



## Comparing Honduran and United States Consumers' Sensory Perceptions of Honduran and U.S. Beef Loin Steaks

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**Abstract:** The objective of this study was to compare the eating quality characteristics of beef from the United States and Honduras and to assess the willingness of Honduran and U.S. consumers to pay for these products. All U.S. sourced strip loins from grain-finished cattle, aged 21 d, were selected to equally represent USDA Select (SEL;  $n = 6$ ) and upper 2/3 (Top) Choice (TC;  $n = 6$ ) quality grades. Additionally, strip loins ( $n = 6$ ) from Honduran grass-finished (HGRASS) cattle and grain-finished (HGRAIN) cattle ( $n = 6$ ) were collected from a commercial abattoir in Siguatepeque, Honduras and aged 21 d. Samples were evaluated on 8-point hedonic scales for flavor, tenderness, juiciness, and overall liking by 240 consumers in each country. Consumers indicated if each trait was acceptable, and willingness to pay for each sample was rated in U.S. dollars (or the Honduran Lempiras equivalent): \$0, 3, 6, and 10 per 0.45 kg. Chemical composition and Warner-Bratzler shear force (WBSF) were also determined. The TC had greater ( $P < 0.05$ ) fat percentage than SEL and HGRASS, but did not differ ( $P > 0.05$ ) from HGRAIN. The HGRAIN had greater WBSF values than TC and SEL, which did not differ ( $P > 0.05$ ); however, HGRASS was similar ( $P > 0.05$ ) to all other treatments. The TC had greater tenderness and flavor liking scores ( $P < 0.05$ ) than all other treatments, followed by SEL, HGRASS, and HGRAIN, with a significant difference between each treatment. Honduran consumers assigned greater ratings for tenderness and flavor liking when compared to U.S. consumers. The lowest rated treatment in both countries was Honduran grain-finished followed by Honduran grass-finished. Consumers in Honduras were willing to pay more for samples when compared to U.S. consumers. Consumers were also willing to pay a premium for products with greater palatability, regardless of the country of origin.

**Keywords:** beef, consumer, country of origin, diet, palatability

*Meat and Muscle Biology* 2(1):233–241 (2018)

doi:10.22175/mmb2018.03.0003

Submitted 29 Mar. 2018

Accepted 12 July 2018

## Introduction

Cattle production systems in Central America fall into three main classifications: beef production, milk production, and dual purpose, with native grass pasture serving as the main source of feed (Canu et al., 2018; French, 1994). *Bos indicus* breeds are predominant for meat production in this region, namely because of their genetic potential for productivity, hardiness, and tolerance to adverse environmental conditions, such as heat, humidity, parasites, low quality feed resources, and low feed availability (Toledo, 1994). However, *Bos indicus* cattle have notable issues with beef ten-

derness compared to *Bos taurus* breeds (Lage et al., 2012; Pereira et al., 2014; Shackelford et al., 1995; Wheeler et al., 1994; Whipple et al., 1990).

In 2015, the United States led all world markets in beef production, but also imported more beef than any other country (USDA Foreign Agricultural Service, 2016). The majority of these imports came from Australia, Canada, New Zealand, Mexico, and Uruguay, where production systems can differ greatly from the U.S. (USDA Foreign Agricultural Service, 2016). Honduras is one of a few countries that are eligible to ship fresh or frozen beef to the United States and has preferential tariff rate quotas in accordance

with the 2004 Dominican Republic-Central American Free Trade Agreement (CAFTA-DR). In 2015, U.S. beef imports from Honduras totaled 1,140 metric tons and were valued at \$6 million (USDA Foreign Agricultural Service, 2016). Conversely, red meat exports, which included pork, from the U.S. into Honduras, totaled \$55 million in 2016 and have become crucial to fill consumer demand, which revolves around beef cuts and prime pork as the number of U.S. restaurants and franchises in Honduras continues to grow (USDC International Trade Administration, 2017).

Commonly in the United States, cattle are finished on high energy diets resulting in greater fat deposition, which fosters consumer satisfaction; however, in many Central American countries, such as Honduras, cattle are finished on pasture (Canu et al., 2018). Due to the success of U.S. beef in international markets, some countries have tried to adapt their production systems to produce beef similar in quality and composition to U.S. beef. Currently, however, there are no data describing consumer (Honduran or U.S.) perception of grain-finished U.S. beef compared to Honduran beef. The objective of this study was to characterize the palatability of beef from the United States compared to Honduras according to both Honduran and U.S. consumers, and to assess the willingness to pay for these products in both countries.

