Stakeholder and consumer reactions towards innovative processed meat products: Insights from a qualitative study about nitrite reduction and phytochemical addition

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ARTICLE INFO
Article history:
Received 15 June 2015
Received in revised form 27 August 2015
Accepted 1 September 2015
Available online 4 September 2015

Keywords:
Colorectal cancer
Consumers
Nitrite
Phytochemicals
Processed meat
Stakeholders

ABSTRACT
This focus group study explored stakeholder and consumer reactions towards innovative meat products that potentially contribute to better gut health by means of nitrite reduction and phytochemical addition. This innovation might improve both the healthiness and health image of processed meat products, in spite of concerns and challenges related to safety, taste, price and communication. Stakeholders and consumers held ambivalent reactions towards this concept. The idea of replacing nitrite with phytochemicals, which were referred to as “natural extracts” in the consumer groups, was generally favoured by both stakeholders and consumers, albeit for different reasons. Nitrite received a negative health image among consumers, while phytochemicals were generally perceived as natural and healthy. Stakeholders supported the idea of putting more efforts into the development of these new processed meat products but found it difficult to communicate about this innovation to the public, as they felt an apparent gap between consumers’ perceptions and facts might exist. Consumers’ concerns mainly laid on the resulting products’ taste, healthiness and shelf-life. In order to be successful, the innovative meat products were expected to possess desirable sensory characteristics and proven healthiness compared to conventional meat products. Future studies are warranted to provide quantitative insight into how to design and implement effective market positioning and communication strategies regarding this type of newly developed and innovative processed meat products.

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1. Introduction
Consumers’ perceived healthiness of meat products is an important determinant of meat consumption largely influencing contemporary meat industries’ legitimacy and competitiveness (Grunert, Verbeke, Kügler, Saeed, & Scholderer, 2011). Processed meat consumption is often ambivalently perceived as partially beneficial and partially harmful for human health (Van Wezemael, Verbeke, de Barcellos, Scholderer, & Perez-Cueto, 2010). The positive effects mainly relate to the nutritional and safety benefits, as meat itself is an excellent dietary source of proteins, iron, zinc and vitamin B12, all providing high biological value for humans (Hathwar, Rai, Modi, & Narayan, 2012). The processing of meat into meat products improves the product’s shelf-life and microbiological safety (Aoki, Shen, & Saijo, 2010). Some negative aspects associated with particular processed meats are such as the high fat and cholesterol content and the possible cancer promoting effects related to high intakes (Valsta, Tapanainen, & Mannisto, 2005). The report of the World Cancer Research Fund (WCRF, 2007) and the American Institute for Cancer Research (AICR) indicated a weak but significant relationship between increased intake of red and processed meats and an increased risk of colorectal cancer. As a consequence, experts recommended to limit red meat and avoid processed meat intake.

Regardless of the negative associations between the consumption of specific meats or meat products and human health, and despite weak signals of meat consumption reduction in some high-income countries (Mathijs, 2015), global meat production and consumption are unlikely to experience any significant decline in the near future (Alexandratos & Bruinsma, 2012; Speedy, 2003). Anyhow, by reducing meat consumption alone, the decrease in cancer risks might not be significant and it could be accompanied...
by several drawbacks such as the loss of nutritional benefits, particularly iron which is still an important nutritional deficiency disorder affecting large parts of the global population. In addition, livestock farmers and meat industries would experience important economic hardship (Demeyer, Honikel, & De Smet, 2008) and consumers would lose the pleasure of eating processed meat products (Pérez-Cueto & Verbeke, 2009; Resano et al., 2011). Therefore, rather than expecting or watching processed meat product consumption to decline, it is more sensible both from a public health and industry commercial perspective to proactively invest in the development and promotion of innovative meat products based on scientific knowledge.

The concept of “innovative meat products” in the context of the present study refers to processed meat products with new ingredients, more specifically phytochemicals or natural bioactive compounds that potentially provide additional health benefits without compromising on safety, taste and nutritional value. Meat products could be an excellent candidate as a functional food due to the suitable matrices for phytochemical addition, the versatility in production, their intrinsic nutritious value and strong consumer appeal (Van Wezemael, Caputo, Nagy, Chryssouchiostis, & Verbeke, 2014). Furthermore, adding phytochemicals during processing rather than through the livestock’s feed offers a better control over costs, quantities and overall quality of the end product (Grasso, Brunton, Lyng, Lalor, & Monahan, 2014). The resulting meat products may potentially avail of an improved health image, which could be attractive to the growing segment of health conscious consumers.

