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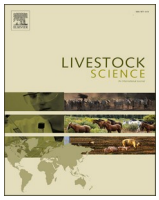

Developing more extensive pig and broiler husbandry from farm to fork: Key results from the mEATquality project

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HIGHLIGHTS

- European consumers are interested in extensification attributes, but not all want to pay for it.
- Improvements in space allowance, feed and space enrichment can improve animal welfare.
- These improvements have almost no negative effects on meat quality.
- Breed is a major driver of sensory profile and consumer sensory liking.
- Information about husbandry influences consumer sensory liking and willingness to pay.
- Extensification parameters need to be embedded in an attractive bundle of parameters.

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ABSTRACT

In the mEATquality project, four groups of factors of extensive husbandry practices for pigs and broilers – breed, feed, space allowance and space enrichment – were investigated with regard to their effect on animal welfare, their effect on meat quality, and their consumer acceptance. Results show that it is possible to implement elements of extensive husbandry in pig and broiler production that increase animal welfare and are not detrimental to meat quality. Also, results show that consumers are interested in such elements of extensive husbandry and are, to varying extents, willing to pay for them. Results also indicated a huge diversity of husbandry systems across Europe and the need to take into account local conditions in any attempt to work for more extensive husbandry. Results for consumer acceptance showed that while consumers were generally positive, messages about extensive husbandry need to be embedded in a product concept that also entails the right sensory profile, the right packaging and the right level of convenience for preparation and consumption.

1. Introduction

Animal husbandry for meat consumption has come under increased scrutiny with regard to animal welfare and with regard to its environmental impact. This, in turn, has led to a focus on possible transitions from intensive to more extensive farming systems. However, extensification of animal husbandry can involve many parameters, and they need to be selected and combined not only with regard to potential improvements in environmental impact and animal welfare, but also in terms of potential effects on meat quality, production costs and, not least, with regard to consumer acceptance and willingness to pay. Consumers are interested in more sustainable food husbandry and many consumers are also willing to pay for it (Li and Kallas, 2021), but that does not mean that any form of more extensive meat husbandry system will succeed in the market. If a process towards extensification of animal husbandry should, in the end, lead to a product that consumer regard as desirable and are willing to pay for, it is therefore imperative to align potential effects of extensification on animal welfare and sustainability

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Table 1
Attributes and attribute levels used in the choice experiment.

Attribute	Attribute levels		
Sensory properties	Superior taste	Superior Tenderness	None
Feed origin	Farm husbandry	Purchased on international market	Mix of farm husbandry and purchased feed on international market
Breed	Traditional, local breed	Mainstream, coventional breed	
Space allocation	Current legislation	30% more than current legislation	100% more than current legistlation
Outdoor access	Outdoor access	No outdoor access	
Price	25% more than usual price	50% more than usual price	75% more than usual price

From Peschel et al. (2025).

with potential changes in meat quality and with consumer acceptance and demand. This has been attempted in the mEATquality project[1] with regard to husbandry systems for pigs and broilers.

Consumers play a major role as a change agent in the green transition of the food sector (Grunert, 2025). Consumer demands for meat and meat-based products have become considerably more complex over the last few decades (Grunert, 2005, 2006). While consumer demand used to be mainly directed at sensory properties, consumers today also demand convenience, health, animal welfare and, most recently, sustainability. Living up to consumer demands is a joint task for all actors in the meat value chain. Some aspects like convenience and, to a lesser extent, sensory properties can be dealt with at the processing level. However, core attributes of meat products come about at the level of animal husbandry, and to the extent that consumers have more varied, heterogenous and complex demands, meat husbandry at the farm level must be designed to fulfil those demands and the rest of the value chain must ensure that the resulting differentiated meat is safely slaughtered, packaged and distributed, that the meat products can be traced in the chain back to its origins, and that consumers are informed about the product attributes, especially those experience and credence attributes that are not amenable to consumer scrutiny before the purchase (Girard and Dion, 2010), in an efficient and credible way.

The more differentiated consumer demands become, the higher is the risk that products that come on the market will fail, especially if their development was not based on a thorough understanding of consumer demands. This goes also for animal husbandry. Some consumers are interested in extensive husbandry systems and are willing to pay for it (Lin-Schilstra et al., 2022; Lund et al., 2021; Ngapo et al., 2004; Verbeke et al., 2010), but not all do, and those that do will differ in their views on which attributes of extensive husbandry are the most attractive ones, and to which extent they are willing to trade increased sustainability and animal welfare for a potential change in meat quality, especially the sensory properties.

Calls for consumer-driven new product development in the meat sector are not new (Grunert and Valli, 2001). But the rising interest in sustainable animal husbandry makes it all the more relevant to find ways in which consumer preferences can be analysed, linked back to design factors in animal husbandry, and then turned into products with attractive prices and accompanied by communication that allows consumers to understand why this particular product should fulfil their needs and wants.

The European Union (EU) funded mEATquality project provides insights into the complexities of linking extensification of animal husbandry to a value-chain based new product development process. In the present paper, we will show how an analysis of consumer preferences was turned into design factors for animal husbandry, how these affected outcome parameters in terms of meat quality and animal welfare, and how consumers reacted when they were confronted with products resulting from this process. More specifically, we will address the following research questions:

1. Which aspects of extensive husbandry of pigs and broilers are consumers most interested in?
2. When those aspects of extensive husbandry are implemented, what will be the implications for animal welfare, meat quality and sensory properties?
3. How will consumers react to meat products incorporating these characteristics?

Describing this process allows insights into the complexities of such a value-chain spanning process and can therefore provide valuable input to future attempts at extensification of animal husbandry and of consumer-driven product development in the meat sector.

2. Consumer preferences for animal husbandry characteristics

Consumer preferences for attributes related to the husbandry of pigs and broilers can be analysed by means of choice experiments, where consumers have to choose between hypothetical products derived from an underlying factorial design (Lizin et al., 2022). Consumer interest in husbandry attributes related to animal welfare and sustainability were therefore investigated using a discrete choice experiment in Denmark, Germany, Italy, Poland, the Netherlands and Spain. Details are available in Peschel et al. (2025).

The selection of attributes for the study was carried out in three steps. First, an analysis of the available literature on consumer perceptions of pork and broiler meat was carried out. In the second step the resulting list of attributes and their levels was validated by 25 expert interviews with meat chain professionals in the six countries covered by the study. This resulted in a list of 52 attributes and attribute levels for pork and 34 for broiler meat. The attributes were divided into five categories: sensory properties, feed, breed, space allocation and space quality. To reduce the list of 86 attributes for pork and broiler meat to a manageable number for a choice experiment, a best-worst scaling was carried out (Louviere et al., 2015). This study was carried out with 200 German consumers to review and select which attributes from the attribute list were most important for the consumers. Germany was chosen as the largest market out of the six countries selected for the main study. In this process, consumers rated which attributes within each of the five categories for both pork and broiler meat were of most (best) and least (worst) importance. The attributes with the highest best-worst rating in each dimension were included in the choice experiment and can be seen in Table 1.

The main study was carried out in Denmark, Germany, Italy, the Netherlands, Poland and Spain, with a sample size of at least 500 per country (overall n=3028). Participants chose repeatedly between two pork chops or broiler breast alternatives (3 pieces, 600g). These products were chosen because they are very common pork and broiler meat products in all included countries. Each subject made 9 choices per meat category in randomized order. The pork chops and broiler breast were characterized by different combinations of the attributes shown in

[1] The mEATquality project was funded under the EU Horizon 2020 research and innovation program, grant Aagreement no 101000344. It was coordinated by Hans Spoolder from Wageningen University and had participants from Denmark, Germany, Italy, the Netherlands, Poland and Spain. For details see meatquality.eu.

