



Consumers' Sensory Assessments, Descriptive Profiling and Purchase Behavior Toward Fresh Versus Frozen Goat Meat

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Abstract: Consumers often believe that fresh meat products are of higher quality than frozen. This can influence consumer purchase intent and willingness to pay, impacting producer sales and price points. The objective of this research was to determine if there is a difference in consumer acceptability and perception between fresh and previously frozen goat meat using affective testing. Consumer sensory hedonics ($n = 105$) of cooked fresh vs. frozen goat tenderloin (*Psoas major*) and loin (*Longissimus lumborum*) from the same goats were tested for overall liking and for the specific attributes of appearance, color, aroma, meat flavor, flavor strength, fat content, aftertaste, overall texture, tenderness, juiciness, quality, and purchase intent. Consumer sensory evaluations show there were no ($P > .05$) differences in acceptability between fresh and frozen goat meat in blind affective assessments. Samples described with the attributes 'juicy', 'savory', and 'tender', were most liked, while consumers preferred less samples described as 'tough' or 'chewy.' Locally raised meat, higher nutritional value, and more product availability were important reasons to purchase more goat meat, while the key themes of humanely/ethically raised, flavor, freshness, locally raised, grass fed/free range, and color were most used to describe high-quality goat meat. Blind consumer evaluations show frozen goat meat can be of equal quality to goat meat that is marketed fresh.

Keywords: frozen meat quality, goat meat, fresh vs. frozen, consumer sensory evaluations, locally raised, humanely raised

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Introduction

Federally inspected goat slaughter makes up approximately 0.3% of all federally inspected slaughter in the United States (US Department of Agriculture [USDA] Agricultural Marketing Service, 2025). Only 214 of the 7135 federally inspected establishments slaughter and process goats in the United States (USDA Food Safety Inspection Service, 2025). A number of these facilities only slaughter and process goats for a limited time each week or month. This generally means that goat producers have limited access to slaughter and processing facilities both in location and available time, which limits their marketing decisions and ability to provide a constant

supply of fresh goat meat. One way to preserve meat is to freeze it, but this practice goes against traditional US markets and the seasonal demand for goat meat (Liu et al., 2013). In an online survey of 593 Georgia residents conducted in 2012, Ibrahim et al. (2018) reported that 94% of respondents answered that freshness or nonfrozen meat was either somewhat or very important. However, in a fresh and frozen consumer study of lamb meat quality, Muela et al. (2016) found that though fresh and previously frozen meats were equally preferred, fresh meat was scored with the lowest acceptance after consumption by one-third of the test population.

Many studies have measured the impact of freezing on the quality of meat, demonstrating the

improved technologies of freeze and thaw (Leygonie et al., 2012). In a recent study by Holman et al. (2025), cuts of lamb meat frozen at either -12°C or -18°C over 2 y of time had acceptable quality. Additionally, lamb meat frozen for 12 mo had good sensory acceptance (de Paula Paseto Fernandes et al., 2013). Freezing and vacuum-packaging can enable producers to ship meat to markets outside a local region or even export to other countries to compete with fresh local products (Mills et al., 2014).

Goat meat is known for its health benefits and advantageous fatty acid profile (Hogg et al., 1992; Mahgoub et al., 2002). It has been suggested that goat meat can be a good animal origin source of protein and should be marketed as healthy and lean to improve product acceptance (Webb, 2014). When compared to chicken, beef, pork, and lamb, goat meat has the lowest fat, saturated fat, cholesterol, and overall calorie count per gram when cooked/roasted (Mazhangara et al., 2019). Goat-meat extract has even been found to exhibit anti-inflammatory effects and improve skin barrier function (Bae et al., 2024). South African youth appreciated goat meat's role in assisting with health concerns associated with red meat consumption (Ngomane et al., 2022). It is noted in Vietnam that increasing health consciousness is helping to expand and develop the goat-meat industry (Nguyen et al., 2023). In Algeria, a survey of 240 consumers found that the top 3 reasons to consume goat meat were flavor, low fat level, and health (Hamad et al., 2024), reinforcing the importance of health benefits as a driver of goat-meat consumption.

Beef, lamb/mutton, and chicken are meat products produced in the greatest quantities worldwide and have been studied more extensively than goat. In 2024, Fevold et al., found that untrained university faculty and staff preferred lamb loins that were fresh never frozen, whereas no differences in liking were found between fresh vs. frozen lamb legs. Consumer preferences in fresh vs. frozen beef strip loins were studied by Beyer et al. (2024), wherein the frozen samples were rated as more tender than the fresh, but no other significant differences were found. Although there have been other studies on consumers' assessments of the quality of fresh vs. frozen red meats, published research on consumer acceptability of fresh vs. frozen goat meat is not available.

As was suggested by Polkinghorne et al. (2014), the type of consumer population can affect sensory product expectations of red meat. Holman and Hopkins (2021) noted that differences in consumer

testing methodology and participant demographics can affect the validity of proposed consumer thresholds of red meat quality. Due to lack of resources or other constraints, scientists often rely on a population of university students or faculty as authentic target market consumers, but MacFie (2007) argues the importance of running consumer testing with the potential customer. This research explores target market consumers' sensory assessments and opinions of fresh vs. previously frozen goat-meat quality to determine if sensory differences exist and which attributes may drive consumer preference with prescreened goat-meat consumers. A series of standard consumer sensory approaches were used to achieve this goal including overall hedonics using 9-point hedonic scales, just-about-right (JAR) questions (Lawless and Heymann, 2010), quality ratings, and purchase intent questions. Although it has been shown that the physical, chemical or microbiological properties of meat can change during long periods of frozen storage (Medić et al., 2018), the aim of this study was not shelf-life quality but rather consumer acceptance with targeted goat-meat users of like-for-like fresh vs. previously frozen goat meat.

