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Consumers' beef purchasing behavior across countries

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ABSTRACT

In 2022, the value of United States (US) beef and beef product exports was $11.7 billion, and the US was the world's largest beef producer and second-largest beef exporter by volume. Therefore, we conducted surveys to evaluate beef purchasing behavior among consumers in important and emerging US beef export markets, including Japan, the United Kingdom (UK), Germany, and Mexico. Results reveal differences in consumers' beef purchasing behavior across countries. Most Mexican consumers purchase beef two-to-three times a week, while consumers in other countries typically purchase it once a week. Using ordered probit models, we examined the factors associated with beef purchase frequency in each country. Japanese consumers who consider price to be an important factor when purchasing beef are less likely to purchase it frequently. German consumers, for whom brands are important when buying beef, are more likely to buy it frequently. British consumers, who consider hormone-free production to be important when purchasing beef, are less likely to buy it frequently. Mexican consumers, who consider grass-fed production to be an important factor when purchasing beef, are less likely to buy it frequently. Across all countries, individuals who purchase beef at supermarkets and from butchers are more likely to purchase it more often. Results also indicate that various consumer demographics are associated with beef purchase frequency across countries. The findings provide valuable insights for stakeholders regarding international consumer beef purchasing behavior.

1. Introduction

Cattle and calves are the most valuable agricultural commodity sector in the United States (US) accounting for the largest share of cash receipts (United States Department of Agriculture (USDA) Economic Research Service (ERS), 2024). In 2023, cash receipts for cattle and calves were $99 million, which represented approximately 20% of all agricultural commodity cash receipts (USDA ERS, 2024). In 2022, the US was the world's largest beef producer and second largest exporter by volume, and US beef and beef product exports were valued at $11.7 billion (USDA Foreign Agricultural Service (FAS), 2022a). Since 1976, beef consumption in the US has experienced a significant decline (Bentley, 2019); however, beef consumption is expected to remain steady in the future (Drouillard, 2018). The static expected US domestic demand for beef underscores the importance of evaluating export markets.

Recognizing the importance of the US beef export market, it is critical to examine the factors influencing international consumer preferences for specific beef attributes and how frequently they consume beef. Examining beef purchase frequency can provide valuable insights into purchasing habits and contribute to demand analysis (Buason, Kristofersson, & Rickertsen, 2020, 2021). Therefore, the goal of this study was to evaluate beef purchase behavior in important and emerging US beef export markets, including Japan, the United Kingdom (UK), Germany, and Mexico. Specifically, the objective of this research was to determine how frequently beef is purchased by international consumers, which characteristics of beef they consider to be important when making purchase decisions (e.g., country of origin, price, traceability), at which outlets they usually purchase beef, and which consumer demographics affect beef purchase frequency.

Understanding the factors affecting international beef demand is critical in developing strategies to expand market opportunities for future US beef demand growth. In 2022, US exports of beef to Japan, Mexico, and the European Union (EU) were $2.3 billion, $968 million,

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and $247 million, respectively (USDA FAS, 2022). Thus, Japan, Mexico, and the EU were the second, fourth and eighth most valued export destinations for US beef, respectively (USDA, 2022). According to the USDA FAS (2022c), beef is an important agricultural export good that has future potential in the UK market. However, the US only exported $3000 worth of beef and beef products to the UK in 2022 (USDA FAS, 2022c). While the US does not currently have a trade agreement with the UK, this could be negotiated once the countries agree on issues such as hormone treated beef (Stacey, 2023; US Meat Export Federation, 2023).

Beginning in 2020, an agreement between the US and Japan became effective that will lower tariffs on US chilled and frozen beef from 38.5% to 9% over 15 years (US Meat Export Federation, 2023). This reduced tariff schedule is expected to increase the competitiveness of US beef exports to Japan. US beef exports to Mexico are tariff-free as covered by the US-Mexico-Canada Trade Agreement (USDA ERS, 2022). In 2019, the US reached an agreement with the EU that will allow the US to export $420 million of beef duty-free by the end of a seven-year period (Office of the US Trade Representative, 2023). Germany is the largest EU market for US beef under the EU import quota for high-quality beef. In 2020, the export of US beef (fresh/chilled and frozen) to Germany was $31.8 million (USDA FAS, 2022d). Thus, to evaluate consumer beef purchasing behavior in important existing and emerging markets for US beef, we focused on Japan, the UK, Germany, and Mexico.

This study adds to existing literature that has examined consumer beef purchase behavior at a global scale including countries such as Canada, Japan, Mexico, the US, China, Spain, France, and Brazil (e.g., Tonsor, Schroeder, Pennings, & Mintert, 2009; Sánchez, Beriain, & Carr, 2012; Henchion, McCarthy, Resconi, & Troy, 2014; Peschel, Grebitus, Colson, & Hu, 2016; Lewis, Grebitus, Colson, & Hu, 2017; Ngapo, Braña Varela, & Rubio Lozano, 2017; Ellies-Oury, Lee, Jacob, & Hocquette, 2019; Parra-Bracamonte, Lopez-Villalobos, Morris, & Vázquez-Armijo, 2020; Magalhaes et al., 2022; Sasaki, Motoyama, Watanabe, & Nakajima, 2022; Gao, Grebitus, & DeLong, 2023; Gao, Grebitus, & DeLong, 2024; Dahal, DeLong, Gao, Grebitus, & Muhammad, 2024). Results of previous research indicate beef production process attributes (e.g., country of origin, organic, grass-fed) and product attributes (e.g., price, brand, quality labels) affect consumer preferences and willingness to pay (WTP) for beef. Most similar to this study is Dahal et al. (2024) who examined factors associated with Chinese consumers' beef purchase frequencies. They found that factors, such as demographics, beef cut, and retail outlet were associated with beef purchase frequencies.