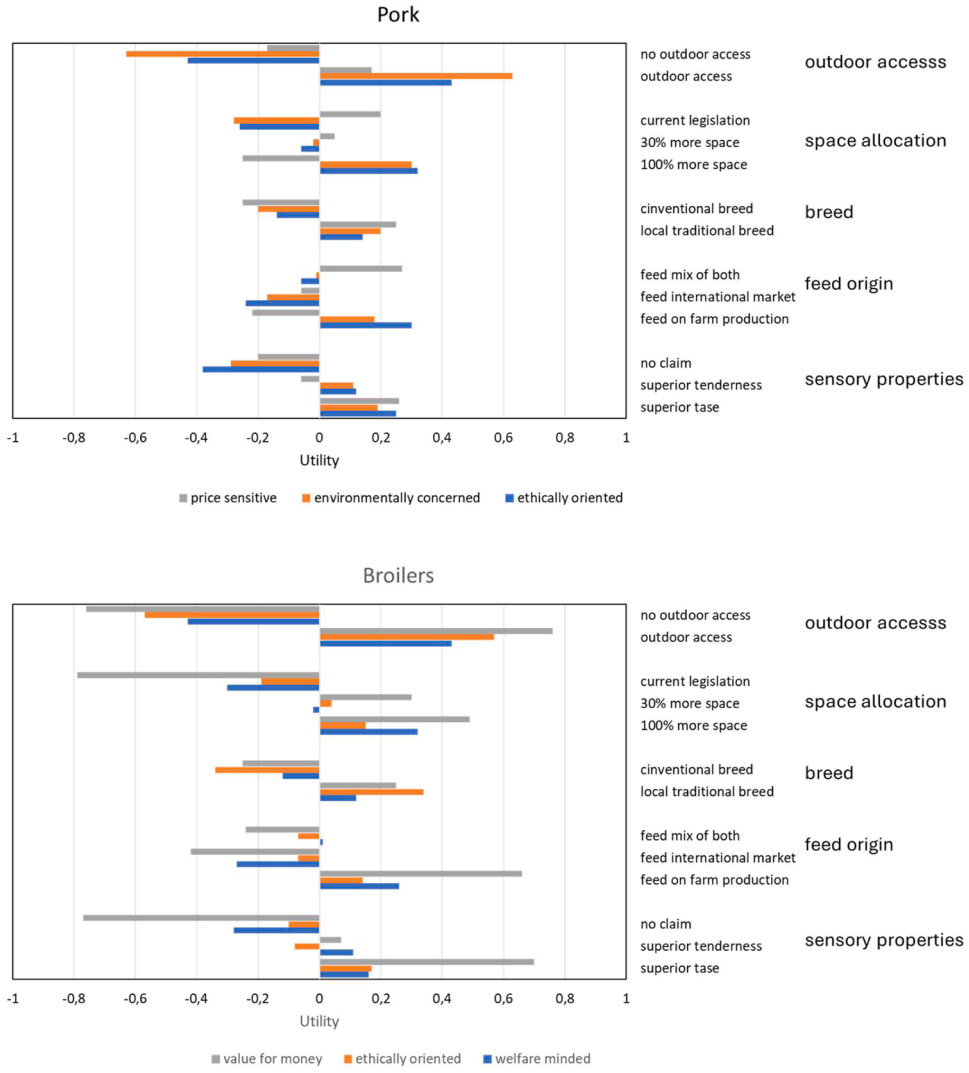

Fig. 1. Utility estimates for meat choices for three groups of consumers.
Based on choice experiment carried out in six countries, total N=3028, based on Peschel et al. (2025).

Table 1. To account for consumer heterogeneity, results were analysed by means of a latent class mixed logit model (Vermunt and Magidson, 2002).

The latent class analysis indicated that consumer heterogeneity can be captured by classifying consumers into three groups, of which one assigned major importance mostly to price and the others were, to various extents, interested in animal welfare and sustainability attributes. The parameter estimates for the three groups (except for price) are displayed in Fig. 1 and the respective willingness to pay values in Table 2. When viewing the results in Fig. 1, it becomes apparent that the pattern of results is similar for both meat products. There is a price conscious group (22% for pork and 18% for broilers), and there are two groups that are willing to pay for animal welfare and sustainability attributes, although with different weights. Outdoor access stands out in terms of utility and willingness to pay for both groups.

Overall, the results show that a majority of consumers is willing to pay more for specific attributes of extensive animal husbandry. Outdoor access stands out as the most desired attribute. More space for the animals is attractive only if the increase is substantial (100%). Likewise, locally produced feed is attractive, but a mix of local and internationally bought is not much desired. Local breeds are viewed as positive, although less so than locally produced feed and 100% more space and outdoor access.

The next step in the process was to translate these insights into parameters that are implementable at the farm level.

3. Husbandry attributes and their impact on animal welfare, meat quality and sensory characteristics

3.1. Design factors for pig and broiler husbandry

The consumer study only indicates the general directions in which to look for relevant parameters in the design for husbandry systems for pigs and broilers. Selection of design parameters for the experimental work in the project was therefore based on a review of husbandry systems in Europe.

Pig husbandry systems vary substantially between European countries, as does the outcome in terms of pork quality (Ludwiczak et al., 2023). From the South of Europe with Spain's most extensive *montanera* system ('pannage' in English), where Iberian pigs are foraging acorns and grass using very open space in nature (Rodríguez-Estévez et al., 2009) to central and northern Europe with highly intensive indoor, low space allowance, feed concentrate pig farms rearing commercial hybrids, especially in Denmark and Poland. When implementing changes towards more extensification, implications for animal welfare and meat quality need to be taken into account, as trade-offs can be

Table 2
Willingness-to-pay (€ per 600 g pack) estimates for meat attributes.

	Pork chops			Broiler breasts		
Group	Ethically oriented	Environmentally conscious	Price sensitive	Welfare minded	Ethically oriented	Value for money
Relative Size	50%	27%	23%	46%	35%	19%
Attributes						
Sensory						
Superior taste	1.61	2.63	0.17	1.09	.80	.23
Superior tenderness	.80	1.46	-.04	.74	-.35	.02
No claim	-2.42	-4.09	-.13	-1.84	-.44	-.25
Feed						
On-farm husbandry	1.90	2.47	-.14	1.74	.63	.22
Purchased on international market	-1.54	-2.35	-.04	-1.81	-.30	-.14
Mix of both	-.36	-.12	.18	.07	-.33	-.08
Breed						
Local, traditional	0.85	2.76	.17	.83	1.55	.08
Conventional, mainstream	-.85	-2.76	-.17	-.83	-1.55	-.08
Space						
100% more	2.07	4.10	-.16	2.11	.68	.16
30% more	-.41	-.24	.04	-.13	.20	.10
Current legislation	-1.66	-3.86	.13	-1.98	-.88	-.26
Outdoor access						
Yes	2.80	8.78	.11	2.86	2.58	.25
No	-2.80	-8.78	-.11	-2.86	-2.58	-.25
N=3028						

Note: WTP = $-(\beta_x/\beta_{price})$ in €. From Peschel et al. (2025).

Table 3
Tested extensification factors and the countries that have performed experiments with them in the mEATquality project.

Pigs				
Extensification factor	*Denmark intensive*	*Italy intensive + extensive*	*Poland intensive*	*Spain Intensive + extensive*
Use of local breed		✓	✓	✓
Forage/Diet	✓		✓	✓
Quality of space/ enrichment	✓	✓		✓
Space allowance	✓	✓	✓	

Broilers				
	Poland intensive	Poland organic	Germany organic	Netherlands extensive
Genetics		✓	✓	✓
Diet	✓			✓
Enrichment	✓	✓	✓	✓
Stocking density	✓			✓

involved and a husbandry parameter favoured by consumers will not necessarily lead to a product that consumers will like, as it may involve, for example, a lower meat quality (Ludwiczak et al., 2023; Grønbeck and Mielby, 2025). The extensification factors with most variation in Europe are use of local breed, foraging or diet including locally grown non-concentrate feed, quality of space (or enrichment) and the space allowance (Ludwiczak et al., 2023), which is in line with the results on consumer preferences referenced above. Those factors became the key focus of the mEATquality project and were evaluated in different countries in animal experiments (Table 3). Because the availability of local pig breeds varies widely between countries (Łodyga et al., 2026), a wide range of breeds were involved in the experiments, as shown in Table 4, and the use of local breeds could not be varied systematically across countries. Regarding the feed factor, the Polish diet experiments involved mixing locally grown agri-food by products (e.g. buckwheat, chokeberry, linen seeds or apple) with the concentrate feed (Kasprowicz-Potocka et al., 2025; Łodyga et al., 2025; Łodyga et al., 2024), the Danish team provided pigs with a daily bucket of locally grown maize-based roughage (Coutant, Grønbeck, et al., 2025), and pigs in the Spanish experiment received an addition of locally grown carob and oranges (Rodríguez-Fernández et al., 2024). Quality of space (enrichment) of the rearing conditions was investigated by providing pigs with paper bags, ropes and wooden logs in Denmark (Coutant, Grønbeck, et al., 2025), shade and branches in Italy and chains, and ropes and beach balls in Spain (Revilla et al., 2024, 2025). Table 5 presents the different levels of space allowance tested in Denmark (Coutant, Grønbeck, et al., 2025), Poland (Sell-Kubiak et al., 2026) and Italy (Ferrari et al., 2025) taking into account the current minimum (The European Union sets as minimum 0.65m^2 per finishing pig of 85–110 kg LW). All of those experiments were run from Autumn 2022 to Spring 2024 with Denmark using the experimental farm of Aarhus University whereas in the remaining countries farmers were contracted.

