

## Consumer Sensory Evaluation of Plant-Based Ground Beef Alternatives in Comparison to Ground Beef of Various Fat Percentages

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### Abstract

The objective of this study was to determine if current plant-based protein ground beef alternatives offer similar palatability characteristics to ground beef patties of varying fat percentages. Fifteen different production lots ( $n = 15/\text{fat level}$ ) of 3-lb ground beef chubs of three different fat levels (10%, 20%, and 30%) were collected from retail markets in the Manhattan, KS area. Additionally, alternative products including a soy protein-based foodservice ground beef alternative, a pea protein-based retail ground beef alternative, and a traditional soy protein-based ground beef alternative, ( $n = 15$  production lots/product) currently available through commercial channels were collected from retail markets and a commercial foodservice chain. All ground beef and alternative treatments were formed into 0.25-lb patties and frozen at  $-40^{\circ}\text{F}$  until consumer sensory analysis. All three ground beef samples rated higher ( $P < 0.05$ ) than the three alternative samples for appearance, overall flavor, beef flavor, and overall liking. Retail alternative rated lowest ( $P < 0.05$ ) for appearance, overall flavor, texture, and overall liking. Of the alternative samples, the foodservice alternative rated highest ( $P < 0.05$ ) for juiciness, beef flavor, and texture liking, and the traditional alternative rated lowest ( $P < 0.05$ ) for juiciness. However, foodservice alternative samples rated higher ( $P < 0.05$ ) for tenderness than the 20% fat ground beef samples. Moreover, of the alternative samples, foodservice alternative and traditional alternative samples rated similar ( $P > 0.05$ ) for appearance, tenderness, overall flavor liking, and overall liking. Among the ground beef samples, no differences ( $P > 0.05$ ) were found for appearance, juiciness, overall flavor liking, beef flavor liking, or overall liking. For the percentage of samples rated acceptable for each palatability trait, all three ground beef treatments had a higher ( $P < 0.05$ ) percentage of samples rated acceptable for appearance, overall flavor liking, beef flavor liking, texture, and overall liking than the three alternatives. Retail alternative had the lowest ( $P < 0.05$ ) percentage of samples rated acceptable for appearance, overall flavor, texture, and overall liking. Traditional alternative had the lowest ( $P < 0.05$ ) percentage of samples rated acceptable for juiciness. Among the alternative

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samples, the foodservice alternative had the highest ( $P < 0.05$ ) percentage of samples rated acceptable for juiciness and beef flavor liking. Furthermore, among the alternative treatments, foodservice alternative and traditional alternative had a similar ( $P > 0.05$ ) percentage of samples rated acceptable for appearance, overall flavor liking, texture liking, and overall liking.

## Introduction

Plant-based ground beef alternatives have seen increased demand in recent years (Aubrey, 2017). As time has progressed, vegetable-based patties have changed to more closely mimic the texture, taste, and juiciness of ground beef (Lopez, 2020). Multiple plant-based ground beef alternative companies have made claims stating they would like to replace animals in the food system. Their products are said to be almost identical to ground beef. However, little research has been conducted to assess the differences between ground beef and ground beef alternatives.

## Experimental Procedures

Fifteen different production lots ( $n = 15$ /fat level) of 3-lb ground beef chubs of three different fat levels (10%, 20%, and 30%) were collected from retail markets in the Manhattan, KS, area. Additionally, ground beef alternative products including a soy and potato protein-based foodservice ground beef alternative, a pea protein-based retail ground beef alternative, and a traditional soy protein-based ground beef alternative, ( $n = 15$  production lots/product) currently available through commercial channels were collected from retail markets and a commercial foodservice chain. All ground beef and alternative treatments were formed into 0.25-lb patties and frozen at  $-40^{\circ}\text{F}$  until consumer sensory analysis. Patties were thawed 12–24 hours prior to cooking and were cooked to  $160^{\circ}\text{F}$  on a clamshell-style grill, cut into six equally sized wedges, and served within five minutes of cooking to consumers. Consumers ( $n = 120$ ) were fed six samples (1 wedge/sample) in a random order and evaluated sample appearance, juiciness, tenderness, overall flavor liking, beef flavor liking, texture liking, and overall liking on continuous 100 point line scales verbally anchored at the ends and midpoints. Additionally, consumers rated each trait as either acceptable or unacceptable. All data were analyzed as a completely randomized design with treatment as a fixed effect.

## Results and Discussion

As shown in Table 1, all three ground beef samples rated higher ( $P < 0.05$ ) than the three alternative samples for appearance, overall flavor, beef flavor, and overall liking. Retail alternative rated lowest ( $P < 0.05$ ) for appearance, overall flavor, texture, and overall liking. Of the alternative samples, foodservice alternative rated highest ( $P < 0.05$ ) for juiciness, beef flavor, and texture liking, and traditional alternative rated lowest ( $P < 0.05$ ) for juiciness. However, foodservice alternative rated higher ( $P < 0.05$ ) for tenderness than the 20% fat ground beef samples. Moreover, of the alternative samples, foodservice alternative and traditional alternative rated similar ( $P > 0.05$ ) for appearance, tenderness, overall flavor liking, and overall liking. Among the ground beef samples, no differences ( $P > 0.05$ ) were found for appearance, juiciness, overall flavor liking, beef flavor liking, or overall liking. For the percentage of samples rated acceptable for each palatability trait (Table 2), all three ground beef treatments had a higher ( $P < 0.05$ ) percentage of samples rated acceptable for appearance, overall flavor liking, beef

flavor liking, texture, and overall liking than the three alternatives. Retail alternative had the lowest ( $P < 0.05$ ) percentage of samples rated acceptable for appearance, overall flavor, texture, and overall liking. Traditional alternative had the lowest ( $P < 0.05$ ) percentage of samples rated acceptable for juiciness. Among the alternative samples, foodservice alternative had the highest ( $P < 0.05$ ) percentage of samples rated acceptable for juiciness and beef flavor liking. Furthermore, among the alternative treatments, foodservice alternative and traditional alternative had a similar ( $P > 0.05$ ) percentage of samples rated acceptable for appearance, overall flavor liking, texture liking, and overall liking.

