



# We have Some Calves left! Socially Accepted Alternatives to the Current Handling of Male Calves from Dairy Production

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## Abstract

Consumers' actual knowledge about modern food production is limited, and their judgment is often guided by assumptions or associations that are not necessarily in line with reality. Consumers' rather unrealistic idea of livestock farming is driven by beautiful and romanticized pictures in advertising. If confronted with the reality of modern livestock farming, consumers' responses are mainly negative. So far, dairy farming still has a more positive image and thus is less affected by public criticism. However, if made public, some of the current production practices in dairy farming have the potential to reduce consumer acceptance which in turn can have a tremendous effect on farmers. A particularly urgent topic is the handling of male dairy calves. Such calves are often treated as surplus animals due to their low genetic merits for meat, with the risk of resulting in the deprivation of animal welfare. To maintain consumer acceptance of dairy products and find socially accepted alternatives for the handling of male calves, insights into consumer perception of current and future production practices in dairy farming are needed. Thus, the aim of this study is to analyze how consumers evaluate the current situation of male dairy calves and alternatives in male calf management. A quantitative online survey, representative for the German population in terms of gender, age, education, region, and income, was carried out with 1 194 participants in February 2022. Overall, 60% of participants were not aware of the fact that male dairy calves are less appropriate for fattening purposes. Respondents saw a clear need for alternative methods for handling male calves from dairy production. More, our results show that the use of sexed semen encounters consumer resistance, while other alternatives that were evaluated as more natural were more accepted. A cluster analysis identified 3 distinct consumer segments labelled "sexed semen opponents" (31.6%), "undecided" (30.4%), and "proponents of all alternatives" (38.0%) that differed in their acceptance of alternative handling practices of male dairy calves. The results emphasize the gap between consumers' expectations and reality on farms and the importance of considering consumer preferences when developing future pathways for dairy farming.

**Keywords** Calf Management · Dairy Farming · Surplus Calves · Ethical Consumption

## Introduction

Consumers' knowledge about food production is limited, and their judgment is often guided by assumptions or associations that are not necessarily in line with reality (Placzek et al. 2021). This gap between most consumers' assumption of how food is being produced and what actual production practices look like has especially been observed in the livestock sector. Consumers' rather unrealistic idea of livestock farming is driven by beautiful and romanticized pictures in advertising (Kühl et al. 2019; Velde et al. 2002). If confronted with the reality of modern livestock farming, consumers' responses are mainly negative (Delezie et al. 2006; Busch et al. 2015). What seems appropriate for farmers (e.g., the use of specialized breeds in milk production that lead to the unwanted counterparts of male calves) is often hardly understandable for lay people, such as the average consumer (Busch et al. 2018a). The relationship between humans and animals has changed over time. The majority of consumers is not used to modern farming practices. Most consumers only have contact with animals as companion animals that tend to have the status of a family member (Hölker et al. 2019). This development has led to a gap between consumers' expectations of how animals need to be raised and actual practices on farms. As such, a growing group of consumers demand that housing and handling conditions of livestock offer animals the possibility to express their natural behaviors, which is, from a consumers' perspective, strongly connected with social interaction and outdoor or preferably pasture access (Schulze et al. 2021; Kühl et al. 2021; Winkel et al. 2020). Overall, the majority of consumers in Western countries has a clear preference for naturalness when it comes to food products and perceives more natural products as healthier, tastier, and better for the environment (Siegrist et al. 2020). However, reality in intensive livestock farming that has a strong focus on efficiency and technological progress often differs from consumers' expectations of "natural" housing and handling conditions (Schulze et al. 2021; Kühl et al. 2021; Anneberg et al., 2019).

Thus, if made public, some of the current production practices in livestock farming have the potential to reduce consumer acceptance which in turn can have a tremendous effect on farmers. A well-known example is the ban of battery cage systems for laying hens in the EU in 2012, which was initiated by public pressure after consumers were made aware of handling and housing conditions (Busch et al. 2018). However, although officially a change in regulations took place, the loss in consumer acceptance has had a lasting effect on the image of the sector. As such, still years after the ban of battery cages for laying hens, consumers were convinced that battery cages are the predominant housing form (Busch et al. 2018b).