Materials and Methods

Products

Fresh and frozen goat tenderloin (*Psoas major*) and loin (*Longissimus lumborum*) samples were procured from a goat-meat ranch in Oregon for the sensory evaluation. The Boer \times American Range goats were suckled and weaned at 5 mo of age, then were allowed to range, browse, and graze on a diet of sage brush, bitter brush, wild currents, mahogany, wild meadow grasses, and sedges until approximately 2.5 y of age. One week prior to the consumer panels, 8 goats were humanely slaughtered using standard commercial techniques with an average carcass weight of 31.8 kg. After chilling carcasses at 2.2°C for 24 h, carcasses were split into 2 equal halves and allotted to either fresh or frozen treatments. Each half of each carcass was processed into the leg, loin, rack, and shoulder. The full loins were further fabricated into the boneless loin (*Longissimus lumborum*) and the tenderloin (*Psoas major*) and vacuum packaged (Promax TC-420LR, Promarks Corp., Ontario, CA) in 3-mm bags (Uline S-12339, Pleasant Prairie, WI) to prevent the growth of oxygen requiring spoilage bacteria (Gill, 1989). The frozen treatment was frozen and maintained at -23°C , whereas the fresh

treatment was refrigerated and maintained at 2.2°C. The frozen samples were maintained at –23°C for 48 h and then transported frozen to the Oregon State University's Food Innovation Center (FIC) in Portland, Oregon in coolers packed with ice, where they were immediately transferred to a commercial walk-in refrigerator (Imperial Manufacturing, Portland, OR) set at 1.8°C to thaw approximately 24 h prior to the sensory testing. Fresh samples were transported to the FIC in refrigerated coolers and stored in the FIC commercial walk-in refrigerator (Imperial Manufacturing, Portland, OR) set at 1.8°C. This was designed as a balanced trial where one-half of each of 8 goats were the fresh-never-frozen treatment and the equal but opposite half was the frozen treatment in a paired design. Since 1 side of each carcass was allotted to the fresh treatment and the other to the frozen, samples were tracked through to the consumers' plates so that each consumer received like-for-like samples from each treatment from the same animal.

Sample Preparation

All product preparations were conducted by a professional chef at the FIC to present samples modeled in a consumer-centric experience of normal consumption (Drake et al., 2023). Preparation and cooking were chosen to minimally mimic consumer eating habits of whole-muscle goat-meat products. The morning of the sensory evaluation, the epimysium on the goat tenderloins was removed. The tenderloins were portioned into approximately 57-g pieces, while the goat loins were portioned into approximately 85-g allotments due to the size difference of the 2 muscles. Samples were placed on parchment paper lined baking sheets and seasoned with 1 g of kosher salt (Diamond Crystal, St. Clair, MI) 10 min prior to cooking. The goat-meat samples were seared in stainless steel sauté pans (Thermalloy by Browne, 30 cm) using 15 mL of canola oil (Wesson Oil, Memphis, TN) on a gas range (Wolf Regency, Baltimore, MD). The meat was seared over medium high heat for approximately 4 min to 5 min per side until an internal temperature of 68.3°C was reached. The samples were left to rest for 5 min prior to portioning. Several grinds (0.25 g) of freshly ground black peppercorns (Penzeys Spices, Wauwatosa, WI) seasoned the samples after cooking in order not to burn the pepper during the searing process, and each consumer received 2 medallions of tenderloin or 1 piece of loin. All samples were served on white ceramic 15-cm plates labeled with 3-digit blinding codes on a tray.

Consumer Sensory Evaluation

The central location testing (Lawless and Heymann, 2010) was conducted at the FIC with permission from the Oregon State University Institutional Review Board, Study #2023-573, and each consumer signed their consent prior to participation. Rather than student or faculty participants, general population target market consumers of a diverse demographic background were screened and recruited from the Portland, Oregon metropolitan area using both the FIC consumer database and social media with an online survey to which 1771 consumers responded for the chance to participate. Potential participants were selected if they were self-reported likers and consumers of goat meat. Selection preference was given to consumers who reported consuming goat meat at least once a month or more. Compusense Cloud v23.0.34 software (Academic Consortium, Compusense Cloud, Inc., Guelph, Ontario, CA) was used to develop the questionnaires and test designs and to administer the tests. Panelists were seated in individual sensory booths under white light. Each consumer was provided with room temperature spring water, seltzer water, and unsalted crackers as palate cleansers. Samples for the affective testing were presented in a complete block design, balanced for carryover and order effects. Consumers were instructed to cleanse their palates before and between samples. Participants received monetary compensation for participation.

Consumer Affective Testing

105 preselected goat-meat consumers participated in the goat loin or tenderloin acceptance testing of cooked products. The acceptance test is the most widely executed method of consumer hedonic testing (Drake et al., 2023). The attributes of overall appearance, color, aroma, overall liking, meat flavor, flavor strength, fat content, aftertaste, overall texture, tenderness, and juiciness were measured on a horizontal, labeled 9-point hedonic category scale from 1 = 'dislike extremely' to 9 = 'like extremely' for acceptability. JAR scales were used by consumers to rate their opinions of the product attributes' color (where 1 = 'much too light/pink', 2 = 'somewhat too light/pink', 3 = 'just about right', 4 = 'somewhat too dark/red' to 5 = 'much too dark/red'), flavor intensity (where 1 = 'much too bland', 2 = 'somewhat too bland', 3 = 'just about right', 4 = 'somewhat too strong/intense' to 5 = 'much too strong/intense'), firmness (where 1 = 'much too soft', 2 = 'somewhat too soft', 3 = 'just about right', 4 = 'somewhat too firm/tough' to 5 = 'much too firm/tough'), juiciness

(where 1 = ‘much too dry’, 2 = ‘somewhat too dry’, 3 = ‘just about right’, 4 = ‘somewhat too moist/juicy’ to 5 = ‘much too moist/juicy’), and fat content from the consumer perspective, which could include both visual and in the mouth-eating experience fat-content assessment (where 1 = ‘much too lean’, 2 = ‘somewhat too lean’, 3 = ‘just about right’, 4 = ‘somewhat too fatty’ to 5 = ‘much too fatty’).