## Materials and Methods

### *Product collection and sample preparation*

Four treatments were used for this study, which included U.S. sourced strip loins that were procured from local supermarkets in Lubbock, TX from grain-finished cattle (no labeling claims for grass-fed), aged 21 d postmortem, which were selected to equally represent Select (USDA Select;  $n = 6$ ) and Top Choice (upper 2/3 USDA Choice;  $n = 6$ ) quality grades (USDA, 1997). Additionally, strip loins ( $n = 6$ ) representing traditional Honduran grass-finished *Bos indicus* cattle were procured from a commercial abattoir in Siguatepeque, Honduras, vacuum packaged, and aged 21 d postmortem. Since they were procured from a commercial abattoir, exact breed type and animal age was unknown. However, Brahman is the predominant breed for meat production in this region. The traditional Honduran extensive grazing system consists of native grass (*Hyparrhenia rufa*) and improved grasses (*Panicum maximum*, *Cynodon plectostachyus*, *Digitaria swazilandensis*, *Brachiaria decumbens*, and *Brachiaria brizantha*) until cattle are approximately

3 yr of age when they reach approximately 408 kg. In addition, the manager of the cattle department at the commercial abattoir identified cattle, which were known to be finished at a regional feedlot, which supplements cattle diets with sorghum and corn. Cattle feeding practices in Honduras are not standardized with well-defined phases (backgrounding or finishing) so it is possible and probable grain-finished cattle were grazing prior to their entry into a feedlot; however, animal age and dietary background is unknown prior to feedlot entry. Cattle typically enter feedlots in Honduras weighing 360 to 410 kg and remain in feedlots until reaching weights of approximately 500 to 550 kg. Therefore, feedlot entry weight of grain-fed cattle is often similar to finished weight of grass-fed cattle, so it is possible that grain-fed cattle were older animals. Strip loins ( $n = 6$ ) from grain-finished cattle were procured from the same commercial abattoir in Siguatepeque, Honduras, vacuum packaged, and aged 21 d postmortem. Treatments from this study were referred to as: USDA Top Choice (TC), USDA Select (SEL), Honduran grass-fed (HGRASS) and Honduran grain-fed (HGRAIN). Subprimals were fabricated into 2.5 cm steaks at 21 d postmortem, individually packaged, and frozen (0°C) until further analysis. From each subprimal, the anterior-most steak was assigned to proximate analysis, followed immediately by a steak for Warner-Bratzler shear force (WBSF) evaluation. All remaining 2.5-cm thick steaks were designated for consumer panel evaluations and were labeled with subprimal identification and steak position. Any steaks destined to be tested in the country other than where collection took place, including all Honduran steaks destined for shear force and compositional analyses, were shipped via commercial air in a frozen state (0°C), and were stored frozen on arrival until further testing.

### *Proximate analysis*

Proximate analysis was conducted using an AOAC-approved (Anderson, 2007) near infrared spectrophotometer (FOSS FoodScan 78800; Dedicated Analytical Solutions, Hilleroed, Denmark). This method was used to determine chemical values of fat, protein, and moisture. Samples were thawed at 2 to 4°C for 24 h prior to analysis. All external fat, connective tissue, and secondary muscles were trimmed from each steak leaving only the *longissimus lumborum*. Each sample was finely ground through a commercial food grinder (Krupps 150-Watt Meat Grinder item #402-70, Krups, Shelton, CT) to obtain a 200-g sample from each steak.

### **Warner-Bratzler Shear Force evaluation**

Objective tenderness measures were obtained by utilizing a WBSF analyzer (G-R Elec. Mfg., Manhattan, KS). Steaks from each subprimal were thawed for 24 h at 2 to 5°C. Prior to analysis, steaks were trimmed of external fat and cooked on grated, non-stick electric clam shell grills (George Foreman, Wilkes Barre, PA) to an internal temperature of 77°C to obtain a well-done degree of doneness. This temperature was chosen because consumers in Central America prefer steaks cooked to a well-done degree of doneness (McDonald, 2009).

Temperature was monitored using a thermocouple probe (Type J, Cole Parmer, Vernon Hills, IL) attached to a thermometer (Digi-Sense; Cole Parmer). After cooling for 24h at 2°C, six 1.3-cm cores were removed from each steak parallel to the orientation of the muscle fibers. The 6 cores were sheared, recording peak shear force (kg) for each core, which were averaged to obtain 1 value for each steak to be used for statistical analysis.

### **Consumer sensory assessment**

The Texas Tech University Institutional Review Board approved procedures for use of human subjects for consumer panel evaluation of sensory attributes in both Honduras (Proposal # 504078) and the United States (Proposal # 504351).

Honduran panels were conducted at the annual Pan-American Celebration Fair at Zamorano University in Tegucigalpa, Honduras. Consumers ( $n = 240$ ) were recruited verbally in Spanish with a predetermined speech describing the study. A booth was set during the fair specifically for consumer sensory evaluation of this study. Consumer testing in Honduras was arranged in 24 sessions, each consisting of 10 panelists. Consumer testing in United States was conducted at Texas Tech University, where consumers ( $n = 240$ ) were recruited from Lubbock, TX and surrounding communities. Panelists were monetarily compensated for their participation in the United States only. Each session consisted of 20 panelists. Four sessions were conducted per day over the course of 3 d. In both locations, each session consisted of consumers evaluating each of the 4 treatments, which were presented in a predetermined arrangement.