So far, dairy farming still has a more positive image and is less affected by public criticism (Placzek et al. 2021). However, this may erode if consumers are made aware of actual housing and handling conditions. An especially urgent topic in the dairy sector is the handling of male calves from dairy production.

It is common practice in modern dairy production to use breeds that have high genetic merits for milk but not for meat (Placzek et al. 2021). This leads to male calves becoming bulls that have low slaughter weights as well as meat with low intramuscular fat content. Thus, male calves are less profitable for farmers and sometimes considered a by-product of dairy production (Cave et al. 2005). In Australia and New Zealand, male dairy calves are sold as so-called "bobby calves" and subsequently slaughtered under the age of 7 days (Cave et al. 2005). In North America, most male dairy calves are sold within their first weeks of life and subsequently reared until the age of 16–18 weeks (Bolton et al. 2021; Ritter et al.

2022). In Germany, male calves are commonly sold by dairy farmers either at 2 weeks or at 4 to 6 months of age and reared until 18 months before slaughter. The killing of male calves due to reasons of inefficiency is prohibited in Germany (Placzek et al. 2021). However, rearing costs often exceed the economic value of male calves from high-yielding dairy breeds, which may lead to a lower willingness to invest in male calf husbandry and care conditions and could thus result in higher mortality rates or animal welfare problems (Cuttance et al. 2017; Gulliksen et al. 2009; Hyde et al. 2020). Previous research has already pointed to the need for changes regarding male dairy calves to solve ethical challenges such as increased mortality and morbidity of male dairy calves (Wilson et al. 2020). Additionally, the current handling practices have the potential to erode the positive image of dairy farming. A potential loss in consumer acceptance could jeopardize the license to produce of the sector. From a consumer perspective, animals have a right to exhibit natural behaviors (Hölker et al. 2019). The current management of dairy calves subverts this right (Cohen et al. 2012) because animals do not get enough time to develop natural behaviors, such as building a mother–calf relationship (Busch et al. 2017). As such, socially accepted alternatives are needed that solve the ethical questions regarding the handling of very young animals and reduce the gap between consumers' expectations of what livestock farming looks like and the reality on farms. Some alternatives to solve the challenge of male dairy calves already exist but are not widely applied in dairy farming yet. Four possible alternatives as well as their benefits and barriers are discussed in the following:

One option that has the potential to improve the handling of male calves is the use of sexed semen. The procedure allows the predetermination of the calf's sex with a reliability of more than 90% (Holden and Butler 2018). Thus, the technology increases efficiency in dairy production by mitigating the surplus of male calves and increasing female replacement numbers in dairy herds (Holden and Butler 2018). Sexed semen thereby has the potential to reduce the ethical concern regarding the slaughter of very young animals and the economic loss of farmers. Sexed semen is currently not predominantly used, although the numbers are increasing. Reasons for the comparably low implementation rate according to different stakeholders, are grounded in lower conception rates, high costs, breed availability, and commercial availability (Balzani et al. 2021). Although previous studies have already shown that consumers dislike food technologies (e.g., Siegrist et al. 2020), it is unclear how consumers evaluate sexed semen. The peculiarity of the technology of sexed semen is that it is not a modification of a product by technologies (as, for example, with gene technology) but to avoid a by-product and thereby reducing animal suffering.

Another option is to fatten the calves for an extended period on the farm of birth (e.g., up to a weight of 100 kg). By doing so, very low prices for young calves from high-yielding breeds (Zanon et al. 2020) and long-distance transport with an increased risk of mortality can be prevented (Cave et al. 2005). Currently, the main barrier for this strategy is the establishment of new market channels as well as attracting consumers with a willingness to pay a premium for additional production costs resulting from more space and labor needed on the farm.

The use of dual-purpose breeds is another option to mitigate the problem of male dairy calves. Using dual-purpose breeds leads to higher prices achieved through calf sales (Zanon et al. 2020) and might therefore provide an option to increase calf value and reduce potential welfare problems. However, such breeds perform worse in milk yields (Toledo-Alvarado et

al. 2017), and management needs to be adapted in order to compensate for such losses (e.g., through intensive feeding [Kühl et al. 2020]).