There is indeed a growing trend of consumers opting for healthier and more natural meat products (Verbeke, Pérez-Cueto, de Barcellos, Krystallis, & Grunert, 2010), partly due to the confusion and fear created by mass media coverage of information about processed meat products and cancer risk (Verbeke, Frewer, Schorderer, & De Brabander, 2007). When many negative connotations are linked to constituents that are commonly perceived as unhealthy such as food additives and preservatives (Liu, Pieniak, & Verbeke, 2014; Shim et al., 2011; Van Loco, Vandejiere, Cimenci, Vinkx, & Goscinny, 2015), a reduction of these substances is seemingly favoured (Kumar et al., 2012). Nitrite is a conventional food additive in various meat products, serving to inhibit the development of food spoilage caused by Clostridium botulinum, contributing to desirable colour development and exhibiting anti-oxidative activity that gives the characteristic flavour of cured meats (Deda, Bloukas, & Fista, 2007). However, the intake of nitrite added in meat processing may result in the formation of carcinogenic N-nitroso compounds in the stomach and large intestine in the presence of amino acids (Herrmann, Duedahl-Olesen, & Granby, 2015). In addition, it has been shown that consumers may not favour the use of sodium nitrite, regardless of the presence or absence of detailed information about this additive (Aoki et al., 2010).

With the goal of reducing potentially unhealthy ingredients in meat products, product reformulation has been identified as “probably the private-sector action that brings the most benefits” (Capacci et al., 2012). The (partial) replacement of nitrite with health-promoting substances, for instance phytochemicals, could be a promising solution to attain the goal of improving meat products. Phytochemicals are natural bioactive compounds present in vegetables and fruits, for example, and known to have a health-promoting efficacy (de Kok, van Breda, & Manson, 2008). These compounds may contribute to the preservation of food products in terms of microbiological safety and quality, owing to their strong antimicrobial and antioxidant capacity (Surh, 2003). Substantial anti-carcinogenic and anti-mutagenic properties have been identified in various phytochemicals, which can potentially protect the human gut from adverse health effects by reducing the formation of carcinogenic N-nitroso compounds such as nitrosamines along with meat product ingestion and preventing the induction of oxidative genetic damage (Chung, Lim, & Lee, 2013; de Kok et al., 2008). Unfortunately, there are no conclusions yet on the most effective bioactive compounds for reducing the formation of N-nitroso compounds or counteracting the nitrosamine induced damage (Oostindjjer et al., 2014).

Public health authorities, research institutes and meat industries have been actively searching for possibilities to replace nitrite in meat products. Several evidences suggest that this could be feasible and possibly beneficial, e.g. with the use of plant extracts, herbs and berries as natural preservatives (Burt, 2004; Davidson & Naidu, 2000; Gyawali & Ibrahim, 2014; Saltoft-Jensen & Hansen, 2005; Viskelis et al., 2009), Deda et al. (2007) have shown a promising example of reducing the nitrite level without compromising the processing and quality characteristics of frankfurter sausages by the addition of tomato paste. Haugaard, Hansen, Jensen, and Grunert (2014) reported positive consumer attitudes towards processed meat products with only natural preservatives. The authors stressed that preservation with natural extracts could be highly relevant in conventional meat production, as it minimizes the amount of chemical additives needed.

The aim of this study is to explore and integrate stakeholder and consumer reactions towards innovative processed meat products, i.e. meat products with reduced nitrite and added phytochemicals that potentially contribute to a better gut health. The study aims at providing a broad spectrum of opinions and at facilitating the development, production and marketing of innovative processed meat products. The present study includes both stakeholders and consumers, as they are the main actors in the meat production chain from farm to fork. Stakeholders play a key role in product development, market positioning, marketing and legislation. Specific actions towards the development of innovative meat products will only be effective if stakeholders, in accordance with their respective domains of activity, are supportive of the idea. As the ultimate target user group, consumers are another key player. Their openness to the idea, perceptions or beliefs, and acceptance shape their future food choices and hence the potential marketplace success of innovative processed meat products (Aoki et al., 2010; Grunert et al., 2011; Verbeke, 2006). A study with an integration of reactions by stakeholders and consumers towards the concept of innovative meat products is thus extremely useful to unveil the potential benefits, challenges and chances for success of these innovative meat products.

2. Materials and methods

This study was part of the integrated project “PHYTOME”, Phytochemicals to reduce nitrite in meat products, funded within the 7th Framework programme for Research and Technological Development of the European Commission. Focus group discussion methodology was adopted. This type of qualitative research method is suitable to collect preliminary and exploratory insights, which is relevant in the present case as this innovation is at an early stage of development and new in the commercial context. Hence, stakeholders would have no or little knowledge of the feasibility and outcomes, and also consumers would have no or only limited knowledge about this innovation. Focus group discussions have been shown to be an effective way to gain exploratory insights into reactions, beliefs, attitudes and intentions from a diverse population regarding food in general (Kitzinger, 1995) and meat products in particular (Van Wezemael et al., 2010; de Barcellos et al., 2010). The strength of using focus groups pertains also to the interaction among participants in a social context, which enables the collection of less accessible data and insights and opening to themes that have
not been anticipated beforehand (Krueger, 1994). However, focus group discussions have limitations too, such as the small number of participants involved and the lack of representativeness of the sample compared to the population. Furthermore, the relative importance among opinions and strength of attitudes, beliefs and intentions cannot be sorted out as the method is qualitative and exploratory rather than quantitative and conclusive. In this study, six focus group discussions were conducted in four EU countries selected based on their geographical locations in Europe and the level of meat product consumption. There were two focus groups with international stakeholders from various sectors involved in the processed meat production and supply chain, and four focus groups with consumers from Belgium, the Netherlands, Italy and Germany.

