**REVIEW ARTICLE**

# Intrinsic and extrinsic attributes that influence choice of meat and meat products: techniques used in their identification

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## Abstract

The aim of this work was to determine the main sensory and non-sensory attributes that influence choice of meat and meat products, and to review the latest trends in sensory analysis techniques and consumer opinion studies. For this purpose, a literature review was carried out. Taste/flavour, texture, appearance, colour and odour were identified as the most relevant intrinsic attributes to influence acceptance. The presence of *fat* was very important for consumers. Of the most relevant extrinsic attributes, price, origin, production methodology, and certified control measures to preserve food safety and quality, are worth highlighting. Some studies also show interest in healthy natural products with some type of quality certification (credence attributes). Factors directly linked with individuals, such as age, gender or level of education, affect their perception. Women and people with a higher level of education are more aware of the diet-health relation, and older people are also concerned. For sensory analysis and consumer opinion techniques, a wide variety of methodologies is applied depending on studies' objective. Classic methods, newer quantitative techniques and/or qualitative techniques are often used alone or combined.

**Keywords** Meat products · Sensory attributes · Credence attributes · Consumer opinion · Sensory evaluation techniques

## Introduction

In the last 2 decades, global meat consumption has increased by 58% [1], and the growing world population most contributed to this circumstance, together with economic growth. The most marked growth in consumption occurs in developing countries, while is more contained in developed countries, even at minimal levels. Although the drivers that explain increased meat consumption follow an upward global trend, between 2019 and 2024, a shift towards poultry consumption and a slowdown in meat consumption growth in developed countries were predicted in 2018 [1].

Meat consumption has formed part of human culture for millennia and has been historically driven by the pleasurable experience of eating meat and its high nutritional value [2]. The identification of behaviour patterns in consumers is a formidable challenge given the countless variables involved in the purchase process. Consumers behave in line with not only their own characteristics (psychological, personal, social or cultural), but also with the environmental stimuli to which final customers are constantly subjected. This process can be complicated by the possibility of disappointing or satisfying consumer expectations once the purchase process has been completed. Therefore, the experience of consuming food begins long before product purchase and does not necessarily end once a product has been eaten [3]. Precisely defining which factors are involved in the quality of a product is a complex task, and it is essential to understand how consumers form quality judgements [4]. In the literature, a widespread consensus has been reached about the multidimensional nature of a product or service's quality assessment [5], and the interconnection between different types of attributes when consumers make their quality judgement [6]. According to Moser et al. [7], the attributes involved in perceived quality can be classified according to two criteria. The first criterion is based on whether these attributes are inherent to the product (intrinsic attributes) or not (extrinsic attributes). The second criterion is to classify them into 1-search attributes (they appear before the time of purchase), 2- those of experience (they appear after consumption) and

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3- those of belief (those related to health, type of production, environmental aspects, etc.) that are difficult for consumers to verify, even after the product has been consumed, due to lack of either technical expertise or practical possibilities [2, 8]. The consumers who choose what they buy based on extrinsic attributes do so regardless of uncertainty about product quality [9]. Consumers also make decisions to buy a product, or not, based on credibility or trust attributes [10], which some authors [9] consider to be a special group that forms part of extrinsic attributes. As quality perceptions are connected to consumers' knowledge, experience and personal beliefs, it is crucially important to translate consumers' subjective needs into objective product specifications. Ripoll et al. [11] established that the consumer quality perception process comprises two phases: the first is based on the perception of intrinsic attributes, such as colour and extrinsic attributes (i.e., packaging, origin, price, etc.), which are formed at the point of sale; the second is based on the experience formed while preparing and consuming the product (determined by physical quality attributes, such as flavour, odour and texture). Brunsø et el. [12] classified consumer quality appreciation into four categories: sensory, healthy/nutritional, type of processing and convenience.

Meat consumption patterns favour products that are healthier and produced in a sustainable way by respecting the environment and animal welfare. This falls in line with the production methods of organic meat or those of animal welfare certificates and products that are low in fat or salt [13]. Animal production impacts on the environment, the climate crisis and animal welfare have sometimes resulted in reducing the consumption of meat products and the search for alternatives made using plant-based ingredients, insects, or even lab-grown meat. These new trends have resulted in new or improved production lines, such as organic farming, meat production alternatives technologies like 3D printing and genetic modification [14]. Although consumers increasingly show an interest in aspects that have been discussed, food sensory properties remain one of the most important reasons why consumers select one food or another [15]. For the meat industry, knowing what consumers value the most is extremely important and, considering that consumption needs to change over time, it is necessary to analyse current trends that may mark forthcoming consumer expectations. The objectives of this work were to determine the main sensory and non-sensory attributes that have a decisive influence on choice of meat and meat products, and to review the latest trends in sensory analysis techniques and consumer opinion studies, applied to evaluate organoleptic characteristics and market studies of meat products.

## Materials and methods

A systematic review following the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines [16] was carried out to identify the intrinsic and extrinsic parameters that are most valued by consumers. Likewise, a compilation of the relevant sensory analysis techniques employed in sensory evaluations of meat products and the methodologies available to study consumer opinions was done.

### Search strategy

The employed research databases were Scopus, Web of Science and PubMed. The following search strategy was used: (meat products consumer quality perception) OR (meat products sensory analysis) OR (intrinsic extrinsic quality meat products). The period selected was between 2018 and 2022. The search results were exported to the EndNote reference manager.

### Inclusion and exclusion criteria

The following inclusion criteria were applied:

Type of document: peer-reviewed article.

Language: English.

Year of publication: 2018–2022.

Title and abstract: Word(s) referring to meat or meat products AND explanation related to sensory evaluation AND/OR consumer research.

Full text: The full text availability AND the use of sensory evaluation AND/OR consumer research as an important tool in the study AND an adequate description of the materials and methods and results of these types of analyses AND the relevance of the study for the objective of this work.

The following exclusion criteria were applied:

Type of document: books/book chapters, conference proceedings and reviews.

Title and abstract: No word(s) referring to meat or meat products OR meats that are not for mass consumption, such as camel, buffalo or llama OR no explanation related to sensory evaluation AND/OR consumer research AND information no relevant for the objective of the present work.

Full text: Articles that focus on very different areas from sensory evaluation AND/OR consumer research, such as works about food safety or toxicology AND articles of no relevance for the objective of the present work.

## Selection process

The selection process was based on other works [17, 18]. Two reviewers independently carried out the literature searches and removed records that did not meet the inclusion criteria for type of document and language. The results were then exported to EndNote to remove duplicate records. The remaining records were screened according to the inclusion and exclusion criteria in the title and abstract. Eligible articles were evaluated after considering the inclusion and exclusion criteria for full text, as mentioned above.

## Results and discussion

### Literature search results

The search in the databases (Scopus, Web of Science and PubMed) retrieved 2,645 references. A total of 422 records were removed (331 of them correspond to conference proceedings, books/book chapters or reviews, and 91 of them were not in English). After removing duplicates, 1391 records were subjected to title and abstract screening and 168 records were subjected for full-text screening. Finally, 129 articles met the inclusion criteria and were included in

the study (Fig. 1). Additionally, other research articles that had been reviewed by the authors in a previous study or that were referenced in retrieved articles, and which were not included in the search results, were considered because of their relevance in this study.

## Factors that influence consumers' perception of meat and meat product quality

### Intrinsic parameters

Intrinsic parameters are those that depend on a product's physical characteristics and nutritional composition, such as its appearance (colour, brightness, shape), taste, odour, texture and sound [8]. Banovic et al. [19] observed that repeated meat purchases ultimately depend on quality experience and are largely influenced by sensory attributes in beef. Consumer familiarity with the meat product influences the signals that tend to be used to determine quality. Consumers who are familiar with a product employ intrinsic attributes to assess its quality [2].

Tables 1 and 2 show the most relevant intrinsic quality attributes for consumers that were identified in this work: taste/flavour, texture appearance, colour and odour. For beef burgers, texture, flavour, odour, colour and appearance are mainly relevant for consumers [20, 21]. With pork meat,



**Fig. 1** Summary of the selection process of the included articles. Results of the systematic review

**Identification**

Records identified: n=2645
- Scopus (n=986)
- Web of Science (n=1030)
- PubMed: (n=629)

Records excluded: n=1254
- Language (n=91)
- Conference papers, book/book chapters, reviews (n=331)
- Duplicates (n=832)

**Screening**

Titles and abstracts screening: n=1391

- Records excluded after screening titles and abstracts: n=1223

**Eligibility**

Full text assessed for eligibility: n= 168

Records excluded (n=39)
- Full text not found (n=3)
- Records excluded after screening full text (n=36)