Extending the inter-calving period to have longer lactation cycles and fewer calves born is a fourth option. This strategy leads to fewer male calves needing to be cared for—but fewer female calves born for replacement must be considered as one of the possible disadvantages. In terms of economic returns from milk, an extended calving interval (+60 days) might even be advantageous, especially in primiparous cows (Arbel et al. 2001). To maintain the license to produce, the dairy sector needs to find practical and socially accepted alternatives that reduce ethical concerns regarding the handling of male dairy calves and reduce the gap between consumer expectations and the reality on farms.

Insights into consumer perception of the current situation as well as different alternatives are needed to support the imminent implementation and to maintain long-term consumer acceptance of livestock farming. Thus, the aim of this study is to analyze how consumers evaluate the current situation of male dairy calves and alternatives in male calf management. More specifically, this study will answer whether consumers are aware of the current handling of male calves from dairy production and how consumers evaluate alternative handling methods, namely the use of sexed semen, longer fattening periods, dual-purpose breeds, and the extension of inter-calving periods. Further, as individuals often have different perceptions of housing and handling conditions in livestock production (Boaitey 2022; Schütz et al. 2020; Kühl et al. 2022), this study additionally examines whether different consumer segments exist and how they perceive alternative handling practices for male dairy calves. The results provide detailed insights into what a future socially accepted alternative in male calf management could look like.

## Materials and Methods

An online survey with participants from Germany was conducted in February 2022. The questionnaire was sent out via an online access panel provider (Respondi AG, Cologne, Germany). Quota sampling based on data from the Federal Statistical Office (2021) was used to reflect the German population in terms of age, gender, income, and place of residency. To ensure high data quality, two quality checks were included in the questionnaire (e.g., “Please select ‘agree’”). Respondents who incorrectly answered those questions were automatically excluded from the survey ( $n=235$ ). Of the remaining participants, 18 were excluded due to rapid response behavior (faster than 1/3 median response time indicating careless response behavior). Furthermore, participants who violated streamlining twice (using less than 2 s per item on a set of items) were identified as speeders and subsequently excluded from the sample ( $n=64$ ). In the end, 1 194 participants remained for further data analyses.

Respondents were asked to answer questions on their sociodemographic background, followed by questions regarding participants’ preference for food naturalness and innovativeness. Participants’ preference for food innovation was quantified with 5 items measured on 5-point Likert scales ranging from 1 = “Totally disagree” to 5 = “Totally agree”. Items were inspired by the Food Technology Neophobia Scale (Cox & Evans 2008). Preference for food naturalness was quantified with 4-items likewise measured. Those items were inspired by Bäckström et al. (2004) and Siegrist et al. (2008). Familiarity with the challenge

of male calves from dairy production was measured by asking the participants whether they had ever heard that male calves from dairy production are not suitable for fattening, with “Yes, I’ve heard of it”, “No, I haven’t heard of it”, and “I don’t know” as answer options. Also, perceived severity of the challenge for calves and farmers in general was investigated with the following items: “I consider the situation for the calves (farmers) as...”, with responses measured on 5-point Likert scales from 1 = “Not problematic at all” to 5 = “Very problematic”. Both questions were asked after a short introductory text describing the current situation. Four alternative scenarios of how to change the handling of male calves were presented. Namely, this study investigated consumers’ perception of sex-sorted semen, longer fattening periods on the farm of birth, dual-purpose breeds, and extended inter-calving period. All four scenarios had in common that they were characterized by high practical relevance of the dairy sector. The presented scenarios in this study were selected based on several rounds of discussions with researchers having a deep knowledge in agricultural production practices in the dairy sector. A detailed overview of the introductory text as well as the scenarios is shown in Appendix A. After describing each scenario to participants, they were asked whether the presented alternative should be implemented. This was done by using a single item (“Do you think sexed semen/extended fattening period/use of dual-purpose breeds/extended inter-calving period should be implemented?”) measured on 5-point Likert scales from 1 = “No, absolutely not” to 5 = “Yes, definitely”. Afterwards, semantic differential scales were used to examine participants’ detailed evaluation of the scenarios. As such, for each scenario 8 items (e.g., “From my perspective, sexed semen is natural/unnatural”) were included.