This analysis builds on previous literature by conducting a cross-country study to evaluate drivers of beef purchase frequency in major US beef-importing countries and in potential markets. We focus on beef purchase frequency because beef has a short shelf life; therefore, the difference between purchase frequency and consumption quantity is likely minimal. Research has also postulated that purchase frequencies are a determinant of consumption habits and, thus, demand (Buason et al., 2020, 2021; Dahal et al., 2024). Finally, this study also examines how the beef retail outlet (point of sale) is related to purchase frequency which will expand the literature on how consumer store choice is associated with purchase frequencies (Bhatnagar & Ratchford, 2004).

2. Materials and methods

2.1. Design of the study

We conducted a cross-country study to evaluate the influence of product attributes, production process characteristics, retail outlets, and socio-demographic characteristics on beef purchase behavior among consumers in Japan, the UK, Germany, and Mexico during 2022. Surveys were created for beef consumers in each respective country resulting in four unique, but similar, surveys. The surveys were created with input from various beef industry stakeholders and experts. Based on this input, each survey was slightly varied depending on the uniqueness of each country's beef market. The surveys were all pretested for readability by speakers of each country's respective native language prior to the full survey launch.

The four surveys were coded in the Qualtrics platform and completed by Qualtrics consumer panels in the respective countries. Qualtrics recruited panelists from a variety of sources with the goal of the samples being representative of the general populations within each country. The panelists were also compensated by Qualtrics for taking the survey (Qualtrics, 2024). The survey was administered to consumers in their home country language. Participants had to be 18 years or older, residents of the respective country, and consumers of beef to take the survey. There were 646, 656, 563, and 576 beef consumers in Japan, the UK, Germany, and Mexico who completed the surveys, respectively. The representativeness of the samples was compared to the population averages in each respective country for age and gender (The World Factbook, 2024), household size (ArcGIS Hub, 2024), and educational attainment (The World Bank, 2024a). The surveys were also preregistered (Wharton Credibility Lab, 2024) on aspredicted.org.

2.2. Conceptual framework and ordered probit model

Examination of consumer purchasing habits can provide valuable insights into consumer preferences and contribute to demand analysis (Buason et al., 2020, 2021). Considering that consumers make economic decisions to maximize their level of satisfaction, we assume that they purchase beef more frequently if the beef is produced according to their preferences. Further, we assume that consumers' beef purchase frequency is affected by their socio-demographics and the retail outlet from which they purchase beef (point-of-sale). Thus, we hypothesize that for consumer *i*, in country *j*, their beef purchase frequency (*Beef_Frequency*) is a function of the following factors:

$$Beef\_Frequency_{ij} = f\Big(Product\ Attributes_{ij}, Production\ Attributes_{ij}, Point\ of\ Sale_{ij}, SocioDemographics_{ij}\Big) \quad (1)$$

where *product attributes* are beef attributes consumers consider to be important when purchasing beef (e.g., price, marbling, brand), *production attributes* are production processes consumers consider to be important when purchasing beef (e.g., country of origin, grass-fed production), *point-of-sale* indicates where consumers most often purchase beef, and *socio-demographics* are characteristics of the respondents (e.g., age, household size, education, income). To compare income and education across countries, income and education brackets were created as described in Table 1 and Table 2. Socio-demographics are included as independent variables to examine how differences in consumers' demographics affect beef purchasing behavior. Frequencies of purchasing beef were never, less than monthly, monthly, every other week, weekly, two-to-three times per week and more than three times per week. The complete names and definitions of the variables are found in Table 1.

To analyze factors that affect consumers' beef purchase frequency, we applied an ordered probit model to the data of each country. The ordered probit model is used when survey responses are ordinal, and is an extension of the binary probit model (Daykin & Moffatt, 2002; Fielding, 1999; Greene, 2000). For individual *i*, in country *j*, the ordered probit regression is:

$$y^*_{ij} = \boldsymbol{x}'_{ij}\boldsymbol{\beta} + \varepsilon_{ij} \quad (2)$$

where y^*_{ij} is an unobserved measure of beef purchase frequency, $\boldsymbol{x}_{ij}$ is a measurable factor consisting of the independent variables outlined in Table 1, $\boldsymbol{\beta}$ is a vector of parameters to be estimated, and ε_{ij} is assumed to be normally distributed. Beef purchase frequency has seven categories (1 = *never*, 2 = *less than monthly*, 3 = *monthly*, 4 = *every other week*, 5 = *weekly*, 6 = *two-to-three times a week*, *7* = *more than three times per week*); therefore, we observe that:

Table 1
Description of variables included in the ordered probit regression.