**Included**

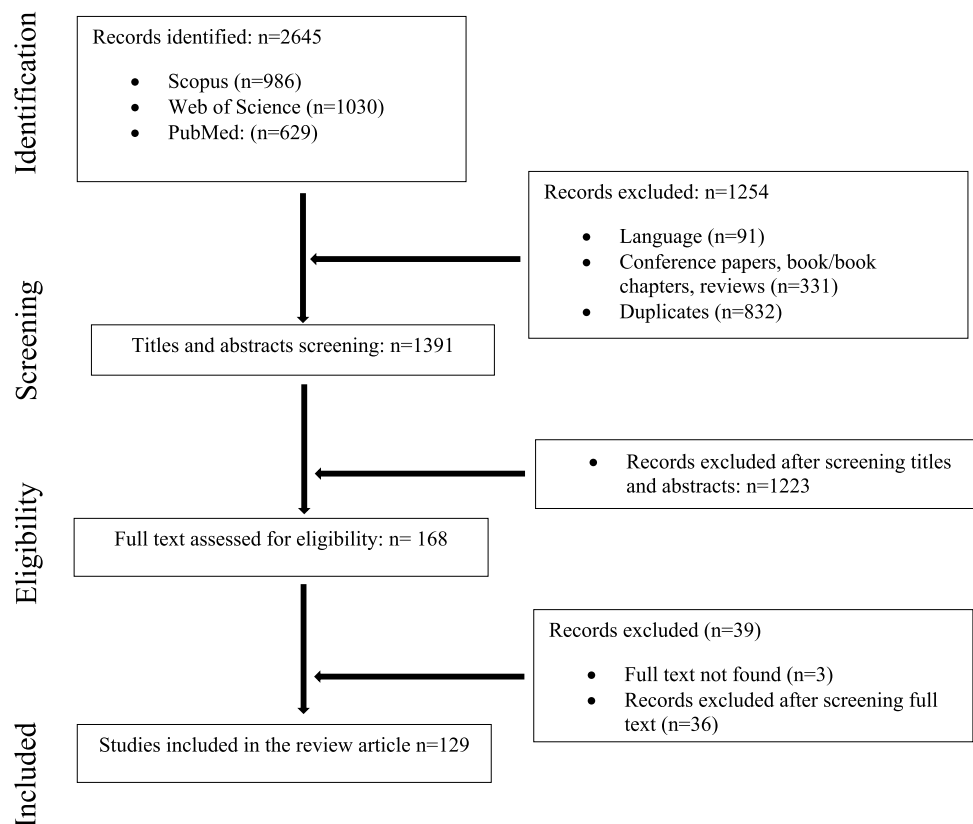Studies included in the review article n=129

**Table 1** Summary of the evaluation methods of relevant attributes in meat and meat products, and the moderating variables that affect consumers' quality perception

| Reference number | Authors | Country | Participants (consumers, unless otherwise specified) | Method | Attributes/moderating variables | Meat product |
|---|---|---|---|---|---|---|
| [11] | Ripoll et al. (2018) | Spain | 200 | "Online" survey/Likert scale 4p | Freshness, fat content, brand, category, price, easy-to-cook, breeding, origin, colour | Lamb meat, lamb confit |
| [20] | Soares et al. (2021) | Brazil | 80 | Hedonic scale 9p | Texture, colour, flavour, odour and appearance | Beef burgers |
| [22] | González-Mohíno et al. (2019) | Spain | 12<br>6<br>(Staff in the research centre) | Napping + Ultra Flash-profile (UFP) Quantitative Descriptive Analysis (QDA) | Appearance, odour, texture and flavour | Pork loin |
| [23] | Altmann et al. (2022) | Germany | 254 | Triangular tests | Colour | Pork loin |
| [25] | Foggiaro et al. (2022) | Spain | 38 | Hedonic scale 7p Preference test (1-to-3-point scale) | Appearance, cooked odour, firmness, juiciness, fatty appearance, flavour and overall liking | Pork burgers |
| [26] | Devatkal et al. (2019) | India | 120<br>50 (semi-trained panelist) | Preference test Hedonic scale 8p Paired comparison | Colour, flavour, tenderness, juiciness and overall acceptability | Chicken |
| [27] | Saldaña et al. (2020a) | Brazil | 21/81 | Repertory grid method/ Hedonic scale 10p Check-All-That- Apply (CATA) | Overall liking/Appearance, colour, flavour and odour | Chicken burger |
| [28] | Souza-Cócaro et al. (2019) | Brazil | 100 | Hedonic scale 9p Check-All-That-Apply (CATA) | General acceptance Appearance, colour, aroma, saltiness, flavour, juiciness, texture | Chicken burger |
| [29] | Sanah et al. (2020) | Algeria | 360 | Face-to-face interview | Tenderness, freshness, colour, origin, taste, nutritional value, price, accessibility for purchase, lack of information, consumption habits, ethical aspects | Rabbit meat |
| [31] | Aguayo et al. (2020) | Netherlands, China | 43/64 | Check-All-That-Apply (CATA)/Temporal dominance of sensations (TDS) | Texture | "Hot dog" sausages |
| [33] | Felderhoff et al. (2020) | United States | 1440 | Continuous linear ladder of 100 mm/Four discrete satisfaction levels | Flavour, juiciness, tenderness, overall liking and satisfaction/Satisfaction | Beef |

**Table 1** (continued)

| Reference number | Authors | Country | Participants (consumers, unless otherwise specified) | Method | Attributes/moderating variables | Meat product |
|---|---|---|---|---|---|---|
| [35] | Lorido et al. (2018) | Spain | 7 (staff in the research centre) | Flash profile Time-Intensity (TI) Temporal dominance of sensations (TDS) | Colour, appearance, fat, odour, flavour, taste, texture | Dry cured loin |
| [36] | Di Vita et al. (2019) | Italy | 499 | Conjoint analysis | Overall flavour, texture, salty taste, bitter taste, odour, hardness, flavour Salty, flavour, texture Salt content, presence of nitrites, price and fat content/odour, taste, freshness, colour, juiciness, texture | Cured meat |
| [37] | Cruz López et al. (2022) | Italy | 100 | Hedonic scale 7p Check-All-That-Apply (CATA) | Taste, odour, texture, colour, fatty and appearance | Sausages with grasshopper flour |
| [38] | Hung and Verbeke (2018) | Belgium Netherlands | 208 107 | Hedonic scale 9p/Intensity scale 5p/Just About Right (JAR) 5p Auction | Overall liking/Appearance, colour, odour, taste, texture/Appearance, odour, colour, taste Willingness to pay (WTP) | Sausage and cured ham |
| [39] | Díaz-Caro et al. (2019) | Spain | 178 | Hedonic scale 5p Choice experiment | Appearance, odour, texture, taste and overall asessment Origin, type of feed, % Iberian breed, packaging, price | Iberian dry-cured ham |
| [40] | Lang (2020) | United States | 602 | Likert scales 10p | Taste, health, sustainability, cost, novelty. Food values, lifestyle, healthy eating, and food innovativeness | Hybrid meat products |
| [41] | Niewiadomska et al. (2020) | Poland | 450 | Computer-assisted Telephone Interviewing (CATI)/Food Choice Questionnaire (FCQ) Likert scale 5p | Taste, texture, appearance, colour, odour, healthy, convenience (easy-to-use), ethical concern, nutritional value, fat, price, familiarity, best before date, origin, method of production, … | Game meat |
| [43] | Rodrigues et al. (2022) | Brazil | 32 119 | Focus Group Check-All-That-Apply (CATA) | Appearance, aroma, taste and texture attributes | "Hot dog" sausages |

**Table 1** (continued)

| Reference number | Authors | Country | Participants (consumers, unless otherwise specified) | Method | Attributes/moderating variables | Meat product |
|---|---|---|---|---|---|---|
| [46] | Grasso et al. (2019) | United Kingdom | 60 | Hedonic scale 9p Check-All-That-Apply (CATA) | Texture, flavour, appearance, colour | Beef dumplings |
| [47] | Rodrigues et al. (2020) | Brazil | 120 | Hedonic scale 9p Just About Right (JAR) | Appearance, flavour, texture and overall quality/ Saltiness level | "Hot dog" sausages |
| [48] | Pellatiero et al. (2020) | Italy | 17 (trained assessors) 162 | Quantitative Descriptive Analysis (QDA) Hedonic scale 6p | Texture, flavour, odour/ Appearance, odour, flavour, texture and overall acceptability | Chicken and ground chicken meat |
| [49] | Honrado et al. (2022) | Spain | 8 expert sensory assessors/10 (trained panellists) | Hedonic scale 10p and JAR 5p Quantitative Descriptive Analysis (QDA) Sensory texture profile | Overall acceptability/Visual attributes (colour homogeneity, spices presence), odour, texture and flavour Taste/flavour, odour Visual attributes (dough homogeneity, spices presence), odour Texture | Rabbit sausages |
| [50] | Mohan et al. (2022) | India | 510 | Face-to-face interview | Freshness, colour, tenderness, juiciness, flavour Ritual slaughter, animal welfare and food safety | Chicken, Beef |
| [51] | Wang et al. (2019) | China | 6 (trained panel) | Quantitative Descriptive Analysis (QDA) | Aroma and flavour | Traditional bacon (Larou) |
| [52] | Meyerding et al. (2018) | Germany | 55 | Hedonic scale 9p Choice-based conjoint analysis | Odour, taste, tenderness, juiciness Willingness to pay (WTP) Quality labels, price, ethics labels, origin | Beef |
| [53] | Benešová et al. (2019) | Slovakia | 13 assessors 140 | Preference mapping Hedonic scale 9p | Colour, odour, consistency, flavour, and overall appearance | Ham |
| [54] | Saldaña et al. (2019a) | Brazil | 93 | Napping + UFP | Texture, appearance, odour, taste, liking | Smoked bacon |
| [55] | Katiyo et al. (2020) | South Africa | 863 | "Online" survey/Scales 7p and 5p | Price, odour, visible fat, use-by date, sell-by date, colour, brine, growth-hormones, free range, origin, brand and packaging | Chicken |

