Design of Cues on Supply Chain Encryption through Blockchain Technology and Animal Welfare Compliance on Meat Product Packaging

By Andrea Gröppel-Klein* and Kenya-Maria Kirsch

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Meat is increasingly being marketed based on credence characteristics, such as healthiness and production methods, which cannot be experienced before purchase and therefore need to be communicated. Consumer confidence in the integrity of the supply chain and the information printed on the packaging plays a critical role in the success of packaged products. This study is among the first to examine how blockchain encryption might be labeled on prepacked ecologically produced meat to increase consumers' trust in the information and for quality assessment. It also explores whether emotive or factual references to animal welfare are more effective and whether they interact with different blockchain claims. The theoretical background includes the cue utilization theory and the heuristic-systematic model of information processing as well as insights into "scientificity appeals."

Andrea Gröppel-Klein is Chair of Marketing and Director of the Institute for Consumer & Behavioral Research, Saarland University, Campus A5.4, 66123 Saarbruecken, Germany. Phone: +49/681 302 2135, E-Mail: groeppel-klein@ikv.uni-saarland.de.
*Corresponding author

Kenya-Maria Kirsch is Research Associate at the Chair of Marketing and Institute for Consumer & Behavioral Research, Saarland University, Campus A5.4, 66123 Saarbruecken, Germany. Phone: +49/681 302 3531, E-Mail: kirsch@ikv.uni-saarland.de

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1. Introduction

Worldwide, around 337.2 million tons of meat were produced in 2020. This was an increase of 45 % compared to the year 2000. Poultry production almost doubled. According to the Food and Agriculture Organization of the United Nations (FAO 2022) and the OECD, the globally produced amount of meat is estimated at around 345.2 million tons in 2022, so we continue to see a significant increase (Statista 2023). However, in many countries, there is also a trend towards conscious meat consumption, explained by consumers' increasing sustainability concerns, quality orientation, and animal welfare concerns (Aboah and Lees 2020; Tandon et al. 2020; van Loo et al. 2011). Vion, the largest beef producer in the Netherlands and Germany, forecasts that the number of pigs and cattle in Western Europe will reduce by 20 % in 2030 and that meat consumption will fall by 2 % annually. The company also believes that increasing animal welfare and food safety requirements, as well as transparency of supply chains, are becoming progressively more significant: "Ensuring that products are traceable upstream and downstream in the supply chain is a significant challenge for companies that produce food items originating from complicated supply chains" (Vion 2022).

Thus, consumers' confidence in the integrity of the supply chain and the information printed on the packaging plays a critical role in the success of packaged products. Blockchain technology could support the reliability of information transmitted through the value chain and thus increase the credibility of the information communicated to consumers.

Blockchain supports integrated and transparent communication within complex supply chains. This can significantly increase trust, security, and speed between all parties involved in the supply chain and the use of blockchain technology is, for instance, highly recommended for organic food (transparency from "farm to fork"). According to the Blockchain Interoperability Pilot Project Report (FDA 2020), "blockchain is a distributed ledger technology that provides an immutable audit trail of transactions, allowing for transparency while maintaining data privacy, and uniting disparate sources of data

from various stakeholders. Immutability of the data enables the technology to be considered for highly regulated industries," such as the food or pharmaceutical industries. With the help of the information encrypted in the blockchain, product traceability is possible, revealing the origin of the product, its components, further processing, and distribution. Stored information cannot be overwritten, modified, or deleted. For animal food products, the type of livestock rearing (e.g., husbandry stage, feed) is also fed into the blockchain. There are distinct product identifiers via serialization. It must be possible for transaction information and declarations to be exchanged and verified in a secure, interoperable manner for all properties (including SNI). In the pharmaceutical industry, for example, this is how counterfeit drugs are attempted to be detected (FDA 2020).

However, it is not clear whether consumers would understand the blockchain concept and what might be needed to be able to use it to support trustworthiness (Sander et al., 2018). Joo et al. (2023, p. 12) declare that blockchains "are potential solutions to a wide variety of issues in the digital advertising market." But can this also solve the information asymmetry on the part of consumers, so that consumers can be more certain about the correctness of the supply chain by referring to the blockchain technology? More precisely, we want to investigate how the wording relating to the blockchain encryption on the product packaging might look, to evoke more trust in consumers. It should be taken into account that consumers have more or less knowledge regarding this technology. In addition, we also consider more- or less-emotive appeals about animal welfare per se, and check whether these are more important for consumers than supply chain traceability. A recent study by Choi et al. (2023) investigated the impact of product-package Corporate Social Responsibility (CSR) messages and found (also on the basis of sales data) that message type plays an important role in consumers' purchase decisions, thus showing again how important product packages are as "silent sellers."

2. Conceptual Framework and Hypotheses Development

2.1. Explanation and selected empirical findings on intrinsic and extrinsic cues on product packaging

Signaling theory (Kirmani and Rao 2000) assumes that there is information asymmetry between sellers and buyers. This means that the seller has more information than the buyer about the origin or quality of the goods on offer, which is particularly the case with credence goods. Various "signals" or "cues" (e.g., quality seals) can be used to reduce this asymmetry.

Meat is increasingly being marketed based on credence characteristics that need to be communicated (Grunert et al. 2015) and which often have to be detected within a few moments (Königstorfer and Gröppel-Klein 2012). According to *cue utilization theory* (Olson and Jacoby, 1972), quality cues can be used to infer the quality of the meat (Acebrón and Dopico 2000). Quality cues are, according to Steenkamp (1990, p. 312), "informational stimuli that are, according to the consumer, related to the quality of the product, and can be ascertained by the consumer through the senses prior to consumption."

Here, intrinsic and extrinsic characteristics can be distinguished (Olson and Jacoby 1972, see *Fig. 1*). *Intrinsic cues* refer to product attributes that cannot be changed

