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### Abstract

The objective of this study was to evaluate the palatability traits and consumer acceptance of three plant-based ground beef alternatives in comparison to ground beef in a foodservice-like hamburger application. One ground beef (80% lean/20% fat; 1 lb chubs) and three commercially available plant-based ground beef alternative (GBA) treatments ( $n = 20$  production lots/treatment) were formed into 2.5 oz patties to be served to consumers on a bun with an opportunity to apply ketchup, mustard, cheese, lettuce, and pickles to samples. The GBAs were selected as representatives of GBAs well-known to be sold at foodservice (FGBA) and retail (RGBA). In addition, a popular “traditional” soy-based patty (TGBA) on the market was selected for use. Consumers ( $n = 120$ ) evaluated samples for juiciness, tenderness, texture, flavor liking, beef-like flavor intensity, overall liking, and willingness to purchase. Panelists rated each of the samples as acceptable or unacceptable for these sensory traits. Furthermore, panelists assigned a purchase price they would be willing to pay for each sample if purchasing a similar product at foodservice. Overall, GB was preferred by consumers compared to all three GBAs. The GB treatment rated higher ( $P < 0.05$ ) for juiciness and texture compared to all GBAs. The GB, FGBA, and RGBA tenderness ratings were similar ( $P > 0.05$ ), but all three rated higher ( $P < 0.05$ ) than the TGBA. Consumer ratings for overall flavor liking, beef-like flavor intensity, and overall liking showed GB was higher ( $P < 0.05$ ) compared to all three GBAs. However, GB and FGBA were similar ( $P > 0.05$ ) for the percentage of samples rated acceptable by consumers for juiciness and texture, but both had a higher ( $P < 0.05$ ) percentage rated acceptable for these traits than RGBA and TGBA. Similar to the consumer ratings, the percentage of samples rated acceptable for tenderness for GB, FGBA, and RGBA were similar ( $P > 0.05$ ), but all three had a higher ( $P < 0.05$ ) percentage rated acceptable than the TGBA. The GB treatment had a higher ( $P < 0.05$ ) percentage of samples rated acceptable for overall flavor liking, beef-like flavor intensity, and overall liking than all GBAs. Moreover, consumers rated GB higher ( $P < 0.05$ ) for purchase intent than all GBAs and indicated they would be willing to pay a price more than 50% higher ( $P < 0.05$ ) for the GB than all the GBAs. Subsequently, this research shows the use of ground beef and ground beef alternatives provide different eating experiences when consumed as a complete hamburger and should be marketed as such by the foodservice and retail sectors.

## Introduction

During the past decade, modern plant-based ground beef alternatives have grown in market share in food markets. A push for healthy, environmentally friendly food production has sparked consumer interest in the trend to use plant-based meat alternatives. While research has been completed comparing ground beef alternatives and ground beef directly, the research of these products in at-home or a foodservice environment is minimal (Davis et al., 2021). The addition of toppings is commonplace for American consumers in hamburger consumption and can affect palatability preferences among consumers. Thus, the objective of this study was to evaluate the palatability traits and consumer acceptance of three plant-based ground beef alternatives in comparison to ground beef in a foodservice-like hamburger application.

## Experimental Procedures

One ground beef (80% lean, 20% fat; 1.0 lb chubs) and 3 commercially available plant-based ground beef alternative (GBA) treatments ( $n = 20$  production lots/treatment) were purchased from five supermarkets in the Manhattan, KS, area over a 5-month period. The plant-based GBAs were selected as representatives of GBAs well-known to be sold at foodservice (FGBA) and retail (RGBA). In addition, a popular "traditional" soy-based patty (TGBA) on the market was selected for use. Ground beef (GB) and the 3 GBA packages were stored frozen at the Kansas State University Meat Laboratory in Manhattan, KS, for no more than 4 months prior to patty fabrication. All lots were formed into 2.5 oz patties to be served to consumers on a bun with an opportunity to apply ketchup, mustard, cheese, lettuce, and pickles to samples.

A total of 20 sensory panels were conducted at the Kansas State University Meat Science Sensory Lab. Consumers ( $n = 120$ ) evaluated samples for juiciness, tenderness, texture, flavor liking, beef-like flavor intensity, and overall liking on 100-point continuous line scales anchored on both ends with descriptive terms. Panelists rated each of the samples as acceptable or unacceptable for each of the sensory traits. Furthermore, panelists rated each sample on their willingness to purchase on a 100-point continuous line scale, and assigned a purchase price they would be willing to pay for each sample if purchasing a similar product at foodservice.

## Results and Discussion

Overall, GB was preferred by consumers compared to all three GBAs (Table 1). The GB treatment rated higher ( $P < 0.05$ ) for juiciness and texture compared to all GBAs. The GB, FGBA, and RGBA tenderness ratings were similar ( $P > 0.05$ ), but all three rated higher ( $P < 0.05$ ) than the TGBA. Consumer ratings for overall flavor liking, beef-like flavor intensity, and overall liking showed GB was higher ( $P < 0.05$ ) compared to all three GBAs. However, GB and FGBA were similar ( $P > 0.05$ ) for the percentage of samples rated acceptable by consumers for juiciness and texture, but both had a higher ( $P < 0.05$ ) percentage rated acceptable for these traits than RGBA and TGBA (Table 2). Similar to the consumer ratings, the percentage of samples rated acceptable for tenderness for GB, FGBA, and RGBA were similar ( $P > 0.05$ ), but all three had a higher ( $P < 0.05$ ) percentage rated acceptable than the TGBA. The GB treatment had a higher ( $P < 0.05$ ) percentage of samples rated acceptable for overall flavor liking, beef-like flavor intensity, and overall liking than all GBAs. Moreover, consumers rated GB higher ( $P < 0.05$ ) for purchase intent than all GBAs and indicated they would be

willing to pay a price more than 50% higher ( $P < 0.05$ ) for the GB than all the GBAs (Table 1).