**Table 1** (continued)

| Reference number | Authors | Country | Participants (consumers, unless otherwise specified) | Method | Attributes/moderating variables | Meat product |
|---|---|---|---|---|---|---|
| [56] | Ortiz et al. (2020) | Spain | 253 | Hedonic scale 5p Choice test | Appearance, taste, texture, odour and overall assessement | Cured ham |
| [57] | Souza-Paglarini et al. (2020) | Brazil | 20/68/61 | Kelly's repertory grid/Temporary -Check-All-That-Apply (TCATA) Temporal dominance of sensations (TDS) Hedonic scale 9p | Saltiness, Bologna flavour, fat flavour, spicy, texture | Bologna sausage |
| [58] | Escobedo del Bosque et al. (2022) | Germany | 9/95 | Quantitative Descriptive Analysis/Hedonic scale 9p Check-All-That-Apply (CATA) | Appearance, taste, aroma, texture/Overall liking | Chicken meat |
| [59] | Montoya et al. (2022) | Colombia | 387/8/87 | Likert scale 7p/Quantitative Descriptive Analysis (QDA)/Hedonic scale 9p/ JAR (scale 3p) (Home Use Test) | Healthy, probability of purchase and general acceptance/Appearance, aroma, flavour, texture and fatty sensation/Colour, texture, flavour and fat level | Chicken and pork meatballs |
| [61] | Čandek-Potokar et al. (2020) | Germany | 10 (trained assessors) | Quantitative Descriptive Analysis (QDA) | (Boar taint) Appearance, odour, texture and taste/flavour | Dry-cured ham |
| [64] | Cardona et al. (2020) | Spain | 58 73 | Triangular tests Word association (WA) | Fat Colour, appearance, fat content, point of sale | Pork meatballs Minced meat |
| [65] | Indrawan et al. (2021) | Indonesia | 400 | Choice-based conjoint experiment | Freshness, food safety certification, label (production date, name and certification type), price | Chicken meat |
| [66] | Kiran et al. (2018) | India | 260 | Survey | Colour, texture, freshness, meat safety, quality, animal welfare, ritual slaughter, nutritional quality | Meat |
| [67] | Udomkum et al. (2018) | Democratic Republic of Congo (DRC) | 309 | Survey Likert scale 5p | Colour, odour, texture, availability, price, quantity, unhealthiness, and harmful effects. WTP | Meat products including beef, pork, goat, chicken, and rabbit |

**Table 1** (continued)

| Reference number | Authors | Country | Participants (consumers, unless otherwise specified) | Method | Attributes/moderating variables | Meat product |
|---|---|---|---|---|---|---|
| [68] | Hawthorne et al. (2020) | Germany | – | Check-All-That-Apply (CATA) Intensity scale 5p | Colour, appearance, odour, product presentation, overall impression and liquid discharge | Fresh meat: pork and boneless pork loin |
| [69] | Silvestri et al. (2020) | Italy | 447 | Questionnaire Likert scale 6p | Colour, cut, fat, origin, price, quality certification, brand, nutritional value, freshness, taste, texture, odour, healthiness and safety | Beef |
| [70] | Groot et al. (2021) | Brazil | 51/97 | Free Elicitation Method (FEM) Best–Worst Discrete Choice Experiment (EEDMP) | Colour, flavour, texture and price | Beef |
| [71] | Vitale et al. (2014) | Spain | 8 (trained panel) | Scale 8p | Colour | Beef |
| [72] | Battagin et al. (2021) | Brazil | 1457 | "Online" survey/Verbal scale 4p | Colour and freshness Price and ease of preparation | Lamb meat |
| [75] | Merlino et al. (2018) | Italy | 401 | Face-to-face interview (Best-worst scaling questionnaire) | Price, animal welfare, brand, colour, country of origin, nutritional information, organic label, quality certification, animal breed, taste/flavour, tenderness, traceability | Beef |
| [76] | Saldaña et al. (2019b) | Brazil | 100 | Check-All-That-Apply (CATA) Hedonic scale 9p Ideal Profile Method (IPM) | Fatty, appearance, colour, aroma, taste, texture/ Overall liking | Smoked bacon |
| [77] | Bernabéu et al. (2018) | Spain | 400 | Conjoint analysis (card scoring in Likert scales 10p) | Origin, type of meat, PGI (Protected Geographical Origin) certification, price, production method | Lamb meat |
| [78] | Kung et al. (2021) | Taiwan | 1042 | "Online" survey/Likert scale 6p | Taste, certification seals, price, texture, appearance, colour, cut, safety, animal welfare, quality, origin, process, brand, packaging, place of purchase. WTP | Pork |

**Table 1** (continued)

| Reference number | Authors | Country | Participants (consumers, unless otherwise specified) | Method | Attributes/moderating variables | Meat product |
|---|---|---|---|---|---|---|
| [80] | Vecchiato et al. (2021) | Italy | 249 | Hedonic scale 9p/Contingent valuation method (CVM) | Odour, taste, texture, appearance, and general acceptance Willingness to pay (WTP) | Canned beef |
| [81] | Kallas et al. (2019) | Spain, Croatia, Italy, Slovenia | 121 | Food Neophobia Scale (FNS)/Non-hypothetical discrete choice experiment (NH-DCE) Hedonic scale 9p | Neophobia/Price (Purchase intent, WTP)/ Expected liking | Pork patties |
| [83] | Troost and Kirsten. (2022) | South Africa | 42 | Auction/Hedonic scale 9p | Type of cut, age of animal, price/Flavour, juiciness, tenderness and overall liking. WTP | Sheep |
| [86] | Lee et al. (2019) | Korea | 1061 | Sales data of and "online" retail | Geographical indication, price and certifications | Foods |
| [87] | Saldaña et al. (2020) | Brazil | 150/95 | Word association (WA) Projective mapping Conjoint analysis/Scales 10p and 5p | Healthiness (natural, or artificial), context of consumption and convenience (shape) Expected quality, purchase intent | Smoked bacon |
| [88] | Vidal et al. (2020) | Brazil | 70 | Hedonic scale 9p Sorting task Word associations (WA) Likert scale 5p | Overall liking/Grouping accoding to concept of health/Health concern | Salting of meat |
| [89] | Polizer-Rocha et al. (2019) | Brazil | 164 | Scale 7p/Sorting task and hard laddering | Healthiness, nutritional value, willingness to taste/ Fat, healthy, additives , safety, nutritional quality, flavour | Frankfurt-type sausages |
| [92] | Paiva et al. (2022) | Portugal | 491 | "Online" and face-to-face survey/Likert scale 5p | Environmental aspects, animal welfare, religion, place of purchase, texture, taste/flavour, freshness, origin, colour, appearance, fat, expiration and packaging date, price, animal breed | Beef |
| [93] | Talens et al. (2022) | Spain | 8 | Quantitative Descriptive Analysis (QDA) | Colour, appearance, odour, chewiness, juiciness and pastiness | Hybrid meat products |

**Table 1** (continued)

| Reference number | Authors | Country | Participants (consumers, unless otherwise specified) | Method | Attributes/moderating variables | Meat product |
|---|---|---|---|---|---|---|
| [94] | Tárrega et al. (2020) | Spain | 251 | Word association (WA)/ Hedonic scale 9p/Likert scale 5p | Ethic, health, environment/ Expected liking/Purchase intention | Beef and vegetable burgers |
| [95] | Torquati et al. (2018) | Italy | 252 | Discrete Choice experiment (DCE) Hedonic scale 9p | Meat type, organic, reared in a traditional rural landscape, processing mehtod, PGI certification, packaging, price, overall liking, appearance, odour, flavour and texture | Tinned beef |
| [96] | Angón et al. (2022) | Spain | 100 300 | Hedonic scale 9p Conjoint analysis | Colour, taste, odour, juiciness, tenderness and overall assessment Price, origin, animal welfare, PGI, organic production | Beef |
| [98] | Hong et al. (2021) | China | 431 | Choice-based conjoint (CBC) experiment | Nutrition claims, origin and price/WTP | Pork sausages |
| [99] | Caroprese et al. (2020) | Italy | 101 | Focus group Likert scale 7p | Geographical origin, animal welfare, taste, brand, production method, ethical aspects, healthiness | Lamb meat |
| [100] | Meier et al. (2021) | Switzerland | 108 | Hedonic scale 9p Questionnaire (opened questions) | Overall liking Willingness to pay (WTP), purchase intent Organic | Pork salami |
| [103] | Gaspar et al. (2022) | Spain | 1501 | Discrete choice experiment | Label (animal welfare, organic, carbon footprint, Protected Origin Denomination (DOP)), origin, seal (black, red,...), traceability, price | Iberian cured products |
| [108] | Czine et al. (2020) | Hungary | 12/477 | Focus group Discrete choice experiment (DCE) | Price, meat origin label, Mangalica meat content, point of sale | Pork sausage |

**Table 1** (continued)

| Reference number | Authors | Country | Participants (consumers, unless otherwise specified) | Method | Attributes/moderating variables | Meat product |
|---|---|---|---|---|---|---|
| [109] | Grubor et al. (2021) | Serbia | 449 | Questionnaire/Likert scale 5p | Quality, prices, assortment, and moderating variables (proximity of the point of sale to home, convenience of the store, schedules compatible with the working day,…) | cured meat |
| [110] | Panea and Ripoll (2020) | Spain | – | – | Safety, apperance, colour, texture, flavour, perception and environment | Beef, lamb, chicken |
| [112] | Lignou et al. (2021) | United Kingdom | 12 (trained assessors)/130 | Quantitative Descriptive Analysis (QDA) Hedonic scale 9p and Just About Right (JAR) 5p | Meat package attributes: Appearance, colour, texture, easy-to-use/Appearance, design, feel, overall/ Strenght of the package and naturalness | Fresh meat packaged with containers made of different materials |
| [113] | Schnettler et al. (2018) | Chile | 411 | Conjoint analysis | Meat source, packaging, origin, price and functional ingredient claims | Pork, turkey and lamb |
| [114] | Alves et al. (2022) | Brazil | 297 | Hedonic scale 9p Questionnaire Food Technology Neophobia Scale (FTNS) | Overall acceptance Purchase intent Food neophobia | Beef and lamb meat |
| [118] | Conroy et al. (2018) | Ireland | 228 | Scale 8p (Hedonic and intensity) | Flavour, texture and acceptability/spiciness, texture, flavour, saltiness | Corned beef |
| [122] | Boito et al. (2021) | Brazil, Spain | 1039/314 | Self-administered interviews/Likert scale 5p | Appearance, colour, freshness, tenderness, fat, origin, feeding system, age and sex of the animal, date and place of slaughter | Beef |
| [127] | Carabante et al. (2018) | United States | 150 118 | Hedonic scale 9p JAR 5p Intensity scale 5p/CATA | Overall liking, appearance, aroma, flavour, tenderness, juiciness/Tenderness and juiciness Consumer emotional profile Purchase intent | Beef |
| [45] | Grabez et al. (2020) | Norway | 8 (Staff in the research centre) | Napping + Ultra Flash-profile (UFP) | Flavour, texture, colour | Pork |