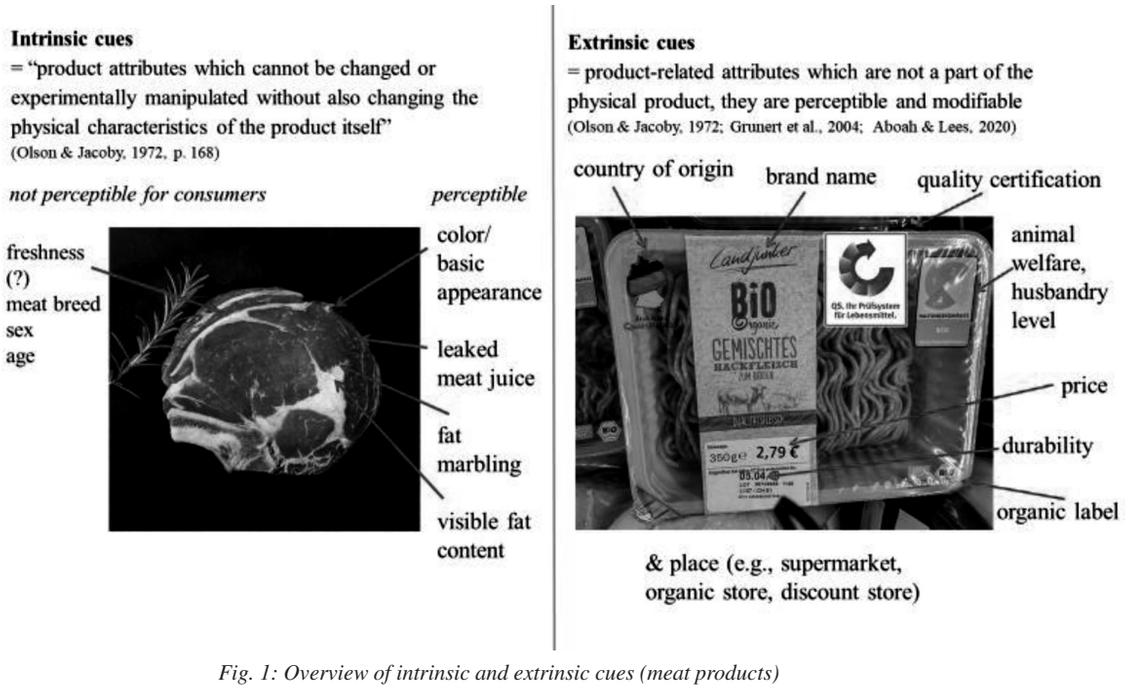

Fig. 1: Overview of intrinsic and extrinsic cues (meat products)

Studies on intrinsic cues (e.g., fat percentage, color, appearance, freshness) vs. **extrinsic cues** (e.g., country of origin, place of sale, packaging labels)	**Main results**
Acebrón and Dopico (2000): Survey, panel of 239 households.	Basic research in this area: Consumers, when shopping at the store, have expectations about beef quality, which they evaluate based on intrinsic (color, freshness, and visible fat) as well as extrinsic cues (price, designation of origin, and presentation). Food quality is a multidimensional concept.
Grunert et al. (2015): Discrete choice experiment, latent class analysis, final sample: written interviews with 877 urban Chinese food shoppers; the questionnaires were filled out directly before the shopping.	More and more western-style supermarkets are appearing in China. Chinese consumers are in a transitional phase. Latent class analysis shows that for the majority of Chinese consumers (in contrast to western consumers), intrinsic cues still dominate choice; only for a small segment do extrinsic cues (like brand name, origin, and quality certification) play an important role.
Brečić et al. (2017): 500 face-to-face interviews conducted in respondents' homes, segmentation analysis.	Based on the relevance of intrinsic and extrinsic food quality attributes, different food buyer clusters can be identified, which attach more or less importance to different cues.
Aboah and Lees (2020): Journal article network analysis, comparative analysis (a pool of 96 closely connected articles were used for the comparative analyses).	The aggregate ranking of important quality cues shows that "the five most important quality cues (country of origin, food safety certification, price, production system and quality certification labels) are extrinsic and relate to credence attributes" (p.108).

Tab. 1: Selected studies on intrinsic and extrinsic cues in the food industry

without altering the physical product – e.g., cut, fat, marbling – while *extrinsic cues* relate to non-physical product attributes, such as price, labels, or country-of-origin-references (Grunert et al. 2004). Not all intrinsic quality cues *can be perceived* by consumers, owing to limited cognitive processing, especially for purchases carried out quickly, and some intrinsic characteristics *cannot be perceived* by consumers, such as the breeding of the animal (Acebrón and Dopico 2000, p.231; Steenkamp 1990, p.324). Nonetheless, Olson and Jacoby (1972) pointed out 50 years ago that intrinsic cues are particularly relevant to quality judgments. Brunsø et al. (2002, p. 9f) likewise assume that the sensory characteristics of the product play an important role. Grunert et al. (2015) found that Chinese consumers, who are in a transition phase to more self-service shopping in supermarkets as they are mainly found in western cultures, still use more intrinsic cues to evaluate the meat. A recent study by Aboah and Lees (2020) also shows, for example, that color, appearance, and visible fat content are of particular importance (Aboah &and Lees 2020); however, the authors conclude (on the basis of studies) that the most important "quality cues" are extrinsic in nature. Hoffmann et al. (2020) come to the conclusion that there is still a lack of research concerning extrinsic product attributes (e.g., price, brand, labeling, country of origin) and intrinsic food attributes and their interplay.

Grunert (2005) assumes that the question of whether consumers tend to use intrinsic or extrinsic cues in their purchase decisions cannot be answered unambiguously and depends on whether meat products are sold labeled (at the self-service counter) or unlabeled (at the fresh food counter). Non-labeled products would tend to be chosen on the basis of intrinsic cues, while labeled products would tend to be evaluated by extrinsic cues (Grunert 2005, p. 151). In addition, as already mentioned, Grunert et al. (2015) state that meat "increasingly becomes more a credence good than an experience good. Taste and other sensory properties can be experienced after purchase, but meat today is sometimes also marketed in terms of its healthiness, its way of production, its safety – all credence characteristics that cannot be experienced by the consumer and hence need to be communicated," mainly on the product packaging.

Our research thus focuses on the extrinsic cues displayed on product packaging (Aboah and Lees 2020; Brečić et al. 2017), which have the potential to influence purchase intention (Samant and Seo 2016). Here, two extrinsic cues are of particular importance to us: first, whether consumers value the tracking of the supply chain via blockchains; and second, portrayals of animal welfare. Both stimuli can be presented on the product packaging.

Tab. 1 provides an overview of studies on intrinsic and extrinsic cues in the food industry. In a recent study by Kakaria et al. (2023), which also used cue utilization theory as a theoretical basis (but for a different background, asking which elements of online reviews are most relevant to consumers, thus not quoted in the table), the importance of this theory is summarized once again as follows: "cue utilization theory is consistently used to examine consumers evaluation of a product based on diverse cues, influence of product cues on consumer attitudes, and interaction between several cues to impact purchase intentions." The authors were also able to identify a total of 64 different empirical studies from 2000 to 2022, which in summary show the relevance of the theory for attitude formation and cognitive processing.