2.1. Stakeholder focus groups

2.1.1. Participant selection

The first stakeholder group discussion (n = 10) took place in Brussels (Belgium) in May 2013. The second stakeholder group discussion (n = 14) was held in The Hague (The Netherlands) in July 2013. The groups included representatives from the government (n = 3), various food experts (n = 3), representatives from food communication organisations (n = 2), meat producers and their associations (n = 7), retailers (i.e., supermarkets and traditional butchers) and their associations (n = 6), and ingredient suppliers (n = 3). Contacts were provided by national and international meat producers’ associations.

2.1.2. Study design

In accordance with the objectives of the study, a topic guide was prepared to facilitate a semi-structured discussion, in which some sections were similar for both stakeholder and consumer groups. In the stakeholder groups, discussions started after an introduction, probing participants’ associations with meat and processed meat products, their perceived importance and efforts put in the development of improved meat products. This was followed by their opinions on the desired extent of nitrite reduction (no, partial or complete elimination) and how this could be achieved (e.g., the choice of replacing agents and selection criteria). The next section was related to the responsibility for the development, production and marketing of the resulting innovative meat products and the roles of the meat industry. The discussion proceeded with stakeholders’ expectations (i.e., perceived risks and benefits) from developing these innovative meat products and the corresponding valuation potential. This part was followed by the communication about nitrite replacement (i.e., to whom this should be communicated and how it should be done). Stakeholders were asked to provide meaningful thoughts about and ideas for future research in the last section.

2.2. Consumer focus groups

2.2.1. Participant selection

The four consumer focus group discussions were carried out between July and October 2013 in Belgium (BE), the Netherlands (NL), Italy (IT) and Germany (DE). Participant selection was done by market research and recruitment agencies (AsKIT in Belgium, R&N Matrix in the Netherlands, Ales in Italy, and Skopos in Germany), all abiding the ICC/ESOMAR International Code on Market and Social Research regarding ethics in social sciences research (ICC/ESOMAR, 2008). Each focus group consisted of seven or eight meat consumers, in line with general guidelines for conducting focus group research. Selection criteria were based on age (between 18 and 60 years old, representation of all age categories), gender (equal amount of males and females) and the consumption frequency of meat products (at least once a week). All participants were involved in their household’s food purchase but not necessarily the main shopper. Each focus group comprised participants from a variety of socio-economic backgrounds. Table 1 provides an overview of the demographics and the meat product consumption frequency of the consumer participants.

2.2.2. Study design

The focus group discussions were organized according to a topic guide that facilitated a semi-structured conversation. After an introduction, consumers were asked to provide their associations with meat products, followed by a discussion about phytochemicals in general and in processed meat products specifically. Importantly, as consumers may not be familiar with the term “phytochemicals”, the concept was consistently expressed as “natural extracts” in the consumer focus group discussions. A photo association exercise was carried out to elicit participants’ reactions towards a variety of natural sources of phytochemicals that might qualify as ingredients in future meat products with reduced nitrite content. The list of sources included acerola, blueberry, cochineal insect, coffee, cranberry, curcumin (Indian turmeric), grape seed, green tea, Japanese knotweed (polygonum cuspidatum); jasmine, onion, oregano, red beet, red wine/grape, red yeast rice, rosemary, sophora (honey tree) and thyme. These 18 potential sources of phytochemicals were selected based on scientific judgements using the following criteria: 1. Natural, possibly of plant or botanical origin and with recognized anti-oxidative properties and antimicrobial activities; 2. Commercially available, accessible through the market of ingredients and additives for the food industry; and 3. Compatible with meat products, which must not adversely influence the technological and sensory properties. Consumers were asked to indicate for each of the 18 sources of phytochemicals: 1. General associations with this source of phytochemicals; 2. Associations if this extract would be added in meat products; and 3. Ranking of the sources of phytochemicals according to the perceived acceptability of it being added in meat products. The next section was related to the healthiness of meat products and its effect on purchase behaviour, which included the probing for possible ways to improve the healthiness of meat products, asking who should be responsible for driving and monitoring this innovation, and how much consumers would be willing to pay more for the resulting innovative meat products.

Consumer opinions about nitrite and nitrite reduction in meat products were also discussed. Participants were asked what they knew about nitrite. Afterwards, textual information about nitrite and its functions in food and meat products was presented, followed by a discussion on what consumers think about the use of nitrite, the idea of nitrite reduction or elimination, and the possible replacement by phytochemicals. Finally, participants were asked about their preference for information about innovative meat products, which aimed to gain insights into whether and what type of information they would like to receive about nitrite and nitrite reduction in meat products, and the addition of natural extracts. The topic guide was arranged in a way to avoid possible order biases. Hence, consumers’ reactions regarding (the addition of) phytochemicals in meat (previous section) were not influenced by the information provided about nitrite and nitrite replacement.