**Table 1** (continued)

| Reference number | Authors | Country | Participants (consumers, unless otherwise specified) | Method | Attributes/moderating variables | Meat product |
|---|---|---|---|---|---|---|
| [130] | Cubero-Dudinskaya et al. (2020) | Italy | 23 | Discrete choice experiment (DCE) Eye tracking | Price, halal seal, origin, protected geographical indication, animal feed, carbon footprint label, organic label, fat, protein content, format | Meat |
| [131] | Michel et al. (2021) | Germany | 1039 | Free association/Semantic differential scale 100p | Easy-to-prepare, healthy, natural, environmentally friendly, traditional, protein content, liking, price,… | Meat and meat alternatives |
| [132] | Kemper (2020) | New Zealand | 36 | Focus group | Health, price, environment, taste, nutritional, cognitive, cultural and affective aspects | Meat |
| [133] | Boimah et al. (2021) | Senegal | 38 | Focus group | Product form, price, point of sale, freshness, taste, quality, risk, health, religion | Chicken meat |
| [135] | Gluchowski et al. (2021) | Poland | 56 | QDA/Food neophobia scale 7p/ Hedonic scale 9p Check-All-That-Apply (CATA) Facial reader | Odour, flavour, taste and texture/Neophobia/ Appearance, flavour, taste, texture and overall liking/ Emotional attributes and taste | Combined dish with meat ingredient |
| [137] | Barragán-Hernández et al. (2020) | Colombia | 400 | Survey Hedonic scale 5p | Colour, fat, appearance, purchase intent | Beef |
| [138] | Casal et al. (2018) | Spain | 110 | Hedonic scale 9p Conjoint analysis | Overall liking, texture, odour and flavour/Feeding, production system and price | Pork |
| [139] | Juzl et al. (2018) | Slovakia | 8 (trained panel) | Hedonic scale 100 mm | Colour, appearance, texture, juiciness, aroma, taste | Beef and pork frankfurters |
| [140] | Nawi et al. (2018) | Malaysia | 503 | Questionnaire Likert scale 7p | Halal certificate, transparency, quality, confidence, food safety and knowledge, country of origin | Meat and meat products |
| [141] | Montero-Vicente et al. (2018) | Spain | 749 | Positioning image analysis CATI Likert scale 5p | Fat, healthy, price, taste | Rabbit, beef, pork, turkey and lamb |

**Table 1** (continued)

| Reference number | Authors | Country | Participants (consumers, unless otherwise specified) | Method | Attributes/moderating variables | Meat product |
|---|---|---|---|---|---|---|
| [142] | Chong et al. (2019) | Ireland, Great Britain | 360 | Scale 100 mm (Hedonic and intensity) | Palatability traits: aroma, tenderness, juiciness, flavour, overall liking/WTP | Beef |
| [143] | De Andrade et al. (2019) | Brazil | 202 | Hedonic scale 9p/Check-All-That- Apply (CATA) | Overall liking/Colour, taste, texture, fatty | Sheep meat coppa |
| [144] | Djinovic-Stojanovic et al. (2019) | Serbia | 3291 | Hedonic scale 5p Questionnaire | Salt, taste, fat | Chicken and beef salami |
| [145] | Kessler et al. (2019) | Denmark | 100 | Hedonic scale 9p CATA | Overall acceptability/Taste, texture, fat, familiar, artificial, well balanced, quality | Snack sausages |
| [146] | Lorido et al. (2019) | Spain | 15 (experienced assessors) | Temporal Dominance of Emotions (TDE) (intensity scale 10 cm) Temporal Dominance of Sensations (TDS) | Emotions (intense, authentic, pleasant, ordinary, indifferent, dissatisfied, desirable,...)/Overall liking | Iberian, Serrano and Curado dry-cured ham |
| [147] | Predanocyová et al. (2019) | Slovakia | 498 | Questionnaire | Price, taste, nutritional value, freshness, country of origin, package, producer,... | Poultry, pork and beef meat and meat products |
| [148] | Sharma et al. (2019) | United States | 147 6 (trained assessors) | Hedonic scale 9p CATA Open-ended questions Descriptive quantitative analysis | Appearance, aroma, flavour, texture, aftertaste/Colour, fat, flavour, texture/ Appearance, aroma, flavour, texture | Smoked pork |
| [149] | Gutkowska et al. (2019) | Poland | 1004 | Questionnaire (closed-ended and open-ended questions) | Taste, healthy, easy-to-prepare,... | Beef |
| [150] | Kaygisiz et al. (2019) | Turkey | 506 | "Online" questionnaire | Price, health, animal welfare and protection of the environment | Chicken (organic) |
| [151] | Brunoro et al. (2020) | Brazil | 2.949 | Interviews | Quality control stamp, traceability, certified origin, price, fat, easy-to-prepare, texture, odour, colour, rearing system, breed, nutritional value, wastes, flavour, safety, ... | Beef |

**Table 1** (continued)

| Reference number | Authors | Country | Participants (consumers, unless otherwise specified) | Method | Attributes/moderating variables | Meat product |
|---|---|---|---|---|---|---|
| [152] | Saldanha-Escobar et al. (2022) | Brazil | 381 | Interviews/Likert scale 5p | Appearance, odour, taste, colour, type of cut, softness, price, brand, no hormones, animal wellfare | Beef |
| [153] | Guzek et al. (2020) | Poland | 1009 | Computer-Assisted Personal Interview (CAPI)/Open-ended questions/Closed-ended questions (Likert scale 7p) | Origin, production technology, manufacturer, components and nutritional value, visual and sensory characteristics (flavour), expiry date, cost | Meat products |
| [154] | Palma et al. (2018) | United States | 218 | Discrete Choice experiment (DCE) | Production method, tenderness, quality grade, origin, growing technology and price. WPT | Beef |
| [155] | Rodriguez (2020) | United Kingdom | 20 | Soft-laddering interviews | Regionality-origin, brand, identity | Lamb |
| [156] | Sardi et al. (2020) | Italy | Panel of trained experts | Intensity scales 0-10 | Colour, marbling, tenderness, juiciness, chewiness, aroma, off-flavours | Pork |
| [157] | Pinto da Rosa et al. (2021) | Brazil | – | Temporal Dominance of Sensations (TDS) | Taste and texture. Production method, price, packaging, labelling | Chicken |
| [158] | Smetana et al. (2021) | Germany | 136 | Hedonic scale 9p/Just About Right (JAR) 5p/Scales 5p and 6p | Appearance, odour, taste and overall impression/Bite firmness, colour, flavour, taste/Willingness to buy, WTP | Burgers made of beef, meat analogues, hybrid meat products and insects |
| [159] | Solomando et al. (2021) | Spain | 14<br>154<br>17 | Quantitative Descriptive Analysis (QDA)<br>Hedonic scale 5p<br>Temporal dominance of sensations (TDS) | Appearance, colour, odour, flavour, salt, texture<br>General acceptance, purchase intent, nutritional information<br>Taste, flavour, texture, oiliness | Sausages cooked and cured |

**Table 1** (continued)

| Reference number | Authors | Country | Participants (consumers, unless otherwise specified) | Method | Attributes/moderating variables | Meat product |
|---|---|---|---|---|---|---|
| [160] | Alanís et al. (2022) | Mexico | 332 | Face-to-face interview/ Multiple choice questions/ Likert scale 5 p | Willingness to pay (WTP)/ Healthy, safety, organic, local, animal welfare, packaging,.../Odour, taste, juiciness, tenderness, appearance, nutritive value, locally produced, origin | Sheep meat |
| [161] | Enthira et al. (2022) | Malaysia | 30 384 | Open-ended interviews Survey (Likert scales 5p) | Personal, psychological factors cultural and societal factors Internal and external factors related to purchasing roasted chicken products | Fried and roasted chicken |
| [162] | Font-i-Furnols et al. (2022) | Spain | 32/252 | Focus group, questionnaire, hedonic semi-structured scale 10 cm/Likert scale 7 p | Overall liking and willingness to buy/Opinion related to castration | Pork |
| [163] | Magalhaes et al. (2022) | Spain | 77 | Focus group | Healthy, taste, flavour, nutritional value, texture, colour, freshness, fat, price, expiration date, point of sale, safety, packaging, origin, traceability,... | Beef |
| [164] | Thangavelu et al. (2022) | Ireland | 548 | "Online" survey/Likert scale 7p | Flavour, texture, eating quality, health, palatability | Phosphate-reduced processed meat product |

(p: points)

**Table 2** Studied attributes in the selected articles

| Attributes | Number of mentions in articles |
|---|---|
| **Intrinsic** | |
| Taste/Flavour | 81 |
| Texture | 77 |
| Appearance/freshness | 46 |
| Colour | 45 |
| Odour/aroma | 43 |
| Fat | 24 |
| **Extrinsic** | |
| Price | 45 |
| Production method/animal welfare/organic | 30 |
| Origin | 28 |
| Healthy | 19 |
| Quality certifications/food safety | 31 |
| Label information | 6 |
| Packaging/presentation/format | 13 |
| Best before/expiry date/used by/sold by | 7 |
| **Moderating variables** | |
| Environment/social/ethics/Emotional/religious | 25 |
| Additives/salt/nutritional value | 23 |
| Meat type/meat product/type of cut | 11 |
| Familiarity | 6 |
| Point of sale | 8 |
| Availability | 2 |
| Neophobia | 3 |
| Easy to prepare | 6 |

Texture includes tenderness and juiciness

texture and flavour were highly appreciated [22–24], and texture attributes like firmness and juiciness, together with appearance, flavour and odour during cooking, were very important for consumers for pork burgers [25]. In works on chicken meat, tenderness and juiciness strongly influenced their preference, together with flavour and colour [26]. General chicken burger acceptance was also influenced by texture, with juiciness being the main textural attribute, connected to appearance, colour, aroma, saltiness and flavour [27, 28]. Sana et al. [29] concluded that with rabbit meat, tenderness was a key driver for its consumption, who also considered other intrinsic attributes, such as taste and freshness.