Sample preparation for both locations (Honduras and U.S.) was identical; steaks were thawed at 2 to 4°C prior to sensory evaluation. Samples were cooked on grated, non-stick electric clam shell grills (George Foreman, Wilkes Barre, PA) to an internal temperature of 77°C to obtain a well-done degree of doneness where temperature was monitored using a thermocouple probe (Type J, Cole Parmer, Vernon Hills, IL) attached to a

thermometer (Digi-Sense; Cole Parmer). This temperature was chosen because consumers in Central America prefer steaks cooked to a well-done degree of doneness (McDonald, 2009). Each consumer was presented with 4 samples at once representing the 4 treatments. Samples were served on a white 10" × 14" rectangular Styrofoam tray. The location where each sample was to be placed on the tray was hand labeled with a numeric code, which was linked to the identification on the paper ballot. Participants were asked to evaluate tenderness (1 = extremely tough, 2 = very tough, 3 = moderately tough, 4 = slightly tough, 5 = slightly tender, 6 = moderately tender, 7 = very tender, 8 = extremely tender), juiciness (1 = extremely dry, 2 = very dry, 3 = moderately dry, 4 = slightly dry, 5 = slightly juicy, 6 = moderately juicy, 7 = very juicy, 8 = extremely juicy), flavor liking (1 = extremely dislike flavor, 2 = very much dislike flavor, 3 = moderately dislike flavor, 4 = slightly dislike flavor, 5 = slightly like flavor, 6 = moderately like flavor, 7 = very much like flavor, 8 = extremely like flavor), and overall liking (1 = extremely dislike overall, 2 = very much dislike overall, 3 = moderately dislike overall, 4 = slightly dislike overall, 5 = slightly like overall, 6 = moderately like overall, 7 = very much like overall, 8 = extremely like overall) for 4 samples. In addition, participants indicated if each palatability trait (tenderness, juiciness, flavor, and overall liking) was acceptable by checking yes or no. Also, willingness to pay for each sample was rated as either \$0, 3, 6, 10 (U.S. dollars) per 0.45 kg. For Honduran panels, willingness to pay was presented in Honduran currency equivalent to U.S. dollars.

### **Statistical analysis**

All statistical tests were conducted in SAS (Version 9.3; SAS Inst. Inc., Cary, NC). Proximate and consumer data were analyzed using the GLIMMIX procedure and were analyzed as a 2 × 4 factorial design representing the two feeding countries and four treatments. The model for consumer rating data included the fixed effects of country and treatment and the random effect of session. Tenderness, juiciness, flavor liking, and overall acceptability were analyzed as binomial proportions using the GLIMMIX procedure of SAS. Proximate data were analyzed with a model that included the fixed effect of treatment. For all analyses, denominator degrees of freedom were calculated using the Kenward-Roger approximation. Demographic data was summarized using the PROC FREQ procedure. For all tests, the PDIF option was used to compare treatment least squares means when the F-test for the main effects or the interaction of factors was significant ( $P < 0.05$ ).

## Results and Discussion

### Proximate analysis and WBSF

Results for proximate analysis are shown in Table 1. Each component (protein, fat, and moisture) was influenced by treatment ( $P < 0.01$ ). The HGRAIN beef samples had greater ( $P < 0.05$ ) protein compared to all other treatments; however, no differences ( $P > 0.05$ ) were observed in protein levels between TC, SEL, and HGRASS. Although protein normally remains constant with fluctuation between fat and moisture, if HGRAIN cattle were indeed older animals than all other treatments, it is possible that accumulation of sarcoplasmic and stromal proteins caused an increase in total protein in comparison to other treatments. The TC had greater ( $P < 0.05$ ) fat percentage than SEL and HGRASS, but did not differ ( $P > 0.05$ ) from HGRAIN. The TC had similar fat percentage to previously reported values by authors comparing top loin from various USDA quality grades; however, SEL was slightly higher than previously reported values (Corbin et al., 2015; Hunt et al., 2014; O'Quinn et al., 2012). An inverse relationship was observed between fat and moisture, which is a common finding in beef top loin (Corbin et al., 2015; Hunt et al., 2014; O'Quinn et al., 2012).

Results from Warner-Bratzler shear force can also be found in Table 1. The HGRAIN had greater WBSF values than TC and SEL, which did not differ ( $P > 0.05$ ); however, HGRASS was similar ( $P > 0.05$ ) to all other treatments. It is important to note that most cattle fed in Honduras are strongly influenced with *Bos indicus* genetics. These results are consistent with findings by Whipple et al. (1990), who showed that meat from *Bos indicus* crosses, containing similar marbling levels as *Bos taurus* crosses, had less tender meat. Although WBSF of HGRASS was not significantly different from TC or

SEL, the average WBSF difference between HRASS and TC or SEL was 1.41 kg and 0.99 kg, respectively. The average consumer can detect a 0.5-kg difference in WBSF when consuming meat at home (Miller et al., 1995), indicating despite lack of statistical difference, these samples could differ in tenderness according to consumers. The greater WBSF values (either numerical or statistical) of Honduran beef loins steaks can probably be attributed to differences in animal age, as Honduran cattle were likely over 3 yr of age, regardless of treatment. However, age and carcass maturity were not available for any of the treatments to confirm this hypothesis.