2.3. Content analysis

All focus group discussions were audio-recorded and transcribed verbatim for thematic analysis. Three researchers checked the transcripts and had regular meetings to distil the main messages. Open coding was employed, messages were compared and
grouped into different themes based on similarities. The main themes were identified based on the patterns of meaning in the content as outlined in the topic guide. Selected quotes from the stakeholders (Box 1) and consumers (Box 2) that support the presented findings are available as Supplementary data. The quotes are categorized into the same themes and they are presented in the same order as included in the results section. The anonymity of participants was ensured by labelling only the activity domain of stakeholders or the country of the consumer participants.

3. Results

3.1. Stakeholder reactions

3.1.1. Perceived importance of developing improved meat products

Stakeholder participants showed a strong interest in the development of innovative meat products, aiming at improved healthiness, and perceived it as an important initiative. A great deal of the health issues and controversies faced by the meat sector were highlighted, such as the demand for reduction of salt, fat and saturated fat, the reduction of E-numbers on the ingredient list, the elimination of mono-sodium glutamate, and improvements in traceability. Examples were mentioned to demonstrate the industry’s proactive engagement to improve the healthiness of meat products. Generally, stakeholders referred to food safety as the first priority, then to the organoleptic quality and finally to the nutritional value as issues that should receive attention when innovating processed meat products. Some stakeholders also referred to the development of improved meat products as a component of “corporate social responsibility”.

3.1.2. Reduction or elimination of nitrite in meat products

Stakeholders pointed to mass media as the culprit for the negative health image of nitrite in meat products. Retailers and producers specified that the reduction of fat and salt has been far more important than nitrite reduction according to consumer perception. They also pointed to the fact that nitrite reduction is very difficult owing to nitrite’s multiple functionalities. Nevertheless, stakeholders agreed that if nitrite could be reduced or eliminated from meat products, this goal should be pursued. Disagreements existed about striving for partial reduction versus complete elimination of nitrite. Some considered complete elimination to be unrealistic, especially with reference to the end-product’s colour; the others believed that complete elimination of nitrite from particular meat products should be possible, but a challenging goal to strive for.

3.1.3. Replacement of nitrite by the addition of phytochemicals in meat products

Different reactions existed towards the concept of nitrite replacement in meat products by phytochemical addition. The participants involved with regulatory issues and legislation warned that the replacement of nitrite by phytochemicals containing nitrate (such as celery or red beet) was not a correct procedure to follow, since this might not give rise to an actual improvement in the healthiness of meat products. Some argued that the reduction or elimination of nitrite might not be feasible without the addition of phytochemicals, while phytochemical addition into meat products as a fortification alone would not be meaningful enough. They flagged that it would be completely irrelevant to position the innovative products as “contributing to an increase in vegetable or fruit consumption”, given the very small amount of the extracts in final meat products, and the relatively low consumption level of meat products compared to staple foods. Yet most stakeholders still found the addition of phytochemicals worth pursuing.

Several criteria for selecting suitable phytochemicals were anticipated. The consensus was that the phytochemicals used in meat products must be in line with the (European) legislation and give rise to competitive and comparable end-products (as the ones with nitrite). This implies exhibiting desirable colour and sensory properties (taste and texture). In terms of shelf-life, the phytochemicals should ensure good microbial safety, allow efficient technological processing during production and remain stable from production to consumption.

3.1.4. Responsibility to improve the healthfulness of meat products

National food safety agencies were considered as an important actor in monitoring and controlling the healthiness and safety of the resulting meat products, notably including imported meat products. Stakeholders suggested the development of a clearer legal framework as an indispensable part of a long-term and sustainable solution. They believed that it should be the task of the national government (Public Health departments or ministries), yet the government could only set benchmarks but not force actors to add specific substances to their meat products.

Producers or manufacturers were expected to take the initiative to improve the healthiness of meat products. Collective research efforts, involving producers were seen as very promising. Although large companies could carry out large-scale research individually, collective research efforts could integrate knowledge and budgets, as such to involve also small and medium-sized enterprises to make the innovations more effective and beneficial for the whole sector. Meanwhile, as retailers have the most direct contact with consumers, they might be able to come up with meaningful solutions based on the enquiries, comments or complaints from consumers. Some meat processors stressed that the demand and expectations of supermarkets (retailers) are critical in the innovation, e.g. the expected cost and shelf-life of the meat products. Since the negative health image of meat products was mainly created by mass media, stakeholders found it necessary for opinion leaders to change their way of reporting about processed meat, whereby communication must be organized in a more uniform way across the meat sector.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Mean age (range) and distribution of gender and processed meat product consumption frequency of consumer participants (n = 30).</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Belgium (n = 7)</td>
</tr>
<tr>
<td>Gender (frequency)</td>
<td>Male: 4; Female: 4;</td>
</tr>
<tr>
<td>Processed meat products consumption frequency</td>
<td>1 to 5 times a week: 3; Daily or almost daily: 4</td>
</tr>
</tbody>
</table>
Although stakeholders stated that consumers’ consumption patterns of processed meat products were an important factor in the overall health impact of these products, consumers were not suggested to be held responsible, except from being involved indirectly through their feedback to the retailers.