Texture is a very important eating quality attribute for overall consumer judgement, which is assessed during consumption. Texture gathers several attributes like juiciness, tenderness etc. [30, 31]. Physical attributes, such as moisture, fat content, particle size, among others, are mainly important for consumers' perceived texture. Biswas et al. [32] pointed out that haptics can impact taste, and not only

oral haptics, but also through product texture. In a study carried out to assess knowledge of the main drivers that influence overall beef acceptance, taste, followed by tenderness and juiciness, were the attributes that most influenced consumer satisfaction [33, 34]. With dry cured pork loin textural aspects, hardness is considered especially important, but also its intensity while consuming the product [35]. A study into quality and components with potential negative health effects on cooked ham (fat, salt, nitrite content) observed that tenderness, aroma and texture were equally important as sensory attributes. It also concluded that the most relevant attributes for consumers of such products were texture and colour [36].

Taste is commonly evaluated to assess the acceptability or quality of meat and meat products [35, 37–40], having in some studies, the greatest impact on the frequency of the product consumption [41]. Schulze-Ehlers and Anders [42] highlighted the important role of taste as a differentiation tool in the supply chain and critically argued the need to focus not only on traceability and food safety aspects of pork meat, but also on improving intrinsic attributes. In final preparations, which use a meat product as the main ingredient (e.g., in hot dogs), taste remains an important quality characteristic for consumers [43], and also with more innovative meat products like fresh pork sausages with grasshopper flour [37]. Boncinelli et al. [44] highlighted the importance in functional beef of providing information about the production system as an effective strategy to homogenize taste heterogeneity and improve preference for enriched beef patties. Flavour is a combination of taste and odour. However, it is important to note that in some studies this term is used to refer to taste. Flavour is also a key parameter in the evaluation of the quality of meat and meat products [22, 26, 45–50]. Mohan et al. [50] found that flavour was an important eating quality after meat tenderness and juiciness.

Odour or aroma are also relevant attributes for consumers. Wang et al. [51] showed the relevance of aroma and flavour in meat products. Numerous investigations have included odour/aroma in studies on meat quality or meat product development [20, 22, 28, 35, 37, 39, 52–59]. Montoya et al. [59] stated that when meat products are purchased, aroma, appearance, texture and flavour become decisive factors. Escobedo del Bosque et al. [58] found a direct impact of aroma, flavour and texture parameters on overall liking. However, Damaziak et al. [60] observed that in chicken meat, taste showed the greatest influence on the overall liking, followed by tenderness and juiciness, while the effects of aroma and colour were less significant.

It is worth mentioning the importance of boar taint (a negative parameter that affects taste and odour) in the acceptance of pork meat and pork meat products. This parameter has been profoundly studied due to sensitive concerns that urge alternative solutions to the surgical castration

of piglets. Meat products made with meat from entire male pigs are rated the lowest acceptability, mainly due to odour and flavour [61]. Traditional curing processes are unable to mask these penalising quality characteristics, but the problem requires making more efforts to contribute to the sustainability of the whole value chain, because pork meat and meat products made with entire males are rejected due to the boar taint [62, 63].

Consumers firstly connect with product appearance at the point of sale. It is a searching criterion and contributes to consumers forming quality expectations, which influences quality experience [8]. Moreover, appearance is affected mainly by colour and fat content and distribution. For meat products, particle size also influences appearance [30]. In a study about minced meat, the authors stated that appearance and fat content are very important consumer attributes [64]. In that work, products were only visually evaluated, which might explain why other parameters, such as flavour or juiciness, did not come over as relevant characteristics. Appearance-related attributes can also generate negative consumer expectations, and even rejection [27].

It is worth noting that freshness not only implies aspects of appearance, but also of texture, juiciness, flavour, and odour. In line with this, for chicken meat, Indrawan et al. [65] reported that Malaysian consumers' willingness to pay was higher when meat was warm, because it was assumed that slaughter had been more recent. This was observed for selling channel, traditional point of sale and supermarkets.

Colour for meat and meat products is a highly appreciated attribute [64, 66, 67], especially with fresh meat products [68]. This is a key intrinsic attribute that impacts on purchase decision [6]. It is widely used as an indicator of safety and quality at the point of sale [55]. Colour depends on myoglobin meat content and oxidation state. For beef, colour is a relevant quality characteristic for consumers [69, 70] and monitoring colour changes during aging is of great importance for the industry [71]. It is also highly appreciated for beef and chicken burgers [20, 21]. Colour plays a key role in fresh pork acceptance. Thus, to avoid human-perceptible changes, techniques like computer vision are employed to control the homogeneity of this attribute [23]. Battagin et al. [72] stated that colour and freshness appearance are the most relevant intrinsic attributes. With the aim to produce healthier meat products, the study of Souza-Cócaro et al. [28], which focuses on lowering fat content in chicken hamburgers, concluded that colour is an attribute that impacts product acceptability.

Fat content influences sensory attributes. It is interesting to point out in a research work into beef cuts [73] that consumers visually appreciated several pieces with variable fat contents, and quality expectations were higher for leaner cuts. Nevertheless, when meat was cooked and these differences were not perceptible, quality experience increased

directly with fat content because intramuscular fat leads to greater tenderness and flavour. This fact reveals that fat content correlates positively with intrinsic attributes (i.e., taste and palatability), but negatively with extrinsic credence attributes, because high fat intake is negatively associated with health. It is noteworthy that fat content in different meat types is not known by most consumers, who tend to overestimate the real amount of fat. Most of the population believes that beef is leaner than pork meat. The reason for this is that fat is less visible in beef meat cuts [64, 73] than in commonly marketed pork pieces due to the cut of meat. Shan et al. [74] concluded that meat products made with fresh minced meat, which usually include a mixture of semi-lean carcass cuts and non-meat ingredients, are perceived rather less healthily than entire cured meat cuts like ham and bacon, because people believe that fresh minced meat has a higher fat content. Di Vita et al. [36] pointed out that high salt and fat contents, and addition of nitrites, dissuade final customers from purchasing them. Nevertheless, at the same time, consumers assume that flavour, colour and juiciness are closely associated with those ingredients [36].

Nevertheless, the most rated attributes differ for a meat type to which specific characteristics are attributed [2]. This is the case of the study carried out by Merlino et al. [75] on beef meat with consumers from the Piemont region in NE Italy. Considering the high Piemontese breed cattle quality, the attributes that consumers attach less importance to are organoleptic characteristics, such as taste, colour, odour or tenderness, because the usual buyers of this meat type assume certain quality characteristics. It is worth mentioning that almost 70% of the interviewees were regular consumers of Piemontese beef. This study also concluded that the consumers who normally buy in large stores were notably interested in meat colour. It has been also observed that the relevance of an attribute can depend on consumption frequency. This is the case of the study performed by Saldaña et al. [76], where consumers with a high consumption frequency positively valued the fatty and smoky aspects of bacon, while the other consumers valued attributes related to appearance and texture.

## Extrinsic parameters

This category includes the characteristics associated with the product, but do not form part of it, such as brand, labelling, price, packaging, seller, factors related to production system in which animals are raised, among others [8]. These characteristics help to create signs of credibility or trust, which influence consumers' quality expectations. Fernqvist and Ekelund [8] propose the following categories to group extrinsic quality signs: health, production methods, environment, local production and origin, quality certifications and other labels. Tables 1 and 2 show the most relevant extrinsic

attributes found in different studies, with characteristics such as price, origin, production method (including quality certifications that guarantee the quality controls followed during the manufacturing process), aspects related to the health–diet relation, as well as environmental and ethical aspects. The findings presented by Aboah and Lees [2] about the five main effective quality signs to communicate with consumers evidence that they are extrinsic in nature (country of origin, food safety certification, price, production method and quality certificates), but differ in importance depending on the meat type. These authors also state that lack of consumer familiarity with the meat product favours using such attributes to determine product quality. Accordingly, Akdeniz et al. [9] indicate that the consumers who choose what they buy according to (exclusively) extrinsic attributes do so with some uncertainty as to product quality.

In a study by Bernabéu et al. [77], whose purposes were to identify, explore and quantify consumer preferences for lamb meat depending on their (habitual or occasional) consumption frequency, the order of attributes from the most to the least importance were origin (domestic or imported), meat type (suckling or *ternasco*), certification (with protected designation of origin), price and production method (organic or conventional). Occasional consumers preferred meat to be organic and it having a quality certificate. Habitual consumers attached more importance to the fact that meat is national, because this comes over as an indicator of quality for them, and this increases that product's purchase intention. Therefore, in line with intrinsic attributes, consumption frequency impacts the order followed by consumers to prioritise extrinsic quality characteristics.