2.2. Blockchain encryption, transparency, and trust

2.2.1. Relevance of trusted information in the food sector

Consumers often struggle to verify the information they receive, and labels can help to build trust and differentiate high-quality products from conventional ones (van Loo et al. 2011). However, the plethora of labels and standards can lead to confusion, lack of clarity, and information overload (van Loo et al. 2014). For instance, the establishment of a mandatory and unified animal welfare labeling system has been discussed for many years. The Federal Ministry of Food and Agriculture (BMEL 2023) is working on a mandatory and transparent animal husbandry labeling system for foods of animal origin originating from Germany, and such a system is now to be introduced in Germany for pork (BMEL 2023). Yet, there is a controversial debate as to whether such a system will attract the attention of consumers or rather lead to confusion, since many retail chains in Germany (e.g., Aldi, Lidl) have already been displaying husbandry levels for several years, and not only for pork. The German discount store Aldi declared in 2021 (Aldi Nord. 2023), "We make a promise for more animal welfare. By 2030, we will convert 100 % of our fresh meat range to husbandry levels 3 and 4. This will make fresh meat products from outdoor climate and premium farming, such as organic products, a matter of course. The conversion relates to the largest livestock groups of beef, pork, chicken and turkey in Germany." However, to uphold consumer trust, *authentication of claims* in the food supply chain is required (Janssen and Hamm 2012; Kehlbacher et al. 2012). Consumers want to be sure that they can rely on the declared husbandry levels.

In science and practice, there has been recent discussion about how to increase consumer confidence in products and reduce fraud. In principle, trusted intermediaries play a crucial role here, which – if they do not play by the rules and this becomes known – would lose their business model (as is partly the case with "warranty brands" that certify other brands, in German "Gewährleistungsmarke"), or at least their business reputation would suffer.

Certification, for example as an "organic product," is often not enough to track the entire supply chain. But this often generates enormous amounts of data that can only be tracked transparently using digital technologies. This is where blockchain comes in, or, as Marthews and Tucker put it (2023, p.49): "Blockchain as a technology has amazing promise for applications that require an immutable data digital record, where trust is unlikely."

2.2.2. Potential of encrypted blockchains to track supply chains

Blockchain as a new digital technology seeks to enhance the transparency of supply chains (Treiblmaier and Petrozhitskaya 2023) by providing an immutable record of transactions, allowing real-time viewing and tracking of goods and information (Lemieux 2016). The encryption of data plays a crucial role, making the blockchain tamperproof: All committed transactions are stored in a list of blocks and each block has a unique digital signature (Queiroz et al. 2020; Kouhizadeh and Sarkis 2018). Accuracy is vital, since inaccurate information entered at the first step can be passed on through the blockchain, e.g., that the animal has not received antibiotics (but this was the case de facto). Thus, pure encryption does not completely prevent criminal misuse. But once encrypted, correct information is permanently stored and cannot be overwritten, thereby offering greater protection against fraud (Singh and Sharma 2023; Tan and Saraniemi 2022). We can apply this to a fictitious example and imagine that a pig was given antibiotics during rearing and that the farmer had entered this information correctly in the blockchain. If, for example, a retailer were to try to change this information because he feared that potential customers would take offense, this attempt at forgery would fail.

To make blockchain-stored information accessible to consumers, a QR code can be added to the product package, which can be scanned. However, consumers may not be very familiar with blockchain-based traceability systems (from farm to fork) (Lemieux 2016) and may associate blockchain with cryptocurrencies, which are often viewed with suspicion (Janssen et al. 2020).

In summer 2022 we conducted an explorative pre-study to analyze consumers' familiarity with blockchain technology. We found a below-average mean value (see section 3), and almost one-third are not at all acquainted with the technology. This raises the question about whether the term "blockchain" may elicit negative reactions from some consumers, owing to a lack of understanding or false associations. In our study it is thus also necessary to investigate whether (1) owing to inaccurate knowledge of blockchain technology, a certain aversion to the term and consequently negative attitudes and/or avoidance reactions arise; and (2) whether consumers with objectively high knowledge about blockchain give different responses from those who do not.

Few studies (see *Tab. 2*) have examined the effect of blockchain labels on product perception; instead, research has focused on comparing the presence or absence of a blockchain label, or the comparison between a conventional and a blockchain label in the context of the Theory of Planned Behavior (Dionysis et al. 2022; Mazzù et al. 2021; Lin et al. 2021; Sander et al. 2018; Shew et al., 2022). For instance, Dionysis et al. (2022) found that displaying a blockchain label on organic coffee resulted in consumers perceiving the production process to be more environmentally friendly compared to a conventional one. The product's success depended strongly on consumer awareness of product traceability (Dionysis et al. 2022). Their study suggests that the mere exposure

Study	Main results
Sander et al. (2018): (Explorative) survey with 141 British consumers, seven retail managers, four government officials, and one blockchain service provider to obtain insights of consumers and experts on traceability of products via blockchains.	Reference to blockchain "appears to have significant positive influences on consumers' purchasing decisions, mediated by consumers' quality perceptions" (p.2066). While consumers tended to have positive opinions, experts listed positive and negative arguments (e.g., improving image by tracking through blockchain, higher additional costs, too much complexity of the supply chain).
Mazzù, Marozzo et al. (2021): Experiment, milk carton with understandable reference to tracking via blockchains and QR code versus milk carton without these stimuli. Interviews with 310 primary grocery shoppers from Germany, Italy, and the UK.	Blockchain-certified information available on the packaging affected consumers' perception of healthiness and flavor of the milk. No differences between the three countries.
Lin, Chang et al. (2021): Face-to-face questionnaire with 300 valid responses, Chinese consumers, organic food products with reference to blockchain. PLS, Theory of Planned Behavior (TPB).	Confirmation of TPB: Attitude and perceived behavioral control significantly affect trust, which in turn has an impact on usage intention in adopting blockchain technology.
Dionysis et al. (2022): Online questionnaire study, 123 British participants, using two traceability systems (one based on blockchain and one on a more established traceability certification) for organic coffee.	Confirmation of TPB: Attitude, perceived behavioral control, and environmental protections drive intentions to purchase blockchain traceable coffee.
Shew et al. (2022): Online choice experiment with 1,096 American consumers (valid responses), 99% regular purchasers of beef products, choice of meat products after exposure of 5 different labels (Blockchain Certified, USDA Certified, Grassfed Label, Carbon Label, Digital Ledger Certified, all shown with explanations).	Consumers preferred the two labels "USDA Certified" (United States Department of Agriculture verified the source) and "Blockchain Certified" (BC). The authors recommend an integration of both labels: "BC integration with USDA certification could improve BC's viability for traceability and might increase consumer value and trust in beef traceability" (p.318). This means that the blockchain label should be further supported by a governmental seal of approval.

Tab. 2: The reference to blockchain encryption as an extrinsic cue in the food industry

of the extrinsic cue "blockchain traceability system" for organic coffee may positively influence purchase decisions, and it also shows that a possible aversion effect could not be observed resulting from the term. In contrast, Shew et al. (2022) state that supporting the blockchain label with a state quality seal is particularly promising, which means that the mere reference to the supply chain encrypted in the blockchain and its tracking is not sufficient.