## Implications

This research indicates that when ground beef and ground beef alternatives are used as an ingredient to make products such as a hamburger patty, ground beef provided a different eating experience preferred by consumers. Therefore, the use of ground beef and ground beef alternatives provide different eating experiences when consumed as a complete hamburger and should be marketed as such by the foodservice and retail sectors.

## References

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**Table 1. Least squares means for consumer (n = 120) panel ratings for hamburgers with ground beef and plant-based ground beef alternatives (GBA)<sup>1</sup>**

Trait <sup>2</sup>	Ground beef	Foodservice GBA	Retail GBA	Traditional GBA	SEM <sup>3</sup>	P-value
Hamburger panels <sup>4</sup>						
Juiciness	66.4 <sup>a</sup>	55.3 <sup>b</sup>	53.5 <sup>b</sup>	39.1 <sup>c</sup>	2.2	< 0.01
Tenderness	64.7 <sup>a</sup>	61.4 <sup>a</sup>	62.6 <sup>a</sup>	48.8 <sup>b</sup>	2.1	< 0.01
Texture	64.6 <sup>a</sup>	55.0 <sup>b</sup>	50.0 <sup>b</sup>	40.5 <sup>c</sup>	2.3	< 0.01
Overall flavor	67.7 <sup>a</sup>	48.6 <sup>b</sup>	43.4 <sup>bc</sup>	37.4 <sup>c</sup>	2.5	< 0.01
Beef flavor	66.1 <sup>a</sup>	47.2 <sup>b</sup>	41.0 <sup>c</sup>	36.8 <sup>c</sup>	2.7	< 0.01
Overall liking	67.5 <sup>a</sup>	49.6 <sup>b</sup>	42.3 <sup>b</sup>	34.1 <sup>c</sup>	2.6	< 0.01
Purchase intent <sup>5</sup>	63.3 <sup>a</sup>	42.2 <sup>b</sup>	34.5 <sup>c</sup>	28.3 <sup>c</sup>	2.7	< 0.01
Purchase price <sup>6</sup>	4.8 <sup>a</sup>	3.2 <sup>b</sup>	2.7 <sup>bc</sup>	2.1 <sup>c</sup>	0.2	< 0.01

<sup>abc</sup>Least squares means in the same row without a common superscript differ ( $P < 0.05$ ).

<sup>1</sup>Foodservice GBA = plant-based ground beef alternative most commonly sold in foodservice establishments (restaurants).

Retail GBA = plant-based ground beef alternative most commonly sold in retail markets (grocery stores, supermarkets).

Traditional GBA = plant-based ground beef alternative most indicative of a traditional soy-based product.

<sup>2</sup>Sensory scores: 0 = extremely dry/tough, dislike texture/overall flavor/beef flavor/overall; 50 = neither dry nor juicy/neither tough nor tender, neither like nor dislike texture/overall flavor/beef flavor/overall; 100 = extremely juicy/tender, like texture/overall flavor/beef flavor/overall.

<sup>3</sup>Standard error of the mean (largest) of the least square means.

<sup>4</sup>Consumers were served a hamburger patty on a white bun with an option to add cheese, ketchup, lettuce, mustard, and pickle to their hamburger samples.

<sup>5</sup>If price were not a factor, likelihood of purchase; 1 = Not Likely, 100 = Extremely Likely.

<sup>6</sup>Price, in US dollars, willing to be paid at foodservice for comparable product.

**Table 2. Least squares means for the percentage of ground beef and plant-based ground beef alternatives (GBA)<sup>1</sup> hamburger samples rated acceptable for each palatability trait by consumers (n = 120)**

Trait	Ground beef	Foodservice GBA	Retail GBA	Traditional GBA	SEM <sup>2</sup>	P-value
Hamburger panels <sup>3</sup>						
Juiciness	89.7 <sup>a</sup>	81.5 <sup>ab</sup>	79.0 <sup>b</sup>	50.0 <sup>c</sup>	5.1	< 0.01
Tenderness	93.4 <sup>a</sup>	92.5 <sup>a</sup>	86.7 <sup>a</sup>	70.1 <sup>b</sup>	4.3	< 0.01
Texture	86.7 <sup>a</sup>	82.5 <sup>ab</sup>	72.5 <sup>b</sup>	55.0 <sup>c</sup>	4.5	< 0.01
Overall flavor	90.9 <sup>a</sup>	67.6 <sup>b</sup>	50.8 <sup>c</sup>	45.0 <sup>c</sup>	4.6	< 0.01
Beef flavor	89.4 <sup>a</sup>	61.8 <sup>b</sup>	52.5 <sup>bc</sup>	39.9 <sup>c</sup>	4.8	< 0.01
Overall liking	90.2 <sup>a</sup>	69.4 <sup>b</sup>	49.2 <sup>c</sup>	49.9 <sup>c</sup>	4.8	< 0.01

<sup>abcd</sup>Least squares means in the same row without a common superscript differ ( $P < 0.05$ ).

<sup>1</sup>Foodservice GBA = plant-based ground beef alternative most commonly sold in foodservice establishments (restaurants).

Retail GBA = plant-based ground beef alternative most commonly sold in retail markets (grocery stores, supermarkets).

Traditional GBA = plant-based ground beef alternative most indicative of a traditional soy-based product.

<sup>2</sup>Standard error of the means (largest) of the least square means.

<sup>3</sup>Consumers were served a hamburger patty on a white bun with an option to add cheese, ketchup, lettuce, mustard, and pickle to their hamburger samples.