Dependent variable	Description of variables
Beef purchase frequency	How often respondent purchases beef or beef products with 1 = never, 2 = less than monthly, 3 = monthly, 4 = every other week, 5 = weekly, 6 = 2–3 times per week, 7 = >3 times per week
Independent Variables	
Product attributes	
Price	1 if price is considered an important factor when purchasing beef, otherwise 0
Color	1 if color is considered an important factor when purchasing beef, otherwise 0
Traceability	1 if traceability is considered an important factor when purchasing beef, otherwise 0
Marbling	1 if marbling is considered an important factor when purchasing beef, otherwise 0
Brand	1 if brand is considered an important factor when purchasing beef, otherwise 0
Date of expiration	1 if date of expiration is considered an important factor when purchasing beef, otherwise 0
Quality seal	1 if a quality seal is considered an important factor when purchasing beef, otherwise 0
Quality certification	1 if quality certification is considered an important factor when purchasing beef, otherwise 0
Nutrition label	1 if the nutrition label is considered an important factor when purchasing beef, otherwise 0
Production process attributes	
Country of origin	1 if country of origin is considered an important factor when purchasing beef, otherwise 0
Grass-fed	1 if grass-fed is considered an important factor when purchasing beef, otherwise 0
Grain-fed	1 if grain-fed is considered an important factor when purchasing beef, otherwise 0
Organic	1 if organic is considered an important factor when purchasing beef, otherwise 0
Hormone-free	1 if hormone-free is considered an important factor when purchasing beef, otherwise 0
Animal welfare	1 if animal welfare is considered an important factor when purchasing beef, otherwise 0
Point-of-sale	
Supermarket	Consumer purchases beef at supermarket [a]
Butcher	Consumer purchases beef at butcher [a]
Discount store	Consumer purchases beef at discount store [a]
Online	Consumer purchases beef online [a]
Co-op	Consumer purchases beef at co-op [a]
Weekly market	Consumer purchases beef at weekly market [a]
Street Market	Consumer purchases beef at a street market [a]
Socio-demographics	
Age	Age of the respondent in years
Household size	Number of family members in household
Gender	1 if the respondent is female, otherwise 0
Less than high school	Has not passed high school or equivalent to it
High school & some college	Completed high school or equivalent to it and enrolled in college but did not complete
Bachelor's degree	Completed bachelor's degree or equivalent to it
Master's degree or higher	Completed master's degree or equivalent to it, or higher education than a master's degree
Very low income	Indicates income under €20,000 (Germany), ¥300,000 (Japan), £10,000 (the UK), and MXN $7000 (Mexico).
Low income	In Germany, Japan, the UK, and Mexico indicates income between the *very low income* and €50,000, ¥600,000, £25,000, and MXN $13,000.
Modest income	In Germany, Japan, the UK, and Mexico indicates income between the *low income* and €80,000, ¥900,000, £50,000, and MXN $17,000.
High income	In Germany, Japan, the UK, and Mexico indicates income between the *modest income* and €100,000, ¥1,200,000, £75,000, and MXN $21,000.
Very high income	In Germany, Japan, the UK, and Mexico indicates income between the *high income* and €150,000, ¥1,500,000, £105,000, and MXN $25,000.
Extremely high income	In Germany, Japan, the UK, and Mexico indicates income above €150,000, ¥1,500,000, £105,000, and MXN $25,000.

Notes: [a]0 = never, 1 = less than once a year, 2 = once or twice a year, 3 = a few times a year, 4 = monthly, 5 = weekly, and 6 = daily. Income in Mexico is individual-level monthly income, income in Japan is monthly household income, and income in the UK and Germany is annual household income. For Germany, the education level "less than high school" includes Haupt- oder Volksschule and Realschule. The level "high school and some college" includes Gymnasium and Abitur. The level "Bachelor's degree" includes Bachelor, and the level "Master's degree or higher includes Master, Diplom and Ph.D.

$$y_i = \begin{cases} 1 \text{ if } \mu_0 < y_{ij}^* \le \mu_1 \\ 2 \text{ if } \mu_1 < y_{ij}^* \le \mu_2 \\ \quad \cdots \\ 7 \text{ if } \mu_6 < y_{ij}^* \le \mu_7 \end{cases} \tag{3}$$

where the μ's are unknown parameters that are estimated by maximizing the log likelihood function. StataCorp (2023a) explains the probability of each outcome and the StataCorp command *oprobit* was used to estimate eq. (2) (StataCorp, 2023b). A separate ordered probit model was estimated for each country that describes the relationship between the dependent variable (purchase frequency with seven categories) and the independent variables.

To test for the presence of multicollinearity, the StataCorp command *coldiag2* was used to determine condition indexes. If the condition indices of regression analysis variables are lower than 30, then there is no known issue of collinearity (Belsley, 1991). We also conducted unpaired *t*-tests using the *ttest* command in StataCorp to compare the mean values of common variables across all four countries.

3. Results

3.1. Beef purchase patterns

Results regarding the frequency of beef purchases indicate that consumers in Japan, the UK, and Germany most often purchase beef weekly (Fig. 1). In Japan and Germany, this share was 31% and, in the UK, 45% of respondents purchased beef once a week. In Mexico, the highest share of participants (41%) reported purchasing beef two-to-three times per week (Fig. 1), indicating Mexican consumers purchased beef more frequently than the consumers in the other surveyed countries.

Table 2
Survey respondent socio-demographics across the four countries compared to population averages.