3.1.5. Communication about nitrite reduction

Stakeholders found communication about nitrite reduction very difficult although it could show the industry’s proactive efforts. Communicating to consumers directly was presumed to be problematic due to consumers’ low awareness of the nitrite use in meat products. Stakeholders did not expect them to accept meat products with limited nitrite if there would also be nitrite-free meat products marketed as such. Some advised communicating about the impacts of nitrite reduction (e.g. explaining minor changes of colour in cooked ham) without stressing on the possible negative effects of nitrite. It was agreed that communication about nitrite reduction to consumers could be feasible in the long term when there would be more scientific evidence about potential alternatives. It was recommended to communicate not directly to the end-consumers but first to the relevant stakeholders and opinion leaders. In this way, the industry could demonstrate their awareness and efforts, fitting in a defensive communication approach. The relevant sectors could thus become prepared for the possible emerging issues regarding nitrite reduction. By reaching out to opinion leaders, such a strategy might influence the messages appearing in mass media in the future. However, stakeholders acknowledged the impossibility to change the negative image of meat products through mass media communication in the short run.

Although there was no consensus on how to achieve the communication objectives, it was emphasized that the communication should always be well planned and organized collectively. A defensive strategy was proposed, where the nitrite reduction should be achieved without too much publicity at first; having answers ready if the healthiness of meat products would be questioned in the future, like a contingency plan in case adverse issues or negative news would arise. It was not recommended to communicate through mass media so as to avoid simplified messages and polarization. If mass media (e.g. marketing campaigns) would be used, an independent organisation or person (not directly related to the meat sector) such as a chef or an athlete would be preferred to communicate about the healthiness of meat products. Communication using (health) claims was favoured, and some believed that it was almost impossible to communicate convincingly and effectively without legally approved (health) claims. However, the stringent criteria and time-consuming procedures for claim approval by the European Food Safety Authority (EFSA) were believed to make this most probably unrealistic. It was anticipated that communicating about “improved gut health” would yield a better outcome than “reduced cancer risk”, but stakeholders remained sceptical. They referred to the dairy sector indicating that positive framing of information messages was not always successful, even though dairy products were more often associated with favourable effects in terms of gut health compared to meat products.

3.1.6. Communication about phytochemical addition

Regarding communication about phytochemical addition, stakeholders questioned why this should be done while the current legislation and state of scientific knowledge would not allow health claims on the innovative meat products; as there has not been any precedent of health claims awarded by EFSA to processed meat products up to now. Some stakeholders again expressed the impossibility to promote the innovative products without a scientifically substantiated health claim; others argued the opposite provided messages can be spread through the use of packaging information. Most stakeholders agreed that the addition of specific phytochemicals could improve the health image of processed meat products, yet it would be difficult to communicate especially to consumers about mostly unknown or unfamiliar ingredients.

3.1.7. Expected difficulties facing the innovation

Replacement of nitrite by phytochemical addition was considered very challenging from a technological and market acceptability point of view, since meat products with reduced nitrite levels should ideally have the same or at least an acceptable colour, desirable taste and texture, and be safe for consumption. An alternative with proven efficacy must be available before reducing or eliminating nitrite in meat products, and the perceived fitness of the alternative ingredient in a meat matrix should be taken into account. Nonetheless, meat products with no or reduced nitrite were expected to be attractive only to a niche market, unless all meat products would have these reduced nitrite levels. Consumers’ perception would play a major role and it was perceived not easy to alter.

Current legislation was acknowledged as another difficulty for replacing nitrite. It was highlighted that the use of salt replacers was not allowed, hindering the search for an alternative to replace nitrite. Besides, the approved phytochemicals would have to be labelled with E-numbers, which might reduce the industry’s willingness to use them owing to the risk of marketplace rejection. Another legal aspect mentioned was the monitoring and control on the use of nitrite; recent legislation focused only on the residual amount but not on the amount of nitrite added during production.

Other challenges included the cost of research and development, production technology and market launch. The last hurdle pertained to the feasibility of the innovation in the short run. Attractive outcomes such as a successful replacer of nitrite or a scientifically-proven effective phytochemical that can be legally claimed were only expected in the long run.

3.2. Consumer reactions

3.2.1. Meat consumption in general and general interest

Consumer participants from all four countries agreed that meat products play a very important role in their countries as well as in their personal diets. Generally, consumers expressed trust in European and national food quality controls, and found it very desirable that processed meat products are improved. The price of innovative processed meat products was expected to be higher than of conventional ones. The majority claimed to be willing to pay slightly more for innovative processed meat products that promise to be healthier. However, this willingness was conditional and restricted to products with credible quality improvements but not for marketing fads. Some consumers reacted negatively towards the possible increased price of innovative meat products.

3.2.2. Nitrite in meat products

Most consumers had heard of the link between meat consumption and cancer, but their knowledge about nitrite in food and meat was very limited. Although many had already heard of nitrite (or nitrate) in food, the impact of nitrite on human health and the differences between nitrite and nitrate were largely unknown as they spontaneously mentioned spinach or drinking water as examples of sources of nitrite. After information about nitrite in food and meat products was provided, participants believed that it was safe for consumption as long as the amount of nitrite complied with the legal limits. Some pointed out that if nitrite could ensure food safety, then it should be applied instead of other less effective
substances. By contrast, a Belgian participant considered nitrite as poisonous, as he acknowledged the regulations and norms for the nitrite level in food. Others without this knowledge also agreed that nitrite consumption should be limited, while a few participants showed very little concern about nitrite in their food.