Attribute Assessments

Consumers completed a check-all-that-apply (CATA; Adams et al., 2007) task where they were asked to describe the samples by checking all the attributes that applied from a list of the following attributes: ‘strong aroma’, ‘weak aroma’, ‘sweet’, ‘savory’, ‘salty’, ‘umami’, ‘tender’, ‘tough’, ‘lean’, ‘fatty’, ‘juicy’, ‘fibrous’, ‘chewy’, ‘pungent’, ‘metallic’, ‘liver’, ‘herbaceous’, ‘gamey’, ‘strong flavor’, ‘weak flavor’, ‘red color’, ‘pink color’, ‘dark color’, and ‘light color.’ Consumers also answered a CATA emotion question with the following attributes, ‘adventurous’, ‘impressed’, ‘bored’, ‘daring’, ‘intelligent’, ‘enthusiastic’, ‘pleased’, ‘unhealthy’, ‘accomplished’, ‘guilty’, ‘interested’, ‘joyful’, ‘healthy’, ‘disgusted’, ‘positive’, ‘disappointed’, ‘nostalgic’, ‘peaceful’, ‘satisfied’, ‘simple’, ‘worried’, ‘pleasant’, ‘unsure’, ‘grateful’, ‘satiated’, ‘fancy’, and ‘wasteful.’ Consumers were also asked to rate the flavor intensity where 1 = ‘very little flavor’, 5 = ‘medium flavor intensity’, and 9 = ‘very high flavor intensity’ and the firmness of the samples on a scale where 1 = ‘low firmness/very tender’, 5 = ‘medium firmness/tenderness’, and 9 = ‘high firmness/not at all tender.’ Finally, consumers rated the quality of the samples (1 = ‘low quality’, 5 = ‘average quality’, and 9 = ‘high quality’) and purchase intent at an average retail price (where 1 = ‘definitely would not buy’, 2 = ‘probably would not buy’, 3 = ‘might or might not buy’, 4 = ‘probably would buy’ and 5 = ‘would definitely buy’). A forced pause in the test between samples was included to ensure consumers had adequate time to cleanse their palates before evaluating the second sample.

Consumer Perceptions of Goat Meat

Consumer perceptions were captured to assess the goat-meat category and specifically insights about frozen goat meat. Consumers provided their perceptions about the fresh and frozen samples related to quality, sustainability, and purchase intent in agree/disagree statements. For each sample, consumers rated their agreement on a 7-point Likert scale with the terms ‘delicious’, ‘attractive’, ‘high quality’, ‘sustainable’,

‘trustworthy’, ‘something I would like to buy’, and ‘something I could cook.’ A ranking task was used where consumers ranked the reasons that would increase their purchase intent of goat meat. Responses included ‘supports the livelihoods of local ranchers and their communities’, ‘grass fed’, ‘meat with a lower carbon footprint’, ‘all natural’, ‘meat with a higher nutritional value’, ‘meat that has a third-party certification’, ‘organically certified’, and ‘meat that is more affordable/cheaper.’ Participants responded to a question about willingness to pay more for goat meat that is raised and processed in Oregon, the state in which the test was implemented. Both in a CATA and free-comment (FC) (ten Kleij and Musters, 2003) question, consumers were probed about barriers preventing them from buying more goat meat and preparing goat meat at home with CATA responses including ‘availability of high quality meat’, ‘time/convenience’, ‘finding the exact cut I want’, ‘cost’, ‘not knowing how to cook it’, ‘intimidated by cooking this meat’, and ‘smell.’ Consumers were asked, if purchasing goat meat to prepare at home, do they normally purchase ‘fresh only’, ‘frozen only’, ‘more fresh than frozen’, ‘more frozen than fresh’, or ‘I purchase both equally.’ Information that would increase confidence in frozen quality was asked in a ranking task with the possible responses ‘information on the date when it was processed’, ‘providing a best if consumed by date’, ‘information on where the product was raised’, ‘providing a brief sustainability statement’, ‘providing information on who raised the meat’, ‘brief instructions with best methods to thaw product and maintain quality’, and ‘labeled with a third-party sustainability certification such as Certified Organic, Humanly Raised, etc.’ Agree/disagree statements were asked that included ‘the age of the goat, when it is butchered, makes a difference in my buying choice’, ‘the color of the raw meat makes a difference, pale pink vs. deep red, in my purchase intent’, ‘I prepare goat meat throughout the year’, ‘I prepare goat meat only on special occasions’, ‘I would prepare goat meat more often if it was readily available’, ‘the health benefits of goat meat are very important to me’ (e.g., low fat, low in cholesterol, high in vitamin E), ‘it is important to me that the goat was raised in Oregon’, and ‘it is important to me that the goat was raised in the United States’, on a scale from 1 = ‘strongly disagree’ to 7 = ‘strongly agree.’ Finally, a FC question asked consumers to describe ‘high-quality goat meat.’ Goat-meat consumption frequency was probed by location (‘take out/food cart’, ‘quick-serve restaurant’, ‘high-end restaurant’, ‘prepared at my home’), and the demographic information

Table 1. Consumer acceptability testing participant demographics, $n = 105$

Factor	Frequency	Percentage
Age (y)		
18–25	6	6
26–35	23	22
36–45	32	30
46–55	23	22
56–65	15	14
≥66	6	6
Gender		
Woman	47	45
Man	45	43
Other	13	12
Education		
Some high school	0	0
High school graduate	5	5
Current college student/some college	13	12
2-y college or technical degree	18	17
4-y college degree	40	38
Advanced college degree	29	28
Ethnicity		
American Indian or Alaskan Native	4	4
Asian	15	14
Black or African American	5	5
Latinx or Hispanic	12	12
Middle Eastern or North African	1	1
Hawaiian Native or Pacific Islander	0	0
White	79	75
Prefer not to disclose	2	2
Household annual income (\$)		
<20,000	14	13
20,000–29,999	8	8
30,000–39,999	7	7
40,000–59,999	8	8
60,000–79,999	14	13
80,000–99,999	14	13
100,000–149,999	21	20
≥150,000	19	18

of age, gender, ethnicity, education, and income was collected (Table 1).

Statistical Analysis

Data was analyzed using XLSTAT 2022.4.1 software (Addinsoft, 2025; NY). The means of the hedonic and JAR attributes of the consumer liking data were calculated using analysis of variance at a 95% CI, and the means compared using Tukey's Honestly Significant Difference, where the samples were fixed effects and human subjects random effects. A P value less than .05 was considered significant for all analyses. CATA sensory and emotion data were analyzed using

Cochran's Q test (Parente et al., 2011) to determine any differences in fresh vs. frozen goat-meat product descriptions and principal coordinate analysis (PCoA; Mardia et al., 2024) to show the relationship between the overall liking of the samples and the descriptive or emotive terms. Finally, to determine the importance of the presence or absence of each CATA term on overall liking, a penalty lift analysis (Meyners et al., 2013) was performed. Kruskal-Wallis multiple pairwise comparisons using Dunn's procedure were used to analyze the ranked data (Rayner and Best, 2001).