Where are there still crucial research gaps? First, we believe it is important to control whether the term "blockchain" triggers an aversion effect, as described above. Second, previous studies have only tested whether the reference to blockchain certification (vs. not) exerts an influence on product evaluations. In some cases, a factual explanation was additionally presented, e.g., in the study by Shew et al. (2022): "The presence of this label indicates that independent parties (food producers, feed lots, food processors and retailers) are sharing blockchain technology to verify the source, quality and other attributes of the beef" (p.305). Mazzù et al. (2021, p.1413) also used an understandable explanation: "Company employs an advanced blockchain technology to verify the origin and health of the animals and the entire production process to ensure traceability and transparency of the milk." However, the explanations do not point out that once information is stored in the blockchain, it cannot be erased or overwritten, making it more tamper-proof. The trustworthiness of the information is a big advantage. In our study we are thus also considering how the wording relating to the blockchain technology on the product packaging might look in order to ultimately increase confidence in the information as well as attitude and willingness to buy the product identified in this way. In terms of wording, research into scientific-sounding slogans can help further.

2.2.3. Effects of scientifically formulated (advertising) statements

Previous studies on the textual design of extrinsic cues have yielded ambivalent results. On the one hand, health claims studies show that only health claims that are easy to understand are effective in making healthier choices, particularly when consumers must decide quickly (within seconds) at the POS (e.g., Groeppel-Klein et al. 2017). So, wording of a health claim that is easier to compre-

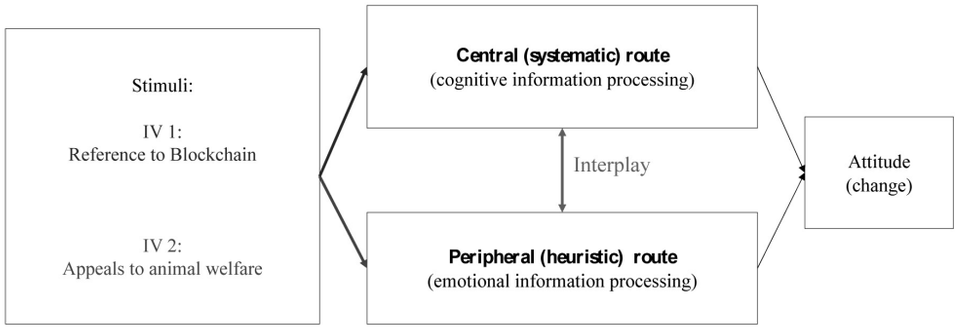

Fig. 2: Transfer of the dual-process models to the research question at hand

hend (e.g., Vitamin E contributes to protection against oxidative stress vs. Vitamin E reduces damage to cells and genetic material) is a promising technique to enhance its relevance, whereas health claims that are formulated in ways that are too complex evoke avoidance. On the other hand, the authors also found that only novel messages get through to the customer: if consumers are too familiar with a health message, then wear-out effects occur. In the opposite direction, the findings of Fowler et al. (2019) show that consumers of cosmetics prioritize "scientific claims" and consider them convincing, even without full comprehension. Indeed, a large number of advertisements attempt to substantiate the quality of the advertised product by use of scientific wording (terms such as liposomes, Q10, ceramides, or probiotic blend of lactococcus lactis) for food, health and hygiene products, medicines, or cosmetics (Pitrelli et al. 2006). This advertising technique is intended to demonstrate the competence and performance of the seller, since independent science is usually (although, of course, not always) ascribed high credibility and a high standing among the population.

Additionally, the widespread appeal of expert information on food product labels suggests that such labels may be crucial in providing consumers with trustworthy information in today's complex global food system (Rupprecht et al. 2020). However, the rationale for this effect may be different: For those who are well versed in blockchain technology, using scientific language may be perceived as acknowledging their expertise. This line of reasoning is supported by the study of Dodds et al. (2008). Their focus group study shows that not only do consumers pay attention to scientifically worded claims in the food sector, but they also view them as "strong arguments" rather than just peripheral cues. In particular, they found that scientific slogans that were consistent with existing health knowledge were more likely to be accepted in the marketing of food products. The participants all worked in a scientific environment, so it can be assumed that they had more knowledge of scientific terms and a high level of education. By difference, we assume that those consumers who are unfamiliar with or simply not involved or trained in the deeper theoretical background of blockchain view such scientific cues as simple peripheral stimuli (like cachets) that are processed quickly and without cognitive effort, according to Fowler et al. (2019). The scientific language, then, is merely experienced as meaningful or innovative without understanding its content, or, simply put, consumers with low involvement trust the expert description just because it sounds scientific.

Therefore, we assume that irrespective of familiarity with the technology, scientific-sounding, expert descriptions of the blockchain principle will increase trust in this technology and its stored information more than a layperson's description that prioritizes understandability over technical accuracy. Increased trust in supply chain information consequently enhances anticipated overall quality and positive purchase intentions, as hypothesis 1 states:

H1: The expert description will (a) trigger a higher trust in the supply chain information than the lay description, (b) positively affecting anticipated overall (ecological) quality, which in turn (c) enhances purchase intention.

As briefly addressed earlier, new stimuli can be processed with high or low cognitive effort. According to dual process models, such as the Elaboration Likelihood Model (ELM) (Petty and Cacioppo 1986) or the Heuristic-Systematic Model (HSM) (Chaiken 1980), information cues can be processed through either the central (systematic) or the peripheral (heuristic) route (see *Fig. 2*).

In systematic processing, positive attitude change is more likely to occur if the arguments are based on factual information, whereas in heuristic processing, affective responses play a more significant role (Chaiken 1980). Several studies in the field of advertising have found that emotive appeals outperform factual appeals (e.g., Guitart and Stremersch 2021; Geuens et al. 2011), making an emotive message key in contributing to attitude change. Since animal welfare is an emotive issue that resonates deeply with many consumers (Feinberg et al., 2019), wording that evokes emotional reactions related to it, such as emphasizing the animal's happy life, may have a more positive impact than wording that is purely factual and objective (such as referring to the animal only as a 'product'), even though not everybody considers animal welfare as equally important or an area of concern (Vanhonacker et al. 2007), or their level of knowledge about farming and animal welfare issues might be relatively

low (Alonso et al. 2020). Emotive appeals get through even if someone is not particularly interested in the issue. If, on the other hand, animal welfare is important to the consumer, then this emotive appeal provides the impetus for cognitive engagement with the issue (e.g., checking other quality seals). Consumers with a high level of involvement want to be sure that they can rely on, for example, the welfare standards declared. By focusing on emotive cues related to animal welfare and the supply chain, we assume that consumers perceive the overall quality more favorably, ultimately increasing purchase intention. This leads to the second hypothesis:

H2: An emotive animal welfare cue will (a) trigger a higher anticipated overall (ecological) quality than a factual cue, (b) positively affecting purchase intention.