3.2.3. Acceptance of natural extracts added to meat products

Table 2 provides an overview of consumers’ reactions towards different natural sources of phytochemicals that qualify for use in processed meat when nitrite is reduced. Based on the associations and comments, several determinants of consumers’ acceptance towards the 18 natural extracts used in meat products were identified. Organoleptic characteristics and sensory expectations (such as taste, texture, aroma, and colour) were the priority for consumers while considering the use and acceptance of natural extracts in meat products. Taste was the most important factor. Fragrant plants and herbs were suggested to positively influence the aroma and taste of processed meat products. Texture was also a key factor; the idea of tough pieces was disliked, but consumers seemed to appreciate a certain crunchy texture in meat products. Perceived health benefits such as from anti-oxidant properties, the presence of vitamins and minerals and expected anti-carcinogenic effects had a positive effect on consumers’ expectations and acceptance regarding the combination of natural extracts and processed meat products. Ingredients with more favourable images in terms of health benefits, such as vegetables, herbs or berries were preferred. Consumption occasions associated with the natural sources were also important. While some sources (e.g. thyme and onion) were associated with eating occasions where meat takes a dominant role, such as Sunday roasts or barbecues, others (e.g. coffee) were associated with non-meat related occasions such as cozy moments or with dessert and therefore perceived as less desirable in combination with meat.

Another crucial dimension related to familiarity. Ingredients used commonly by consumers themselves such as onion, rosemary and oregano were more easily accepted than unknown natural extracts such as sophora or red yeast rice. Differences in the nature or origin of the extracts (i.e. flower, seed, root or insect) led to different degrees of acceptance. Insect-based extracts such as carmine from cochineal insect were the least accepted. Plant-based extracts were clearly more preferred. Type of meat was also considered as a factor shaping acceptance or rejection, for instance, thyme and red wine/grape were more associated with red meat like beef or deer, while oregano was more associated with white meat like poultry. Examples were used to illustrate the association with different types of recipe e.g. prosciutto or salami with herbs like thyme or rosemary, deer paté with cranberry or berries. Perceived geographic or cultural origins (e.g. Italian, French or Asian culture) played a role in acceptability as well; the natural extracts with European cultural origins seemed to be more accepted, probably due to the higher familiarity. Perceived functions of the natural extracts elicited different levels of acceptance. The extracts that were perceived to enhance taste or colour were more accepted than the ones perceived to serve mainly as preservatives.

3.2.4. Replacement of nitrite by the addition of phytochemicals

The idea of replacing nitrite by phytochemicals (referred to as “natural extracts” in the consumer focus group discussions) yielded mixed reactions. A German consumer stated that if nitrite can be completely replaced by a natural compound, it would even be acceptable to consume insect-derived ingredients. On the other hand, some consumers were sceptical about phytochemical addition into processed meat products and they expected themselves to be reluctant to accept the end product until these would be sufficiently proven to cause no harm.

3.2.5. Communication about nitrite reduction and/or natural extract addition

Generally, consumer participants had very limited knowledge regarding ingredients, additives and E-numbers. The majority did not read nutritional information on meat products in detail. For the ones who did, they had a preference for processed meat products with less “E-numbers” and less fat. E-numbers were seen by most participants as the signal for chemical agents with harmful health effects (“and therefore they have to be labelled”, as understood by consumers) giving products an unhealthy image. Belgian consumers seemed to have relatively more knowledge about E-numbers. They mentioned that the ingredients with E-numbers were added for specific functions during processing such as flavour enhancement.

Regarding the use of nitrite, consumers desired to be more informed, especially whether the negative health impacts of nitrite have been scientifically proven. Clear and understandable labelling was favoured. Most participants agreed that nitrite-free products should bear a label. A divergence of reactions between positive and negative labelling of nitrite existed. More consumers agreed with the use of negative labelling (e.g. no nitrite or nitrite-free), which would be more eye-catching than positive labelling (e.g. with nitrite), and it might improve the health image of the carrier products. For the labelling of natural extracts, some possible options such as “with natural extracts” or “with natural anti-oxidants” were suggested, but no overall agreement was found. Product packages were believed to be already overloaded with information.

Consumers suggested that the responsibility for communication should be with the government, national food safety agencies, scientists and health insurance companies. German consumers expressed that it should also be consumers’ own responsibility, whereby they should pro-actively search for information if they would like to be more or better informed. The government (e.g. Ministry of Health) was also considered to be responsible to ensure the healthiness of foodstuffs. In response to the question about the credibility of meat’s healthiness, participants agreed that they would only believe it if it were certified by trustworthy authorities.