### Consumer demographics

Demographic characteristics of Honduran and U.S. consumers can be found in Tables 2 and 3, respectively. Despite the diversity of Latin American students who attend Zamorano University, 70.7% of the participants ( $n = 240$ ) were from Honduran origin (Table 2). Approximately half of the Honduran participants were students, while the remaining participants consisted of faculty, staff, and other fair-goers. Consequently, a majority of participants were under the age of 30. Participants were evenly split according to gender, a trend observed in both countries. In the U.S., a majority of participants fell within the 3 age brackets from 20 to 49 yr of age. As opposed to status (student or not), U.S. consumers were asked their level of education, and nearly all participants

**Table 1.** Least squares means for percentage of protein, fat, and moisture determined by proximate analysis and Warner-Bratzler shear force (WBSF)

Trait	Treatment <sup>1</sup>				SEM	P-value
	TC	SEL	HGRASS	HGRAIN		
Protein, %	21.8 <sup>b</sup>	22.3 <sup>b</sup>	22.2 <sup>b</sup>	23.9 <sup>a</sup>	0.35	0.0001
Fat, %	8.3 <sup>a</sup>	4.7 <sup>b</sup>	5.8 <sup>b</sup>	6.5 <sup>ab</sup>	0.77	0.0001
Moisture, %	68.8 <sup>bc</sup>	72.0 <sup>a</sup>	70.4 <sup>ab</sup>	68.2 <sup>c</sup>	0.62	0.0001
WBSF, kg	3.0 <sup>b</sup>	3.4 <sup>b</sup>	4.4 <sup>ab</sup>	5.3 <sup>a</sup>	0.49	0.0001

<sup>a-c</sup>Means in the same row having different superscripts are different ( $P < 0.05$ ).

<sup>1</sup>TC = USDA top Choice, SEL = USDA Select, HGRASS = Honduras grass-fed, HGRAIN = Honduras grain-fed.

**Table 2.** Demographic characteristics of consumers ( $n = 240$ ) for sensory panel conducted in Honduras

Characteristic	Response	% of consumers
Gender	Male	53.75
	Female	46.25
Age	< 20	24.80
	20–29	43.50
	30–39	5.69
	40–49	13.41
	50–59	10.16
	> 60	2.44
Current Status	Student	53.25
	No job	4.07
	Other	42.28
Country of Origin	Honduras	70.73
	Guatemala	6.91
	Nicaragua	3.25
	El Salvador	3.25
	Panama	2.85
	Colombia	2.03
	Ecuador	7.72
	Other	3.25

**Table 3.** Demographic characteristics of consumers ( $n = 240$ ) for sensory panel conducted in the U.S.

Characteristic	Response	% of consumers
Gender	Male	42.34
	Female	57.66
Age	< 20	6.30
	20–29	31.10
	30–39	20.08
	40–49	20.87
	50–59	11.42
	> 60	10.24
Education Level	Non-high School graduate	2.85
	High school graduate	13.82
	Some College/Technical School	39.43
	College Graduate	25.61
	Post graduate	18.29
Ethnic Origin	African-American	12.90
	Asian	1.21
	Caucasian/White	57.66
	Hispanic	24.60
	Native American	1.61
	Other	2.02

(97%) were high school graduates and/or had at least some post-secondary education. Most U.S. consumers were Caucasian, but Hispanic and African-American conjointly accounted for over 1/3 of participants.

### Consumer ratings and acceptability

Results for consumer subjective ratings for tenderness, juiciness, flavor liking and overall liking are shown in Table 4. An interaction between treatment

and country was detected for juiciness and overall liking ( $P \leq 0.01$ ), while treatment and country independently affected ( $P < 0.01$ ) tenderness and flavor liking. Consumers scored TC more tender ( $P < 0.05$ ) than all other treatments, followed by SEL, HGRASS, and HGRAIN, with a significant difference between each treatment. Despite a lack of statistical difference in WBSF values, consumers were able to detect a tenderness difference between the two Honduran treatments. However, it should be noted there was a 0.93 kg difference in the average WBSF values between the two Honduran treatments, which would typically be a detectable difference according to consumers. Similar to tenderness, TC was rated greater ( $P < 0.05$ ) for flavor liking than all other treatments, followed by SEL, HGRASS, and HGRAIN, again with a significant difference between each treatment. Honduran consumers scored steaks greater ( $P < 0.01$ ) for tenderness and flavor liking than U.S. consumers. Due to the significant interaction between treatment and country of feeding, juiciness ratings are shown in Fig. 1. Honduran consumers rated TC greater ( $P < 0.05$ ) for juiciness than any other treatment by feeding location combination. Apart from SEL, Honduran consumers scored samples greater for juiciness than U.S. consumers. Honduran consumers rated samples from SEL and HGRASS similarly ( $P > 0.05$ ) for juiciness, while U.S. consumers did not distinguish between the 2 U.S. sourced samples or the 2 Honduran sourced samples, rating TC and SEL similarly and scoring HGRASS and HGRAIN similarly for juiciness. All samples were cooked to 77°C, which Honduran consumers may be more accustomed to, whereas cooking steaks well done in the U.S. is not as

