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BEEF COLOR PREFERENCES AMONG U.S. AND GERMAN BEEF CONSUMERS

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I. INTRODUCTION

As part of a more sustainable food system, the Sustainable Development Goal (SDGs) 12.3 aims to halve per capita global food waste by 2030 [1]. In this context, perishable and resource-intensive food products, such as beef, require particular attention. Food choice behavior is influenced by product color (e.g., [2]), while color preference is influenced by culture [3]; therefore, recognizing consumer preferences for beef (dis)coloration is crucial to ensuring the timely marketing of beef products and mitigate food waste. This study aims to quantify and compare U.S. and German color preferences and necessary discounts to avoid waste for beef throughout fresh beef's shelf-life; thus offering valuable insights into U.S. and German consumer preferences of beef color, enabling retailers and policymakers to come up with targeted strategies to minimize beef waste.

II. MATERIALS AND METHODS

A consumer survey including a discrete choice experiment (DCE) was completed using Qualtrics by of 297 U.S. consumers between June and August 2023 [4] and 60 consumers in Germany during a pre-test in January 2025. Digital photos included in the DCE of a beef strip loin steak (*longissimus lumborum*) were taken at 0, 4, 7, and 9 days of storage at 3°C in retail packaging, and under constant fluorescent light (Figure 1; [4]).



Figure 1. Beef steak photos used in discrete choice experiment with associated computer vision color measurements

Three product attributes: 1) beef color, 2) price, and 3) discount sticker were included as attributes in the DCE (Table 1). A D-optimal design with 12 choice sets was created using Ngene (Choicemetrics, Version 1.1), featuring two product alternatives and an opt-out option ("I choose neither of these alternatives"). To encourage realistic decisions, respondents were instructed to consider their actual budgets and informed that all beef steaks had not expired.

Table 1 - Attributes of beef (color, price, and discount) and associated levels considered in the Discrete Choice Experiment.

Attribute	Attribute level applied in the U.S.	Attribute level applied in Germany
Beef steak color	Color at day 0 of retail display	Color at day 0 of retail display
	Color at day 4 of retail display	Color at day 4 of retail display
	Color at day 7 of retail display	Color at day 7 of retail display
	Color day at 9 of retail display	Color day at 9 of retail display
Price*	$12.99/lb.	18.99 €/kg
	$14.99/lb.	20.99 €/kg
	$16.99/lb.	22.99 €/kg
	$18.99/lb.	24.99 €/kg
Discount sticker (total savings per steak)	30% off price per kg	30% off price per kg
	No discount	No discount

*prices are based on inventory analysis in each respective market prior to the start of each respective surveying period

III. RESULTS AND DISCUSSION

Table 2 presents consumer WTP in preference space based on multinomial logit models of DCE data for U.S. and German consumer samples. On average, WTP was negative for all retail display durations and declined as discoloration increased. For a steak that had been on display for four days, U.S. respondents were willing to pay $5.09 per pound less compared to a freshly displayed steak (0 days).

Table 2 – Willingness to pay (WTP) for different days of retail display based on multinomial logit model estimates

Variable	U.S. total sample n=297			German total sample n=60		
	WTP (U.S.$)	Lower bound	Upper bound	WTP (€)	Lower bound	Upper bound
4 days of retail display	-5.08	-6.65	-3.52	-3.39	-9.35	-2.56
7 days of color display	-9.89	-12.21	-7.58	-18.09	-30.50	-5.67
9 days of retail display	-20.05	-24.74	-15.28	-38.75	-66.43	-11.06

Note: Zero days of retail display were used as reference levels to determine WTP.

Similar to the U.S. sample, WTP was negative for all days of retail display; German beef consumers were willing to pay €3.39 per kg less for a steak with four days of retail display compared to a fresh (0 day) light cherry-red colored steak. For both the U.S. and German consumer samples, WTP continued to decline with longer display times, reaching their lowest points at 9 days of in-store display. Nine (9) days of retail display corresponded to negative WTP beneath price zero. German consumers had proportionally to market inventory prices lower WTP for 7 and 9 days of retail display discolored beef steaks compared to U.S. consumers, yet were more tolerant of steaks displayed only for 4 days. This could imply that German consumers are less willing to accept discoloration, compared to U.S. consumers. Yet, this could also mean that German retailers have a longer window (between 4 & 7 days) to sell beef products at higher products, but once products have discolored a large (nearing 100%) discount is necessary to move products off the shelves. Such sensitivity to discoloration could make food waste prevention in a retail setting difficult to implement in Germany compared to the U.S. [4]. Further research on consumer perceptions across cultures linking meat color and food waste is needed to understand how consumers could be convinced to purchase discolored high-resource agricultural products, such as beef, to meet SDGs and create current-day sustainable food systems.

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