Experimental work on *broiler husbandry* focused likewise on identifying how key husbandry factors that are aligned with consumer preferences are associated with broiler meat quality and how these factors influence welfare outcomes across different European husbandry systems (Table 3). A literature review was carried out that synthesised over a decade of broiler research and showed that genotype, stocking density, environmental enrichment, dietary fibre access, and outdoor access were the primary drivers of meat quality differences across husbandry systems (Marchewka et al., 2023). The review showed that fast-growing genotypes suffer from accelerated muscle hypertrophy and impaired vascularisation, contributing to conditions such as wooden breast and white striping, which directly affect texture, drip loss, colour, and pH decline (Sihvo et al., 2014; Petracci et al., 2019). Conversely, slower-growing hybrids typically display improved oxidative metabolism, more stable pH kinetics, and better overall sensory attributes (Fanatico et al., 2007; Tasoniero, 2018). Stocking density was identified in the review as another major determinant of meat quality, primarily through its influence on activity levels, litter condition, and physiological stress. (Buijs et al., 2009; Dawkins and Layton, 2012; Dozier et al., 2006). Given the substantial variation in density practices between husbandry systems, density contrasts were implemented reflecting national husbandry contexts: Poland tested 41 vs. 35 kg/m^2 in Ross 308, whereas the Netherlands examined 39 vs. 21 kg/m^2 in Hubbard JA757 systems. The inclusion of environmental enrichments was likewise motivated by the review, which showed that enrichments such as perches, dustbathing areas, or foraging materials can modulate muscle metabolism through increased activity and improved behavioural expression (Bailie et al., 2018; Riber et al., 2018). We therefore implemented enrichment of various designs in both Poland and the

Table 4
Pig and broiler breeds used across European countries participating in the project.

Breed	Type of breed	Country
Pigs		
DanBred [Duroc × (Landrace × Yorshire)]	Commercial hybrid	Denmark, Poland
Large White x Cinta senese	Italian local with commercial breed cross	Italy
Duroc x Cinta senese	Italian local with commercial breed cross	
Mora Romagnola x Large white	Italian local with commercial breed cross	
Cinta Senese	Italian local	
Topigs Norsvin TN70	Commercial hybrid	
Duroc x Large White	Italian commercial crossbred	
Large White x Duroc	Italian commercial crossbred	
Iberian	Spanish local	Spain
Iberian x Duroc	Spanish local with commercial breed cross	
Large White x Landrace	Spanish commercial crossbred	
(Polish Large White x Polish Landrace) x (Duroc x Pietrain)	Polish commercial crossbreed	Poland
PIC	Commercial hybrid	
Polish Large White	Polish commercial breed	
Pulawska	Polish local	
Pulawska x Polish Large White	Polish local with commercial breed cross	
Broilers		
Ross 308	Fast-growing commercial hybrid	Poland
Hubbard JA757	Slower-/medium-growing commercial hybrid	the Netherlands, Poland
Hubbard JA787	Slower-/medium-growing commercial hybrid	
Hubbard S757N (naked neck)	Very slow-growing / Label Rouge-type hybrid	the Netherlands
Label Rouge-type chickens	Slow-growing premium system chickens	
ÖTZ Coffee chickens	Slow-growing welfare-oriented production system chickens	Germany
Dual-purpose chickens (Lohmann Dual)	Dual-purpose chickens for combined meat and egg production	
Male layer chickens (Lohmann Brown males)	Male layer-line chickens from laying hen genetics (alternative husbandry system)	
Lohmann Sandy	Male layer-line chickens from laying hen genetics (alternative husbandry system)	
Lohmann LSL Lite	Male layer-line chickens from laying hen genetics (alternative husbandry system)	

Table 5
Tested space allowance for pigs across countries.

Space allowance in m^2/pig	Intensive		Extensive	
	Denmark	Poland	Italy indoor	Italy indoor/ outdoor
Control – close to current minimum	0.7	1.0	1.0	1.3+1
Exp. group 1 – 1.5x or 2x minimum	1.5	1.5	2.0	2.6+2
Exp. group 2 – 2x or 3x the minimum	2.1	2.0	3.0	3.9+3

Netherlands. Poland evaluated perch provision in fast-growing Ross 308 and medium-growing Hubbard hybrids, while the Netherlands applied multi-component enrichment packages including lucerne nets, dustbathing material, and barrier perches.

These designs represented the contrast between minimal and high environmental complexity typical for the dominant national systems. Roughage provision was selected because dietary fibre and foraging substrates influence gut function, energy metabolism, and stress regulation, which in turn affect meat quality through changes in nutrient utilisation and muscle biochemistry (Hetland and Svihus, 2001; Mateos et al., 2012). We included lucerne roughage in both Polish and Dutch experiments to test its effects on foraging behaviour, gut activity, and muscle quality traits such as pH decline, water-holding capacity, and texture.

Although the literature review focused mainly on meat quality, outdoor access was included as it was the most important factor in the consumer preference study and because published research shows clear differences in meat traits between indoor and outdoor systems. Birds having an opportunity to use outdoor access often show altered fatty acid profiles, higher antioxidant activity, darker colour, and improved texture due to increased activity and exposure to natural feed sources (Fanatico et al., 2005; Castellini et al., 2002). We incorporated outdoor access in Poland through the Hubbard experiments. In parallel, complementary studies in Germany examined management factors—such as the timing of pophole opening—that influence both outdoor use and carcass cleanliness. Together, these approaches allowed us to assess the meat-quality implications of outdoor systems and how they interact with slower-growing genotypes.

Stocking density was varied in the Netherlands (21, 31, 39 kg/m^2 and in Poland (35, 45 kg/m^2).

3.2. Effects on growth, health and animal welfare

During the pig experiments, the effects on growth, health and welfare were tested. Each partner country had the possibility to collect different indicators of the health and welfare status of the animals; thus, the measures used differ between experiments. In the Polish experiments, the immune-physiological parameters were measured, which indicated that use of agri-food by-products (Kasprowicz-Potocka et al., 2025; Łodyga et al., 2025; Łodyga et al., 2024) and increased space allowance per pig (1.5m2/pig; (Sell-Kubiak et al., 2026) reduce immune stress indicators and maintain redox stability. In the Danish experiments it was observed that pigs in groups with conventional space of 0.7 m2/pig had lower chances to reach the feeder and rest at night and that it was more difficult for them to maintain the cleanness of the pen (Coutant, Juul Pedersen, et al., 2025). Across-country evaluation of the cortisol and dehydroepiandrosterone (sulphate) in pigs' hair from Danish, Italian and Polish experiments indicated that lower stocking density leads to less chronic stress in pigs (Reimert et al., 2025). The treatment groups with enrichment did not provide such clear results for the stress hormones. This is in line with the study on animal-based welfare indicators in Danish experiments (Coutant, Menard, et al., 2025). Interestingly, those animal-based measures systematically differed according to the husbandry week and unless a combination of indicators is used, there are no differences between treatment groups in welfare (Coutant, Menard, et al., 2025; Coutant et al., 2026). Pigs in Denmark and Poland grew faster with more space per pig available (Coutant, Juul Pedersen, et al., 2025) which is most probably linked to less competition to access the feeder (Coutant, Menard, et al., 2025). However, the same was not observed in Italian pig experiments, where there were no differences in growth rate reported regardless of the space per pig or outdoor access (Ferrari et al., 2025). Diets and enrichment of the space did not have any effect on growth rate (Coutant, Juul Pedersen, et al., 2025; Kasprowicz-Potocka et al., 2025; Łodyga et al., 2025; Łodyga et al., 2024).

Key results are summarized in Table 6.

Across broiler studies in Poland, the Netherlands, and Germany, welfare was consistently shaped by the four key husbandry factors as well as the provision of outdoor access. These findings align with established literature identifying slower-growing genotypes, lower densities, and greater environmental complexity as central to improved welfare (Dixon, 2020; Riber and Wurtz, 2024; Buijs et al., 2009), while

Table 6
Selected results of the effect of extensification factors on growth, health and animal welfare.