The software SPSS IBM (version 26) was used for data analyses. Descriptive analyses such as means and standard deviations were applied, followed by mean comparisons (repeated-measures analysis of variance) to identify differences in participants’ perception of the four alternative handling scenarios of male dairy calves. Furthermore, a cluster analysis was applied to identify underlying segments of participants that differ in their perception of how to alternatively handle male dairy calves. First, outliers ( $n=6$ ) were identified using single-linkage clustering. Second, the Ward algorithm was used to identify the number of segments. Third, k-means clustering was applied to classify group membership. For further analysis, a one-way analysis of variance with post-hoc tests (Games–Howell or Tukey) as well as a chi-squared test were carried out.

## Results

The sample reflects the German population in terms of gender, age, place of residence, income, and education (see Table 1).

More than half of the respondents (58.4%) had never heard that male calves from dairy production are not well suited for fattening before the study. One-third (29.6%) had already heard about it, and the remaining 12% of participants did not know whether they had heard about it or not. Additionally, most respondents assessed the situation of male calves as (rather) problematic, mainly for the calves (70%) but also for farmers (63.4%).

Consumer perceptions of how to alternatively handle male calves differed significantly from each other as follows (see Fig. 1 for a graphical illustration and Appendix B for a comprehensive overview). (see Fig. 1).

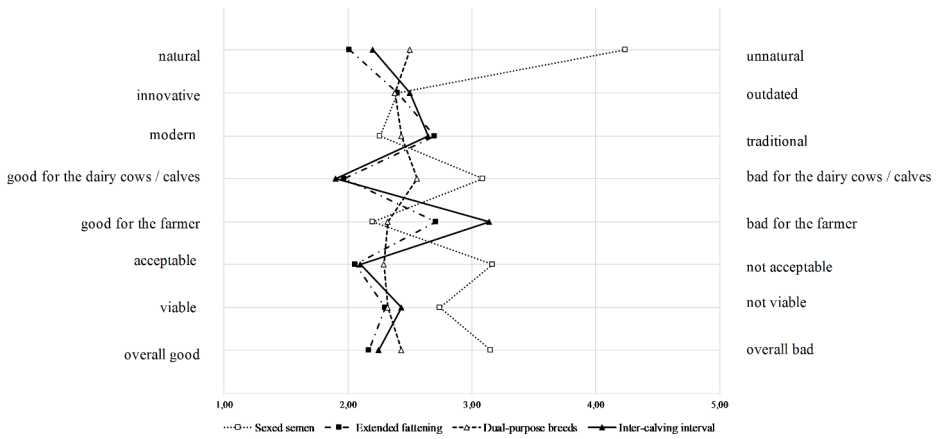


Fig. 1 Semantic differential of how consumers perceive the alternative options

Table 1 Sample description

	Total sample n = 1,194 (%)	German population <sup>1</sup> (%)
<b>Gender</b>		
Male	48.7	49.0
Female	51.0	51.0
Other	0.3	No information available
<b>Age</b>		
16–34 years	23.4	25.9
35–49 years	20.6	21.8
50–64 years	28.2	26.9
65 and older	27.8	25.5
<b>Place of residence</b>		
South	27.1	30.3
North	17.2	18.1
East	19.3	17.6
West	36.3	34.0
<b>Household income</b>		
Less than €1,300	18.8	18.4
€1,300–2,599	37.0	36.6
€2,600–4,499	29.6	28.7
€4,500 and over	14.7	16.3
<b>Education</b>		
No graduation (yet) / certificate of secondary education	35.8	34.3
General certificate of secondary education	31.4	30.8
Qualification / university entrance diploma	32.7	34.9

<sup>1</sup> Federal Statistical Office (2021)

Sexed semen was perceived as most unnatural compared with extending the fattening period, extending the inter-calving period, and the option of using dual-purpose breeds.