3.2.6. Concerns regarding the innovative meat products

Although some consumers were confident that natural extracts could counteract some effects brought by harmful substances in processed meat products, others doubted if natural extracts were truly healthier than nitrite. Justifications for the replacement of

<table>
<thead>
<tr>
<th>Acceptability</th>
<th>Sources of phytochemicals, referred to as “natural extracts”</th>
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<tbody>
<tr>
<td>Acceptable</td>
<td>Onion, oregano, rosemary, thyme</td>
</tr>
<tr>
<td>Rather acceptable</td>
<td>Red wine/grape, acerola, blueberry, cranberry, red beet</td>
</tr>
<tr>
<td>Neutral</td>
<td>Japanese knotweed, sophora, grape seeds, jasmine, Turmeric-Indian saffron</td>
</tr>
<tr>
<td>Rather unacceptable</td>
<td>Green tea, red yeast rice</td>
</tr>
<tr>
<td>Unacceptable</td>
<td>Coffee, cochineal insect</td>
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nitrite by natural extracts were also questioned. Consumers were sceptical about the relevance and magnitude of nitrite reduction and the cancer prevention potential. They suggested that the effects in the long term should be taken into account and that there must be sufficient scientific evidence before replacing nitrite in processed meat products. Another concern was related to the addition of natural extracts: if nitrite would be replaced because of the cancer risk, it should be certain that the replacing agents are free of a similar risk (i.e. not carcinogenic). If it would be done to purely increase profits, then consumers would not be in favour of nitrite replacement and not be willing to accept or pay more.

The amount of phytochemicals needed to replace nitrite in processed meat products was discussed. Some participants found the idea of processed meat products with a large amount of added natural extracts favourable, but others were worried that they might evoke negative health effects, as the different substances may interact with each other and become harmful when combined. Above and beyond the amount, unfamiliarity towards some extracts was also an issue of concern.

Taste was one of the most important factors; consumers stated that if processed meat products with low or no nitrite would not have a good taste, they would not be willing to buy it. Italian and German consumers were concerned about the shelf-life of innovative processed meat products, hence the preservative properties of natural extracts were questioned. A majority of consumers worried about the innovative meat products’ prices, as the production costs were expected to increase. Lastly, consumers emphasized that labelling of these products must be clear, sufficiently understandable and trustworthy.

4. Discussion and conclusion

4.1. Healthiness and safety of meat products

This study has explored consumers’ and stakeholders’ reactions towards nitrite replacement by phytochemical addition in processed meat products. The findings indicate that both stakeholders and consumers regarded the healthiness and safety of meat products as very important. Generally, stakeholders’ reactions were in line with their fields of expertise. Consumers’ reactions varied across countries and individuals, exhibiting different levels of knowledge and familiarity, as in the study of Van Kleef et al. (2006). Consumers’ comments and reactions suggested that their reserved attitudes towards meat were not directly related to nitrite, but rather the result of some major meat safety issues during the past decade, which was also mentioned by stakeholders. Some stakeholders questioned why nitrite was subjected to possible reduction instead of heme iron, as the latter was believed to pose more potential threats to cancer risk. A potential explanation was the high incidence rate of iron deficiency in Europe, while reducing or blocking heme iron in meat products would possibly make menstruating and pregnant women more vulnerable to iron deficiency (Corpet, 2011).

Although it was not explicitly said, several reactions and comments showed that stakeholders found the improvement of the health image of meat products deserving the highest priority. By contrast, consumers were more concerned about the actual healthiness of meat products and worried that innovative processed meat products would be a marketing gimmick instead of a real quality improvement. Nevertheless, consumers expressed trust in European food quality control mechanisms and found the government to be responsible for the healthiness of food (as seen also in Van Wezemael et al. (2010)), which was also agreed by the stakeholders. Both stakeholders and consumers supposed that consumers should only be partially responsible in ensuring food healthiness. Consumers’ role was seen as “information search” to increase awareness and “providing feedback”, as it has been perceived that consumers generally have very little control over what they would be exposed to, e.g. the amount of nitrite added by meat producers (Van Kleef et al., 2006).

4.2. Acceptance of nitrite replacement by phytochemicals

The idea of nitrite replacement by phytochemical addition received generally high acceptance by both stakeholders and consumers, albeit for very different reasons. For stakeholders, the acceptance was related to the possible improved health image of processed meat products, and driven by justification from the perspective of corporate social responsibility. For consumers, the acceptance of this concept was mainly based on the belief that replacement of the chemical additive nitrite by phytochemicals could enhance the perceived naturalness, as food additive use was an important issue of concern and perceived by consumers as an excessive manipulation of meat products which consumers tend to reject (de Barcellos et al., 2010). Moreover, consumers were familiar with most of the natural sources of phytochemicals and perceived them as healthy, in contrast to the unfamiliar food additive nitrite with an unhealthy image. Consumers would thus tend to accept the possible risk or uncertainties posed by nitrite replacement (Sjöberg, 1998). Lastly, when chemical additives in food have become a recognized problem among consumers, the replacement could serve as a solution (Haugaa et al., 2014). This acceptance suggested that marketing innovative meat products could possibly benefit meat industries and it might overcome the expressed difficulty about the negative consumer perception of meat healthiness.