	Japan ($n = 646$)		UK ($n = 656$)		Germany ($n = 563$)		Mexico ($n = 576$)	
	Sample	Population	Sample	Population	Sample	Population	Mean	Population
Age (mean)[f]	45.85[a]	49.5	45.52[a]	40.6	46.24[a]	46.7	43.22[b]	30.6
Household size (mean)	2.88[a]	2.3	2.76[a]	2.4	2.21[b]	2.0	4.17[c]	3.6
Gender (% female)	49.85%[a]	51.28%	49.54%[a]	50.25%	48.49%[a]	50.51%	49.83%[a]	51.02%
Education levels (%)								
Less than High school	2.01%		8.23%		43.34%		5.21%	
High school and Some College	33.59%		53.05%		25.58%		36.28%	
Bachelor's Degree	59.44%		26.68%		11.01%		51.91%	
Master's degree or Higher	4.95%		12.04%		20.07%		6.60%	
Wage levels (%)								
Very low income	26.93%		8.54%		17.05%		19.44%	
Low income	35.29%		26.22%		47.60%		25.35%	
Modest income	18.58%		34.6%		21.67%		14.76%	
High income	10.53%		21.65%		7.28%		10.94%	
Very high income	4.18%		5.95%		6.39%		8.68%	
Extremely high income	4.49%		3.05%		0.00%		20.83%	

Notes: [a,b,c] Sample mean values with different superscripts within the same row differ significantly ($P < 0.05$). For example, age is significantly different between Mexican respondents and Japanese respondents at the 5% level of significance. Education and wage level *t*-tests were not conducted due to frequency data being presented and how the wage levels were constructed (see Table 1). [f] The population estimates are the median age. Age and gender population estimates are from The World Factbook (2024). Household size population estimates are from ArcGIS Hub (2024). According to The World Bank (2024a), educational attainment of at least a bachelor's degree or higher of the population over the age of 25 in Japan, the UK, Germany, and Mexico was 25.5%, 37.3%, 28.3%, and 17.1%, respectively. Complete variable definitions appear in Table 1.

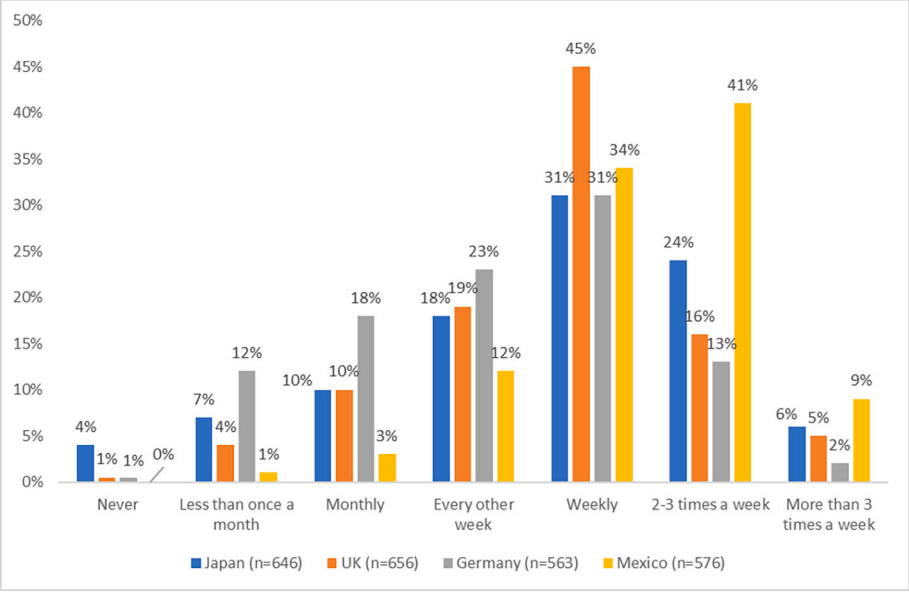

Fig. 1. Beef purchase frequencies in Japan, the UK, Germany, and Mexico.

3.2. Sample socio-demographics

Table 2 provides information regarding the surveyed consumer socio-demographics and their comparison to the population averages across the different countries. German, Japanese, and British respondents were, on average, 46 years old, while Mexican respondents were significantly younger with an average age of 43 years ($P < 0.05$). The samples' average ages were comparable to the population averages across the countries with the exception of Mexican consumers (Table 2). Mexican consumers in our sample were older than the Mexican population average, but this can be partially explained by survey respondents having to be over 18 to take the survey.

The sample average household size in Mexico was the highest among the countries (4.17, $P < 0.05$); the other countries had an average household size of <3 individuals. Average household sizes among our sample were comparable to population averages across the countries (Table 2). Gender among respondents from all countries was evenly distributed with about 50% identifying as female, which is consistent with population averages (Table 2).

Regarding education, in Japan, the UK, and Mexico, over 90% of respondents had at least completed high school. In Germany, only 57% of respondents had completed high school (Table 2). Note that school education differs in the respective countries. In Germany, for example, a three-tier school system exists with 9-, 10- and 12/13-years of school. The 9- and 10-year school education is chosen by those who want to pursue jobs that need a trade school degree. Since this is required for a high share of jobs, the number of those who complete high school might be considered comparatively lower than in other countries. In fact, 43% of the population in Germany falls into the category of no high school degree since 29% of Germans have a Haupt- or Volksschulabschluss (9 years of school education) and 24% have a Realschulabschluss (10 years of school education) (Kurz and Knapp, 2024).