Results and Discussion

Sensory Analysis

Of a possible 1771 potential participants, 105 targeted consumers participated in the sensory evaluations. Thirty-seven percent of participating consumers reported to have eaten goat meat as take out or at food carts at least every 2 mo to 3 mo, 22% at a quick-serve restaurant, 23% at a high-end restaurant, 25% at a friend or family member's house, and 54% from home. A broad and diverse range of ages, incomes, and ethnicities were selected to make a balanced panel of participants (Table 1). The group consisted of 45% women, 43% men and 12% who identified as another gender, with 88% falling between the ages of 26 y and 65 y. The majority (66%) had a 4-y or advanced college degree, and 36% had an average household income below \$60,000 USD/y while 38% reported income above \$100,000 USD/y. The ethnicity of these consumers was reported to be 75% white, 14% Asian, 12% Latinx/Hispanic, 5% Black or Africa American, 4% American Indian or Alaskan Native, 1% Middle Eastern or North African, and 2% who preferred not to disclose. The participants in this study had reported previous experience with goat meat.

Consumer Affective Testing

The liking of blind coded previously frozen and fresh goat-meat samples was rated by consumers of goat meat. In all attributes, the fresh and frozen samples were liked equally ($P > .05$; Table 2). These results are similar to those found in beef *M. longissimus dorsi*, where samples had either been chilled or frozen and were not rated significantly different in liking by consumers (Lagerstedt et al., 2008). Both samples were rated between 'like somewhat' and 'like very much'

Table 2. Mean (\pm SD) of the hedonic (1 = ‘dislike extremely’ to 9 = ‘like extremely’) attributes of the fresh and previously frozen goat-meat samples, $n = 105$

Attributes	Samples		P Value	HSD Value
	Fresh Goat Meat	Previously Frozen Goat Meat		
Overall appearance	7.84 \pm 1.30	8.02 \pm 1.02	.17	0.26
Color	7.59 \pm 1.50	7.85 \pm 1.35	.09	0.30
Aroma	7.72 \pm 1.44	7.98 \pm 1.07	.08	0.29
Overall liking	7.41 \pm 1.45	7.56 \pm 1.18	.26	0.27
Meat flavor	7.70 \pm 1.39	7.88 \pm 1.10	.21	0.27
Flavor strength/intensity	7.41 \pm 1.73	7.64 \pm 1.24	.17	0.33
Fat content	6.90 \pm 1.83	6.69 \pm 1.66	.61	0.37
Aftertaste	7.18 \pm 1.75	7.30 \pm 1.47	.46	0.31
Overall texture	6.64 \pm 1.93	6.95 \pm 1.69	.12	0.40
Tenderness	6.28 \pm 2.13	6.50 \pm 1.96	.37	0.50
Juiciness	7.75 \pm 1.35	7.79 \pm 1.39	.81	0.32

Abbreviation: HSD, honestly significant difference.

on the 9-point hedonic category scale in overall liking. The samples were well liked and rated over 7.0 in the attributes overall liking, appearance, color, aroma, meat flavor, flavor strength, aftertaste, and juiciness. The only attributes where consumers rated the samples under 7.0 on average were fat content, overall texture, and tenderness. Perceived quality and purchase intent also showed no differences ($P > .05$; Table 3) and were rated highly for both samples, where quality scores averaged above 7.0 and purchase intent on average was rated near ‘would probably buy’ for the previously frozen goat meat (3.84).

Attribute Assessments

To understand the attributes that had an impact on consumer liking, JAR scales were employed. The JAR liking was rated on 5-point JAR scale for the sensory attributes’ color, flavor intensity, firmness, juiciness, and fat content (Table 4), where a score of 3.0 was considered closest to ideal. Consumers did not rate any of these JAR attributes as different ($P > .05$) between the fresh vs. previously frozen goat-meat samples. The juiciness of both the fresh (3.0) and previously frozen (2.95) were rated near or at ideal. The color of both

Table 3. Mean (\pm SD) of both the intensity and quality (1 = ‘low’ to 9 = ‘high’) attributes and purchase intent (1 = ‘would not buy’ to 5 = ‘would buy’) of the fresh and previously frozen goat-meat samples, $n = 105$

Attributes	Samples		P Value	HSD Value
	Fresh Goat Meat	Previously Frozen Goat Meat		
Flavor intensity (9 pt)	5.90 \pm 1.90	6.21 \pm 1.65	.08	0.36
Firmness intensity (9 pt)	5.73 \pm 1.69	5.59 \pm 1.71	.49	0.41
Quality (9 pt)	7.15 \pm 1.73	7.48 \pm 1.44	.09	0.37
Purchase intent (5 pt)	3.70 \pm 1.18	3.84 \pm 1.00	.25	0.24

Abbreviation: HSD, honestly significant difference.

Table 4. Mean (\pm SD) of the just-about-right questions (1 = ‘not enough,’ 3 = ‘just about right’ to 5 = ‘too much’) attributes of the fresh and previously frozen goat-meat samples, $n = 105$

Attributes	Samples		P Value	HSD Value
	Fresh Goat Meat	Previously Frozen Goat Meat		
Color (light to dark)	2.93 \pm 0.64	2.80 \pm 0.58	.07	0.14
Flavor intensity (bland to strong)	2.66 \pm 0.60	2.79 \pm 0.57	.06	0.14
Firmness (soft to firm)	3.58 \pm 0.68	3.51 \pm 0.72	.42	0.16
Juiciness (dry to moist)	3.00 \pm 0.34	2.95 \pm 0.35	.25	0.08
Fat content (lean to fatty)	2.74 \pm 0.60	2.70 \pm 0.71	.50	0.14

Abbreviation: HSD, honestly significant difference.