Price is an extrinsic quality dimension that appears among the most important ones according to several studies [8, 69]. Knowledge about the willingness to pay (WTP) for a product based on certain quality characteristics allows a consumer-oriented strategy to be aligned with concrete actions [52, 67, 77–84]. Through this review, it is shown how WTP is a powerful widely used tool to study consumers' meat and meat products acceptance, such as pork, beef, sheep, meat patties or tinned meat [52, 77, 79, 80, 82], and to explore purchase and repurchase intention.

Lee et al. [86] performed a study about the effect of extrinsic characteristics on online fresh product sales. They established a negative relation between price and sales volume. Battagin et al. [72] determined that the price of lamb meat and ease of cooking appeared to be important extrinsic variables for consumers.

Extrinsic parameters influence a product's holistic perception according to the results obtained by Saldaña et al. [87], where the healthy factor comes over as the most important one in consumer preference for smoked bacon with the "natural" claim on its label. The "natural" term has been associated with quality signs in meat products. Many of the articles retrieved focus on health concerns [25, 28, 36, 74, 88, 89]. Reformulation of meat derivatives improves this food category's healthiness perception [81, 90], although the meat product type to which they are applied contributes significantly to this assessment. As for the followed reformulation strategy, it is important to consider population segments' preferences, because some consumers better accept "the reduction" of ingredients considered to be unhealthy by contemplating that the resulting product is more like original meat, while others more positively value "addition of ingredients" depending on their judgement of the type of ingredient added to the meat derivative type. A study on preferences in processed meat products reformulation [74] observed that consumers were not in favour of altering the ingredients of the meat products that they classify as "natural", "low in fat/salt" or "healthy". Fermented sausages (salami, chorizo, pepperoni), bacon, beef burgers and chicken nuggets were generally cited as the least healthy options, while chicken cold cuts, braised turkey and herbal sausages (Irish pork sausage-type) were considered "not so bad", or even "healthy" given the "herbs" term. Lack of participants' nutritional knowledge about the production process of sausages and misconceptions of smoking or curing processes are also highlighted. In the study by Vidal et al. [88], consumers associated the characteristic taste of salt with thoughts and sensations that harm health, such as too much salt, fatty taste, salty taste, strange taste and high blood pressure, in addition to an association between less healthier products with those in which salt taste is characteristic. Finally, respondents are willing to buy low-salt ham or ham with 0% salt if its price is relatively low [91].

Regarding the relationship between animal production and the impact on the environment, in a study on consumer behaviour and beef preferences in Portugal, Paiva et al. [92] showed that although most consumers understand that meat consumption has an environmental impact, only 30% wish to reduce their meat consumption. Therefore, it is important to study the real impact that these types of attributes can have in relation to all the others on consumers' meat valuation. In this line, some authors [93–95] propose the partial replacement of meat as a strategy to reduce the above-mentioned effect. Angón et al. [96] studied the acceptability in meat products of more sustainable alternative production methods as replacement of cereals with inedible biomass for humans. This could reduce the environmental impact of livestock and reduce production costs.

As the evaluation of health or environmental concerns related to meat products is no easy task for consumers, product labelling can help to communicate these attributes, in which a larger proportion of the population is interested. Labels offer consumer information, such as origin, nutritional information, carbon footprint or production method [97]. Different authors study the effect of nutritional claims

[98] and production system information [99–102] on consumer acceptance. Gaspar et al. [103] investigated the effect of sustainability and traceability quality certifications on the preference for Iberian cured products in Spain. Animal welfare certification is another important information that can be found on labels. In recent decades, there has been a growing concern for animal welfare, as demonstrated by different studies on consumer perception [85, 101, 104–106]. It is worth mentioning that in the case of Iberian pig, this extrinsic quality cue is of great importance [106].

Caropese et al. [99] identified the relevance of ethnocentrism in consumer preferences for food from their area of origin. The study of Kumpulainen et al. [107] about the influence of origin on the quality evaluation of different foods demonstrated that despite the product not being attractive, locality and origin can increase their perceived quality. The results of Lee et al. [86] showed that products related to geographical indications are ordered more frequently from online sales channels. This may be due to the limited information available about intrinsic food characteristics for consumers who purchase online. For this reason, with online purchases, extrinsic attributes are exclusively used to evaluate the quality of products. Czine et al. [108] demonstrated that labelling a product with its origin positively influences consumer preferences. This work also revealed that, in relation to point of sale for meat, consumers prefer to buy directly from farmers than from butchers and, finally, from supermarkets. This might be related to the fact that some consumers associate meat and meat products purchased in butcher shops with better quality than those offered in supermarkets [64]. Product availability at points of sale also impacts consumer consumption habits. Sanah et al. [29] pointed out a reason for not consuming rabbit meat: the difficulty of finding this meat type in supermarkets and its consumption being practically related to purchases from local producers/butchers. In a study into the consumption frequency of cured meat products, Grubor et al. [109] highlighted that beyond certain intrinsic and extrinsic attributes, moderating variables like the proximity of points of sale to one's home and the compatibility between opening timetables with working days are relevant aspects for the purchasing frequency of this type of products.

Packaging type is also important for consumers of meat products because it can bring about changes in meat quality, especially its colour and flavour. Both these attributes are used by consumers to evaluate product freshness [110] and, as previously mentioned, consumers employ both these attributes to evaluate meat quality. The study by Ortiz et al. [56] on cured ham demonstrated that vacuum packaging is preferred to modified atmosphere packaging, and consumers are willing to pay more for vacuum packaging, but this depends on their age. Other results obtained from this study revealed the reasons why vacuum packaging is preferred:

better appearance, colour and brightness, and being more environmentally friendly for containing less plastic waste. The packaging colour chosen for a product can arouse certain consumer emotions, even before tasting food. One study showed that the influence of packaging colours is significant, and participants feel different emotions to the stimulus of distinct colours. It concluded that the emotions evoked by food and packaging have a temporal dimension that is not related to the intrinsic attributes of food itself [21]. A study into the satiating effect of certain foods packaged in sustainable packaging found a direct relation between a stronger satiating effect and the sustainable nature of packaging [111], because higher quality was assigned to sustainable packaging. Lignou et al. [112] conducted a study on the sensory evaluation and acceptance of different types of fresh meat packaging, including several proposals that involved more sustainable materials. These authors reported that consumers value size and design more.

Another work that evaluated the importance of different factors, such as animal species, region of origin, packaging type, price and functional ingredients in processed meat products, concluded that animal species for consumers are more important than packaging type, region of origin, price or claims of functional ingredients [113].

Food neophobia or unwillingness to eat new or unfamiliar foods could also affect the acceptability of new meat products [97, 114, 115]. Therefore, this aspect should also be considered in the development of new products.

## Variables linked with consumer type

Some studies state that there are no common consumers' behavioural patterns for meat, because each meat type has its own consumer profile [116]. Segmentation is most important for guiding innovation and communication strategies within the national scope and internationally [117]. Segmentation allows not only the population that may consume a concrete meat type to be identified, but also the main reasons why they are not consumed by another concrete population segment to occupy market niches to be understood.

Variables directly related to consumer type, gender, age, family unit to which they belong, level of income, level of education, etc., should be considered. Battagin et al. [72] link the consumption habit of certain meat types to sociodemographic factors, such as social status and interest in experimenting with "gourmet-type" products. Some studies reveal that women may be more concerned about nutrition and health [64] and are more sensitive to changes in intrinsic attributes than men [33]. Accordingly, Silvestri et al. [69] observed that older women (between 50 and 60 years old) seek quality and food safety in the products they buy, are more aware than men of food risks and are concerned about the importance of food safety. When shopping, women are

more interested in easiness of cooking lamb meat in Brazil, perhaps because the women participating in the study were those who spend more time cooking [72]. This research work also identified that the profile of the consumers who purchase this meat type was made up of middle-aged men whose level of income falls in the study's upper range, they were familiar with animal species and were willing to experience "gourmet-type" food. Another research work related to the gender variable is that by Sanah et al. [29], which linked lower rabbit meat consumption with women due to ethical aspects.

In age terms, Felderhoff et al. [33] carried out a work in the USA to determine the attributes that most affected sensory beef properties when consumed. They concluded that older groups (41–60 years) prefer tenderness, while younger ones (20–40 years) prioritise juiciness. By focusing on how different age groups react to salt and fat reduction in a traditional Irish product, such as breakfast sausages, Conroy et al. [118] noted that the age group of 18–40 years reject samples with less fat (30% reduced fat) because of the meat taste attribute. The same can be stated for the low-salt samples because of the juiciness and flavour characteristics. The 41–64-year-old age group accept low-fat products and better value new product formulations. These findings fall in line with the results obtained by Cardona et al. [64], who concluded that older people are more concerned about nutrition and health, which is consistent with the fact that the younger group do not accept low-fat and low-salt samples. Nevertheless, the participants in the group aged more than 65 years only accept the fat-control sample (original sausage), because they do not like the low-fat samples because of their texture and do not relate them to the original breakfast sausage flavour. Nor do they like the flavour of low-salt samples. This is perhaps because as a person ages, they lose their senses of taste and odour, which might accentuate the negative effects of low fat/salt. Accordingly, Tam et al. [119] pointed out that product design strategies should jointly consider both intrinsic and extrinsic attributes to overcome sensory disabilities to empower products' healthy aspects with an ageing population.