Consumers were generally open-minded regarding the natural sources of phytochemicals. The importance of familiarity, naturalness and a perceived fit between ingredients and carrier products has also emerged from previous studies (Lähteenmäki, 2013; Verbeke, Scholderer, & Lähteenmäki, 2009). Other determinants of acceptance were taste, appearance (colour) and the origin of phytochemicals. Taste remains the most important attribute shaping consumers’ evaluation of food products as also reported in previous studies (e.g. Grunert, Bredahl, & Brunso, 2004; Haugaard et al., 2014; Verbeke, 2006). Also with respect to the concept of the innovative processed meat products discussed in this study, consumers were found to be unlikely to compromise on taste.

While stakeholders were worried about the colour development of nitrite-free meat products, consumers showed relatively less concern about the colour and appearance of the innovative meat products. However, it should be noted that consumers did not have any visual assessment of meat products in this study. Previous studies have shown that consumers’ expectations of meat quality are strongly related to the product’s appearance (Haugaa et al., 2014; Verbeke et al., 2005). Therefore, meat producers should avoid producing meat products with an appearance unfamiliar to consumers, and they seemed to be well aware of this potential risk.

Phytochemicals from plant origin and with a perceived match with meat were generally well accepted by consumers. However, less familiar ingredients such as tea or coffee extracts, and especially insect-derived ingredients were mostly disliked. The latter corroborates with Western consumers’ reluctance to adopt insects or insect-based products in their diet (Verbeke, 2015). Overall, compared to stakeholders, consumers appeared to be more uncertain about what makes processed meat products truly healthier due to their lack of knowledge about ingredients, meat processing, nutrition and health.
4.3. Implications for future communication and product development

Both stakeholders and consumers stressed the importance of effective communication. With regards to labelling, E-numbers have been largely maligned and misunderstood by consumers (Emerton & Choi, 2008), which might explain why stakeholders emphasised on the unfavourableness of using E-numbers and consumers expressed negative attitudes towards food products with E-numbers. However, attention to information cues on meat labels in general cannot be taken for granted (Verbeke & Ward, 2006), and a recent experimental study showed that consumers did not pay attention to E-numbers as much as in self-reported evaluations while judging food products (Cheung et al., 2015). Therefore, future communication should focus on improving consumers’ understanding about food labelling in general, and E-numbers in specific, instead of merely encouraging product reformulation aiming at reducing E-numbers. Furthermore, although stakeholders referred to health claims as an important added value for promoting the health image of meat products, a cross-European study suggested that European consumers reported only a moderate level of motivation to process health claims (Hung, Hoefkens, Hieke, Grunert, & Verbeke, 2015). Hence, it is seemingly more worthwhile for the meat industries to invest in marketing communications that highlight the benefits of the innovative meat products rather than devoting to substantiate health claims. Nonetheless, stakeholders found mass media not an ideal way to communicate to the public, as it could lead to polarization and create negative images by focussing on negative information related to nitrite, as reported also in Verbeke et al. (2007). Although mass media were not considered as a trustworthy source of information, it remains the primary information source for many consumers (Verbeke, 2005), and as such consumers did not express concerns about news related to the innovative meat products being spread through mass media. Consumers preferred information provided by actors that share similar interests or values as them (e.g. Ministry of Health, consumer organization, insurance company, etc.) over economic operators, which corroborates previous findings (Pieniak, Verbeke, Scholderer, Brunso, & Olsen, 2007). As proposed by Van Kleef et al. (2006), the primary reasons for distrust are economic or vested interests and motives. In line with the findings of Verbeke et al. (2007), consumers were keener to receive negative information such as the link between processed meat intake and cancer risks rather than positive information, e.g. referring to possible protective effects of phytochemicals. While consumers have expressed the feeling of information overload, an effective communication would require a careful understanding and targeting of their information needs and specificities (Pieniak, Verbeke, Perez-Cueto, Brunso, & De Henauw, 2008). Given the stakeholder emphasis on uniformity of communication, cooperation between all relevant sectors should be encouraged, enabling the dissemination of consistent messages to avoid consumer confusion. Information could evoke different effects on consumers’ willingness to pay for meat products (Aoki et al. 2010), and conflicting messages would impede consumers from assessing meat healthiness accurately and further affect their purchase intention.

The insights obtained in this study are promising and open up opportunities to encourage the development and production of innovative processed meat products with nitrite replaced by phytochemicals, which could possibly improve the health image of processed meat products and facilitate the achievement of public health goals. However, consumers’ interests in food products in general and innovative meat products in specific extend beyond the potential health benefits provided by the product. Taste, safety, price, production, processing and other characteristics equally matter in shaping intentions, purchase and consumption. Quantitative conclusive studies are thus warranted to quantify consumers’ attitudes, perceptions, beliefs and knowledge, and to assess their purchase and consumption intentions towards these innovative meat products. Such insight will be indispensable in order to identify possible strategies to recover the extra cost for research, development and production of these innovative meat products, as well as to generate guidelines on effective market positioning and communication strategies.

Conflict of interest

The authors declare to have no conflict of interest.

Acknowledgement

The authors gratefully acknowledge the financial support from the European Commission. This research is the result from work package 6 (WP 6) of the integrated project PHYTOME financed under the 7th Framework programme for Research and Technology Development of the European Commission (EU-FP7 grant agreement no. 315683), investigating the possible replacement of nitrite in meat products by natural compounds.

Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.foodcont.2015.09.002.

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