**Table 4.** Least square means by treatment and country of testing for consumer ratings ( $n = 480$ ) of each palatability trait

Trait	Treatment <sup>1</sup>				SEM	P-Value	Country <sup>2</sup>		SEM	P-value	TRT × Country	
	TC	SEL	HGRASS	HGRAIN			USA	HON			P-Value	
Tenderness <sup>3</sup>	6.1 <sup>a</sup>	5.4 <sup>b</sup>	4.3 <sup>c</sup>	3.2 <sup>d</sup>	0.19	0.0001	4.4 <sup>b</sup>	5.2 <sup>a</sup>	0.13	0.0001	0.4976	
Juiciness <sup>4</sup>	5.5	4.9	4.1	3.4	0.16	0.0001	4.0	4.9	0.11	0.0001	0.0006	
Flavor Liking <sup>5</sup>	5.5 <sup>a</sup>	4.8 <sup>b</sup>	4.0 <sup>c</sup>	3.5 <sup>d</sup>	0.15	0.0001	3.9 <sup>b</sup>	5.0 <sup>a</sup>	0.14	0.0001	0.2387	
Overall Liking <sup>6</sup>	5.8	5.2	4.1	3.4	0.15	0.0001	4.0	5.2	0.14	0.0001	0.0159	

<sup>a-d</sup>Means in the same row (and within main effect) having different superscripts are different ( $P < 0.05$ ).

<sup>1</sup>TC = USDA top Choice, SEL = USDA Select, HGRASS = Honduras grass-fed, HGRAIN = Honduras grain-fed.

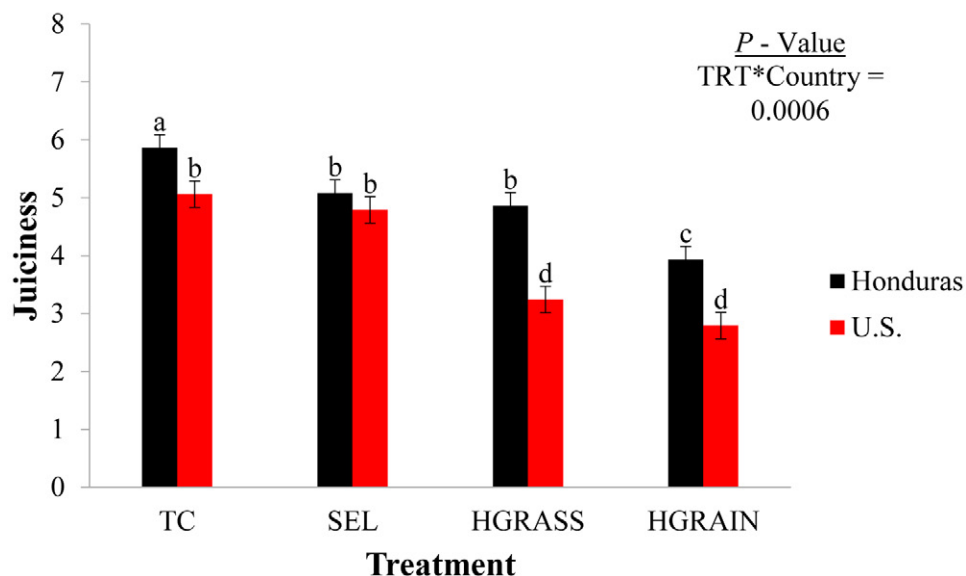
<sup>2</sup>USA = United States of America, HON = Honduras.

<sup>3</sup>Tenderness (1 = extremely tough, 2 = very tough, 3 = moderately tough, 4 = slightly tough, 5 = slightly tough, 6 = moderately tender, 7 = very tender, 8 = extremely tender).

<sup>4</sup>Juiciness (1 = extremely dry, 2 = very dry, 3 = moderately dry, 4 = slightly dry, 5 = slightly juicy, 6 = moderately juicy, 7 = very juicy, 8 = extremely juicy).

<sup>5</sup>Flavor liking (1 = extremely dislike flavor, 2 = very much dislike flavor, 3 = moderately dislike flavor, 4 = slightly dislike flavor, 5 = slightly like flavor, 6 = moderately like flavor, 7 = very much like flavor, 8 = extremely like flavor).