Some studies have shown that level of income also affects consumer preferences [33, 77]. In the study carried out by Felderhoff et al. [33], level of income was another considered aspect: consumers with a higher level of income are more sensitive to changes in tenderness, but those with a lower level of income are more aware of juiciness and/or flavour.

In relation to level of education, Špička et al. [120] investigated consumer behaviour as regards the retail sale of Czech pork. They concluded that people with a low level of education are more sensitive to price than those with a higher one. This might be because these consumers may also have a higher level of income, although this point was not evaluated in their work. Mendoza et al. [121] studied the behaviour of, and attitude to, a low-salt product to find that men and people with a low level of education are less interested in the health-related issues, such as this type of food. For cured meat products, Di Vita et al. [36] stated that people with a high level of education pay more attention to not only the additive content of processed meat, but also to the product's origin, but do not attach as much importance to fat content. Kung et al. [78] pointed out that men with a lower level of education stock up larger quantities of pork at once and show a more marked purchase intention than men whose levels of education and income are higher, and who space out purchases and are more inclined to buy more "premium" pork.

According to existing consumer awareness about the impact of high meat consumption on health, Apostodilis et al. [97] described three consumer types: empowered (habitual consumers who consider their purchases to be "votes"), those who reduce their consumption (flexitarians) and anti-consumers (vegans or vegetarians). When the first group must choose, it decides according to the origin of meat, price does not strongly influence them, and they are willing to pay for healthier and more sustainable premium products. Their trust in a brand is evident for being willing to choose a product that is meat-free (based on vegetable proteins) if it is of the brand they trust. Flexitarians mostly reduce meat consumption for health reasons and personal convictions and rely on fat content and origin to base their purchase choices. Anti-consumers may decide on a meat-free diet if they feel that certain meat products do not match their lifestyle, ideologies and beliefs. Most of the people in this group are young, have medium levels of income and are women.

Regarding lifestyle and eating habits, Ripoll et al. [11] focused their research work on light lamb meat. The purposes of their study were to identify the profiles of lamb meat consumers according to their orientation towards convenience, characterise these profiles in accordance with their socio-economic characteristics and their preferences for the intrinsic and extrinsic quality signs of lamb meat, and analyse their WTP for a premium lamb cut. They identified four different consumer types: "gourmet", "disinterested", "conservative" and "basic". Some of their findings indicated that fat content, related to intrinsic attributes like flavour and palatability and to extrinsic cues like health, is the most important characteristic for each population segment. Other aspects like origin and certifications related to origin are very much appreciated. Lamb breed does not appear to be very important for consumers, but they positively rate the lamb meat from their own region.

Many other variables are directly related to consumers, such as nationality, [36, 76, 122], religion [29], etc., and they can influence the perception of meat products and

should, therefore, be considered to direct efforts in one direction or another, depending on the target market.

By way of conclusion, intrinsic and extrinsic characteristics affect perceptions of quality and differ at the time they form. Prior to purchases, although characteristics related to the manufacturing process, healthy aspects, appearance and other intrinsic quality parameters make similar contributions to the formation of quality expectations, intrinsic characteristics and physical attributes influence experiences after product intake and are shown as the most decisive [90] for repeat purchases. Kallas et al. [81] indicated the homogenising effect of sensory experience on reducing neophobia of new meat derivatives made from fresh minced meat. Zhang et al. [123] pointed out that extrinsic characteristics help to narrow the gap between quality expectations and quality experienced by consumers. This gap is determined by aspects like consumer needs, socio-demographic aspects or previous experiences. Garrido et al. [82] highlighted that, although the order in which extrinsic and intrinsic attributes are presented does not affect the WTP of a product, it affects the relative importance that consumers attach to each one in WTP terms. As there are no common consumers' behavioural patterns for meat, segmentation becomes a very important tool for guiding innovation and communication strategies.

## Techniques employed in sensory evaluations and consumer opinion research

Theoretical conceptualisations about the quality of a product unanimously agree about its multidimensional nature [5]. Intrinsic and extrinsic characteristics evoke different consumer responses that, together, determine purchasing behaviours. A balance between consumer opinion and behaviour research, together with sensory assessment, and employing an appropriate combination of the techniques used to accomplish both research aspects, seem the most appropriate options to study the consumer quality perception process [124]. Some of the most relevant techniques in the agri-food field, specifically in the meat sector, are described and depicted in Table 3.

Among sensory analysis methods, affective hedonic tests (i.e., acceptance and preference tests) are widely used to improve products. In the present review, affective hedonic tests appear on 47 occasions. Applying hedonic scales is common to determine the degree of product acceptance, and information can be obtained about what aspects or attributes make consumers like a product or not [125]. There are different types of scales that researchers can consider, because there are inherent limitations to the "calibration" of people as measurement tools, because not all of them offer the same sensitivity or response to stimuli. Scales with fewer anchor points allow test performance to be simplified, but people's

**Table 3** Sensory evaluation and consumer research methodologies found in the selected articles

| Technique | Number of mentions in articles |
|---|---|
| Scales | 70 |
| JAR | 7 |
| Paired comparison | 1 |
| Triangular test | 2 |
| Projective mapping | 1 |
| Napping + Ultra Flash Profile (UFP) | 3 |
| QDA (Quantitative Descriptive Analysis) | 11 |
| Flash profile | 1 |
| IPM (Ideal Profile Method) | 1 |
| CATA (Check-All-That-Apply) | 14 |
| TCATA (Temporal CATA) | 1 |
| TDS (Temporal Dominance of Sensations) | 6 |
| Time intensity | 1 |
| TDE (Temporal Dominance of Emotions) | 1 |
| Conjoint analysis | 9 |
| DCE (Discrete Choice Experiment) | 6 |
| Best–worst discrete choice | 2 |
| Hard laddering | 1 |
| Soft laddering | 1 |
| WA (Word Association) | 5 |
| Focus group | 7 |
| Free elicitation method | 1 |
| Questionnaire/Survey | 21 |
| Interview/CATI (Computer-Assisted Telephone Interview)/CAPI (Computer-Assisted Personal Interview) | 10 |
| Auction/Contingent valuation method | 3 |
| Facial reader | 1 |
| Eye tracking | 1 |

tendency to avoid categories of extremes must be considered. The nine-point hedonic scale (1: I dislike it extremely – 9: I like it extremely) is an important tool to evaluate acceptability in the food industry, because it not only allows to classify products, but also to analyse differences in their acceptance [126], although other types of scales are also applied. These are classic sensory analysis techniques but are still widely used today in the agri-food sector in general, and in meat products. This is exemplified in the different studies carried out in recent years, such as the work by Souza-Cócaro et al. [28], where a nine-point hedonic scale was applied to evaluate consumer acceptance of chicken burgers with different percentages of flaxseed flour. Similarly, Saldaña et al. [76] used this same scale to evaluate the general opinion of smoked bacon, and Vidal et al. [88] employed it to assess the substitution of NaCl for KCl in meat salting. Other shorter scales have also been applied, such as those used by Ortiz

et al. [56] to evaluate the odour, texture, taste and general opinion of cured ham, or the six-point scale in the work of Silvestri et al. [69] to measure consumer expectations before making beef purchase decisions. Saldaña et al. [27] applied a ten-point scale to assess consumer opinions about adding pink pepper as an antioxidant to chicken burgers. These hedonic scales are applied alone or combined with other methods, as with the CATA (Check-All-That-Apply) analysis (described below) or with JAR (Just About Right) scales. JAR scales are bipolar labelled attribute scales with a midpoint anchored with "just about right" to evaluate the intensity of different attributes. The scale usually contains five points, with the midpoint being the ideal or JAR. When combined with hedonic scales, penalty analyses are carried out to reveal whether non-adequacy in the intensity of an attribute penalises overall product acceptance. As examples of research works in which this technique is applied to meat products, it is worth mentioning the studies carried out to evaluate the adequate intensity of different attributes in new products [ 38, 47, 49, 59, 127]. This technique was applied to processed meat products (sausages and cooked ham) to which natural components were added and a low nitrites level was applied [38], also another study involves low-fat and low-salt hot dog sausages [47]. Saldaña et al. [27] applied a JAR-type analysis in a study about chicken burgers in which artificial antioxidants were replaced with pink pepper [27]. The ideal profile method (IPM) is an extension of the JAR concept, in which consumers must rate the perceived and ideal intensity of sensory attributes.

Scales to evaluate purchase intention are also common but, in this case, five-point scales are normally used.

Another type of widespread sensory analysis method is discriminatory tests. These types of tests reflect whether consumers or trained panellists can appreciate differences in an attribute [125]. This type includes different analysis forms, such as triangular tests, which were used by Cardona et al. [64] to evaluate whether consumers can differentiate the fat content of meatballs. Another common type of test is paired comparison, employed by Devatkal et al. [26] in chicken meat to determine if there were differences between distinct breeding types. It is also very recurrent to apply these techniques in preference tests, where paired comparisons or multiple comparisons are normally made. Ranking is also quite common in preference tests.

In this group of techniques, there are other holistic methods that, instead of evaluating specific attributes, assess global similarities and differences between products, such as Free Sorting Tasks or projective mapping (Napping®). In the first technique, samples are grouped into as many groups as consumers consider. In projective mapping, samples must be placed on a surface of certain dimensions according to the similarity/dissimilarity between them. Recent examples of applying these techniques in meat are the work by Grabez et al. [45], who used Napping® to evaluate different diets in pork, and that by Saldaña et al. [87], who followed this method in combination with the conjoint analysis with smoked bacon. The Napping® and Ultra Flash Profile (UFP) combination in meat products is a proven efficient solution considering the required resources and the provided information [45, 66]. Several authors have used this combination as an alternative to other conventional techniques due to cost and time reduction [22]. Polizer-Rocha et al. [89] used Free Sorting to assess consumer perception in frankfurter sausages with healthy attributes.