All alternative options were perceived as at least somewhat innovative. However, minor differences existed: Extending the inter-calving period was perceived as less innovative compared to sexed semen, extended fattening, and using dual-purpose breeds. Accordingly, sexed semen was perceived as the most modern option compared to dual-purpose breeds and extended fattening. Regarding animal welfare, sexed semen was perceived as the worst for dairy cows, compared with using a dual-purpose breed, extending the fattening period, and extending the inter-calving period. The latter 2 options were evaluated as good for dairy cows/calves. However, significant differences (at the 0.05 level) between those options existed. Sexed semen was perceived as the best option for farmers compared with an extended fattening period, using dual-purpose breeds, and extending the inter-calving period, the latter of which was evaluated as neither bad nor good for the farmer. The most acceptable option was extending the fattening period and inter-calving period. No significant differences (at a 0.05 level) existed between the acceptance of these 2 options. Significant differences existed between extending the fattening period compared with using a dual-purpose breed and with sexed semen, which was perceived as the least acceptable option. In terms of viability, sexed semen was perceived as the least viable option compared with extending inter-calving intervals, extending the fattening period, and using a dual-purpose breed. Overall, sexed semen was perceived as the worst option compared with extending the fattening period, which was evaluated as the best option, and extending the inter-calving interval and using a dual-purpose breed.

The cluster analysis was based on a set of four variables that measured whether participants wanted to implement the described scenario or not and resulted in three segments (see Table 2). Segment 1 consisted of 31.6% of participants and included individuals that highly rejected the use of sexed semen. Individuals in this group thought that the remaining three options should be at least rather implemented. The implementation of an extended fattening period was preferred the most, followed by the extended inter-calving period and the use of dual-purpose breeds. Accordingly, segment 1 was labelled as “sexed semen opponents”. Segment 2 consisted of 30.4% of participants and included individuals that were undecided about whether the four options should be implemented or not. Accordingly, segment 2 was named “undecided”.

With 38.0% of participants, segment 3 was the largest group and named “proponents of all alternatives”. Individuals assigned to this group supported all 4 options—although to different degrees. The most preferred option was extended inter-calving periods, followed by extended fattening on farms and using dual-purpose breeds. Sexed semen was the least preferred option, although segment 3 members showed the highest approval for the implementation of sexed semen compared with the other segments.

Group differences existed regarding preferences for food innovativeness and food naturalness (see Table 3). Overall, “sexed semen opponents” (segment 1) perceived food innovativeness as somewhat important (mean=3.45, SD=0.70). “Sexed semen opponents” (segment 1) were characterized by the lowest preference for food innovativeness compared with the “undecided” segment (segment 2) and “proponents of all alternatives” (segment 3). No significant differences (at a 0.05 level) existed between segments 2 and 3. All 3 segments stated to have a high preference for food naturalness. “Sexed semen opponents” (1) showed the highest preference for food naturalness compared with the “undecided” segment

**Table 2** Results of the 3-cluster solution

	Segment 1	Segment 2	Segment 3		Sample
	Sexed semen opponents	Undecided	Proponents of all alternatives		
	n = 375 31.6%	n = 361 30.4%	n = 452 38.0%		n = 1,188
	Mean (SD)	Mean (SD)	Mean (SD)	( <i>P</i> -values)	Mean (SD)
Do you think sexed semen should be implemented?	1.47 <sup>a</sup> (0.50)	3.17 <sup>b</sup> (0.84)	3.62 <sup>c</sup> (0.71)	1046.81 (<0.001)	2.81 (1.16)
Do you think calves should be housed on farms for longer fattening periods?	4.13 <sup>a</sup> (0.74)	3.26 <sup>b</sup> (0.89)	4.12 <sup>a</sup> (0.71)	158.01 (<0.001)	3.86 (0.87)
Do you think dual breeds should be used?	3.46 <sup>a</sup> (0.91)	3.03 <sup>b</sup> (0.84)	3.70 <sup>c</sup> (0.79)	62.97 (<0.001)	3.42 (0.89)
Do you think the time between the birth of a calf and a new pregnancy of the cow should be extended?	4.06 <sup>a</sup> (0.83)	2.79 <sup>b</sup> (0.79)	4.25 <sup>c</sup> (0.60)	241.20 (<0.001)	3.75 (0.97)