Species	Extensification factor								
	Genetics	Diet			Enrichment			Space allowance	
Pigs		**DK**	**ES**	**PL**	**DK**	**ES**	**IT**	**DK**	**IT**	**PL**
Average daily gain (kg/d)		-	n.e.	-	-	-	n.e.	↑0.05	-	↑0.05
Cortisol		n.e.	n.e.	n.e.	-	-	-	↓3.3	↓3.3	↓1.05
DHEA(s)		n.e.	n.e.	n.e.	-	-	-	↓60.5	↓209.4	↓32.1
Cortisol/DHEA(s) ratio		n.e.	n.e.	n.e.	-	-	-	↑13.4	↑1.9	↓5.7

Countries for pigs: (DK) Denmark; (ES) Spain; (IT) Italy; (PL) Poland. Countries for broilers: (DE) Germany; (NL) The Netherlands; (PL) Poland. Effect based on transition towards more extensification: (↑) Increase observed ($p<0.05$); (↓) Decrease observed ($p<0.05$); (-) No significant differences observed ($p>0.05$); (n.e.) not estimated.

the standardized cross-country design helped disentangle effects often confounded in commercial systems (De Jong et al., 2022; EFSA AHAW Panel, 2023).

Genotype emerged as the strongest and most consistent determinant. In Poland, medium-growing Hubbard birds outperformed fast-growing Ross 308 across all welfare indicators, including FPD, hock burn, lesions, and gait (Sztandarski et al., 2025), confirming that rapid growth impairs locomotion and increases lesion risk (Kestin et al., 1992; Knowles et al., 2008). This robustness persisted across housing conditions and supports broader evidence linking slower growth to better health and behaviour (Marchewka et al., 2023). Outdoor access further improved welfare, enhancing gait, reducing lesions prevalence and plumage cleanliness while increasing activity without compromising health (Sztandarski et al., 2025; Składanowska-Baryza et al., 2025). These effects reflect increased behavioural expression and reduced litter contact (Fanatico et al., 2005; Dawkins and Layton, 2012), with medium-growing birds particularly benefiting through improved musculoskeletal function. Environmental enrichments provided additional, context-dependent benefits. Perches reduced corticosterone and lesions in fast-growing birds, supporting evidence for improved activity and reduced fearfulness (Bessei, 2006; Bailie et al., 2018). Dutch enrichments mainly enhanced behaviour, with variable physical effects depending on design and management (Jacobs et al., 2023; Vas et al., 2023). Stocking density consistently affected welfare: lower densities improved gait, reduced lesions, and enhanced cleanliness (Buijs et al., 2009; Estevez, 2007). Birds at 21 kg/m^2 showed greater activity and better leg health than those at 39 kg/m^2, aligning with EFSA recommendations (EFSA AHAW Panel, 2023), though effects varied with implementation (pen size vs. group size). German results highlighted management effects, with earlier pophole opening increasing range use, activity, and cleanliness, and longer inspection times reducing mortality, reinforcing links between management quality and welfare (Dawkins and Layton, 2012; Fanatico et al., 2005; Hemsworth and Coleman, 2011).

Physiological data supported these patterns. Higher corticosterone levels occurred in high-density and non-enriched systems, while roughage and enrichments reduced stress indicators (Bortolotti et al., 2008; Fairhurst et al., 2011). Slower-growing genotypes also showed more favourable hormone profiles and improved metabolic and immune resilience (Yigitturk et al., 2025; Yigitturk, de Jong, et al., 2026), despite variability in DHEA(S) responses.

Overall, welfare improved along the extensification gradient—from intensive, fast-growing systems to lower-density, enriched, and outdoor-access systems. Genotype effects were most consistent, while density reductions and environmental complexity provided additive benefits. Integrating behavioural, physical, and physiological indicators across countries demonstrates that extensification robustly enhances broiler welfare.

3.3. Effects on meat quality

In previous literature reviews on the effect of extensification factors (breed, forage/diet, space allowance and environmental enrichment) on pork (Ludwiczak et al., 2023) and broiler (Marchewka et al., 2023) meat quality, various effects were shown. However, they were often confounded as meat quality is complex and influenced by multiple factors beyond animal husbandry, such as transportation, animal handling, slaughter method, post-slaughter management, etc. The mEATquality project enabled the testing of these extensification factors on animals across six countries (Denmark, Italy, Spain, Poland, the Netherlands and Germany), using standardised methodology in the different laboratories. Intrinsic meat quality was evaluated using various physicochemical measurements: pH and water holding capacity (WHC) (drip loss, thaw loss, cooking loss), proximate composition (moisture, protein and fat content), texture (shear force), colour (L*, a* and b*) and fatty acids composition.

Pork meat quality. The traditional or local breeds in Italy (Łodyga et al., 2026), Spain (Rodríguez-Fernández et al., 2026) and Poland (Łodyga et al., 2026) produced meat with significantly higher ultimate pH values, lower drip loss (better WHC), darker (lower L*) and redder (higher a*) colour with a higher intramuscular fat content. All of these results align with the patterns reported by Ludwiczak et al. (2023) where the pH of meat from local breeds was higher and darker in colour than in commercial crosses. There was also a tendency to have lower drip loss and higher intramuscular fat content values for local breeds.

It is well known that the fatty acid profile of pigs is strongly affected by diet (Wood et al., 2004). For the experiments testing diet/forage, meat quality was mainly affected in relation to the fatty acid composition for meat from Poland (Kasprowicz-Potocka et al., 2025), where a dietary mixture composed of linseed, apple pomace, and milk thistle increased the *n*-3 PUFA content and reduced the *n*-6/*n*-3 ratio in meat. The provision of roughage significantly increased drip loss in DLY pork from Denmark (Coutant, Menard, et al., 2025), while carob inclusion in the Spanish samples (Rodríguez-Fernández et al., 2024) led to increased redness (a*), moisture, protein and texture (tougher) with reduced intramuscular fat content. Currently in the literature there is no consensus on the effect of diet as it can vary greatly depending on the experimental design and type of diet used with its effects mainly related to the intramuscular fat content and fatty acids composition (Ludwiczak et al., 2023).

The effect of space allowance on meat quality was studied in Denmark (Coutant, Menard, et al., 2025), Italy (Ferrari et al., 2025) and Poland (Sell-Kubiak et al., 2026). Overall, excluding Poland, more space allowance reduced *n*-3, *n*-6, PUFAs (in Italian samples) and redness (a*) and increased lightness (L*) in both Danish and Italian pork. Nannoni et al. (2019) also reported a lower a* for pork raised at increased space allowance, where the pigs showed a reduction in pen floor exploration. The reduction in PUFA for animals reared with more space could be due a change in physical activity which influences the muscle fiber types and resulting affects the fatty acid composition. For colour, it is well-known that animals with increased activity produces meat that is darker and a redder in colour. In Italy, increasing space in conventional indoor housing improved meat tenderness (Ferrari et al., 2025). For the Polish study only very few meat quality parameters differed

Table 7
Selected results (showing significant means) of the effect of extensification factors on intrinsic meat quality.

Species	Extensification factor											
	Genetics			Diet			Enrichment			Space allowance		
Pigs	**ES**	**IT***	**PL***	**DK**	**ES***	**PL**	**DK**	**ES**	**IT***	**DK**	**IT**	**PL**
pH (at 48 h)	↑6.09	↑	↑	-	-	-	-	↓5.71	-	-	-	-
Drip loss (%)	↓0.39	↓	↓	↑5.82	-	-	-	↑2.10	-	-	-	-
Thaw loss (%)	-	-	-	-	-	-	-	-	-	-	↓5.14	-
Cooking loss (%)	-	-	-	-	-	-	-	↑14.66	-	-	-	-
Moisture (%)	-	-	-	-	↑	-	-	-	-	-	↓72.3	-
Protein (%)	-	-	-	-	↑	-	-	↓21.14	-	-	-	-
Fat (%)	-	↑	↑	-	↓	-	-	↑11.47	↑	-	↑4.26 (p=0.073)	↑2.9
Shear force (N)	↑88.96	-	-	-	↑	-	-	↓35.41	-	-	↓95.1	-
L*	↓48.88	↓	↓	-	-	-	-	↓50.91	-	↑54.1	↑57.2	-
a*	↑11.89	↑	↑	-	↑	-	-	↑10.95	-	-	↓1.42	-
b*	↓13.84	-	-	-	-	-	-	↓13.89	-	-	-	-