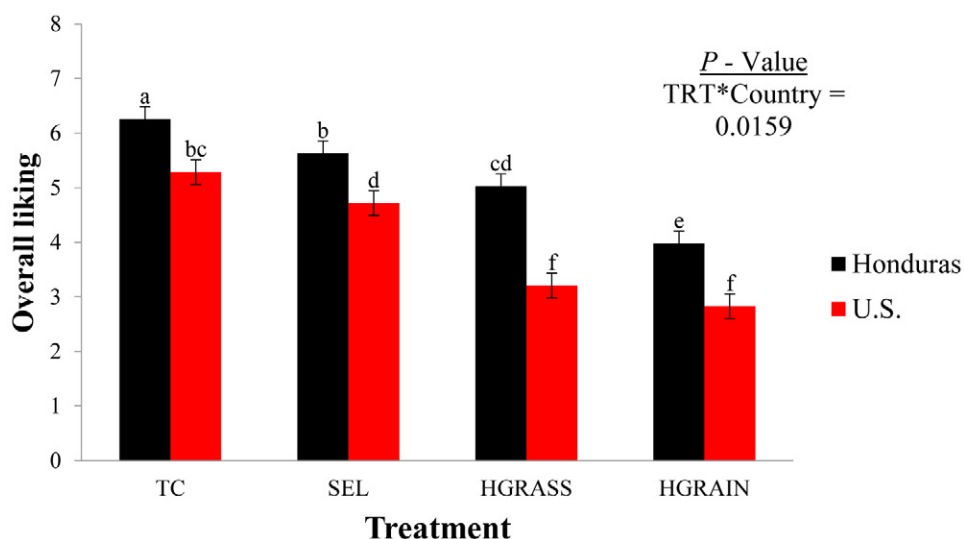
<sup>6</sup>Overall liking (1 = extremely dislike overall, 2 = very much dislike overall, 3 = moderately dislike overall, 4 = slightly dislike overall, 5 = slightly like overall, 6 = moderately like overall, 7 = very much like overall, 8 = extremely like overall).



**Figure 1.** The interactive effects of treatment and country of feeding on consumer ratings of juiciness of Honduran and U.S. beef. Verbal anchors for juiciness evaluation: 1 = extremely dry, 2 = very dry, 3 = moderately dry, 4 = slightly dry, 5 = slightly juicy, 6 = moderately juicy, 7 = very juicy, 8 = extremely juicy. Treatments: TC = USDA top Choice, SEL = USDA Select, HGRASS = Honduras grass-fed, HGRAIN = Honduras grain-fed. Treatment  $\times$  Country interaction:  $P = 0.0006$ .

common as Central America. The interaction for overall liking between treatment and country of feeding is illustrated in Fig. 2. For each treatment, Honduran consumers scored samples greater ( $P < 0.05$ ) for overall liking compared to U.S. consumers. Overall liking scores follow similar trends for previous palatability traits, where TC was most liked, followed by SEL, HGRASS, and HGRAIN, with a significant difference between each treatment. The one exception to this trend occurred for U.S. consumers that did not differentiate ( $P > 0.05$ ) between the two Honduran treatments for overall liking.

Results for acceptability of each trait are reported in Table 5. Treatment and country independently affected ( $P < 0.01$ ) tenderness, juiciness, flavor, and overall acceptability. Across all palatability traits, a greater proportion of consumers found TC more acceptable ( $P < 0.05$ ) than the remaining treatments, followed by SEL, HGRASS, and HGRAIN, with a significant difference between each treatment. A similar ( $P > 0.05$ ) percentage of consumers indicated TC and SEL were acceptable overall; however, both U.S. treatments were found more acceptable than either Honduran treatment, while a greater ( $P <$



**Figure 2.** The interactive effects of treatment and country of feeding on consumer ratings of overall liking of Honduran and U.S. beef. Verbal anchors for overall liking evaluation: 1 = extremely dislike overall, 2 = very much dislike overall, 3 = moderately dislike overall, 4 = slightly dislike overall, 5 = slightly like overall, 6 = moderately like overall, 7 = very much like overall, 8 = extremely like overall. Treatments: TC = USDA top Choice, SEL = USDA Select, HGRASS = Honduras grass-fed, HGRAIN = Honduras grain-fed. Treatment  $\times$  Country interaction:  $P = 0.0159$ .

**Table 5.** Percentage of consumers indicating each trait was acceptable according to treatment and country of feeding ( $n = 480$ ).