Items measured on a 5-point Likert scale from 1 = “No, absolutely not” to 3 = “Undecided” to 5 = “Yes, definitely”;

<sup>a–c</sup> Mean values in the same row with different superscripts differ ( $P < 0.05$ ) according to Games–Howell or Tukey post-hoc test, depending on whether Levene’s test was significant or not

(segment 2). Between “sexed semen opponents” (segment 1) and “proponents of all alternatives” (segment 3), no significant differences could be detected.

Significant differences between the segments were found in terms of perceived severity of the challenge. “Undecided” (segment 2) members perceived the challenge as less severe (mean = 3.65, SD = 0.95) compared to “sexed semen opponents” (segment 1) (mean = 3.97, SD = 1.07,  $P \leq 0.001$ ) and “proponents of all alternatives” (segment 3) (mean = 4.12, SD = 0.92,  $P \leq 0.001$ ). No significant differences between the segments could be detected in terms of how problematic the challenge is for farmers. All three segments perceived the challenge as problematic in that sense with means ranging from 3.62 to 3.83. Cross tabulation showed that the three segments also differed according to their familiarity with the challenge of male calves ( $\chi^2(4) = 10.17$ ,  $P = 0.38$ ). Of the “proponents of all alternatives” (segment 3), 34.1% had already heard about the challenge, while only 27.2% of “sexed semen opponents” (segment 1) and 26.6% of individuals assigned to the segment “undecided” (segment 2) were already familiar with the issue. In addition, the chi-squared test showed no significant differences between the different segments for gender ( $P = 0.073$ ), education ( $P = 0.444$ ), and income ( $P = 0.288$ ). Significant differences, however, existed in terms of age ( $P = 0.003$ ). That is, with 65.3% of individuals being 50 or older, “sexed semen opponents” (segment 1) were associated with the oldest individuals, while “undecided” (segment 2) and “proponents of all alternatives” (segment 3) were associated with 50.7% and 52.6% of individuals older than 50 years.



**Table 3** Means comparison of segment-specific differences in preference for food innovativeness and food naturalness

	Segment 1	Segment 2	Segment 3		Sample
	Sexed semen opponents	Undecided	Proponents of all alternatives		
	n = 375 31.6%	n = 361 30.4%	n = 452 38.0%		n = 1,188
	Mean (SD)	Mean (SD)	Mean (SD)	(P-values)	Mean (SD)
<i>Preferences for (food) innovativeness<sup>1</sup></i> ( $\alpha=0.77$ )	3.45 <sup>a</sup> (0.70)	3.59 <sup>b</sup> (0.64)	3.64 <sup>b</sup> (0.70)	8.37 (<0.001)	3.56 (0.69)
Technologies can improve foods.	3.28 <sup>a</sup> (0.94)	3.50 <sup>b</sup> (0.84)	3.54 <sup>b</sup> (0.90)	10.08 (<0.001)	3.45 (0.90)
New technologies in the food sector scare me (r).	2.77 <sup>a</sup> (1.12)	2.59 <sup>a</sup> (1.06)	2.62 <sup>a</sup> (1.16)	2.87 (n.s.)	2.66 (1.12)
New technologies in agriculture can improve the lives of farm animals.	3.73 <sup>a</sup> (0.87)	3.78 <sup>a,b</sup> (0.85)	3.88 <sup>b</sup> (0.87)	3.26 (0.039)	3.80 (0.87)
I think technical progress is important.	3.87 <sup>a</sup> (0.86)	3.97 <sup>a,b</sup> (0.85)	4.02 <sup>b</sup> (0.88)	3.38 (0.034)	3.96 (0.86)
Technological progress is often overstated (r).	2.87 <sup>a</sup> (1.0)	2.72 <sup>a,b</sup> (0.93)	2.64 <sup>b</sup> (1.06)	5.22 (0.006)	2.74 (1.01)
<i>Preferences for food naturalness<sup>1</sup></i> ( $\alpha=0.75$ )	4.41 <sup>a</sup> (0.59)	4.00 <sup>b</sup> (0.72)	4.37 <sup>a</sup> (0.58)	49.16 (<0.001)	4.27 (0.65)
Naturalness in food is not important to me (r).	1.77 <sup>a</sup> (1.03)	2.30 <sup>b</sup> (1.12)	1.89 <sup>a</sup> (1.05)	24.81 (<0.001)	1.97 (1.09)
I appreciate food that is produced in accordance with nature.	4.37 <sup>a</sup> (0.76)	4.04 <sup>b</sup> (0.88)	4.41 <sup>a</sup> (0.71)	25.51 (<0.001)	4.29 (0.80)
It is important to me that food I eat in daily life is as natural as possible.	4.35 <sup>a</sup> (0.75)	3.94 <sup>b</sup> (0.90)	4.29 <sup>a</sup> (0.79)	27.93 (<0.001)	4.21 (0.83)
Farm animals should be kept as naturally as possible.	4.68 <sup>a</sup> (0.56)	4.30 <sup>b</sup> (0.78)	4.66 <sup>a</sup> (0.64)	39.90 (<0.001)	4.56 (0.69)