	Genetics			Diet		Enrichment			Space allowance	
Broilers	**DE**	**NL**	**PL**	**NL**	**PL**	**DE**	**NL**	**PL**	**NL**	**PL**
pH (at 48 h)	↑6.02 (ML)	↓5.86	-	-	↑5.91	-	-	-	-	-
Drip loss (%)	↓0.63 (DP)	↓0.44	-	↓0.73	-	-	-	-	-	-
Thaw loss (%)	↓5.23 (DP)	↓8.41	↑11.6	-	-	-	-	↑8.43	-	-
Cooking loss (%)	-	↓8.85	↑11.1	-	-	-	-	↑14.21	-	-
Moisture (%)	-	↓74.20	-	↓73.88	-	-	-	↑74.43	-	-
Protein (%)	↑23.94 (DP)	↑24.10	-	-	-	-	-	-	-	-
Fat (%)	-	↓0.19	-	-	-	-	-	↓3.43	↓0.40	↑4.10
Shear force (N)	-	↑11.00	-	-	↓8.61	-	-	↑8.92	-	-
L*	-	↑65.35	-	-	-	-	-	-	-	-
a*	-	↓10.84	-	-	-	↓8.55 (p=0.05)	-	-	-	-
b*	-	↓22.41	-	-	↓10.21	-	↑23.57	↑6.1	-	↓10.22

Countries for pigs: (DK) Denmark; (ES) Spain; (IT) Italy; (PL) Poland. Countries for broilers: (DE) Germany; (NL) The Netherlands; (PL) Poland. Effect based on transition towards more extensification: (↑) Increase observed ($p<0.05$); (↓) Decrease observed ($p<0.05$); (-) No significant differences observed ($p>0.05$). (DP) Dual-purpose; (ML) Male-layer. * indicates that this reflects results communicated by project partners with no reference available yet.

significantly, however, no clear pattern was observed between more and less space allowance (Sell-Kubiak et al., 2026).

Environmental enrichment has been broadly studied. Yet, there still exists a wide variety of forms of enrichment, while the studies are confounded with either rearing system (indoor vs. outdoor) and/or with space allowance when exploring its effect on meat quality (Ludwiczak et al., 2023). Furthermore, factors such as pre-slaughter treatment also play a role that is still challenging to underpin. Evidence suggests that access to outdoors, because of increased physical activity, produces meat with a lower pH and WHC, and darker and redder colour compared to indoor-housed pigs (Ludwiczak et al., 2023). In the project, this was observed for the Spanish samples (Rodríguez-Fernández et al., 2026). Meat from the 50% Iberian housed outdoor pigs had a lower pH and higher drip loss (lower WHC) than indoor, while the 50% indoor Iberian pigs had significantly lower a*, cooking loss and higher L*. In Italy, pigs with access to shade and branches showed higher intramuscular fat content compared to those with only branches. The review of Ludwiczak et al. (2023) showed a similar pattern with a higher intramuscular fat content for outdoors and/or access to enrichments. Shade and branches enrichment resulted in higher MUFA (particularly oleic acid) and a lower *n*-6/*n*-3 ratio, while DHA (a fatty acid with relevant biological functions) was more abundant in pigs enriched with branches alone. Here it is speculated that environmental enrichment affects the activity of the animal (as discussed for the effect of space allowance), and/or different energy intake and exposure to seasonal weather conditions (Ludwiczak et al., 2023). Overall, environmental enrichment only partially modified the fatty acid profile without compromising meat quality in the Italian samples. The Spanish free-range group produced pork with greater toughness and higher MUFA and *n*-3 PUFA contents (Rodríguez-Fernández et al., 2026). The latter aligns with the findings of Ludwiczak et al. (2023) that extensification influence the meat fatty acid profile towards a better nutritional value. Denmark found no significant effect on meat quality of indoor reared finisher pigs (Coutant, Menard, et al., 2025).

Overall, the effect of extensification on pork meat quality suggest that when traditional or local breeds are used the meat will be darker, redder, have a higher intramuscular fat, higher pH and less drip loss. When changing the diet, the colour, texture, proximate composition and fatty acid profile can be affected. Allowing more space could reduce the unsaturated fatty acids and redness of the meat and increase the lightness and tenderness. Yet, space allowance also appears to have no definitive effect on meat quality. Environmental enrichment appears to relate to the breed used, where our studies show no effect on conventional finisher pork meat quality, whereas the meat quality of traditional or local breeds varied.

Broiler meat quality. Genotype is known to have a pronounced impact on broiler meat quality (Marchewka et al., 2023). In the project, all meat quality parameters were affected in one way or another by the genetic strain tested. In Poland, the Netherlands and Germany, the slower growing breeds (i.e., Hubbard JA757 and S757N) had higher protein, lower intramuscular fat content and higher shear force (tougher meat), while the faster growing breeds (i.e., Ross 308 and Hubbard JA787) had higher ultimate pH values, higher intramuscular fat content and more tender meat (Składanowska-Baryza et al., 2025; Yigitturk, Grønbeck, et al., 2026). Our molecular insights suggest that Hubbard JA787 broilers prioritise anabolic pathways that drive rapid muscle growth and intramuscular fat accumulation (Yigitturk et al., 2025). The WHC varied between studies, e.g., in Poland Hubbard JA757 had higher thaw losses compared to JA787 (Składanowska-Baryza et al., 2025), while in the Netherlands thaw losses of JA757 and JA787 did not differ but were higher than that of the slow-growing S757N (Yigitturk, Grønbeck, et al., 2026).

The effect of diet has been widely studied, showing the negative effects of feed restriction and the favourable effects on meat quality when diet is supplemented with minerals and microelements, probiotics and prebiotics, enzymes, organic diets and feeding pasture/roughage (Marchewka et al., 2023). In both Poland and the Netherlands, the addition of dietary fibre in the broiler diet produced meat with

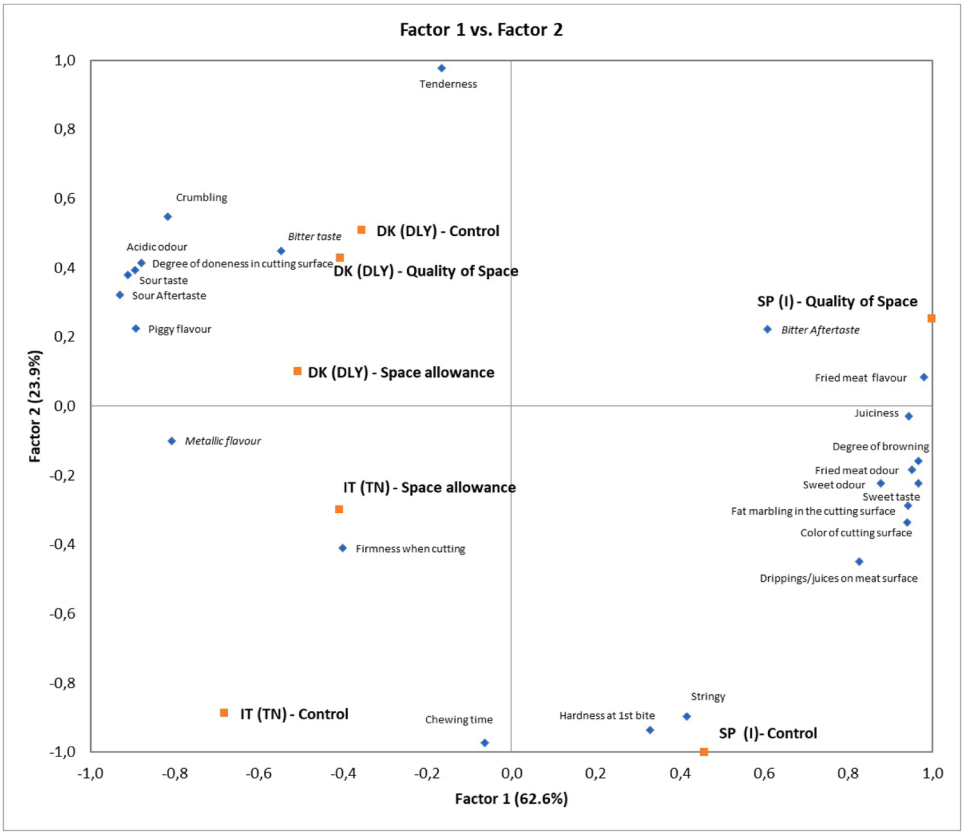

Fig. 2. Principal component analysis (PCA) biplot of the sensory descriptive data for pork chops from seven different husbandry concepts.
DK = Denmark, IT = Italy, SP= Spain. DLY = DanBred [Duroc × (Landrace × Yorshire)], TN =Topigs Norsvin TN70, I = Iberian. Space allowance =50% more space than control. Quality of space = enrichment like rope, page bags etc. Attributes shown in italics were not found to be significantly different across the concepts ($p > 0.05$).

significantly less drip loss, lower moisture content and increased (poly- and mono)unsaturated fatty acids (Ludwiczak et al., 2025; Yigitturk, Grønbeck, et al., 2026). Previous work has also shown reduced drip loss and moisture content in broiler meat with the inclusion of dietary fibre or alfalfa meal (Funaro et al., 2014; He et al., 2021). Interestingly for pigs (previous section), we saw the opposite where roughage provision significantly increased drip loss in DLY pork (Coutant, Menard, et al., 2025).

