 2015) which reported that consumers reveal some concerns about the potential negative long-term effects of novel food technology on human health, which largely based on what might represents the 'unknown' dimension of risk. These worries affect the acceptance of a product which can be considered unnatural, unsafe, and unhealthy (Giordano, Clodoveo, de

Table 6
Chi-square test of Purchase intention – PI per group of respondents (gender, age, level of education, income, presence of children <14, environmental attitude).

	PI - adverse (n = 442; 43.9%)		PI– not adverse (n = 564; 56.1%)				
	n	%	n	%	Total	Chi-square	P-value
Male	194	39.4	299	60.6	493	8.25	**
Female	248	48.3	265	51.7	513		
≤ 33	109	38.0	178	62.0	287		
34–49	175	46.8	199	53.2	374	5.86	*
≥ 50	158	45.8	187	54.2	345		
Low level of education	185	49.2	191	50.8	376		
Medium level of education	200	43.6	259	56.4	459	12.06	**
High level of education	57	33.3	114	66.7	171		
Low income	187	50.5	183	49.5	370		
Medium income	174	39.4	268	60.6	442	21.37	***
High income	33	31.1	73	68.9	106		
Children	129	38.3	208	61.7	337	6.58	**
No children	313	46.8	356	53.2	669		
Sustainble food choice	398	42.6	536	57.4	**72**	9.29	**
No sustainble food choice	44	61.1	28	38.9	934		
Attention to Environment	39	34.2	75	65.8	114	4.94	*
No attention to Environment	403	45.2	489	54.8	892		

Gennaro, & Corbo, 2018). It could be supposed that if consumers are provided with convincing evidence of the sensory properties and safety of meat treated with exogenous tenderization process, they are more likely to buy such products.

The variable "*positive attitude toward innovative technology*" affects significantly only perceived benefits, meaning that, generally, the greater the inclination of people towards experimenting with innovations, the greater will be their perception. Such attitude is in opposition with the food technology neophobia that is a personality trait that influences negatively consumers' willingness to accept new food technologies (Siegrist & Hartmann, 2020).

The variable "*positive attitude toward naturalness and traditional technology*" shows a significative impact on both perceived risks and perceived benefits although in opposite ways: the greater is the preference for natural food and tradition, the higher is the perception of the risks, and the lower the perception of the benefits. This is in agreement with some research findings which show that perceived naturalness, together with other factors, has a decisive role in consumer acceptance of novel food technology (Pakseresht et al., 2022; Siegrist & Hartmann, 2020). The lack of naturalness invokes technology rejection and increases doubts about its purported health benefits (Palmieri, Perito, & Lupi, 2020). This result may be justified to the fact that the survey took place in Italy, where the food quality is mainly equated to the naturalness of the product by consumers (Lazzaroni, Iacurto, Vincenti, & Biagini, 2013); such hypothesis is supported by data highlighting that 55% of Italian consumers look for 100% natural products (Nielsen, 2016).

4.2. Consumer characteristic and purchase intention

The Cluster Analysis allowed the detection of the segment of

Table 7
Cluster analysis results.