Table 5. Mean (\pm SD) of the agree/disagree statements (1 = ‘strongly disagree’ and 7 = ‘strongly agree’) of the fresh and previously frozen goat-meat samples, $n = 105$

Attributes	Samples		P Value	HSD Value
	Fresh Goat Meat	Previously Frozen Goat Meat		
Delicious	5.77 \pm 1.40	5.96 \pm 1.02	.19	0.28
Attractive	5.90 \pm 1.21	6.12 \pm 0.97	.09	0.26
High quality	5.70 \pm 1.38	5.94 \pm 1.18	.11	0.30
Sustainable	5.09 \pm 1.23	5.17 \pm 1.25	.35	0.18
Trustworthy	5.11 \pm 1.20	5.08 \pm 1.12	.65	0.17
Something I would like to buy	5.37 \pm 1.80	5.75 \pm 1.35	.04	0.37
Something I could cook	5.75 \pm 1.62	5.87 \pm 1.44	.39	0.26

Abbreviation: HSD, honestly significant difference.

samples was also close to ideal, with the fresh sample (2.93) being rated slightly darker than the frozen sample (2.80) but not different ($P = .07$). Samples were both rated slightly on the side of ‘too firm’ and ‘too lean’ in firmness and fat content. Additionally, the intensity of both the flavor and firmness on a scale of 1 = ‘low’ and 9 = ‘high’ were rated similarly ($P > .05$) between samples (Table 3). Although there were not any differences in firmness ratings or texture liking found between the fresh and previously frozen samples in this consumer research, Grayson et al. (2014) found that freezing and thawing increased the tenderness in beef steaks when compared to fresh. These samples were not aged. Some researchers have indicated that 24 h to 48 h of chilling is sufficient for the aging process for goat meat (Adeyemi et al., 2016; Biswas et al., 2016), but others have reported that postslaughter aging has been found to improve the tenderness of goat meat (Pophiwa et al., 2020; Sgarro et al., 2022; Holman et al., 2024). Agree/disagree statements were asked about both samples, and 1 significant difference was observed for the statement ‘I feel this product is something I would like to cook’, where the frozen sample was rated higher ($P = .04$) than the fresh (Table 5).

Check All That Apply

Only 2 of the 24 sensory terms were rated as different ($P < .05$) by consumers: ‘gamey’ ($P = .021$) and ‘dark color’ ($P = .033$; Table 6). The fresh sample was again rated darker in color ($P > .05$), though this term was only checked 18 times (Supplementary Table 1) and was defined neither with words nor a color chart for consumers. It is known that consumers expect meat that is the characteristic species color (Altmann et al., 2024), darker red than other red meat sources in the case of goat meat (Gawat et al., 2023), to be fresher, but the fresh sample in this study was not

Table 6. Cochran’s Q test for sensory and emotive check-all-that-apply data with significant ($P < .05$) attributes in bold, $n = 105$

Sensory Attributes	P Value	Emotive Attributes	P Value
Gamey	.021	Pleased	.018
Dark color	.033	Adventurous	.052
Fibrous	.072	Bored	.059
Light color	.090	Daring	.059
Strong flavor	.106	Peaceful	.059
Pungent	.157	Joyful	.072
Tough	.237	Disgusted	.083
Umami	.285	Wasteful	.083
Liver	.317	Grateful	.102
Lean	.384	Satisfied	.128
Pink color	.398	Positive	.194
Metallic	.480	Disappointed	.248
Juicy	.549	Simple	.303
Chewy	.555	Guilty	.317
Savory	.577	Healthy	.346
Weak flavor	.637	Satiated	.353
Fatty	.655	Nostalgic	.405
Herbaceous	.655	Unsure	.491
Strong aroma	.695	Interested	.505
Salty	.732	Unhealthy	.564
Sweet	.763	Impressed	.655
Red color	.857	Accomplished	.739
Weak aroma	.866	Pleasant	.739
Tender	.884	Fancy	.853
		Intelligent	1.000
		Enthusiastic	1.000
		Worried	1.000

rated higher in quality. Although the term ‘pink color’ was checked often (68%) to describe the samples and more than twice as many times as ‘red color’ (34%), neither sensory attribute had a significant impact on product liking mean scores (pink color, $P = .864$; red color, $P = .785$; Table 7). The frozen sample was rated significantly more gamey (Table 8), a term checked a

Table 7. Calculated mean impact on liking for each check-all-that-apply attribute with significant attributes in bold, $n = 105$

CATA Variable	Level	Frequency	%	Mean (Overall Liking)	Mean Impact	Standardized Difference	<i>P</i> Value
Strong aroma	Absent	144	69	7.347			
	Present	66	31	7.788	0.441	2.261	.025
Weak aroma	Absent	163	78	7.632			
	Present	47	22	6.979	-0.653	-3.037	.003
Sweet	Absent	191	91	7.518			
	Present	19	9	7.158	-0.360		
Savory	Absent	49	23	6.673			
	Present	161	77	7.733	1.059	5.201	<.0001
Salty	Absent	118	56	7.424			
	Present	92	44	7.565	0.141	0.768	.444
Umami	Absent	134	64	7.373			
	Present	76	36	7.684	0.311	1.643	.102
Tender	Absent	119	57	7.210			
	Present	91	43	7.846	0.636	3.544	.000
Tough	Absent	147	70	7.762			
	Present	63	30	6.841	-0.921	-4.861	<.0001
Lean	Absent	85	40	7.353			
	Present	125	60	7.576	0.223	1.199	.232
Fatty	Absent	190	90	7.505			
	Present	20	10	7.300	-0.205		
Juicy	Absent	39	19	6.513			
	Present	171	81	7.708	1.195	5.419	<.0001
Fibrous	Absent	169	80	7.598			
	Present	41	20	7.024	-0.573		
Chewy	Absent	88	42	7.830			
	Present	122	58	7.238	-0.592	-3.269	.001
Pungent	Absent	206	98	7.500			
	Present	4	2	6.750	-0.750		
Metallic	Absent	198	94	7.530			
	Present	12	6	6.750	-0.780		
Liver	Absent	206	98	7.515			
	Present	4	2	6.000	-1.515		
Herbaceous	Absent	205	98	7.468			
	Present	5	2	8.200	0.732		
Gamey	Absent	184	88	7.543			
	Present	26	12	7.077	-0.467		
Strong flavor	Absent	137	65	7.321			
	Present	73	35	7.795	0.473	2.498	.013
Weak flavor	Absent	184	88	7.674			
	Present	26	12	6.154	-1.520		
Red color	Absent	139	66	7.504			
	Present	71	34	7.451	-0.053	-0.273	.785
Pink color	Absent	67	32	7.463			
	Present	143	68	7.497	0.034	0.172	.864
Dark color	Absent	192	91	7.469			
	Present	18	9	7.667	0.198		
Light color	Absent	191	91	7.581			
	Present	19	9	6.526	-1.055		

Abbreviation: CATA, check all that apply.

