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# Comparison of the Physical Attributes of Plant-Based Ground Beef Alternatives to Ground Beef

K. M. Harr
*Kansas State University*, keaylah@k-state.edu

S. G. Davis
*Kansas State University*, sgdavis@ksu.edu

S. B. Bigger
*Kansas State University*, sydneybigger@k-state.edu

*See next page for additional authors*



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# Comparison of the Physical Attributes of Plant-Based Ground Beef Alternatives to Ground Beef


## Abstract

Objective: The objective of this study was to evaluate the physical attributes of three different plant-based, ground beef alternatives in comparison to ground beef of three different fat percentages.

Study Description: Ground beef of three different fat percentages, a retail pea protein-based ground beef alternative, and a traditional soy-based ground beef alternative were obtained from retail stores (n = 15 lots/treatment). Samples from 15 lots of a foodservice soy protein-based ground beef alternative were obtained from a foodservice chain. All samples were fabricated into 0.25 lb patties assigned to one of four assays: color analysis, texture profile analysis, shear force, and pressed juice percentage.

Results: When evaluating raw color, traditional ground beef alternative had the highest ($P < 0.05$) a* value and were redder when compared to all other treatments, with retail ground beef alternative having the lowest ($P < 0.05$) a* value. Traditional and retail ground beef alternative had the highest ($P < 0.05$) a* value, while foodservice ground beef alternative, and 30% and 10% fat ground beef had the lowest ($P < 0.05$) a* value for cooked surface color. For texture attributes, retail and foodservice ground beef alternatives had lower ($P < 0.05$) values for cohesiveness, gumminess, hardness, and chewiness, as well as higher ($P < 0.05$) values for springiness, than all other treatments evaluated. For shear force, the three ground beef alternatives were more tender ($P < 0.05$) than all three ground beef treatments, with foodservice and retail ground beef alternatives being more tender ($P < 0.05$) than all treatments. The three ground beef treatments had greater ($P < 0.05$) pressed juice percentage values than all ground beef alternatives, indicating the ground beef was juicier than any of the ground beef alternatives evaluated.

The Bottom Line: While the ground beef alternative products attempt to mimic ground beef, they provide very different color, texture, tenderness, and cooking characteristics than traditional ground beef.



## Keywords

alternative proteins, ground beef, texture





## Cover Page Footnote

Funding for this project was provided by the Kansas Beef Council.



## Authors

K. M. Harr, S. G. Davis, S. B. Bigger, D. U. Thomson, M. D. Chao, J. L. Vipham, M. D. Apley, S. M. Ensley, M. D. Haub, M. D. Miesner, A. J. Tarpoff, K C. Olson, and T. G. O'Quinn

K-STATE Research and Extension

CATTLEMEN'S DAY 2021

KANSAS STATE UNIVERSITY CATTLEMEN'S DAY

# Comparison of the Physical Attributes of Plant-Based Ground Beef Alternatives to Ground Beef

*K.M. Harr, S.G. Davis, S.B. Bigger, D.U. Thomson,[1] M.D. Chao, J.L. Vipham, M.D. Apley, D.A. Blasi, S.M. Ensley, M.D. Haub, M.D. Miesner, A.J. Tarpoff, KC Olson, and T.G. O'Quinn*

## Abstract

The objective of this study was to evaluate the physical attributes of three different plant-based, ground beef alternatives in comparison to ground beef of three different fat percentages. Ground beef of three different fat percentages (10%, 20%, and 30%), a retail pea protein-based ground beef alternative, and a traditional soy flour-based ground beef alternative were obtained from retail stores in the Manhattan, KS, area over several weeks (n = 15 lots/treatment). Additional samples from 15 lots of a food-service soy protein-based ground beef alternative were obtained from a commercial foodservice chain. Ground beef, retail ground beef alternative, and foodservice ground beef alternative were fabricated into 0.25 lb patties and assigned to one of four assays: color analysis, texture profile analysis, shear force, and pressed juice percentage. When evaluating raw color, traditional ground beef alternative had the highest ($P < 0.05$) a* value and was redder when compared to all other treatments, with retail ground beef alternative having the lowest ($P < 0.05$) a* value. For texture attributes, retail ground beef alternative and foodservice ground beef alternative had lower ($P < 0.05$) values for cohesiveness, gumminess, hardness, and chewiness, as well as higher values for springiness, than all other treatments evaluated. For shear force, the three ground beef alternatives were more tender ($P < 0.05$) than all three ground beef treatments, with foodservice ground beef alternative and retail ground beef alternative being more tender ($P < 0.05$) than all treatments. The three ground beef treatments had greater ($P < 0.05$) pressed juice percentage values than all ground beef alternatives, indicating the ground beef was juicier than any of the ground beef alternatives evaluated. For physical attributes, the ground beef alternatives evaluated differed from ground beef. Retail ground beef alternative and foodservice ground beef alternative had the greatest differences, with the traditional ground beef alternative being the most similar to 20% and 30% fat ground beef for some traits.