		Cluster 1 (n = 353) [1] Benefit:3.8, Risk:2.5, Purchase Intention:3.6		Cluster 2 (n = 413) [1] Benefit:2.8, Risk:2.1, Purchase Intention:3.5		Cluster 3 (n = 240) [1] Benefit:1.9, Risk:3.5, Purchase Intention:1.6		Total	
		(%)	n	(%)	n	(%)	N	(%)	n
	Male	55.8	197	48.7	201	39.6	95	49.1	493
Gender	Female	44.2	156	51.3	212	60.4	145	52.9	513
	18–33	38.2	135	21.8	90	25.8	62	28,5	287
Age (years)	34–49	35.1	124	39.0	161	37.1	89	37,2	374
	50–64	26.6	94	39.2	162	37.1	89	34,3	345
	Primary school	0.8	3	0.7	3	2.1	5	1,1	11
	Secondary school	31.4	111	39.2	162	38.3	92	36.3	365
Education	High school	45.3	160	44.6	184	47.9	115	45.6	459
	University degree	19.8	70	113	55	10.4	25	14.9	150
	Post-bachelor studies	2.5	9	1.4	6	1.2	3	2.1	17
	Self-employed/freelance	11.9	42	15.0	62	11.2	27	13	131
	Public/private manager	7.4	26	3.4	14	2.9	7	4.7	47
	Public/private employee	41.1	145	39.7	164	37.5	90	39.7	399
Employment status	Retired	4.8	17	4.4	18	6,7	16	5.1	51
	Unemployed	15.0	53	17.7	73	18.3	44	16.8	170
	Student	6.8	24	3.9	16	2.9	7	4.7	47
	Housewife	13.0	46	16.0	66	20.4	49	16	161
	One	4.2	15	9.2	38	8.8	21	7.4	74
	Two	17.6	62	26.9	111	26.2	63	23.5	236
Household's members	Three	29.5	104	31.7	131	30.0	72	30.5	307
	Four	35.1	124	25.2	104	26.7	64	29	292
	≥Five	13.7	48	7.0	29	8.2	20	9,6	97
Children under 14	Yes	40.8	144	31.2	129	26.7	64	33.5	337
	No	59.2	209	68.8	284	73.3	176	66.5	669
	<1000 €	11.0	39	15.7	65	16.7	40	14.3	144
	1000–1500 €	19.0	67	24.9	103	23.3	56	22.5	226
	1501–2000 €	18.1	64	19.9	82	23.3	56	20.1	202
Monthly income	2001–3000 €	29.7	105	22.5	93	17.5	42	23.8	240
	3001–5000 €	10.8	38	5.6	23	6.2	15	7.6	76
	>5000 €	4.8	17	1.9	8	2.1	5	3	30
	no reply	6.5	23	9.4	39	10.8	26	8.7	88

[1] Cluster means obtained using the Ward's method. The score of Benefit, Risk and Purchase Intention is referred to five-point Likert scale: 1 = I strongly disagree; 5 = I strongly agree).

consumers who are more intentioned to purchase meat tenderized with exogenous enzymes. This segment represents more than one third of the sample. Almost all socio-demographic trends are in line with those observed for other novel food technologies in literature. In particular, studies on the acceptance of genetically modified food and cultured meat revealed higher acceptance amongst males vs. females (Mancini & Antonioli, 2019; Moerbeek & Casimir, 2005), amongst younger vs. older people (Dupont & Fiebelkorn, 2020; Magnusson & Hursti, 2002), and amongst people with higher level of education (Huang, Qiu, Bai, & Pray, 2006; Mancini & Antonioli, 2019). Furthermore, results of the present research are partly confirmed by studies about the relationships between sensory evaluations of beef tenderness and consumer characteristics. Van Wezemael, De Smet, Ueland, and Verbeke (2014) show that consumers positively evaluating tenderness are more often male and have more often children in their household compared to negative tenderness evaluators. Similarly, the study by Felderhoff et al. (2020) reports that males are more responsive than females for tenderness and, moreover, finds that older consumers generally place more emphasis on tenderness. On the other hand, Resano, Olaizola, and Dominguez-Torreiro (2018) show that younger consumers assign greater importance higher degree of tenderness. As for income, few studies analysed the impact of this demographic variable on the acceptance of new technologies in the food sector and they reveal conflicting results. Hocquette et al. (2022) show that the acceptance of cultured meat is the highest for people with high incomes only above 31 years of age. On the other hand, our result is not in line with the survey conducted by Wilks and Phillips (2017) who reports that low income respondents (vs. high income respondents) are significantly more willing to try cultured meat. However, studies that analyse factors driving consumer satisfaction of meat found that consumers with higher income are more critical when evaluating meat tenderness and more responsive to this attribute (Felderhoff et al., 2020). Our findings also reveal that people with higher level of sustainability of food consumption practices are those more prone to accept this new food technology. This result is consistent with the fact that one of the main purposes for the development of plant proteases to enhance meat texture is the achievement of a more sustainable food chain.