According to The World Bank (2024a), in Japan, the UK, Germany, and Mexico, 25.5%, 37.3%, 28.3%, and 17.1%, of the population over 25 years old have completed at least a bachelor's degree. In comparison, on average in our sample for Japan, the UK, Germany, and Mexico, 64.39%, 38.72%, 31.08%, and 58.51% of respondents have completed at least a bachelor's degree. Thus, for Japan and Mexico our sample is more educated than the population average in these countries. This result can be explained with more educated individuals having access to a computer or smart phone to complete the online surveys (Grebitus, Steiner, & Veeman, 2016). Income levels were unevenly distributed among respondents in each country. For example, in Japan and Germany, approximately 35% of respondents had a "modest" income or higher while in the UK and Mexico, 65% and 55% of respondents had a "modest" income or higher, respectively (Table 2).

The sampled income and education levels varied across country and compared to population averages; therefore, these variables, along with the other demographic variables, were included as independent variables in the models to examine how demographics affected beef purchase frequency. Furthermore, other research using surveys to examine consumer preferences for beef found their samples to be more educated and of higher incomes than population averages, given that respondents were beef eaters and needed a computer or smart phone to complete the survey (Gao et al., 2023; Lin, Ortega, Ufer, Caputo, & Awokuse, 2022).

3.3. Beef product and production process attributes and point-of-sale

Table 3 presents respondents' stated importance of product attributes, production process attributes, and where consumers most often purchase beef (point-of-sale). The majority of respondents across the four countries consider price as an important factor when purchasing beef. Among these countries, the respondents from Mexico (80%) and Japan (79%) place a significantly higher importance on price than consumers from the UK (74%) and Germany (72%) ($P < 0.05$). Mexican respondents consider color (85%), traceability (60%), marbling (65%), and brand (48%) important when purchasing beef, which are significantly higher percentages than consumers in all other countries ($P < 0.05$). Ngapo et al. (2017) also reported that marbling is one of the most important choice criteria for Mexican consumers. Nearly all Mexican consumers (94%) consider the date of expiration as important when purchasing beef, which is a significantly higher percentage of consumers than in all other countries ($P < 0.05$). The highest percentage of respondents who consider a quality seal as important when shopping for beef is found in the UK (61%) and this is significantly higher than for consumers in Japan (46%) and Germany (48%) ($P < 0.05$). Seventy-four percent of Mexicans consider the nutrition label important when shopping for beef and this value is significantly larger than for consumers in other countries (where less than half of respondents consider this to be important) ($P < 0.05$).

In terms of production process attributes, Germany has the highest percentage of respondents (63%) who consider country of origin an important factor when purchasing beef and this is a significantly higher percentage than for respondents in Japan (56%), the UK (52%), and Mexico (35%) ($P < 0.05$). This result could be explained by Mexico importing beef primarily from the US while the other countries import beef from a variety of countries. The highest percentage of respondents who consider grass-fed to be important is found in Mexico (67%), and this percentage is significantly higher than in Germany (48%) and the UK (46%) ($P < 0.05$). Mexican consumers also have the highest percentage of respondents who value grain-fed beef (55%, $P < 0.05$). Mexican consumers place the highest importance on organic beef (59%),

Table 3
Survey respondent descriptive statistics of beef purchase frequency, attributes, and point-of-sale.

	Japan (n = 646)		UK (n = 656)		Germany (n = 563)		Mexico (n = 576)	
Variables	**Mean**	**St. Dev.**	**Mean**	**St. Dev.**	**Mean**	**St. Dev.**	**Mean**	**St. Dev.**
Beef purchase frequency	3.61[a]	1.47	3.74[a]	1.16	3.21[b]	1.29	4.36[c]	1.00
Product attributes								
Price	78.79%[a]	0.41	74.09%[b]	0.44	72.29%[b]	0.45	80.38%[a]	0.40
Color	58.51%[a]	0.49	66.62%[b]	0.47	65.19%[b]	0.48	84.55%[c]	0.36
Traceability	31.89%[a]	0.47	47.56%[b]	0.50	49.91%[b]	0.50	60.07%[c]	0.49
Marbling	44.58%[a]	0.50	37.35%[b]	0.48	52.04%[c]	0.50	65.45%[d]	0.48
Brand	38.08%[a]	0.49	32.62%[b]	0.47	28.24%[b]	0.45	48.09%[c]	0.50
Date of expiration	65.94%[a]	0.47	74.54%[b]	0.44	69.80%[a]	0.46	94.27%[c]	0.23
Quality seal	45.82%[a]	0.50	61.28%[b]	0.49	48.13%[a]	0.50		
Quality certification	59.29%[a]	0.49	62.50%[a]	0.48	53.64%[b]	0.50	28.30%[NA]	0.45
Nutrition label	33.44%[a]	0.47	45.88%[b]	0.50	38.19%[a]	0.49	74.13%[c]	0.44
Production process attributes								
Country of origin	55.57%[a]	0.50	52.44%[a]	0.50	63.41%[b]	0.48	35.07%[c]	0.48
Grass-fed			46.34%[a]	0.50	47.78%[a]	0.50	66.67%[b]	0.47
Grain-fed	29.88%[a]	0.46	34.60%[a]	0.48	35.70%[a]	0.48	54.69%[b]	0.50
Organic	28.95%[a]	0.45	31.55%[a]	0.47	42.45%[b]	0.49	58.68%[c]	0.49
Hormone-free	46.28%[a]	0.50	60.37%[b]	0.49	66.79%[c]	0.47	82.47%[d]	0.38
Animal welfare	32.20%[a]	0.47	62.20%[b]	0.49	67.50%[b]	0.47	81.42%[c]	0.39
Point-of-sale								
Supermarket[e]	3.90[a]	1.59	4.40[b]	1.13	3.90[a]	1.45	4.12[c]	1.45
Butcher[e]	1.55[a]	1.85	2.33[b]	1.95	2.59[c]	1.90	4.38[d]	1.35
Discount store[e]	1.20[a]	1.84	1.90[b]	2.11	3.05[c]	2.01		
Online[e]	0.99[a]	1.62	1.33[b]	1.93	0.63[c]	1.42		
Co-op[e]	1.27	1.94						
Weekly market[e]					1.35	1.80		
Street market[e]							2.39	2.22