Up to this point, we have only been interested in main effects (independent variable 1: type of blockchain description: lay vs. expert; and independent variable 2: animal welfare cue: factual vs. emotive). However, the dual process model HSM (in contrast to the dual process model ELM) also posits that the two modes of information processing can occur concurrently (Chaiken 1980), meaning that central and peripheral stimuli can *strengthen* each other (or mutually attenuate or reverse each other, which is not relevant here). For instance, heuristic cues can be used to form an initial impression, and then further systematic cues can be used to check and evaluate that impression. As previously mentioned, emotive stimuli are usually processed through the heuristic route of persuasion, whereas expert and technical descriptions require more cognitive effort, leading to the systematic route being used more often (Xiao et al. 2018; Zhang et al. 2014). Our study assumes that the expert description will outperform the lay description (H1) and that the emotive animal welfare cue will be more relevant than the factual cue (H2). We also assume that if both paths are activated via the expert description and the emotive welfare appeal, an interaction effect between the independent variables should occur, in such a way that the combination of expert description and emotive cue will be more effective regarding the dependent variables than all other combinations. In other words, we expect that the scientific explanation of blockchain technology and the emotive appeal of animal welfare will touch minds and hearts. This leads to hypothesis 3:

H3: There is an interaction effect between the blockchain description and the animal welfare cue, whereby the combination of expert description and emotive cue outperforms all other combinations towards all dependent variables.

3. Empirical Investigation

We started with an explorative pre-study that we conducted in summer 2022 (online, n = 298; M_{age} = 30.35, SD = 11.84; 63.4 % female). The objective of this pre-study was to find out how familiar consumers are with blockchain technology (subjective assessment). The result reveals a below-average mean value of consumers' familiarity with blockchain technology (not at all (1) – very familiar (7)) with M = 3.17 (SD = 1.96). 31.5 % of the respondents indicated that they are "not at all" familiar with this new technology. For this reason, we conducted an (objective) knowledge test in the main study to control whether individuals with more or less knowledge responded differently.

3.1. Design of the main study

In our main study we also conducted an online study using an online panel. The questionnaire was created with Qualtrics so that we could determine the response time. A total of 502 people participated in the survey. Participants were asked to use their desktop PC or their laptop, not a smartphone, to answer the questionnaire. After excluding those participants who ate an exclusively vegan or vegetarian diet, those who did not agree to the GDPR guidelines, those younger than 18 years old, and those participants whose measured response time was so short that careless responding has to be inferred (less than one-third of the response time determined by Qualtrics), n = 389 people remained in the sample. The study (see *Fig. 3*) was a 2 × 2 between-subjects design, with two additional control groups. The independent variables of the between-subjects design were type of blockchain description (lay vs. expert) and type of animal welfare cue (factual vs. emotive). The stimulus showed a package of fresh poultry breast.

As indicated, we added two control groups (CG1 & CG2): (1) lay description with factual animal welfare cue (n = 66), and (2) lay description with emotive welfare cue (n = 70), both without using the term "blockchain," to check whether the term "blockchain" per se elicited aversions (see *Fig. 4*). We focused on two control groups, because the technical characteristics of the scientific expert description make no sense if the technical term is missing. There are no significant differences (all p_s >.36) between the two experimental groups (lay description with the term "blockchain") and the two control groups (lay description without the term "blockchain") and regarding trust (M_{group1} = 4.99, M_{CG1} = 5.13, M_{group2} =5.16 M_{CG2} = 5.09) or anticipated overall quality (M_{group1} = 5.47, M_{CG1} = 5.60, M_{group2} = 5.40, M_{CG2} = 5.40), indicating that the expression "blockchain" itself does not evoke aversion. Thus, we can focus entirely on the 2 × 2 design. Group sizes ranged from 60 to 69 participants.

Pretest and checks. We pretested (n = 64, M_{age} =26.63, SD = 11.35; 53.1 % male) whether the emotive appeal was perceived as more emotive (e.g., "is formulated emotively," α = .80) and the factual appeal as more factual (e.g., "is formulated factually," α = .77), respectively whether the expert description was perceived as less lay than the lay one (e.g., "is formulated in layman's

Type of Blockchain description		Type of appeal: Emotive cue	Type of appeal: Factual cue
	Lay description	"**Animal welfare is close to your heart?** Follow the animal's journey: **From happy chicken to delicious meat**" "Guaranteed **trustworthy** tracking using **blockchain**: For complete transparency of the entire supply Chain"	"**Animal husbandry is important to you?** Follow the path of the product: **from breeding to sale**" "Guaranteed **trustworthy** tracking using **blockchain**: For complete transparency of the entire supply chain"
	Expert description	"**Animal welfare is close to your heart?** Follow the animal's journey: **From happy chicken to delicious meat**" "**Cryptographic** encryption using **blockchain**: the decentralized database with tamper-proof signature throughout the supply chain"	"**Animal husbandry is important to you?** Follow the path of the product: **from breeding to sale**" "**Cryptographic** encryption using **blockchain**: the decentralized database with tamper-proof signature throughout the supply chain"

Fig. 3: Independent variables and example for the product package (here group 4)