5. Conclusions

The present study investigated consumer response towards tender meat produced by using exogenous enzymatic treatment. Results showed that response is mainly affected by consumers perception of benefits, related to the emerging tenderization process compared to risks. In addition, perceived benefits are mainly influenced by trust in institutions involved in scientific research and food regulations which, consequently, plays a relevant role in the intention to purchase meat incorporating such process. The positive attitude has been found for a wide segment of consumers (35% of the sample) who could act as early adopters of the product obtained by such innovative technology. As a consequence, it could be very relevant the role of an effective communication strategy by highlighting positive attributes as the sustainability of the treatment, its effectiveness, the absence of health risks and the role played by scientific institutions.

Finally, the study allowed to profile consumer segments on the basis of socio-demographic characteristics in order to provide information useful for promotion activities aimed to support the introduction of the new product on the market.

5.1. Future perspective

The findings of this study may be used to provide more practical suggestions for practitioners of meat industry. Companies should be encouraged to adopt this emerging technology in order to benefit of the associated reduction of production costs and, at the same time, to improve the environmental sustainability of the production process. However, since there is evidence of a significant segment of consumers who show a negative attitude towards meat obtained by using exogenous enzymatic treatment, it would be appropriate to adopt strategies of product differentiation and to make the innovative product recognizable through a specific label indication. This would ensure an adequate market transparency by allowing consumers the opportunity to make informed purchasing decisions. At the same time, the indication of the specific treatment could be accompanied by a brief description of the benefits, in particular on the environment, and by a warranty of safety which could be provided by a scientific and/or government institution. This initiative could be useful both in supporting the launch of the innovative product and in promoting its progressive diffusion on the market.

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CRediT authorship contribution statement

Biagia De Devitiis: Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Writing – original draft, Writing – review & editing, Visualization. **Rosaria Viscecchia:** Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Writing – original draft. **Antonio Seccia:** Writing – original draft, Writing – review & editing, Visualization. **Gianluca Nardone:** Writing – review & editing, Visualization. **Domenico Carlucci:** Writing – review & editing, Supervision. **Marzia Albenzio:** Conceptualization, Writing – review & editing, Visualization. **Agostino Sevi:** Conceptualization, Writing – review & editing, Visualization. **Rosaria Marino:** Conceptualization, Funding acquisition, Project administration, Data curation, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The authors declare no conflict of interest.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.meatsci.2023.109164.

References

Bearth, A., & Siegrist, M. (2016). Are risk or benefit perceptions more important for public acceptance of innovative food technologies: A meta-analysis. *Trends in Food Science & Technology, 49*, 14–23. https://doi.org/10.1016/j.tifs.2016.01.003

Bimbo, F., Bonanno, A., Nocella, G., Viscecchia, R., Nardone, G., De Devitiis, B., & Carlucci, D. (2017). Consumers’ acceptance and preferences for nutrition-modified and functional dairy products: A systematic review. *Appetite, 113*, 141–154. https://doi.org/10.1016/j.appet.2017.02.031

Bolumar, T., Enneking, M., Toepfl, S., & Heinz, V. (2013). New developments in shockwave technology intended for meat tenderization: Opportunities and challenges. A review. *Meat Science, 95*(4), 931–939. https://doi.org/10.1016/j.meatsci.2013.04.039

Bredahl, L. (2001). Determinants of consumer attitudes and purchase intentions with regard to genetically modified food–results of a cross-national survey. *Journal of Consumer Policy, 24*(1), 23–61. https://doi.org/10.1023/A:1010950406128

Bryant, C., & Barnett, J. (2018). Consumer acceptance of cultured meat: A systematic review. *Meat Science, 143*, 8–17. https://doi.org/10.1016/j.meatsci.2018.04.008

Campos, D. A., Gómez-García, R., Vilas-Boas, A. A., Madureira, A. R., & Pintado, M. M. (2020). Management of fruit industrial by-products—A case study on circular economy approach. *Molecules, 25*(2), 320. https://doi.org/10.3390/molecules25020320