Notes: [a,b,c,d] In each country, sample mean values with different superscripts within the same row differ significantly ($P < 0.05$). For example, marbling is significantly different across all the countries ($P < 0.05$). [e] 0 = never, 1 = less than once a year, 2 = once or twice a year, 3 = a few times a year, 4 = monthly, 5 = weekly, and 6 = daily. [NA] In Mexico, "quality certification" appeared as "premium quality" so it was not compared with t-tests to the other countries. Blank entries indicate the question was not asked in that particular country. St. Dev. is standard deviation. Complete variable definitions appear in Table 1.

and this is significantly higher than for consumers in Germany (42%), the UK (32%), and Japan (29%) ($P < 0.05$). The importance of hormone-free production significantly varied across consumers in all countries ($P < 0.05$). The highest percentage of consumers considering hormone-free beef to be important is found in Mexico (82%), followed by Germany (67%), the UK (60%), and Japan (46%). Finally, Mexico has the highest percentage (81%) of respondents who value animal welfare when purchasing beef, followed by Germany (68%), the UK (62%), and Japan (32%) ($P < 0.05$).

In terms of point-of-sale, on average, respondents from Japan, the UK, Germany, and Mexico purchase beef from supermarkets (Table 3). Consumers from the UK purchase beef at supermarkets significantly more frequently than consumers in the other studied countries ($P < 0.05$). On average, respondents from Mexico most frequently purchase beef from the butcher and at a significantly higher frequency than consumers from all other studied countries ($P < 0.05$). German consumers shop for beef at discount stores more frequently than consumers in Japan and the UK ($P < 0.05$).

3.4. Factors affecting beef purchases in Japan, the UK, Germany, and Mexico

The ordered probit regressions for Japan, the UK, Germany, and Mexico are presented in Table 4. The model's pseudo-R^2 values were 0.1611, 0.1695, 0.1839, and 0.0887 for Japan, the UK, Germany, and Mexico, respectively. The Wald chi-square statistic ($P < 0.001$) was significant for all estimated ordered probit regressions. The multicollinearity diagnostics showed that the Condition Indices of all the variables in the model are below 30, indicating the absence of significant multicollinearity.[1]

With respect to product attributes, results indicate Japanese consumers who consider price to be an important factor when purchasing beef are less likely to purchase beef frequently ($P < 0.05$). German and British consumers who consider color to be important when purchasing beef are more likely to purchase beef frequently ($P < 0.10$). Germans who consider brand to be important are more likely to purchase beef frequently ($P < 0.05$). Japanese respondents who regard expiration dates and quality certification to be important factors are more likely to buy beef frequently ($P < 0.10$) (Table 4). Germans who view nutritional labels to be important are less likely to purchase beef frequently ($P < 0.05$).

With respect to production process attributes, Mexican consumers who consider grass-fed production to be important are less likely to purchase it frequently ($P < 0.05$). In the UK, consumers who view grain-fed beef to be important are more likely to purchase beef frequently ($P < 0.10$). In Germany, consumers who consider organic to be an important beef production attribute are less likely to buy beef frequently ($P < 0.1$). British consumers who consider hormone-free production to be important are less likely to buy beef frequently ($P < 0.05$). However, Mexican consumers who consider hormone-free production to be important are more likely to purchase beef more frequently ($P < 0.10$).

With respect to point-of-sale, consumers who purchase beef from supermarkets and butcher shops are more likely to purchase beef more frequently in all four countries ($P < 0.01$). Japanese consumers who purchase beef from cooperatives (co-ops), British consumers who purchase from discount stores and online stores, and German consumers who purchase from discount stores are more likely to purchase beef frequently ($P < 0.01$ for cooperatives and discount stores, and $P < 0.05$ for online stores).

In terms of socio-demographics, female consumers from Germany and Japan, and older consumers from Germany and Mexico, have a lower probability of purchasing beef frequently ($P < 0.01$). German consumers with larger households are more likely to purchase beef more frequently. Consumers with a bachelor's degree (as opposed to less than high school education) in Germany ($P < 0.10$) and with a master's or higher academic degree (as opposed to less than high school education) in the UK ($P < 0.05$), are more likely to purchase beef frequently. Mexican consumers with extremely high-income levels, compared to very low-income levels, are more likely to purchase beef frequently ($P < 0.10$).

4. Discussion

Results indicate there is heterogeneity among respondents from different countries regarding their beef purchase frequencies and preferences for different beef attributes. Consumers across the studied countries typically purchase beef at least weekly with purchase patterns being similar in Japan, the UK, and Germany. Mexican consumers purchase beef most frequently with over 50% of purchases occurring two-to-three times a week or more than three times a week. Consumers across the studied countries consider many product and production process attributes as important when purchasing beef. Mexican consumers consider many attributes as more important than consumers in the other more developed countries, which could be considered somewhat surprising since Mexico is a lower-income country compared to the other studied countries (The World Bank, 2024b). However, Miranda-de La Lama et al. (2017) also reported that Mexican consumers were interested in animal welfare, and they showed a high level of empathy with animal feelings and emotions.