[1] Department of Animal Science, Iowa State University, Ames, IA.

## Introduction

Plant-based ground beef alternatives have seen increased demand in recent years (Aubrey, 2017). As time has progressed, vegetable-based patties have evolved to more closely mimic the texture, taste, and juiciness of ground beef (Lopez-Alt, 2020). Little research has evaluated the differences between ground beef and ground beef alternatives. Therefore, our objective was to evaluate the physical attributes of three different plant-based, ground beef alternatives in comparison to ground beef of three different fat percentages.

## Experimental Procedures

Ground beef of three different fat percentages (10%, 20%, and 30%), a retail pea protein-based ground beef alternative, and a traditional soy flour-based ground beef alternative were obtained from retail stores in the Manhattan, KS, area over several weeks in order to obtain different production lots for each product (n = 15 lots/treatment). Additional samples from 15 production lots of a foodservice soy protein-based ground beef alternative were obtained from a commercial foodservice chain. Ground beef, retail ground beef alternative, and foodservice ground beef alternative were fabricated into 0.25 lb patties using a manual patty former and randomly assigned to one of four assays: color analysis, texture profile analysis, shear force, and pressed juice percentage. Patties used for texture profile analysis and shear force were cooked to 160°F on a clamshell-style grill with three 1-in cores taken from each patty for texture profile analysis and two 1-in wide strips taken from each patty for shear force. Patties were evaluated for L* (lightness), a* (redness), and b*(yellowness) using a handheld spectrophotometer both in the raw, precooked state as well as after cooking for both external and internal color. Pressed juice percentage measured the percentage of weight lost from 0.06-in$^3$ cooked samples that were compressed for 30 seconds at 17.6 lb of force. During cooking for texture profile analysis, shear force, and pressed juice percentage, patty weights, diameters, and thicknesses were measured for determination of size change through cooking. All data were analyzed as a completely randomized design.

## Results and Discussion

Color results are listed in Table 1. When evaluating raw color, traditional ground beef alternatives had the highest ($P < 0.05$) a* value and were redder when compared to all other treatments, with retail ground beef alternative having the lowest ($P < 0.05$) a* value. Traditional ground beef alternative and retail ground beef alternative had the highest ($P < 0.05$) a* value, while foodservice ground beef alternative, and 30% and 10% fat ground beef had the lowest ($P < 0.05$) a* value for cooked surface color. Additionally, 30% and 20% fat ground beef had higher ($P < 0.05$) L* values for internal cooked color than all other treatments, with all ground beef alternative patties having the lowest ($P < 0.05$) L* values. For texture attributes (Table 2), retail ground beef alternative and foodservice ground beef alternative had lower ($P < 0.05$) values for cohesiveness, gumminess, hardness, and chewiness, as well as higher values for springiness, than all other treatments evaluated. Few differences were found between traditional ground beef alternative and 20% and 30% fat ground beef for texture, with traditional ground beef alternative only found softer and less chewy ($P < 0.05$) than both ground beef treatments. For shear force, the three ground beef alternatives were more tender

($P < 0.05$) than all three ground beef treatments, with foodservice ground beef alternative and retail ground beef alternative being more tender ($P < 0.05$) than all treatments. The three ground beef treatments had greater ($P < 0.05$) pressed juice percentage values than all ground beef alternatives, indicating the ground beef was juicier than any of the ground beef alternatives evaluated. Finally, during cooking, the three ground beef treatments had a greater ($P < 0.05$) cook loss percentage and decrease in patty diameter and thickness than the three ground beef alternatives, with foodservice ground beef alternative and retail ground beef alternatives increasing in thickness during cooking (Table 3).