Cavaliere, A., & Ventura, V. (2018). Mismatch between food sustainability and consumer acceptance toward innovation technologies among millennial students: The case of

shelf life extension. *Journal of Cleaner Production, 175*, 641–650. https://doi.org/10.1016/j.jclepro.2017.12.087
De Barcellos, M. D., Kügler, J. O., Grunert, K. G., Van Wezemael, L., Pérez-Cueto, F. J., Ueland, Ø., & Verbeke, W. (2010). European consumers' acceptance of beef processing technologies: A focus group study. *Innovative Food Science & Emerging Technologies, 11*(4), 721–732. https://doi.org/10.1016/j.ifset.2010.05.003
Dupont, J., & Fiebelkorn, F. (2020). Attitudes and acceptance of young people toward the consumption of insects and cultured meat in Germany. *Food Quality and Preference, 85*, Article 103983. https://doi.org/10.1016/j.foodqual.2020.103983
Felderhoff, C., Lyford, C., Malaga, J., Polkinghorne, R., Brooks, C., Garmyn, A., & Miller, M. (2020). Beef quality preferences: Factors driving consumer satisfaction. *Foods, 9*(3), 289. https://doi.org/10.3390/foods9030289
Gagaoua, M., Dib, A. L., Lakhdara, N., Lamri, M., Botinestean, C., & Lorenzo, J. M. (2021). Artificial meat tenderization using plant cysteine proteases. *Current Opinion in Food Science, 38*, 177–188. https://doi.org/10.1016/j.cofs.2020.12.002
Giordano, S., Clodoveo, M. L., de Gennaro, B., & Corbo, F. (2018). Factors determining neophobia and neophilia with regard to new technologies applied to the food sector: A systematic review. *International Journal of Gastronomy and Food Science, 11*(August 2017), 1–19. https://doi.org/10.1016/j.ijgfs.2017.10.001
Henchion, M. M., McCarthy, M., & Resconi, V. C. (2017). Beef quality attributes: A systematic review of consumer perspectives. *Meat Science, 128*, 1–7. https://doi.org/10.1016/j.meatsci.2017.01.006
Hocquette, É., Liu, J., Ellies-Oury, M. P., Chriki, S., & Hocquette, J. F. (2022). Does the future of meat in France depend on cultured muscle cells? Answers from different consumer segments. *Meat Science, 108776*. https://doi.org/10.1016/j.meatsci.2022.108776
Huang, J., Qiu, H., Bai, J., & Pray, C. (2006). Awareness, acceptance of and purchase intention genetically modified foods in urban China. *Appetite, 46*(2), 144–151. https://doi.org/10.1016/j.appet.2005.11.005
Kim, Y. H., Ma, D., Setyabrata, D., Farouk, M. M., Lonergan, S. M., Huff-Lonergan, E., & Hunt, M. C. (2018). Understanding postmortem biochemical processes and postharvest aging factors to develop novel smart-aging strategies. *Meat Science, 144*, 74–90. https://doi.org/10.1016/j.meatsci.2018.04.031
Lazzaroni, C., Iacurto, M., Vincenti, F., & Biagini, D. (2013). Consumer attitudes to food quality products of animal origin in Italy. In *Consumer attitudes to food quality products* (pp. 83–96). Wageningen: Wageningen Academic Publishers.
Lewin, K. (1938). *The conceptual representation and measurement of psychological forces*. Durham, NC: Duke University Press.
Magnusson, M. K., & Hursti, U. K. K. (2002). Consumer attitudes towards genetically modified foods. *Appetite, 39*(1), 9–24. https://doi.org/10.1006/appe.2002.0486
Mancini, M. C., & Antonioli, F. (2019). Exploring consumers' attitude towards cultured meat in Italy. *Meat Science, 150*, 101–110. https://doi.org/10.1016/j.meatsci.2018.12.014
Moerbeek, H., & Casimir, G. (2005). Gender differences in consumers' acceptance of genetically modified foods. *International Journal of Consumer Studies, 29*(4), 308–318. https://doi.org/10.1111/j.1470-6431.2005.00441.x
Nielsen. (2016). *What's in our food and on our mind. Ingredient and dining-out trends around the world*. The Nielsen Company.
Oliver, R. L. (1980). A cognitive model of the antecedents and consequences of satisfaction decision. *Journal of Marketing Research, 17*(November), 460–469. https://doi.org/10.1177/002224378001700405