Table 8. Multiple pairwise comparisons on sensory check-all-that-apply attributes where values in rows with different letters are significantly different $P < .05$ using the critical difference (Sheskin) procedure, $n = 105$

Attributes	Fresh Goat Meat	Previously Frozen Goat Meat
Juicy	0.829 (a)	0.800 (a)
Savory	0.752 (a)	0.781 (a)
Pink color	0.705 (a)	0.657 (a)
Lean	0.571 (a)	0.619 (a)
Chewy	0.600 (a)	0.562 (a)
Tender	0.429 (a)	0.438 (a)
Salty	0.448 (a)	0.429 (a)
Strong flavor	0.305 (a)	0.390 (a)
Umami	0.381 (a)	0.343 (a)
Red color	0.343 (a)	0.333 (a)
Strong aroma	0.324 (a)	0.305 (a)
Tough	0.333 (a)	0.267 (a)
Weak aroma	0.219 (a)	0.229 (a)
Gamey	0.086 (a)	0.162 (b)
Fibrous	0.238 (a)	0.152 (a)
Light color	0.057 (a)	0.124 (a)
Weak flavor	0.133 (a)	0.114 (a)
Fatty	0.086 (a)	0.105 (a)
Sweet	0.095 (a)	0.086 (a)
Metallic	0.048 (a)	0.067 (a)
Dark color	0.124 (b)	0.048 (a)
Herbaceous	0.019 (a)	0.029 (a)
Pungent	0.029 (a)	0.010 (a)
Liver	0.029 (a)	0.010 (a)

total of 26 times between both samples. The terms most used to describe these samples were ‘juicy’ (171, 81%), ‘savory’ (161, 77%), ‘pink color’ (143, 68%), and ‘lean’ (125, 60%). The term ‘pleased’ was the one different ($P = .018$) emotive attribute between fresh and frozen samples, with consumers feeling more pleased with the previously frozen sample (Table 6). Emotions most used to describe these samples included ‘satisfied’ (143, 68%), ‘pleased’ (134, 64%), ‘interested’ (130, 62%), ‘pleasant’ (126, 60%), ‘positive’ (123, 59%), and ‘healthy’ (114, 54%; Supplementary Table 1). Only 3 consumers (1%) rated either goat-meat sample as feeling ‘disgusted.’

A PCoA was run to visualize the proximities of the sensory attributes tested to overall liking in 2 dimensions (Figure 1). Overall liking is associated with the attributes ‘savory’, ‘tender’, and ‘juicy’, while the mean impact chart and data show those sensory terms that had the most significant positive and negative impact on liking (Figure 1; Table 7). Those positive sensory attributes included ‘juicy’, ‘savory’, ‘tender’, ‘strong flavor’, and ‘strong aroma.’ These results are similar to the findings of Liu et al. (2020) who reported that in addition to the sensory property flavor, tenderness and juiciness were most important to overall liking of beef with European consumers, and Alcalde et al. (2023) who found that goat kid meat tenderness and taste were decisive factors in product liking. Additionally, in a review by Miller (2020), flavor, tenderness, and juiciness were reported as associated with consumer acceptance of the red meats pork, lamb, and

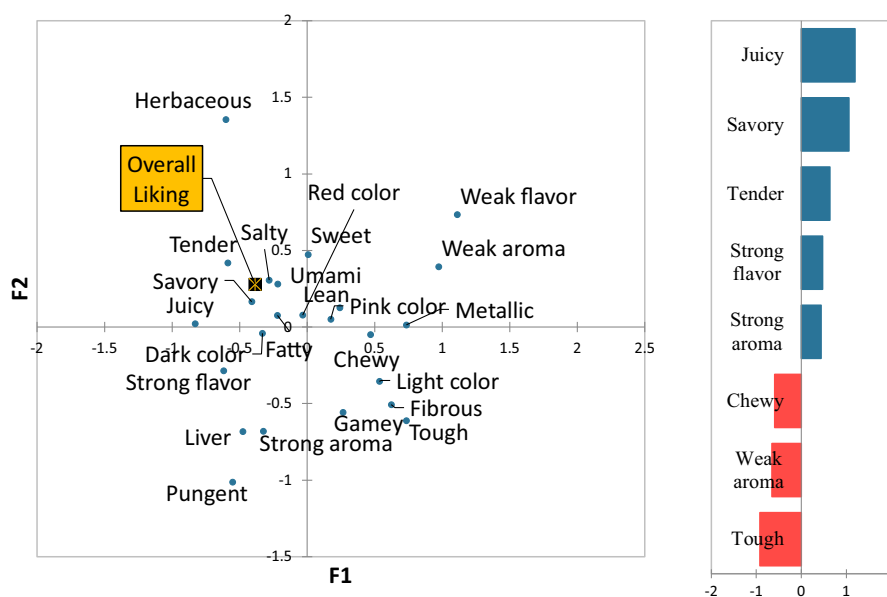


Figure 1. Principal coordinate analysis on sensory attributes and mean impact chart of sensory terms, where significant mean increases are displayed in blue and decreases in red, $n = 105$.

beef. Those sensory attributes that had a significant ($P < .05$) negative impact were ‘tough’, ‘weak aroma’, and ‘chewy’ (Figure 1; Table 7).