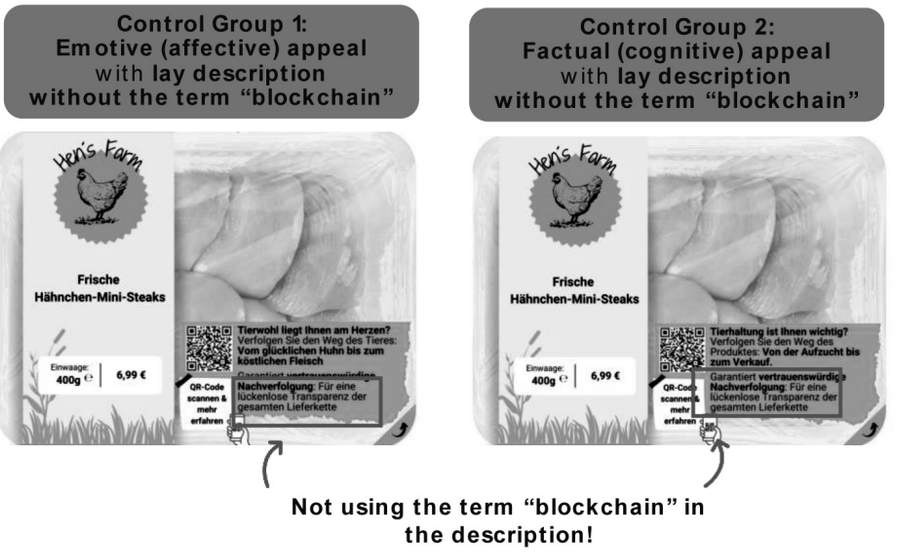

Fig. 4: Control groups (CG1) and (CG2), German version of the product packaging

terms"). The emotive appeal scored significantly higher on perceived emotionality (M_{emo} = 4.75 vs. M_{fact} = 3.16, $t(62) = 5.45$, $p < .001$) and lower on perceived factuality (M_{emo} = 2.70 vs. M_{fact} = 4.39, $t(62) = -4.67$, $p < .001$), and the expert description was significantly perceived as less lay (M_{lay} = 3.62 vs. M_{exp} = 2.26, $t(62) = 3.54$, $p < .001$). The manipulation check (same items as in pretest) in the main study was also successful, both for appeal (perceived emotionality: M_{emo} = 5.18 vs. M_{fact} = 4.56, $t(260) = 4.21$, $p < .001$; perceived factuality: M_{emo} = 4.68 vs. M_{fact} = 5.15, $t(260) = -2.68$, $p = .008$) and description (M_{lay} = 3.63 vs. M_{exp} = 3.10, $t(260) = 2.28$, $p = .023$). A confounding check showed that appeals and descriptions were perceived as realistic and suitable (no significant differences between groups, means > 5.07).

Measures (see Appendix). All constructs were measured on seven-point scales. To measure trust in the supply chain information we used three items (Kozup et al. 2003; Moussa and Touzani 2008), slightly adjusted to fit the stimuli (e.g., "The origin information is very credible," $\alpha > .95$). According to factor analysis, all items load on the same factor. The anticipated overall (ecological) quality was measured with eight items (e.g., "The meat seems sustainably produced," "The meat seems to be organic," "The meat is probably good quality," $\alpha > .94$), based on previous studies (Bao et al. 2011; Magnusson et al. 2001; Brunsø et al. 2002; Samant and Seo 2016). An additionally conducted factor analysis reveals that all items also load on one dimension. In the later analyses, the higher-level dimensions were used for fur-

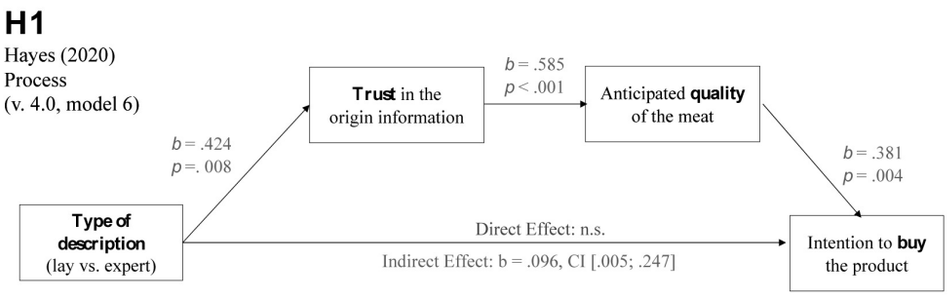

Fig. 5: Results H1

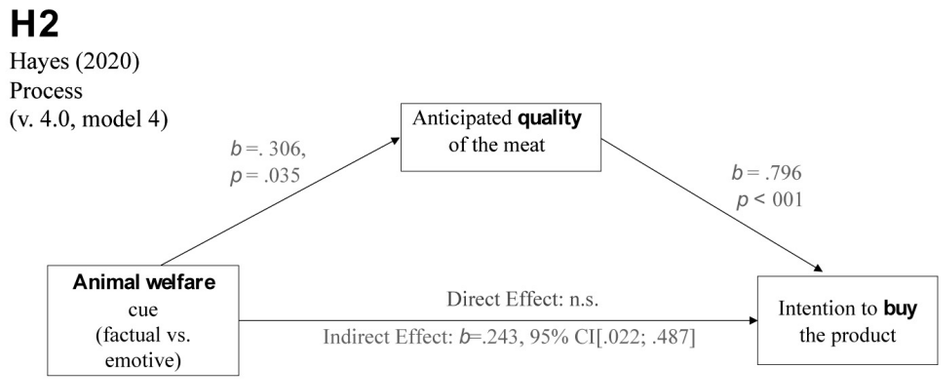

Fig. 6: Results H2

ther calculations. Intention to buy and scan the QR code were measured with single items each.

Objective blockchain knowledge was measured according to Pieniak et al. (2010) by having participants indicate whether statements about blockchain technology were true or false. A (metric) score was computed from participants' answers to five statements (0–5 scale: no correct answers = 0 to all correct answers = 5). 36 % answered four or five questions correctly, thus showing a high objective knowledge. Interestingly, objective knowledge does not correlate with any dependent variables (all r <.1, all n.s.) and was equally distributed across all groups, so does not need to be considered as a covariate.

Sample. As indicated, n = 398 respondents (M_{age}=52.38, SD = 14.22; 63.3 % male) remained in the sample who were randomly assigned to the four experimental conditions and the two control groups (between 60 and 70 participants per group). Chi-squared tests and ANOVAs showed that the groups did not differ significantly concerning socio-economic variables and all control variables (technological affinity, sustainable lifestyle, meat consumption, and, as already indicated, objective blockchain knowledge).

3.2. Results

We tested H1 via a serial mediation using Hayes (2020) Process (v. 4.0, model 6). First, trust in the supply chain information is higher for the expert description than the lay description (b = .424, p = .008; M_{lay} = 5.02, M_{exp} = 5.44). The trust in the supply chain information in turn positively influences the anticipated overall quality (b = .585, p < .001), which consequently increases purchase intention (b = .381, p = .004). The indirect effect of description type over trust and anticipated overall quality on purchase intention is also significant (b = .096, 95 % CI [.005; .247]), supporting H1 (see *Fig. 5*).

H2 (see *Fig. 6*) was tested with mediation model 4 (Hayes 2020). The emotive cue demonstrates a significant increase in the anticipated overall quality (b = .306, p = 035; M_{fact} = 5.16, M_{emo} = 5.47), which enhances the purchase intention (b =. 796, p < .001). The indirect effects of the type of animal welfare cue over anticipated overall quality on purchase intention are significant (b =. 243, 95 % CI [.022, .487]), supporting H2.

To test H3, we used a 2 × 2 MANOVA with trust in the supply chain information, anticipated overall quality, and purchase intention serving as dependent variables. No significant interaction effect of "type of blockchain description" × "appeal" was found for any of the variables (trust: p = .144, quality: p = .326, purchase intention: p = .466). However, if we have a closer look, the mean values tend to go in the right direction (see for all hypotheses the summarizing *Tab. 3*).