## Implications

These results indicate that ground beef samples had higher palatability ratings than alternative samples for most palatability traits evaluated. Moreover, a higher percentage of samples were rated as acceptable for ground beef than for alternatives. This clearly indicates that the eating experience provided by the alternatives is different than that provided by traditional ground beef. Thus, consumers who purchase alternatives should not expect the same eating quality as they would receive with ground beef.

## Acknowledgements

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## References

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**Table 1. Least squares means for consumer (n = 120) ratings<sup>1</sup> of the palatability traits of ground beef and plant-based ground beef alternative patties**

Treatment	Appearance liking	Juiciness	Tenderness	Overall flavor liking	Beef flavor liking	Texture liking	Overall liking	Price factor <sup>2</sup>
Ground beef 90% lean/10% fat	56.9 <sup>a</sup>	65.8 <sup>a</sup>	64.5 <sup>a</sup>	57.2 <sup>a</sup>	65.9 <sup>a</sup>	62.5 <sup>a</sup>	58.5 <sup>a</sup>	51.7 <sup>a</sup>
Ground beef 80% lean/20% fat	59.4 <sup>a</sup>	63.8 <sup>a</sup>	57.3 <sup>bc</sup>	58.6 <sup>a</sup>	64.3 <sup>a</sup>	59.8 <sup>b</sup>	56.5 <sup>a</sup>	50.6 <sup>a</sup>
Ground beef 70% lean/30% fat	63.2 <sup>a</sup>	68.3 <sup>a</sup>	63.5 <sup>ab</sup>	59.0 <sup>a</sup>	67.5 <sup>a</sup>	64.3 <sup>a</sup>	59.6 <sup>a</sup>	56.2 <sup>a</sup>
Retail ground beef alternative	26.7 <sup>c</sup>	47.0 <sup>b</sup>	56.4 <sup>c</sup>	27.5 <sup>c</sup>	28.7 <sup>c</sup>	28.0 <sup>d</sup>	23.8 <sup>c</sup>	17.9 <sup>c</sup>
Foodservice ground beef alternative	46.9 <sup>b</sup>	68.0 <sup>a</sup>	64.9 <sup>a</sup>	44.6 <sup>b</sup>	37.0 <sup>b</sup>	46.6 <sup>b</sup>	41.2 <sup>b</sup>	34.1 <sup>b</sup>
Traditional ground beef alternative	41.0 <sup>b</sup>	32.7 <sup>c</sup>	62.3 <sup>abc</sup>	40.0 <sup>b</sup>	27.2 <sup>c</sup>	37.7 <sup>c</sup>	34.7 <sup>b</sup>	26.2 <sup>bc</sup>
Standard error mean (largest) of the least square means	2.93	3.01	2.52	2.87	2.59	2.57	2.95	3.03
<i>P</i> -value	< 0.01	< 0.01	0.04	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

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

<sup>1</sup>Sensory scores: 0 = extremely dislike/extremely dry/extremely tough/extremely dislike; 50 = neither like nor dislike/neither dry nor juicy/neither tough nor tender, neither like nor dislike; 100 = like extremely/extremely juicy/extremely tender/like extremely.

<sup>2</sup>If price were not a factor, how likely would you be to purchase each treatment (1 = not likely, 100 = extremely likely).

**Table 2. Least squares means for percentage of samples rated acceptable by consumers (n = 120) of ground beef and plant-based ground beef alternative patties**

Treatment	Appearance liking	Juiciness	Tenderness	Overall flavor liking	Beef flavor liking	Texture liking	Overall liking
Ground beef 90% lean/10% fat	83.9 <sup>a</sup>	88.2 <sup>a</sup>	92.8 <sup>a</sup>	77.5 <sup>a</sup>	83.6 <sup>a</sup>	89.0 <sup>a</sup>	77.5 <sup>a</sup>
Ground beef 80% lean/20% fat	83.9 <sup>a</sup>	84.9 <sup>a</sup>	82.1 <sup>bc</sup>	70.8 <sup>a</sup>	77.0 <sup>a</sup>	81.7 <sup>a</sup>	73.3 <sup>a</sup>
Ground beef 70% lean/30% fat	90.4 <sup>a</sup>	84.1 <sup>a</sup>	84.6 <sup>ab</sup>	78.3 <sup>a</sup>	84.5 <sup>a</sup>	86.6 <sup>a</sup>	79.2 <sup>a</sup>
Retail ground beef alternative	28.7 <sup>c</sup>	61.3 <sup>b</sup>	71.3 <sup>c</sup>	30.8 <sup>c</sup>	28.9 <sup>c</sup>	34.4 <sup>c</sup>	22.5 <sup>c</sup>
Foodservice ground beef alternative	67.9 <sup>b</sup>	88.2 <sup>a</sup>	84.6 <sup>ab</sup>	51.7 <sup>b</sup>	41.5 <sup>b</sup>	63.1 <sup>b</sup>	51.7 <sup>b</sup>
Traditional ground beef alternative	59.4 <sup>c</sup>	38.8 <sup>c</sup>	81.3 <sup>bc</sup>	50.8 <sup>c</sup>	28.9 <sup>c</sup>	50.9 <sup>b</sup>	45.8 <sup>b</sup>
Standard error mean (largest) of the least square means	5.01	5.18	4.49	4.56	4.38	5.42	4.56
<i>P</i> -value	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

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