Consumer Perceptions of Goat Meat and Frozen Product

Consumers in this study overwhelmingly reported they would pay more for goat meat that is raised and processed in Oregon (71%), while 17% were not sure and 12% answered no. Additionally, ‘locally raised (supporting livelihoods of local ranchers/communities)’ and ‘meat with a higher nutritional value’ were the most important factors, while both ‘organically certified’ and ‘meat that has a third-party certification’ were the least important reasons of those listed to purchase more goat meat (Figure 2). A recent study

(Ibrahim et al., 2018) found that consumers were more willing to purchase locally grown, organic and grass-fed goat meat compared to genetically modified, and Hambaryan et al. (2024) found that consumers preferred goat meat that was locally raised and USDA inspected. To consumers in the current study, the goat being locally raised was even more important than the importance of the goat being raised in the United States, where 37% strongly agreed and another 26% agreed that this was important as compared to only a combined 37% who felt the same about goat raised in Oregon (Figure 3). Additionally, 90% of consumers agreed that they ‘would prepare goat more often if it was readily available’, suggesting access is a large barrier to greater consumption. Health benefits of the goat meat were important to 72% of those who participated. Similarly, a computer-assisted telephone

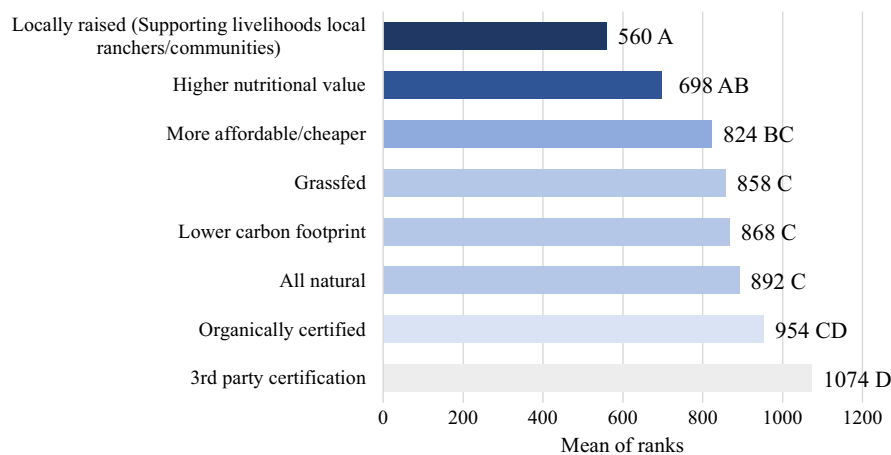


Figure 2. Ranked reasons to purchase more goat meat, $n = 105$.

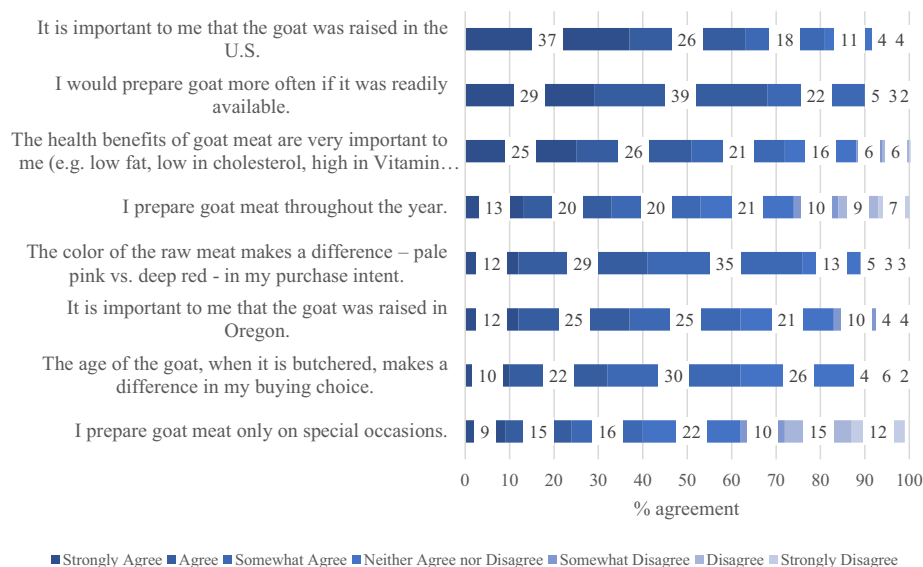


Figure 3. Agree/disagree statements about goat meat, $n = 105$.

interview with 450 participants in Europe about game meat found that rational motives influence consumers' choice more than emotion motives, with the most important being those connected to health (Niewiadomska et al., 2020). More consumers agreed that they prepare goat meat throughout the year (53%) than on special occasions (40%).

Consumers in this study buy fresh product more often than frozen, with 31% buying fresh only and another 26% buying more fresh than frozen. Only 8% buy only frozen goat meat, 10% buy more frozen than fresh, and 11% buy both fresh and frozen goat meat equally. In a ranked question on information that could be provided that would increase confidence in the quality of frozen product, consumers reported the 'date when it was processed', the 'best if consumed by date', and 'where the product was raised' were most important, while a 'sustainability statement' and 'third-party sustainability certification' were least important (Figure 4).

To probe consumer perceptions about goat-meat quality, an FC question asked consumers to describe 'high-quality goat meat.' The top themes that emerged (Figure 5) included raised humanely/ethically (45%), good flavor/taste (29%), fresh (26%), local (24%), grass fed/free range (23%), and color (16%). Common descriptors used to define high-quality goat meat included: humanely raised, flavorful, fresh, local, grass fed, good or no smell, good appearance, tender, lean, organic, free range, no additives, and no antibiotics. Less used descriptors included: good value/cost, nutrition, natural, young, seasonality, non-GMO grain, disease free, or halal (Supplementary Table 2). The living conditions were also noted as important, with the goat being raised on a healthy/natural diet in a humane environment with access to the outdoors. These results are similar to those by Spain et al. (2018) who found

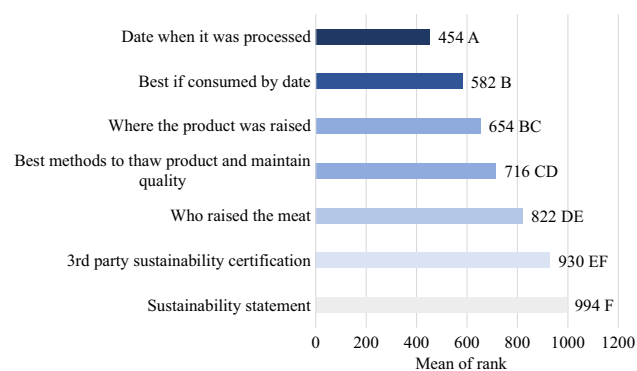


Figure 4. Ranked information that would increase consumer confidence in the quality of a frozen meat product, $n = 105$.