In addition, we wanted to find out which combination of blockchain description and animal welfare cues elicits the highest scan intent. We found neither an interaction effect (p = .781) nor a main effect of the animal welfare cue (p = .221). But we found, even if only at a 10 % level, a main effect for type description (F(1, 219) = 3.20, p = .075), to the extent that the expert description outperforms the lay one (M_{lay} = 3.23, M_{exp} = .74). Here again, al-

H1: Serial mediation analysis (model 6)	Unstandardized coefficient *b*	Standard error	*t* value	*p*
Outcome: trust in the supply chain information (med. 1)				
Type of blockchain description (lay vs. expert)	0.424	0.160	2.645	.008
Outcome: anticipated overall (ecological) quality (med. 2)				
Type of blockchain description (lay vs. expert)	0.034	0.111	0.359	.719
Trust in the supply chain information	0.585	0.046	12.644	< .001
Outcome: purchase intention (dv)				
Type of blockchain description (lay vs. expert)	0.129	0.219	0.591	.555
Trust in the supply chain information	0.534	0.120	4.445	< .001
Anticipated overall (ecological) quality	0.381	0.134	2.849	.004
Indirect effect	Effect coefficient	Bootstrapping standard error	Bootstrap CI: lower level	Bootstrap CI: upper level
iv → med. 1 → dv (sign.)	0.228	0.101	0.048	0.442
iv → med. 2 → dv (n.s.)	0.015	0.046	-0.078	0.111
iv → med. 1 → med. 2 → dv (sign.)	0.096	0.060	0.005	0.247

Descriptive statistics				
Variable	**Condition**	***M***	***SD***	***n***
Trust in the supply chain information	Lay description	5.01	1.27	104
	Expert description	5.44	1.09	115
Anticipated overall (ecological) quality	Lay description	5.16	1.11	104
	Expert description	5.46	1.02	115
Purchase intention	Lay description	4.22	1.89	104
	Expert description	4.69	1.81	115

H2: Mediation analysis (model 4)	Unstandardized coefficient *b*	Standard error	*t* value	*p*
Outcome: anticipated overall (ecological) quality (med)				
Type of animal welfare cue (fact. vs. emo.)	0.306	0.144	2.126	.035
Outcome: purchase intention (dv)				
Type of animal welfare cue (fact. vs. emo.)	0.136	0.227	0.599	.550
Anticipated overall (ecological) quality	0.796	0.106	7.484	< .001
Indirect effect	Effect coefficient	Bootstrapping standard error	Bootstrap CI: lower level	Bootstrap CI: upper level
iv → med. → dv (sign.)	0.243	0.119	0.022	0.487

Descriptive statistics				
Variable	**Condition**	***M***	***SD***	***n***
Anticipated overall (ecological) quality	Factual cue	5.16	1.08	107
	Emotive cue	5.47	1.04	112
Purchase intention	Factual cue	4.41	1.84	107
	Emotive cue	4.52	1.87	112

Tab. 3: Summary of all results

H3: 2 × 2 MANOVA					
Descriptive statistics (no significant interactions, but mean values for combination scientific expert description x emotive appeal highest)					
Variable	**condition 1**	**condition 2**	***M***	***SD***	***n***
Trust in the supply chain information	Lay	Factual	5.16	0.99	52
No significant interaction, but means for combination expert x emotive appeal highest (in bold).		Emotive	4.89	1.49	52
		Total	5.01	1.27	104
	Expert	Factual	5.34	1.14	55
		Emotive	**5.53**	1.05	60
		Total	5.44	1.09	115
	Total	Factual	5.25	1.07	107
		Emotive	5.23	1.31	112
Anticipated overall (ecological) quality	Lay	Factual	5.09	1.14	52
		Emotive	5.24	1.08	52
		Total	5.16	1.11	104
	Expert	Factual	5.23	1.02	55
		Emotive	**5.66**	0.96	60
		Total	5.45	1.02	115
	Total	Factual	5.16	1.08	107
		Emotive	5.47	1.03	112
Purchase intention	Lay	Factual	4.08	1.97	52
		Emotive	4.37	1.79	52
		Total	4.22	1.88	104
	Expert	Factual	4.65	1.66	55
		Emotive	**4.73**	1.95	60
		Total	4.69	1.81	115
	Total	Factual	4.41	1.84	107
		Emotive	4.52	1.87	112

Further analyses		
Dependent variable	**independent variable**	**Test statistics**
Intention to scan	Type of blockchain description (lay vs. expert)	$F(1, 219) = 3.200$, $p = .075$
	Type of animal welfare cue (fact. vs. emo.)	$F(1, 219) = 1.507$, $p = .221$
	Type of blockchain description (lay vs. expert) * Type of animal welfare cue (fact. vs. emo.)	$F(1, 219) = 0.077$, $p = .781$

Descriptive statistics					
Variable	**condition 1**	**condition 2**	***M***	***SD***	***N***
Intention to scan	Lay	Factual	3.02	2.12	52
		Emotive	3.44	2.09	52
		Total	3.23	2.11	104
	Expert	Factual	3.60	1.99	55
		Emotive	**3.87**	2.09	60
		Total	3.74	2.04	115
	Total	Factual	3.32	2.06	107
		Emotive	3.67	2.09	112

Note: Design: Between-subjects design (four experimental groups, two control groups). Independent variables: iv1: type of blockchain description: lay vs. expert (coded: 0 = lay, 1 = expert); iv2: type of animal welfare cue: factual vs. emotive (coded: 0 = factual, 1 = emotive). H1: Serial mediation analysis: iv1, using PROCESS (v. 4.0, model 6) by Hayes (2020). H2: Mediation analysis: iv2, using PROCESS (v. 4.0, model 4) by Hayes (2020). H3: 2 × 2 MANOVA: iv1, iv2. Further research: 2 × 2 ANOVA: iv1, iv2.

Tab. 3: Summary of all results (continued)

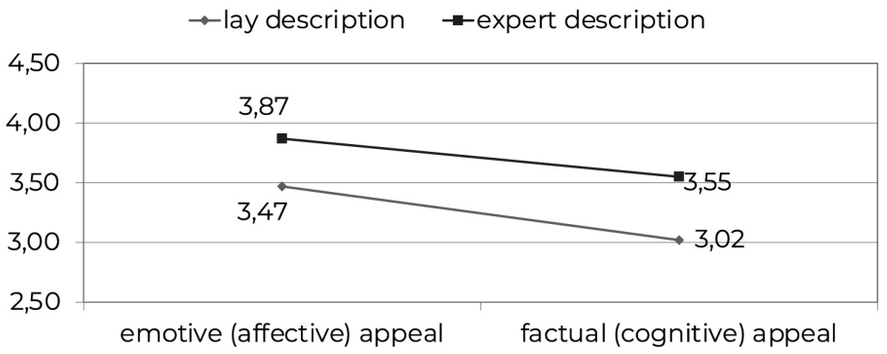

Fig. 7: Intention to scan

though not significantly, the combination of expert description and emotive cue obtains the highest mean value (see *Fig. 7*).