Items measured on a 5-point Likert scale from 1 = “Totally disagree” to 5 = “Totally agree”

<sup>a-c</sup> Mean values in the same row with different superscripts differ ( $P<0.05$ ) according to Games–Howell or Tukey post-hoc test, depending on whether Levene’s test was significant or not

<sup>1</sup>Mean index values with  $\alpha$ =Cronbach’s alpha. (r)=Reverse-coded for reliability analysis and mean index calculation

## Discussion

The results of this study emphasize the low awareness of consumers about specific challenges in livestock farming, such as the problematic use of male calves from dairy production. This is in line with existing studies (e.g., Sonntag et al. 2018). It is also apparent that the current approach is considered problematic by the majority of consumers and therewith reveals a gap between consumers’ expectations and reality on farms that can lead to a challenge for dairy production (Bolton et al. 2021; Ritter et al. 2022). Overall, when consumers were made aware of the problem, they saw a clear need for alternative male calf handling methods in dairy production. This additionally indicates that the current handling practices of male calves is not in line with consumers’ idea of good practice, which might be due to

the perception that animals should have a good life when used by humans (Hölker et al. 2019). A good life, however, is often associated with high naturalness (Schulze et al. 2021; Kühl et al. 2021; Winkel et al. 2020). The current handling of male calves subverts this right.

Regarding the alternative options, respondents particularly preferred extended fattening on farms as an alternative to solve the problem of young male calves. Consumers perceive this option as the most natural and most acceptable. This result highlights the importance of perceived naturalness in the production process of food products. Although this was not explicitly mentioned in our survey, and even though it is not the case in practice, respondents may have assumed that longer on-farm retention means that calves remain with their mothers longer—an approach that is highly valued by consumers because it enables the cow and calf to exhibit their natural behavior (Ritter et al. 2022; Busch et al. 2017). Additionally, Ritter et al. (2022) found that consumer acceptance of production methods increases when a purpose is identified for which the calves are raised. It seems that the idea of calves being born and killed without or with only low benefit negatively affects perceptions, while a meaningful purpose, such as for meat production, is more acceptable to many.

Participants also evaluated the usage of dual-purpose breeds as a promising alternative. A study by Schulze et al. (2021) found similar results and revealed that consumers value dual-purpose breeds when buying beef, indicating consumers' preference for animal welfare and food naturalness.

Also, the extended inter-calving intervals are perceived as a suitable alternative for the management of male dairy calves. This result can be explained as follows: It is already a well-known fact that cows have to calve to produce milk (Pieper et al. 2016). Thus, the public is aware of the purpose of calves being born. In addition, a growing population segment is convinced that humans are allowed to use animals if they treat them well and give them the opportunity to behave naturally (Hölker et al. 2019). This treatment presumably also includes reducing negative effects on cows from pregnancies. Thus, extended inter-calving periods can offer animal welfare and naturalness advantages from the consumer perspective.