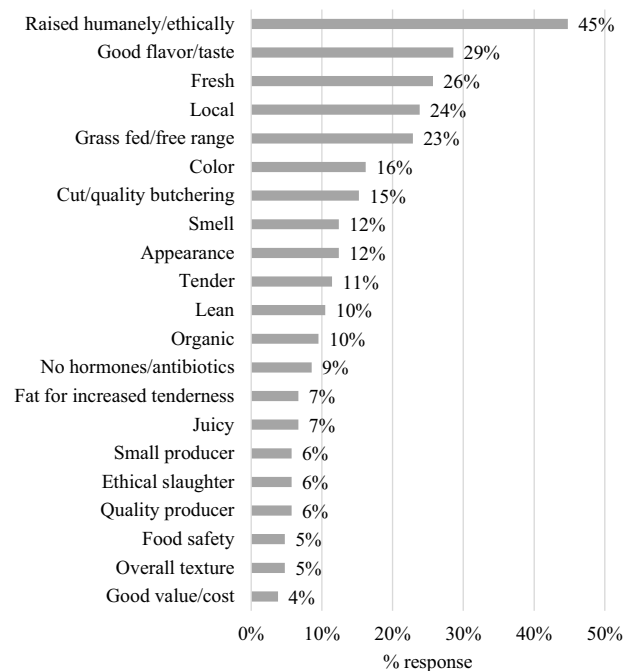


Figure 5. Free-comment question descriptions of high-quality goat meat, $n = 105$.

that in a survey with 1000 US meat consumers, 70% reported paying attention to how the animals were raised. In a separate study of 1000 US grocery shoppers, 79% indicated they had willingly paid more for a product with an animal welfare label in the last year because they thought it indicated "better-than-standard" animal welfare (Thibault et al., 2022). Although health benefits were rated as important in an agree/disagree statement (Figure 3), the nutrition or health benefits of the meat were only mentioned by 3% of these consumers to describe high-quality goat meat. Flavor and color were the most mentioned sensory properties of high-quality goat meat followed by smell and overall appearance. It was reported that meat color is a frequent cue used by consumers in their preferences for goat meat (Ripoll et al., 2019), while Alcalde et al. (2023) found color to be a factor of medium importance with 60% of participants in an assessment of goat meat.

When asked about the biggest barriers to buying more goat meat in an FC question, the most mentioned issues were availability/access (78%), cost (27%), cooking/preparation uncertainty (13%), low quality (13%), and preferred cut not available (7%; Figure 6). The largest factors chosen in a CATA question addressing barriers to cooking frozen goat meat at home were 'availability of high-quality meat' (54%), 'finding the exact cut I want' (43%), and 'cost' (32%). Participating consumers recommend that goat meat could be promoted

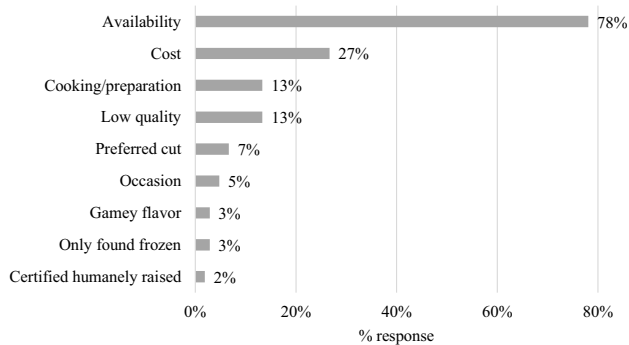


Figure 6. Free-comment question list of barriers to purchasing goat meat, $n = 105$.

by increasing goat-meat availability in mainstream grocery stores and online platforms to make it more accessible to a wider consumer base. Additionally, providing information about how to prepare the product, the nutritional profile, and environmental sustainability of the meat would help to boost consumption, which were similar to themes in the research findings of de Araújo et al. (2022).

Conclusions

To better understand potential product success in the market, testing hedonic and sensory liking from a consumer-centric perspective is critical (Lawless and Heymann, 2010). For this reason, samples were prepared to mimic the consumer environment as closely as possible, explaining the inclusion of seasonings and restaurant quality preparation by a professional chef. This can also be seen as a limitation of the study, as the seasoning could hide any real differences in the samples. The blind sensory evaluations with frequent goat-meat consumers showed frozen and fresh goat-meat samples were liked equally in all hedonic attributes tested, and there were no differences in consumer liking. Samples with the checked CATA attributes ‘juicy’, ‘savory’, and ‘tender’ were most liked, while consumers did not like samples described as ‘chewy’ or having a ‘weak aroma.’ High-quality goat meat as described by these consumers included the aspects of ethics, flavor, freshness, color, grass fed, and local origin. In many different responses, consumers continued to point to the importance of origin when considering both purchase intent and quality assessments, with being raised the United States rated as even more important than raised in their local state of Oregon. Product availability, access, more emphasis from retailers about the lean meat health benefits of goat meat, and

the equal sensory quality of properly frozen meat compared to its fresh counterparts can all be important aspects for increased sales and consumer confidence. Price was reported to be a lower barrier to increased goat-meat consumption than availability. Similar to other meats and produce, frozen goat meat can be a more realistic option to fresh never frozen, which allows the ranchers to slaughter at one time point and distribute product over the season. This allows for a longer shelf-life, and profits during the off-season when markets are not saturated compared to the slaughter period. Ranchers could have confidence that frozen goat meat can be equally liked to fresh and accepted by consumers.

Conflict of Interest

The authors declare no conflicts of interest and that the research was conducted in the absence of any commercial or financial relationships. This research was funded by the Oregon State University Foundation. The funding source had no role in any aspect of the project other than to provide financial support. All consumers who participated in the study signed an informed consent document and human ethics was approved by the Oregon State University Institutional Review Board, study #2023-573.

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Author Contribution

Ann Colonna: conceptualization, data curation, formal analysis, investigation, methodology, project administration, software, supervision, visualization, original draft, and review and editing; and Carol Lorenzen: funding acquisition, conceptualization, data curation, project administration, resources, supervision, original draft, and review and editing.

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