The stocking density of the housing system directly affects the activity level of the birds, their welfare as well as the meat quality (Nasr et al., 2021). In the Netherlands, a high stocking density (39 kg/m^2) using slower-growing Hubbard JA757 broilers, significantly promoted intramuscular fat accumulation in the breast muscle (Yigitturk, de Jong, et al., 2026), which aligns with the conclusion of Marchewka et al. (2023) that lower stocking density decreases the intramuscular fat content (less fat deposition in the meat). Our proteomics results provide a molecular explanation and suggest that broilers with less space allowance, show reduced physical activity and resultingly adapt carbohydrate metabolism pathways that can influence changes in fat deposition and body composition (Yigitturk, de Jong, et al., 2026). However, for the Polish trails using Ross 308 broilers, a lower stocking density (35 kg/m^2) resulted in a higher fat accumulation and less yellow meat (lower b* values) (Ludwiczak et al., 2025).

Environmental enrichment in the form of perches, dustbathing, lucerne bales, etc. are provided to enrich the quality of the space of the birds, thereby also improving their welfare. When providing birds with outdoor access as a form of enrichment, different effects of meat quality has been observed, but drawing definitive conclusions is challenging due to confounding factors linked to management and husbandry procedures affecting the results (Marchewka et al., 2023). For the Ross 308 broiler samples from Poland, access to perches increased the moisture content and reduced the fat content (Ludwiczak et al., 2025). For the broiler samples from the Netherlands, interactions were observed in the genetics and enrichment experiments, suggesting that enrichment likely has an effect only when some breeds are subjected to enriched conditions (Yigitturk et al., 2025). Specifically, only the slower-growing naked-neck Hubbard S757N broilers benefited (enhancing immune function, metabolic resilience and physical health) from environmental enrichment while enrichment led to reduced breast yield in Hubbard JA787. In Poland, environmental enrichment (for both Hubbard JA757 and JA787) in the form of having outdoor (free-range) access produced meat with a higher yellowness (b*), higher thaw and cooking loss, and lower intramuscular fat content (Składanowska-Baryza et al., 2025). This highlights the importance of breed-specific strategies when extensification is applied.

Overall, this means that extensification where the use of slower-growing breeds, including dietary fibre, lowering the stocking density and adding environmental enrichment could likely lead to meat with a decreased intramuscular fat content that is less tender and juicy. Nevertheless, this trade-off should be considered in light of increased animal welfare, and enhanced immune function, metabolic resilience and physical health for broilers.

Key results of the effects of the experimental factors on meat quality are summarized in Table 7.

3.4. *Effects on sensory characteristics*

Descriptive sensory analyses were conducted to provide objective, quantitative assessments of the effects of selected husbandry concepts on the sensory quality of pork and broiler meat. Due to practical limitations

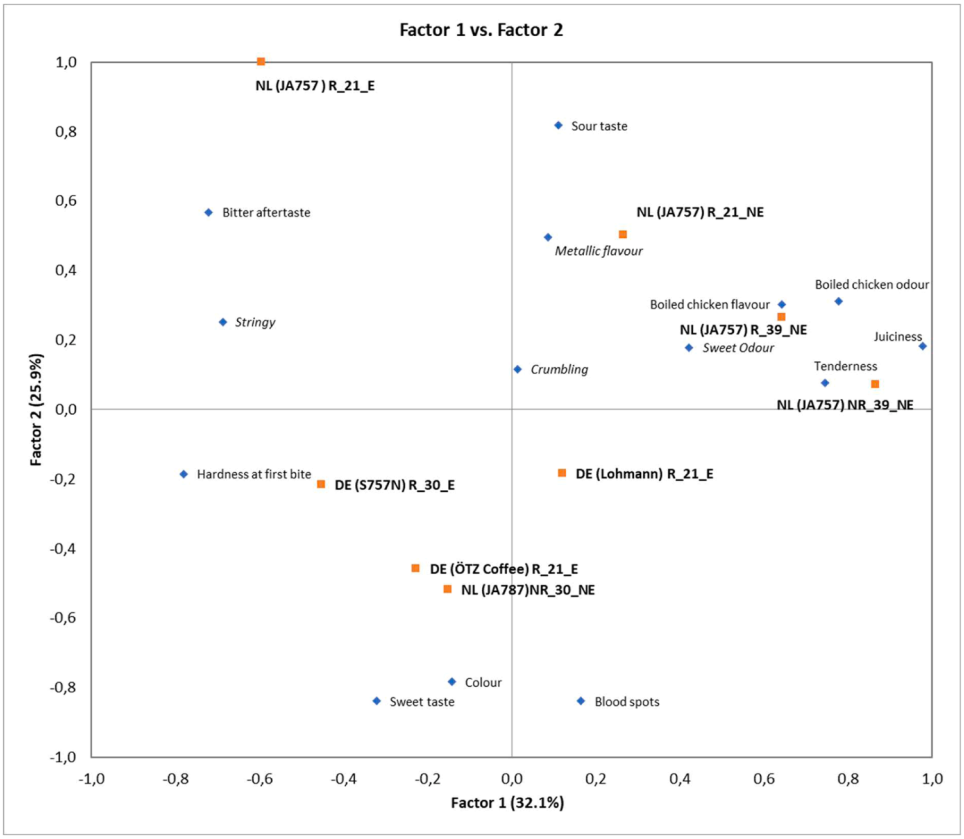

Fig. 3. Principal component analysis (PCA) biplot of the sensory descriptive data for broiler breast meat from eight different husbandry concepts. DE = Germany, NL = The Netherlands. R = roughage supplemented, NR =no roughage supplemented. E= Environmental enrichment, NE= no Environmental enrichment. 21, 30 and 39 = Space allowance (kg/m^2).

and to ensure data quality by minimizing panelist fatigue, a subset of husbandry concepts was selected to represent key experimental contrasts.

All sensory evaluations were conducted in ISO 8589-compliant accredited sensory laboratories (DTI; DANAK 05-0392) using trained descriptive sensory panels. For broiler meat, the descriptive sensory analysis was performed following the protocol described previously (Siebenmorgen et al., 2025), with eight assessors evaluating samples using standardized preparation and serving procedures. For pork, samples were prepared and evaluated under standardized conditions by a trained panel of ten assessors. In both studies, the panels were trained (3 × 3 h) and developed sensory vocabularies prior to evaluation. Samples were evaluated under controlled conditions using coded samples presented in randomized block designs, and sensory attributes were assessed electronically using RedJade® on a 15 cm unstructured line scale.

Overall, the descriptive sensory analyses revealed that breed/genotype was a primary contributor to the sensory differences observed between both pork and broiler meat samples. For pork, the distinct sensory profiles observed between producing countries were largely attributable to the use of different local breeds. Similarly, for broilers, genotype established the fundamental differences in eating quality, which were further modulated by the overall husbandry system (Yigitturk, Grønbeck, et al., 2026).

Sensory characteristics of pork chops. For pork, the descriptive analysis showed that the different genetic backgrounds (breeds) used in the husbandry concepts were the primary driver of the significant variations in the sensory profile. As shown in the Principal Component Analysis (PCA) plot (Fig. 2), the sensory profiles of the breeds differed across appearance, flavour, and texture.

The Ibérico breed used in the Spanish concept was visually distinguished by a darker cut surface, more intense browning, and the highest degree of marbling. Flavour- and taste-wise, it was characterized by high intensities of fried meat flavour and sweet taste, with a significantly lower intensity of piggy flavour. In contrast, the Duroc × (Landrace × Yorkshire) commercial hybrid used in the Danish concepts was defined by high intensities of acidic odour and sour taste. In terms of texture, the panel rated these samples as less hard at first bite and more tender. Pork from the Topigs TN70 × Fomeva K-line cross used in Italy was sensorcally less distinct from the Danish concept in terms of flavour and aroma .

When evaluating the impact of the specific extensification factors, a statistically significant difference between treatments was only detected within the Spanish concept. This is also visible in Fig. 2, where the 'Quality of Space' treatment is positioned in the direction of the tenderness vector relative to its control counterpart. The panel rated meat from this treatment as significantly more tender, juicier, and less hard at first bite compared to the control. For the other genetic lines, no significant sensory differences were found between their respective control and treatment groups.