Trait	Treatment <sup>1</sup>				SEM	<i>P</i> -value	Country <sup>2</sup>		SEM	<i>P</i> -value
	TC	SEL	HGRASS	HGRAIN			USA	HON		
Tenderness	91.2 <sup>a</sup>	85.4 <sup>b</sup>	61.4 <sup>c</sup>	38.0 <sup>d</sup>	0.30	0.0001	63.8 <sup>b</sup>	81.3 <sup>a</sup>	0.29	0.0001
Juiciness	84.3 <sup>a</sup>	75.5 <sup>b</sup>	55.2 <sup>c</sup>	41.8 <sup>d</sup>	0.31	0.0001	56.8 <sup>b</sup>	74.4 <sup>a</sup>	0.29	0.0001
Flavor Liking	82.4 <sup>a</sup>	71.4 <sup>b</sup>	54.0 <sup>c</sup>	45.4 <sup>d</sup>	0.31	0.0001	57.9 <sup>b</sup>	71.1 <sup>a</sup>	0.28	0.0010
Overall Liking	85.1 <sup>a</sup>	79.9 <sup>a</sup>	53.6 <sup>b</sup>	40.9 <sup>c</sup>	0.30	0.0001	58.0 <sup>b</sup>	75.5 <sup>a</sup>	0.28	0.0001

<sup>a-d</sup>Means in the same row (and within main effect) having different superscripts are different ( $P < 0.05$ ).

<sup>1</sup>TC = USDA top choice, SEL = USDA select, HGRASS = Honduras grass-fed, HGRAIN = Honduras grain-fed.

<sup>2</sup>USA = United States of America, HON = Honduras.

0.05) percentage of consumers indicated HGRASS was more acceptable overall compared to HGRAIN. A greater proportion of Honduran consumers indicated tenderness, juiciness, flavor, and overall liking was acceptable compared to U.S. consumers ( $P < 0.01$ ).

Even when Sitz et al. (2005) matched U.S. strip steaks to either Canadian or Australian grass-fed strip steaks according to similar Warner-Bratzler shear force values and marbling, U.S. consumers were accustomed to U.S. domestic beef flavor and preferred that over either imported option, which aligned with the current results. Honduran consumers, however, did not show allegiance to their domestic product, rating both U.S. treatments greater for overall liking than either of the Honduran treatments. Although the fat percentage was similar between SEL and the 2 Honduran treatments, Honduran consumers still rated SEL greater for all palatability traits and preferred it more overall, indicating they preferred the flavor and tenderness of U.S. grain fed beef to that of their domestic grass fed or grain fed beef. No matter how accustomed Honduran consumers were to their domestic beef flavors, this could not overcome their preference for U.S. beef and the higher fat level of TC beef, even when cooked to a high degree of doneness. This finding aligns with previous results where U.S. consumers rated Top Choice strip steaks more palatable than Select strip steaks (Corbin et al., 2015, Hunt et al., 2014, O'Quinn et al., 2012). Delgado et al. (2005) observed an alternative trend when comparing strip steaks obtained from retailers in three major Mexican cities compared to imported USDA Choice or No Roll beef. Mexican retail strip steaks (2.7 to 3.6%) had similar fat percentage to that of No Roll U.S. beef (2.9%), and all were significantly lower than USDA Choice strip steaks (6.3%). Despite registering a lower shear force value than Northern Mexican beef, USDA Choice was rated similar for tenderness by Mexican consumers. Overall desirability for all Mexican beef, regardless of the region (North, Center, South), was similar to that of USDA Choice beef, and all were more desirable

than No Roll U.S. beef. The authors attributed this phenomenon to Mexican beef consumers' familiarization with the taste, flavor, and aroma of locally produced beef due to the rich tradition of beef consumption in Mexico.

Oliver et al. (2006) conducted a multi-national consumer study comparing beef from Uruguay to beef produced in three European countries. Consumers in Germany, Spain, and the United Kingdom compared Uruguayan beef to beef from their respective countries. Cluster analysis grouped consumers in two main clusters of either preference for foreign-imported beef (Uruguayan beef), which was the predominant trend in Germany, and preference for local beef, which was more evident in Spain and the United Kingdom. These results illustrate that consumers do not necessarily prefer beef from their home country, which was the case of Honduran consumers in the current study. Realini et al. (2009) evaluated consumer acceptability for Uruguayan beef from four finishing diets (pasture, pasture with low concentrate supplement, pasture with high concentrate supplement, or concentrate) in France, United Kingdom, Spain, and Germany. European consumers tended to prefer low levels of concentrate supplementation or beef from cattle that were solely pasture-fed, indicating European consumers may gravitate toward leaner beef that is produced from grass fed cattle. The HGRASS had numerically less fat than HGRAIN, which could partially explain why Honduran and U.S. consumers preferred HGRASS over HGRAIN. However, this theory conflicts with greater consumer preference for the higher fat percentage of TC. Breed type, gender, or animal age could also play a factor since HGRASS was more tender than HGRAIN, as evidenced by lower WBSF values and greater consumer tenderness scores. However, all three traits (tenderness, juiciness, and flavor liking) differed between HGRASS and HGRAIN, but the greatest differential between these 2 treatments was observed for tenderness. Even so, the combined effort of all palatability traits likely resulted in greater overall acceptability of HGRASS over HGRAIN.