4. Summary, Discussion, and Limitations

Our study sheds light on how consumers respond to innovative technology in the high-quality meat market, specifically focusing on blockchain technology. We examine which extrinsic quality cues on the packaging exert an influence on product perception of meat with high levels of animal welfare in terms of husbandry. This study is among the first to examine how declaration of blockchain encryption of supply chains, specifically for meat products, should be framed to increase consumers' trust in the information, perception of organic quality, and purchase intention. The wording of the slogans plays a crucial role. While previous studies (see *Tab. 2*) either only investigated whether a reference to blockchain technology (blockchain certified) vs. not had an influence on consumer reactions or provided an understandable explanation as an add-on, we systematically varied the wording in our study. Additionally, the study explores whether emotive vs. factual references to animal welfare are more relevant for consumers and whether these cues interact with different blockchain information. The study also investigates whether the term "blockchain" triggers aversion and considers consumers' knowledge of the technology.

From a theoretical point of view, cue utilization theory once again provides a fruitful basis for the derivation of hypotheses. First, we found two main effects: (1) The expert description of blockchain leads to higher levels of trust in the supply chain information, overall (ecological) quality perception, and in turn purchase intention than the commonly understood description used by previous authors (e.g., Shew et al. 2022; Mazzù et al. 2021), even though participants' familiarity with and knowledge of the technology varied widely. Knowledge was determined with the help of a test that revealed which participants were really familiar with the technology. Of the respondents, approximately 36 % were able to answer 4 or 5 questions correctly, and approximately 24 % were able to answer fewer than two questions correctly. Thus, it can be assumed that the expert description works for those who understand blockchain, because this description is in line with their knowledge, while the uninformed trust the description more because it sounds scientifically accurate. However, in future studies, we should specifically investigate the rationale again; this is probably only possible with a qualitative survey. Interestingly, the use of the buzzword "blockchain" itself does not create any negative reactions, and objective knowledge of blockchain technology plays no role. In a future qualitative study, one could therefore also examine whether associations such as bitcoin come to consumers' minds at all (we are talking about supply chain here, after all), and, if so, whether these associations have negative connotations.

(2) Emotive animal welfare cues were found to be more effective than factual ones. This challenges on the one hand the "meat paradox" literature. The meat paradox means that consumers experience a psychological conflict between their preference for meat and their moral response to animal slaughter. So why is it more moral to eat the meat of a happy animal? On the other hand, the emotive cue appeals more strongly to the consumer: The animal lover is appealed to when the animal was happy in its live. Last but not least, although no significant interaction effects are observed, the combination of an emotive cue and an expert description tends to increase trust and quality perception. It might have been expected that a congruence (expert description and factual animal welfare appeal or understandable lay statement plus emotive appeal) would lead to the best values, but this was not the case. Based on the HSM, we assumed that it is most effective to appeal to both, heart and mind. As mentioned, the values point in this direction, although not significantly.

Our hypotheses should be re-examined in future point of sale (POS) studies. This is a first and thus explorative investigation. The study has limitations, such as being conducted online and not accounting for other extrinsic cues at the POS where decisions are mostly made in a few seconds. Already planned future studies will include field research, also with mobile eye-tracking (to check whether the cues are actually noticed). We are aware that POS studies are extremely important. Even though our

test subjects attributed a very high degree of realism to the manipulated product packaging, our online study obviously did not. Approximately 97 % of German food is sold in stationary retail, so we need to do a POS study to validate our results. We kept the price constant for the packaging, but in real retail scenarios, the customer naturally has opportunities for comparison with other meat products. So, it would also be worth checking whether consumers – no matter what the product packaging says – reach for other offers if the price is cheaper. Real sales data could support the results of our experiment (of course, only if a retailer agreed to redesign the product packaging according to our design). Moreover, in our research, respondents could only indicate their intention to scan the QR code. Whether consumers actually do this (especially under time pressure) at the POS also remains to be investigated.

Further studies should also investigate the development of standards and best practice for implementing blockchain labels, owing to the lack of uniformity in the current market. The novelty effect of blockchain technology should also be kept in mind, as the technology is still quite young and fascinates many people. In a few years, this may have subsided and then it could be that a familiarization effect will have set in and this specific extrinsic cue will have lost significance, irrespective of the wording. The question also arises as to how such information works at the deli counter. Is it sufficient here if QR codes are placed next to the meat on the counter? Do we perhaps need additional large (digital) displays that draw attention to the blockchain encryption, or is it only the oral recommendation of the meat seller that counts here? There are still many research questions to be answered.

Appendix

Measures (all seven-point scales)

Anticipated quality of the product (α = .95):
The meat...
1. probably has a good quality.
2. seems to be of high quality.
3. has positive effects on health.
4. is an important part of a healthy diet.
5. is probably free from additives.
6. appears to be organically produced.
7. comes from an animal that has been well cared for.
8. comes from an animal that previously had a happy life.
9. has probably been produced in an environmentally friendly way.
10. seems to be sustainably produced.

Anticipated taste (α = .86):
The meat...
1. probably does not taste good – probably tastes good.
2. is probably not tasty – is probably tasty.
3. does not seem tasty to me – seems tasty to me.

Trust in the origin information (α = .95):
The origin information...
1. are very credible.
2. are very trustworthy.
3. keeps what it promises.

Intention to scan the QR-Code (single item)
„Regardless of whether you have scanned the QR code on the product packaging or not, how would you basically assess your intention to scan this QR code in the scenario described?"

Intention to buy the product (single item)
„How likely is it that you would buy the product? Not at all likely – very likely"

Aversion to the term Blockchain
How do you feel when you think of the term blockchain?
1. I feel aversion – I feel sympathy.
1. I associate it with negative associations – positive association.

Blockchain knowledge test (correct & incorrect statements that have to classified as correct vs. not)
2. Blockchain is a decentralized digital ledger system to which every actor in the supply chain has copy access.
3. Each piece of injected information has a digital fingerprint and is therefore unique.
4. If one changes even a single piece of information in the blockchain, the chain is invalid and all actors are notified.

5. Information does not have to be chronologically injected into the blockchain because it is not directly linked.
6. The blockchain is transparent in that all actors can review and modify the stored information.

Further control variables
technological affinity, sustainable lifestyle, frequency of meat consumption

Manipulation checks
Emotive vs. factual appeal: The slogan...
1. is emotionally formulated.
2. uses figurative language.
3. is sentimental.
4. is formulated in an embellishing way.
5. is formulated factually.
6. is formulated neutrally.

Expert vs. laymen's description: The slogan
1. is formulated in layman's terms.
2. uses complex technical terms
3. is easy to understand.

Confounding check
1. The appeal/description fits the product well
2. The appeal/description is realistic

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Keywords

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