Sensory characteristics of broiler breast meat. For broiler breast meat, the descriptive analysis identified genotype as the principal driver of the sensory profile, a differentiation clearly illustrated in the PCA plot (Fig. 3).

As seen in Fig. 3, the different genetic strains resulted in meat with clearly distinct eating qualities. The slower-growing Hubbard JA757 genotypes (grouped on the right side of the plot) consistently resulted in meat with high perceived tenderness and juiciness, alongside a characteristic boiled chicken flavour. In contrast, the Hubbard S757N strain and the Lohmann male-layer strains (positioned on the opposite, left side of the plot) were characterized by a perceptual firmer texture, particularly a higher hardness at first bite. This was also confirmed with

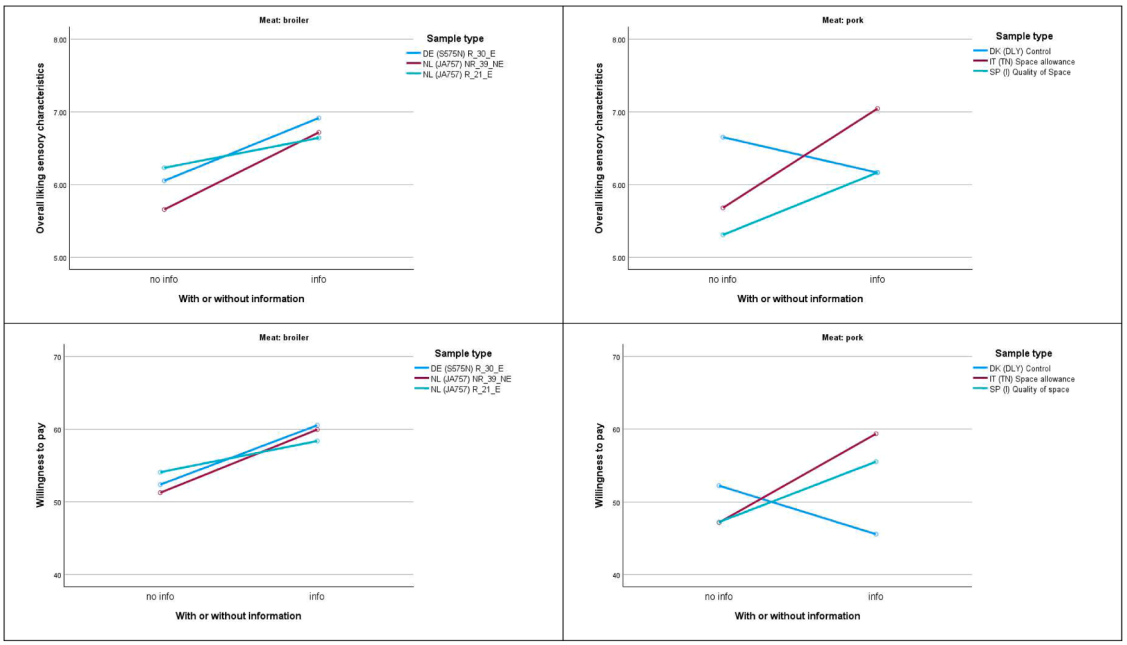

Fig. 4. Effect of information and sample type on sensory liking and willingness to pay for broiler meat (left plots) and pork meat (right plots).
For broiler meat: DE = Germany, NL = The Netherlands. R = roughage supplemented, NR =no roughage supplemented. E= Environmental enrichment, NE= no Environmental enrichment. 21, 30 and 39 = Space allowance (kg/m^2). For pork meat: DK = Denmark, IT = Italy, SP= Spain. DLY = DanBred [Duroc × (Landrace × Yorshire)], TN =Topigs Norsvin TN70, I = Iberian. Space allowance =50% more space than control. Quality of space = enrichment like rope, page bags etc. The colours of the lines indicate the different sample types used.

our physicochemical measurements (Yigitturk, Grønbeck, et al., 2026), indicating a higher shear force. Furthermore, the panel rated the meat from the S757N strain as significantly less juicy than that from the JA757 genotype, which was also reflected in the *liking of juiciness* by Danish consumers (Yigitturk, Grønbeck, et al., 2026).

Attributes shown in italics were not found to be significantly different across the concepts ($\boldsymbol{p} > 0.05$).

The impact of other husbandry factors on sensory perception was also evaluated. A significant effect was observed when comparing the same genotype (JA757) across different husbandry systems. This is reflected in the plot, where the organic JA757 sample is positioned lower than the other JA757 concepts, in the direction of the bitter aftertaste vector. The panel perceived meat from this organic system as less juicy and with a more pronounced bitter aftertaste compared to its counterparts from the indoor, non-organic systems. In contrast, more targeted interventions within a single husbandry system - such as varying stocking density or supplementing dietary fibre - did not produce statistically significant changes in the sensory profile of the cooked meat.

4. Consumer liking, willingness to pay and interest in new product concepts

4.1. Consumer liking and willingness to pay

The sensory analysis showed that the different types of meat emanating from the experimental designs for pigs and broilers differed in their sensory characteristics and that this difference was mainly driven by the use of different breeds, with limited effect of the other experimental factors.

Even when the implementation of husbandry characteristics related to feed and space do not lead to differences in the sensory characteristics of the meat, consumers could still prefer meat that results from such husbandry systems, because many consumers value husbandry characteristics related to animal welfare and sustainability, as shown above. For a subset of the meat samples used for the descriptive sensory analysis, we therefore carried out a consumer test in which consumers tasted and evaluated meat samples with and without information on the way the meat has been produced and indicated their willingness to pay for the meat.

The test was carried out in Denmark with Danish consumers. Of the various samples included in the descriptive sensory analysis, for both pork and broiler meat the three samples that differed most in the descriptive sensory analysis were selected. Participants (n=76 for broiler meat, n=101 for pork) tasted the three samples in random order first in a blinded condition and then with information about husbandry characteristics provided (participants could not match the 2 × 3 samples).

Liking of taste, juiciness, tenderness and texture were obtained using a 9-point hedonic scale. Willingness to pay was measured using a contingent valuation procedure (Haab et al., 2020). In addition, *warm glow* was measured, a measure of cognitive and affective reactions to 'doing the right thing' that could explain the mechanism by which the information about husbandry characteristics influenced liking and willingness to pay (Kahneman and Knetsch, 1992).

The direction of the effect depends on the information provided. When the information describes aspects of husbandry differing from conventional mainstream husbandry in terms of animal welfare or sustainability, scores go up. If the information states that the husbandry is mainstream conventional husb Results (Fig. 4) showed that the sample had no significant main effect neither on sensory liking nor on willingness to pay.

Information had a significant main effect, and for pork there was also a significant interaction between sample and information. The results thus show that the provision of information on husbandry characteristics influences both liking of sensory characteristics and willingness pay Improvements in space allowance, feed and space enrichment. For all the extensive production systems, scores for both liking and willingness to pay go up when information is provided. For the Danish intensive production system, scores go down. A mediation analysis showed that the effect of information on sensory liking is mostly mediated by the warm glow effect, and that the effect of the information on willingness to pay is completely mediated by sensory liking.

Pork concept 1 (fresh meat product) Pork tenderloins are packaged in cardboard with a transparent top. The tenderloins are from pigs where part of their feed were local byproducts from farming like apples, berries, buckwheat, oranges and carob instead of imported standard feed. In the stable the pigs had access to toys like ropes, paper bags, balls and chewing toys, which is good for animal welfare. This is a product for everybody who is interested in tasty meat that is produced with due concern for sustainability and animal welfare. The product is priced at 20% above the normal price.
Broiler concept 2 (processed meat product) A pack of sliced cooked chicken meat In colourful new packaging. The meat is from a slower growing chicken breed and they have been reared with 50% more space compared to normal procedure. The space in which they live has been enriched with straw bales which is good for animal welfare. This product is for people who want a cold cut with less fat and less calories produced in a way with due concern for sustainability and welfare. The product is priced at the same level as cold cuts based on pork or beef.

Fig. 5. Examples of product concepts.

The results thus show that giving consumers information about how the meat has been produced has an impact not only on their willingness to pay, but also on their liking of the perceived sensory properties. Without given such information, consumers hardly perceive differences in the sensory characteristics. This underlines the importance of information when working with meat husbandry systems that incorporate improvements in anaimal welfare and sustainability.