The finding that Japanese consumers, who consider price to be important, areless likely to purchase beef frequently could be due to Japan's relatively high cost for beef (Motoyama, Sasaki, & Watanabe, 2016). Magalhaes et al. (2022) also observed that extrinsic quality cues, such as price, influenced beef consumption and purchase decisions in Spain and Brazil. Price has also been found to be a primary consideration for beef purchasers in Brazil (Giacomazzi, Talamini, & Kindlein, 2017).

Respondents from the UK and Germany, who considered color to be important, are more likely to purchase beef frequently which is similar to Acebrón and Dopico (2000), who discovered that color is an essential intrinsic quality cue. According to Grebitus, Jensen, and Roosen (2013) and Grebitus, Jensen, Roosen, and Sebranek (2013) color is an important factor when making meat choices. Consumers especially prefer light red and cherry red beef color and associate brownish red beef color with spoilage. The finding that brand importance in Germany is related to an increased probability of more frequent beef purchases aligns with previous research that highlighted consumers' perception of brands as an indicator of safety and quality at the point of sale (e.g., Giacomazzi et al., 2017).

In Japan, expiration date importance is associated with an increased likelihood of beef purchase frequency. This is similar to research by Erikson et al. (1998), which highlighted the significance of the expiration date as one of the critical attributes Japanese beef consumers consider when making purchase decisions. Somewhat similar, Lyford et al. (2010) also found Japanese consumers have a higher willingness to pay for quality beef compared to consumers in the US, Australia, and Ireland, and quality beef is likely associated with fresher beef.

Organic beef labels are considered important among European consumers because they perceive organic as a proxy for food safety, quality, high animal welfare standards, and environmental issues (e.g., Cubero Dudinskaya et al., 2021). However, it was found that Germans who consider organic to be important are less likely to purchase it frequently. Thus, frequent beef shoppers in Germany may be indifferent to organic production. Meanwhile, German consumers who consider country of origin important when shopping for beef are more likely to purchase it frequently. Research has also found that consumers in Europe highly value country of origin information (Cubero Dudinskaya et al., 2021). Thus, this appears to be a label of value to frequent beef consumers in Germany. However, nutrition label importance has a negative

[1] The estimated condition indices were 13.59, 16.35, 16.75, and 19.08 for Germany, Japan, the UK, and Mexico, respectively.

Table 4
Ordered probit regression results for consumers from Japan, the UK, Germany, and Mexico.

	Japan (n = 646)		UK (n = 656)		Germany (n = 563)		Mexico (n = 576)	
Variables	**Coeff**	**SEM**	**Coeff**	**SEM**	**Coeff**	**SEM**	**Coeff**	**SEM**
Product attributes								
Price	−0.243**	0.110	−0.025	0.102	−0.051	0.112	0.042	0.116
Color	−0.012	0.103	0.184*	0.105	0.179*	0.106	−0.096	0.136
Traceability	−0.003	0.121	−0.027	0.109	0.024	0.124	−0.093	0.119
Marbling	−0.031	0.102	−0.043	0.100	0.086	0.106	0.047	0.111
Brand	0.172	0.118	0.056	0.107	0.276**	0.126	0.024	0.106
Date of expiration	0.166*	0.099	−0.079	0.112	−0.148	0.108	0.030	0.211
Quality seal	0.126	0.116	0.152	0.115	−0.026	0.128		
Quality certification[y]	0.195*	0.108	−0.126	0.122	0.163	0.129	0.12	0.112
Nutrition label	0.035	0.121	−0.112	0.109	−0.282**	0.124	−0.11	0.124
Production process attributes								
Country of origin	0.010	0.107	−0.032	0.100	0.192*	0.112	0.012	0.101
Grass-fed			0.131	0.118	0.003	0.128	−0.236**	0.120
Grain-fed	0.065	0.132	0.210*	0.119	−0.02	0.123	0.134	0.112
Organic	0.111	0.140	−0.115	0.109	−0.217*	0.118	0.009	0.113
Hormone-free	0.013	0.108	−0.267**	0.107	0.137	0.122	0.262*	0.138
Animal welfare	−0.128	0.137	−0.140	0.112	0.006	0.123	0.134	0.134
Point-of-sale								
Supermarket	0.339***	0.032	0.470***	0.042	0.275***	0.036	0.189***	0.034
Butcher	0.142***	0.035	0.098***	0.028	0.168***	0.031	0.265***	0.038
Discount store	0.008	0.034	0.144***	0.024	0.093***	0.027		
Online	−0.010	0.042	0.062**	0.025	0.048	0.042		
Co-op	0.087***	0.030						
Weekly market					0.082**	0.037		
Street market							0.052**	0.023
Socio-demographics								
Gender (female)	−0.314***	0.093	−0.108	0.090	−0.368***	0.096	−0.108	0.108
Age	−0.004	0.003	−0.002	0.003	−0.010***	0.003	−0.012***	0.004
Household size	0.010	0.022	0.039	0.031	0.174***	0.044	−0.009	0.012
High school and some college	0.027	0.306	0.164	0.163	0.109	0.119	0.055	0.213
Bachelor's degree	−0.040	0.302	0.181	0.178	0.278*	0.161	0.007	0.213
Master's degree and higher	−0.116	0.354	0.479**	0.210	0.010	0.133	0.156	0.275
Low income	−0.005	0.109	−0.079	0.171	−0.011	0.131	−0.033	0.140
Modest income	0.028	0.134	−0.002	0.167	−0.165	0.157	0.136	0.159
High income	−0.006	0.161	0.124	0.180	−0.122	0.214	0.052	0.176
Very high income	0.122	0.235	0.012	0.245	−0.214	0.228	0.087	0.191
Extremely high income	0.200	0.236	−0.321	0.302			0.284*	0.156