Pakseresht, A., Kaliji, S. A., & Canavari, M. (2022). Review of factors affecting consumer acceptance of cultured meat. *Appetite, 170*, Article 105829. https://doi.org/10.1016/j.appet.2021.105829
Palmieri, N., Perito, M. A., & Lupi, C. (2020). Consumer acceptance of cultured meat: Some hints from Italy. *British Food Journal., 123*(1), 109–123. https://doi.org/10.1108/BFJ-02-2020-0092
Resano, H., Olaizola, A. M., & Dominguez-Torreiro, M. (2018). Exploring the influence of consumer characteristics on veal credence and experience guarantee purchasing motivators. *Meat Science, 141*, 1–8. https://doi.org/10.1016/j.meatsci.2018.03.001
Roininen, K., Lähteenmäki, L., & Tuorila, H. (1999). Quantification of consumer attitudes to health and hedonic characteristics of foods. *Appetite, 33*(1), 71–88. https://doi.org/10.1006/appe.1999.0232
Roosen, J., Bieberstein, A., Blanchemanche, S., Goddard, E., Marette, S., & Vandermoere, F. (2015). Trust and willingness to pay for nanotechnology food. *Food Policy, 52*, 75–83. https://doi.org/10.1016/j.foodpol.2014.12.004
Santeramo, F. G., Carlucci, D., De Devitiis, B., Seccia, A., Stasi, A., Viscecchia, R., & Nardone, G. (2018). Emerging trends in European food, diets and food industry. *Food Research International, 104*, 39–47. https://doi.org/10.1016/j.foodres.2017.10.039
Scholderer, J., Brunsø, K., Bredahl, L., & Grunert, K. G. (2004). Cross-cultural validity of the food-related lifestyles instrument (FRL) within Western Europe. *Appetite, 42*(2), 197–211. https://doi.org/10.1016/j.appet.2003.11.005
Siegrist, M., & Cvetkovich, G. (2000). Perception of hazards: The role of social trust and knowledge. *Risk Analysis, 20*(5), 713–720. https://doi.org/10.1111/0272-4332.20506
Siegrist, M., & Hartmann, C. (2020). Consumer acceptance of novel food technologies. *Nature Food, 1*(6), 343–350. https://doi.org/10.1038/s43016-020-0094-x
Siegrist, M., Stampfi, N., & Kastenholz, H. (2009). Acceptance of nanotechnology foods: A conjoint study examining consumers' purchase intention. *British Food Journal, 111*(7), 660–668. https://doi.org/10.1108/00070700910972350
Stampfli, N., Siegrist, M., & Kastenholz, H. (2010). Acceptance of nanotechnology in food and food packaging: A path model analysis. *Journal of Risk Research, 13*(3), 353–365. https://doi.org/10.1080/13669870903233303
Troy, D. J., Ojha, K. S., Kerry, J. P., & Tiwari, B. K. (2016). Sustainable and consumer-friendly emerging technologies for application within the meat industry: An overview. *Meat Science, 120*, 2–9. https://doi.org/10.1016/j.meatsci.2016.04.002
Ullman, J. B., & Bentler, P. M. (2012). *Structural equation modeling* (2nd ed.) (2nd ed.,. *2*. Handbook of Psychology.
Van Wezemael, L., De Smet, S., Ueland, Ø., & Verbeke, W. (2014). Relationships between sensory evaluations of beef tenderness, shear f.Orce measurements and consumer characteristics. *Meat Science, 97*(3), 310–315. https://doi.org/10.1016/j.meatsci.2013.07.029
Verbeke, W., Marcu, A., Rutsaert, P., Gaspar, R., Seibt, B., Fletcher, D., & Barnett, J. (2015). Would you eat cultured meat?': Consumers' reactions and attitude formation in Belgium, Portugal and the United Kingdom. *Meat Science, 102*, 49–58. https://doi.org/10.1016/j.meatsci.2014.11.013
Verneau, F., Caracciolo, F., Coppola, A., & Lombardi, P. (2014). Consumer fears and familiarity of processed food. The value of information provided by the FTNS. *Appetite, 73*. https://doi.org/10.1016/j.appet.2013.11.004, 140–14.
Wilks, M., & Phillips, C. J. (2017). Attitudes to in vitro meat: A survey of potential consumers in the United States. *PLoS One, 12*(2), Article e0171904. https://doi.org/10.1371/journal.pone.0171904