4.2. Developing and testing new product concepts

The study in the previous section 4.1. showed that husbandry characteristics improving animal welfare and sustainability, when they are communicated properly to consumers, can increase perceived value and willingness to pay. The work in the project also showed that the various factors investigated within the categories space, space enrichment and feed had no or little effect on the meat quality and mostly had a positive effect on animal welfare, although in the case of broiler husbandry some of these effects were contingent on the breed used. Also, the various factors differed considerably in the costs they would add to husbandry, with increased space for the animals (both pigs and broilers) and use of slow-growing breeds (for broilers) being the costliest changes.

We therefore tried to find and test examples of new product concepts, both for fresh and for processed meat, that would incorporate some of the more promising factors (for details see Grunert and Lejsgaard, just accepted). The concepts were developed in a co-creation process with consumers in two focus groups carried out in Germany and Spain. After discussing general practices with regard to buying, preparing and eating pork and broiler meat, participants in the focus groups were informed about some of the sustainability initiatives that were being tested as part of the project. The key messages conveyed to participants were:

- Pork
  - More space per animal increases animal welfare, but has considerable impact on husbandry costs, and research shows that consumers appreciate it only if the increase in space is considerable
  - Space enrichment by ropes, paper bags, balls and chewing toys are good for animal welfare
  - Supplementing feed by use of local by-products from farming apples, berries, buckwheat, oranges and carob as an addition to the feed can increase animal welfare and sustainability and is a low-cost option
- Broilers
  - More space per animal and outdoor access increases animal welfare only for slower growing breeds, but has considerable impact on husbandry costs and environmental sustainability; research shows that consumers appreciate it only if the increase in space is considerable
  - Space enrichment by wooden perches, straw bales and dust bathing facilities are good for animal welfare
  - Supplementing feed by locally produced lucerne and roughage can increase animal welfare and sustainability for all breeds
  - It is difficult to increase animal welfare for fast-growing breeds, and slow-growing breeds are an expensive niche product, but a medium growing breed may be of interest; it is also positive evaluated in terms of sensory properties

Based on this, focus group participants developed, in groups, product concepts that involve some of these elements. This resulted in the development of 6 new product concepts, 3 for pork and 3 for broilers. Two examples are shown in Fig. 5. For both broilers and pork, one of the concepts was on fresh meat, one was about processed meat, and a third was about processed meat directed specifically at a children target group. For all three pork concepts, it was mentioned that part of the feed of the pigs was replaced by locally sourced feed, and that the feed was based on byproducts from the production of fruits and vegetables, which is good for sustainability. In addition, it was mentioned that the pigs have access to toys like ropes, paper bags, balls and chewing toys, which is good for animal welfare. For all three broiler concepts, it was mentioned that the meat is from a slower growing broiler breed and that they were reared with 50% more space compared to normal procedure. Also it was mentioned that the space in which they live has been enriched with straw bales, which again is good for animal welfare.

The concepts were tested with consumers by a study carried out in the six countries participating in the project (Denmark, Germany, Italy, the Netherlands, Poland, Spain, n=1965; details in Grunert and Lejsgaard, just accepted). Respondents rated the different elements of the concepts according to their liking, and these were than used to explain consumer perceptions of the product concepts in terms of

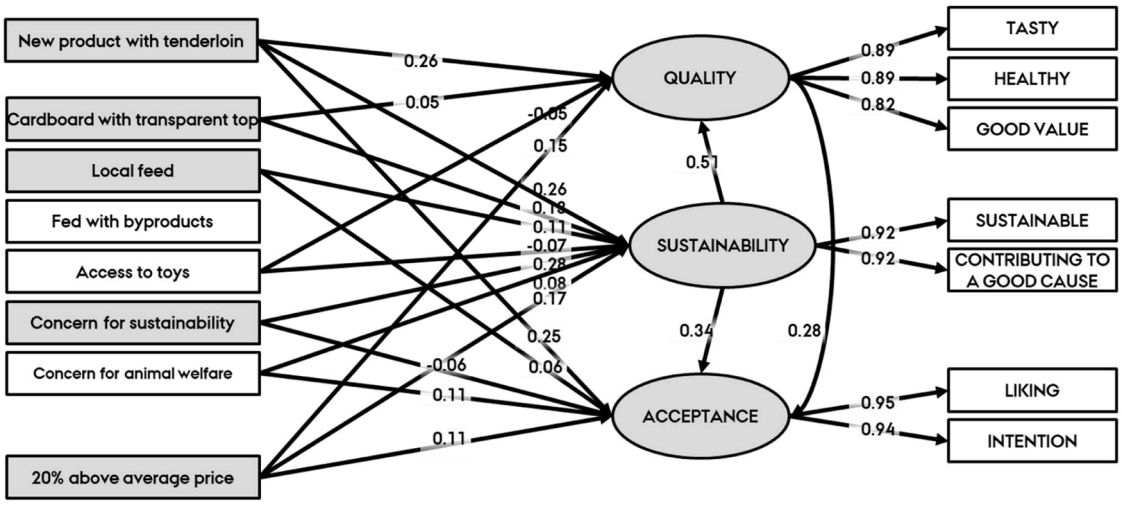

Fig. 6. Determinants of acceptance of pork concept 'pork tenderloin'.
Based on Grunert and Lejsgaard (just accepted). Coefficients are path coefficients from a PLS analysis. Concept elements with no or little effect on acceptance are in white, the remaining concept elements in grey.

perceived quality, perceived sustainability and overall acceptance. Depending on answers to the acceptance measures, respondents were classified as convinced, almost convinced or not convinced about the concept. Between 6% and 12% of respondents were classified as convinced, and an additional 3% to 6% as almost convinced. The way in which acceptance came about by making inferences from the concept description was modelled by partial least squares structural equation analysis. Fig. 6 shows an example of the results for the concept about pork tenderloin. Results generally showed that sustainability aspects had a positive impact on acceptance and that perception of sustainability and perception of quality are closely linked. Not all aspects of sustainability mentioned in the concepts had a significant effect on acceptance, though, for example it showed that local feed is much appreciated, but the mention of use of byproducts does not result in any additional levels of acceptance. Also the animals' access to toys had no impact, whereas the use of sustainable packaging had. Consumers differed in their acceptance of higher prices for such a product, and in their overall liking of the type of product described in the concept.

5. Conclusions

Above, we have presented a fork to farm analysis of ways to develop more extensive husbandry systems for pigs and broilers. We have shown that it is possible to implement elements of extensive husbandry in pig and broiler production that increase animal welfare and are not detrimental to meat quality. We have also shown that consumers are interested in such elements of extensive husbandry and are, to varying extents, willing to pay for them.

This should be seen as a proof of principle. Our work has, at the same time, shown the huge range of factors to take into account and the huge diversity that exists across Europe in pig and broiler husbandry. Any specific plan to implement elements of more extensive husbandry needs to be carefully planned and tested taking into account the specific local conditions.

The same goes for plans to develop meat products based on such systems and introduce and market them to consumers. Just because animals have received local feed or grew up in an enriched space does not guarantee that there will be a demand for the products resulting from it. Consumers react to a bundle of marketing parameters, and elements of extensive husbandry are only a small part of it. The need to be embedded in a convincing product concept that also entails the right sensory profile, the right packaging and the right level of convenience for preparation and consumption.

In addition, consumers can react favourably to products resulting from more extensive husbandry systems only when they know about the relevant husbandry parameters. Our research has shown that such information, when actually read by consumers, can have a powerful impact on liking and willingness to pay. Channelling this communication to consumers in a way where they will actually read this information is a big challenge when developing and marketing products where elements of husbandry are part of the positioning. At the same time, giving such information to consumers always entails potential issues with regard to credibility, as the average consumer has no means of finding out whether such information is in fact correct. Transparency and traceability in the value chain is therefore important, and technologies like blockchain may potentially help in assuring correct and verifiable information for consumers.

Finally, our work has clearly shown the high importance of regional differences and region specific trajectories of the development of husbandry systems. Different breeds, many with roots in local traditions and embedded in local husbandry systems, turned out to be the major driver of the sensory profile of the meat samples investigated. This regional diversity is a resource to draw upon when aiming for more extensive husbandry systems.

CRediT authorship contribution statement

Klaus G. Grunert: Writing – review & editing, Writing – original draft, Formal analysis, Data curation, Conceptualization. **Sara Wilhelmina Erasmus:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Marlene Schou Grønbeck:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Formal analysis, Data curation, Conceptualization. **Joanna Marchewka:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Ewa Sell-Kubiak:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare no conflict of interest.

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