Note: ***, **, and * reflect 1%, 5%, and 10% level of significance. SEM = standard error mean and coeff = coefficients. [y] In Mexico, "quality certification" appeared as "premium quality". Blank entries indicate the variable was not obtained in the survey for the respective country. The "less than high school" category was dropped from the model so the other education categories are compared to it. The "very low income" category was dropped from the model so the other income categories are compared to it.

relationship with purchase frequency in Germany.

Results show that there is heterogeneity in preferences for hormone-free production across countries. Only in the UK are consumers who consider hormone-free production to be important less likely to purchase beef frequently. Meanwhile, we did not find this variable to affect beef purchase frequency in Germany despite the EU currently having a ban on hormone-treated beef (Congressional Research Service, 2024). Only 67% of Germans considered hormone-free beef production important when purchasing beef (Table 3), which, while a majority, still indicates at least a third of consumers might be willing to consume hormone-treated beef. Tonsor, Schroeder, Fox, and Biere (2005) also found that beef consumers have shown heterogeneity in preferences for hormone-free beef. Lusk, Roosen, and Fox (2003) found that British consumers did not assign a significantly higher value to hormone-free beef compared to French consumers. However, Alanís et al. (2022) found that Mexican consumers highly prefer hormone-free meat. We found that Mexican consumers who consider hormone-free production to be important are more likely to purchase beef frequently.

UK consumers who consider grain-fed beef as important have a higher likelihood of frequently purchasing beef while Mexican consumers who value grass-fed beef are more likely to have a lower beef purchase frequency. This may be attributed to the higher price of grass-fed beef compared to grain-fed beef (Owens, 2021). In this regard, Parra-Bracamonte et al. (2020) found that beef consumers in Mexico are particularly price-conscious, which could explain the reduced purchase frequency associated with grass-fed beef if it is more expensive.

In Mexico, extremely high-income individuals are more likely to purchase beef frequently. Zhu, Chen, Zhao, and Wu (2021) also found that higher-income individuals are more likely to purchase beef more frequently. The findings that older individuals and females are less likely to purchase beef frequently are consistent with previous studies that also reported older individuals and females as having a decreased beef purchase frequency (Giacomazzi et al., 2017; Lui, Parton, & Cox, 2006). Respondents from Germany with larger households are more likely to have a higher purchase frequency. Those results align with the findings of Xue, Mainville, You, and Nayga (2010), who found that household

size correlates with a higher willingness to pay for grass-fed beef. On the other hand, Lui et al. (2006) found a negative relationship between family size and higher purchase frequency. They observed that more men in the family led to a higher purchase frequency. Respondents who purchase beef from supermarkets are more likely to purchase beef more frequently. Dahal et al. (2024) and Lui et al. (2006) also found that consumers who purchase from supermarkets tend to buy beef more often.

5. Conclusion

This study aimed to understand drivers of beef purchase frequency among consumers in Japan, the UK, Germany, and Mexico. Given that these countries represent both existing and emerging markets for US beef, and considering the changing beef consumption patterns observed in some of these countries (Organisation for Economic Co-operation and Development (OECD), 2023; Euromeat, 2022), this study offers insights for improving marketing strategies for beef exporters. Moreover, this study holds the potential to benefit domestic beef producers in these countries, enabling them to align their production with beef attributes that domestic consumers prefer, and catering to their purchase patterns. In sum, our findings provide information regarding consumer beef purchasing behavior in countries in Asia, North America, and Europe.

It is worth noting that this study examined purchase frequencies instead of consumption frequencies. However, given that beef is a perishable item, it is likely that beef purchase frequencies are highly correlated with actual beef consumption. It should also be mentioned that we asked consumers about their beef purchase frequency and their preferences for beef attributes in general, and not by cut. Therefore, results would likely differ by specific beef cut. This is a limitation of our research that future research could further examine.

Recognizing the varying factors influencing beef shopping behavior in Japan, the UK, Germany, and Mexico is important for marketing beef efficiently and effectively. For instance, tailored marketing campaigns could highlight product and production process attributes that are highly valued by each country's consumers. Further, information from this study is also important for retail outlets to understand expected beef purchase frequencies of consumers. Information from this study has implications for policymakers and beef industry stakeholders seeking to optimize US beef marketing strategies in export markets.

Author statement

Informed consent was obtained for the surveys. Data involving human subjects was not identifiable to individuals and was only used in aggregate form.

CRediT authorship contribution statement

Bhishma R. Dahal: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology, Formal analysis, Data curation, Conceptualization. **Karen L. DeLong:** Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Shijun Gao:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Carola Grebitus:** Writing – review & editing, Writing – original draft, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization.

Declaration of competing interest

None for all authors.

Data availability

Data will be made available on request.

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