Moreover, descriptive techniques allow product attributes to be sensorily described and relations to be established with its ingredients and/or its manufacturing processes. With this methodology, complete sensory product descriptions can be obtained, and the most relevant food sensory attributes can be determined and/or in which attributes various products differ [125, 128]. The Quantitative Descriptive Analysis (QDA) is widely used in the food industry with trained panellists to provide a detailed product profile, although this technique is expensive and time-consuming. Within the scope of the present review, the QDA has been employed in 11 studies (Table 3). External preference maps combine descriptive sensory assessments from a trained panel with hedonic consumer assessments and have been widely employed.

As an alternative to the classic descriptive analysis with a trained panel, other techniques have been developed to do these descriptive tasks with consumers without having to train them. For instance, the Free Choice Profile (FCP), where each participant generates his/her own list of descriptive terms to be evaluated later by them by classifying them on an intensity scale. This technique is widely used. A variant of this technique is the Flash Profile (FP) and is like the previous one, but instead of using scales, samples are ranked for each attribute depending on their intensity. Lorido et al. [35] used the FP method together with other techniques to evaluate different types of dry cured loin. They concluded that this technique offers a fast efficient discrimination between samples. González-Mohíno et al. [22] applied a simplified version of the most economical FP in time and cost terms called the Ultra Flash Profile (UFP) to evaluate the influence of the cooking method on pork loin sensory characteristics.

Of the other methods that have emerged to determine which attributes define products, it is worth mentioning the CATA analysis (Check-All-That-Apply) or the Temporal Dominance of Sensations (TDS) test. CATA is a multiple-choice questionnaire with a series of terms that consumers must choose if they apply to the product being evaluated. These terms, which may or may not be sensory attributes, are previously chosen by experts based on preliminary studies, other works, etc. This technique has been

widely used in recent years for studies with meat products, and either alone or combined with other techniques, as in the studies by Souza-Cócaro et al. [28] and Saldaña et al. [27] to evaluate chicken burgers. In a study conducted to evaluate smoked bacon [76], the CATA analysis was combined with a hedonic scale of global acceptance (as mentioned above) and with the ideal profile method (IPM). This combination proves to be a powerful tool for the process of developing new foods. Escobedo del Bosque et al. [58] applied this technique combined with a nine-point hedonic scale to evaluate the most relevant quality characteristics in meat. Rodrigues et al. [43] used it in combination with a focus group to study the most relevant attributes for the hot dog consumers. Grasso et al. [46] employed the CATA analysis to investigate the effect of introducing textured soya protein into beef dumplings. There are some variations of this method, such as TCATA (Temporary Check-All-That-Apply) or RATA (Rate-All-That-Apply), although both are less used than CATA. Xu et al. [85] jointly employed CATA and RATA analyses in combination with a hedonic scale to evaluate chicken meat. The TCATA technique consists of evaluating the multisensory properties of a product while it is consumed [129]. The TDS test involves the consumer choice of the dominant sensation of sensory attributes from a list, which is perceived at any point in time. In a work by de Souza-Paglarini et al. [57], the TCATA method was applied together with TDS, plus a nine-point hedonic scale, for the global acceptance of Bologna-type sausages with low sodium and fat contents. According to this study, a dynamic sensory evaluation represents the most realistic process of eating by considering consumers' real perception of food.

One of the advanced market research techniques is the conjoint analysis. This is a widespread technique in studies performed with consumers, because it helps to determine the importance of a series of variables for consumer preference. In the present review, this technique appeared in nine research articles. Studies by Di Vita et al., Meyerding et al., and Angón et al. [36, 52, 96] are three examples, together with that of Saldaña et al. [87], where this methodology was used to study pork meat products. In the study of Meyerding et al. [52], the variables price, salt and fat content reduction, and the presence or absence of nitrites, were evaluated. In another work, the evaluated variables were price, label, ethical aspects (animal welfare, organic) and the origin of meat [96]. Di Vita et al. [36] evaluated the extrinsic attributes of price, ethical aspects and origin with the conjoint analysis. At present, studies with a conjoint analysis often include Discrete Choice Experiments (DCE). DCE was also employed in some works in this review on meat and meat products. Czine [108] followed this methodology coupled with a focus group to assess the most relevant extrinsic

attributes of pork sausages. It has also been used together with eye tracking to explore main attributes in meat [130] and Iberian dry-cured ham [39].

Other methods, such as qualitative ones, help to provide a more holistic vision. It is worth highlighting techniques like focus groups, in-depth interviews, observational techniques or projective techniques, including free word association (FWA or WA), free listing, complementation techniques, etc. Of these, a widely used technique in meat research is WA, just as the research works by Cardona et al. [64] on minced meat, Vidal et al. [88] on relevant intrinsic attributes in salted meats, among others, Michel et al. [131] with meat and meat alternatives and Tárrega et al. [94] with hamburgers all reveal. Other techniques, such as focus groups, have often been used. This is the most employed qualitative technique in the selected articles herein reviewed. It is very often combined with other quantitative or qualitative techniques. Kemper et al. [132] applied this technique to study consumers' motivations, barriers and strategies for reducing meat consumption. Another study in which a focus group was used was that of Boimah and Weible [133] with chicken meat, which studied the participants' points of view on some measures taken to protect local poultry meat production in Senegal. More recently, Font-i-Furnols et al. [162] employed this technique in combination with questionnaires and hedonic scales to assess the impact of animal castration on pork acceptance, while Rodrigues et al. [43] used it synergistically with the CATA technique to evaluate the most important hot dog attributes for consumers.

Surveys and/or questionnaires, personal telephone or computer-assisted telephone interviews (Computer-Assisted Telephone Interviewing; CATI) are the most widely used techniques in this review. Niewiadomska [41] used CATI to study preferences in game meat in Poland. Personal interviews or "online" variants are widely used in the meat products category, as in the study by Barcellos et al. [134], where it was applied to study beef consumers' perceived quality in different regions of Brazil.

Finally, new technologies to study consumer behaviour have recently gained importance. These methodologies are based on using computational techniques, such as the "eye tracking" method, to track what consumers look at all times [130]. Another interesting technique is the facial reader, applied by Gluchowsky et al. [135] to evaluate a cooked dish containing meat as an ingredient. At different times within defined intervals, an image capture is taken of the participants' faces from the time food is placed inside their mouths until it is swallowed (FaceReader). They are associated with seven reaction patterns (happy, sad, angry, surprised, scared, disgusted and neutral). Another interesting technique is to study functional magnetic resonance imaging (fMRI) images. The combination of these techniques, with the "most classic" ones, allows differences between the type

of attributes to be identified and studied, which come over as relevant depending on the employed technique, and also for evaluating the effect "of the politically correct" on sincerity of answers.

It is important to note that context should be considered when evaluating a product. The product to be evaluated is sometimes presented as a dish to determine consumers' perception in a more realistic situation than presenting a product alone [125]. In a study conducted to assess smoked bacon, the second most important factor was the consumption context which, by using an image of a hamburger on a label, consumer expectations and purchase intention increased as bacon was a relevant part of the flavour of the illustrated preparation [87]. The location where food is eaten, different environments, and even the position acquired during intake, all affect consumption decisions. Recently, there has been an incipient boom in using virtual reality techniques to simulate consumption scenarios to evaluate the impact of the environment on sensory evaluations and the eating experience of different foods. One such study is that by Crofton et al. [136], which reports higher pleasure scores for beef when simulating an environment like a restaurant.

The large number of studies that have focused on sensory analysis and consumer opinion studies, which are herein mentioned, demonstrates the keen interest in these techniques and their usefulness for evaluating meat products, especially while developing new products. Understanding the quality perception process in its multidimensional nature requires appropriately combining sensory evaluation and market research to obtain the holistic vision inherent to the human being [124].

## Conclusions

*Taste/flavour, texture, appearance, colour and odour* are some of the most relevant intrinsic attributes that influence acceptance of meat products. Taste and flavour together with texture attributes of firmness, tenderness and juiciness, are very important in cooked meat and meat products. Meat colour and appearance have been identified in several studies as the most relevant intrinsic attributes, and these parameters contribute to consumers forming quality expectations. The presence of fat is extremely important for assessing meat products. Of the extrinsic attributes that most strongly impact consumers, it is worth highlighting *price, origin and production method* (considering food safety- and quality control-related aspects), although some studies also demonstrate an interest in *healthy natural products* (credence attributes). Factors directly linked with consumers, such as age, gender or level of education, affect their perception, which shows the need to identify real or potential consumers

to adapt products to their preferences. There are no common consumer behaviour patterns regarding preferences for meat products, because each meat type has a consumer profile. It is important to study the impact of segmentation and conduct cross-sectional studies across countries.

In relation to sensory analysis methods and consumer opinion techniques, a wide variety of methodologies are used either alone or combined, and the balance between both disciplines offers a more realistic vision of consumers' quality perception process. The hedonic scale is one of the most widely used classic techniques. Of the most advanced methods, techniques like FP or CATA stand out, as do qualitative techniques like focus groups or FWA.

This work offers relevant information to understand all the variables that can influence consumers' choice of meat products. Likewise, it provides an overview of the most important sensory analysis methods and consumer opinion techniques, which can be useful to design new studies about meat products by researchers and the food industry.

**Data availability** All data included in this manuscript are available upon request by contacting with the corresponding authors.

## Declarations

**Conflict of interest** There is no conflict of interests.

**Compliance with ethics requirements** This article does not contain any studies with human or living animal subjects.

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