In contrast, sexed semen was the least accepted and was perceived as highly unnatural by consumers. This might be due to its highly innovative and technological nature. Although sexed semen promises new possibilities and advantages for calves and farmers, like other new technologies in the food sector (e.g., genetic modification [Grunert et al. 2003] or cloning of animals [Brooks and Lusk 2011]), using sexed semen faces strong resistance by consumers, which could negatively affect the willingness to buy associated milk products. More, sexed semen is also perceived worst for the cows. This result highlights that perception of animal welfare and perceived naturalness are connected from a consumer perspective. Similar results were found by Thibault et al. (2022).

The subsequent cluster analysis showed that acceptance of the four alternatives for handling male calves varies between consumer segments. These segments also differ regarding their attitude toward innovative technologies in food production and food naturalness and perception. "Proponents of all alternatives" (segment 3) value the advantages of innovative technologies, whereas "sexed semen opponents" (segment 1) are less convinced that technologies can improve the food products or the lives of farm animals. However, there is a high preference for food naturalness in both segment 1 and segment 3. Naturalness preference in food thus appears to be less responsible for the potential rejection of sexed semen, although there are clear differences in how the alternatives are rated in terms of naturalness.

Moreover, the groups differ with respect to the question whether they consider the situation of male calves as problematic. Especially segment 3, “proponents of all alternatives”, sees a problem for the cows and farmers, and higher problem awareness seems to lead to a higher acceptance of all alternatives—including sexed semen. Thus, it might be possible that skepticism can be overcome if the awareness of the problem is high enough. The considerable opposition toward sexed semen, mainly driven by the perception that this approach is rather unnatural, should be taken into account when finding appropriate solutions for male calf management—either by implementing other alternatives or by using effective communication with the public as well as with consumers. The more natural alternatives for male calf avoidance, on the other hand, seem better suited for communication and marketing approaches. Except for age, no significant differences were found for sociodemographic characteristics. This result is in line with previous research showing that consumers’ perception of housing and handling conditions of livestock is rarely influenced by sociodemographic characteristics (Schütz et al. 2020; Kühl et al. 2022).

To maintain the dairy sector’s license to produce, the industry needs to carefully consider consumers’ perceptions and expectations of what livestock production looks like. More specifically, the case of the ban of battery cages has shown how public pressure can impact the industry and that a loss in consumer acceptance can have long-lasting effects on the image of the sector. To maintain its positive image, the dairy sector needs to actively define the problem and find a solution, not solely within the sector but also by considering consumer demands and expectations.

This study provides insights into consumers’ level of knowledge about the handling of male calves, their perceived severity of the challenge, as well as how different consumer segments perceive alternative handling approaches. The results suggest that information about the benefits of sexed semen is currently only convincing to a small group of consumers and those being very sensitive to the problem. The use and communication of sexed semen should therefore be done with caution, and further research is needed to identify arguments that will increase social acceptance. The fact that with sexed semen there is no change in the product itself does not appear to have a positive influence on acceptance. Rejection seems to be similar to that of gene technology.

The study is limited by its focus on German citizens and the tested alternatives. Furthermore, the acceptance of new technologies is presumably influenced by the way these innovations are presented and explained. Future studies should investigate whether there are other factors in addition to attitudes toward innovative technologies and naturalness preference in foods that influence the evaluation of the use of sexed semen. In addition, the alternatives investigated in this study are possible approaches to solve the current handling of male calves from dairy production. This study explored consumers’ evaluation of different alternatives to the current practices in dairy farming to find a socially accepted pathway. Hence, this study did not aim to discuss the ethical consequences of the implementation of the different approaches. Nevertheless, our results give first insights into citizens’ attitudes and their acceptance of different alternatives in direct comparison, which are relevant for the long-term strategies in dairy farming.

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## Statements and Declarations

**Competing Interests** None

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