## Willingness to pay

Values for consumers' willingness to pay for each treatment of this study are shown in Fig. 3. No interaction was detected ( $P > 0.05$ ), but both treatment and country of feeding impacted willingness to pay ( $P < 0.01$ ). As seen with previous palatability traits, consumers were willing to pay the most ( $P < 0.05$ ) for TC, followed by SEL, HGRASS, and HGRAIN, again with a significant difference between each treatment. Honduran consumers were willing to pay more ( $P < 0.01$ ) than U.S. consumers.

These results align with previous reports that U.S. consumers were willing to pay more for domestic U.S. grain finished beef when compared to imported beef from countries such as Australia, Canada, and Argentina, where finishing practices differ from those in the U.S. (Killinger et al., 2004; Sitz et al., 2005). Killinger et al. (2004) found that U.S. consumers were willing to pay more for U.S. beef compared to grass-fed Argentine beef, and they were willing to pay even more when they found domestic samples more acceptable than Argentine steaks. Likewise, Sitz et al. (2005) reported that consumers would pay \$1.20/0.45 kg more for domestic strip steak compared to Australian grass-fed strip steak, but only a \$0.38/0.45 kg premium for U.S. beef over Canadian beef.

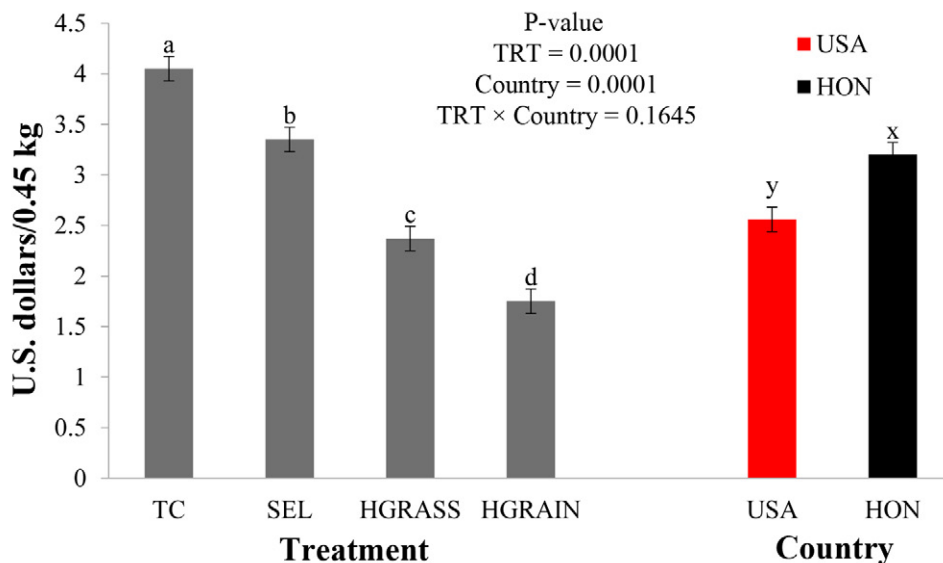
## Conclusions

There is limited information discussing Honduran consumer preference regarding beef traits. Results from

consumer testing in the 2 countries demonstrate that U.S. sourced beef loin steaks are preferred over Honduran beef loin steaks, regardless of the country in which testing took place. When comparing consumers between countries, Honduran panelists assigned greater scores compared to U.S. panelists. Samples were cooked to a well-done degree of doneness (77°C), which Honduran consumers were likely more accustomed to and prefer, which could help explain their elevated scores compared to U.S. consumers. There is an apparent need to improve grain finishing systems in Honduras, given the palatability of meat represented by HGRAIN was scored the lowest overall in both locations. However, consumers scored TC greater for tenderness, flavor liking, and overall liking than all other treatments, followed by SEL, HGRASS, and HGRAIN, with a significant difference between each treatment, indicating there is a market opportunity for U.S. grain finished beef, despite having a higher fat level than what Honduran consumers may be accustomed to. Overall, U.S. consumers were willing to pay less for meat samples when compared to Honduran consumers. However, consumers were also willing to pay a premium for products with greater palatability, regardless of the country of origin.

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**Figure 3.** The effects of treatment and country of feeding on the willingness to pay for Honduran and U.S. beef. Willingness to pay for each sample was rated as either \$0, \$3, \$6, \$10 (U.S. dollars) per 0.45 kg. For Honduran panels, willingness to pay was presented in Honduran currency equivalent to U.S. dollars. Treatments: TC = USDA top Choice, SEL = USDA Select, HGRASS = Honduras grass-fed, HGRAIN = Honduras grain-fed. Country: US = United States of America, HON = Honduras. Treatment:  $P = 0.0001$ ; Country:  $P = 0.0001$ ; Treatment  $\times$  Country interaction:  $P = 0.1645$ .



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