## Implications

This provides evidence that although ground beef alternative products attempt to mimic ground beef, they provide very different color, texture, tenderness, and cooking characteristics than traditional ground beef.

## Acknowledgments

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## References

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Lopez-Alt, J. K. 2020. How Do They Make Plant-Based Meat Behave Like Beef? The New York Times. *https://www.nytimes.com/2020/03/03/dining/plant-based-meat-science.html*. Accessed June 23, 2020.

**Table 1. Raw, cooked surface and cooked internal color values for ground beef and plant-based ground beef alternative patties**

| | Raw color | | | Cooked surface color | | | Cooked internal color | | |
|---|---|---|---|---|---|---|---|---|---|
| **Treatment** | **L*** | **a*** | **b*** | **L*** | **a*** | **b*** | **L*** | **a*** | **b*** |
| Ground beef 90% lean/10% fat | 53.6$^{a}$ | 22.4$^{bc}$ | 22.6$^{d}$ | 37.3$^{bc}$ | 08.4$^{c}$ | 17.1$^{e}$ | 51.7$^{b}$ | 11.3$^{ab}$ | 19.3$^{bc}$ |
| Ground beef 80% lean/20% fat | 53.4$^{a}$ | 24.0$^{b}$ | 25.5$^{c}$ | 38.9$^{ab}$ | 9.1$^{b}$ | 19.7$^{bc}$ | 56.1$^{a}$ | 9.2$^{c}$ | 18.7$^{c}$ |
| Ground beef 70% lean/30% fat | 29.4$^{d}$ | 21.3$^{c}$ | 46.7$^{a}$ | 40.4$^{a}$ | 8.2$^{c}$ | 18.0$^{de}$ | 57.2$^{a}$ | 7.6$^{d}$ | 17.5$^{d}$ |
| Retail ground beef alternative | 52.4$^{a}$ | 11.6$^{e}$ | 14.0$^{f}$ | 36.0$^{c}$ | 12.7$^{a}$ | 18.7$^{cd}$ | 42.3$^{c}$ | 11.6$^{a}$ | 16.6$^{e}$ |
| Food service ground beef alternative | 49.4$^{b}$ | 17.8$^{d}$ | 20.6$^{e}$ | 37.3$^{bc}$ | 8.1$^{c}$ | 20.8$^{b}$ | 41.5$^{c}$ | 12.7$^{a}$ | 19.9$^{b}$ |
| Traditional ground beef alternative | 42.7$^{c}$ | 31.4$^{a}$ | 29.7$^{b}$ | 34.0$^{d}$ | 12.6$^{a}$ | 24.4$^{a}$ | 42.7$^{c}$ | 10.0$^{bc}$ | 28.0$^{a}$ |
| Standard error mean (largest) of the least square means | 0.72 | 0.60 | 0.62 | 0.66 | 0.24 | 0.47 | 0.54 | 0.53 | 0.25 |
| *P*-value | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 |

[abcdef] Least square means without a common superscript differ ($P < 0.05$).
L* = lightness (0 = black and 100 = white).
a* = redness (-60 = green and 60 = red).
b* = blueness (-60 = blue and 60 = yellow).

**Table 2. Texture profile analysis,[1] Warner/Bratzler shear force, and pressed juice percentage results for ground beef and plant-based ground beef alternative patties**

| Treatment | Hardness | Cohesiveness | Springiness | Gumminess | Chewiness | Warner Bratzler shear force (lb) | Pressed juice percentage[2] |
|---|---|---|---|---|---|---|---|
| Ground beef 90% lean/10% fat | 17.2[b] | 31.4[b] | 65.6[a] | 5.4[b] | 3.5[b] | 7.5[a] | 12.7[b] |
| Ground beef 80% lean/20% fat | 21.9[a] | 34.5[a] | 68.6[a] | 7.7[a] | 5.2[a] | 7.7[a] | 14.7[a] |
| Ground beef 70% lean/30% fat | 14.5[c] | 31.4[b] | 55.3[b] | 4.6[b] | 2.6[c] | 6.8[a] | 15.5[a] |
| Retail ground beef alternative | 3.6[e] | 21.5[c] | 39.8[c] | 0.8[c] | 0.3[d] | 4.0[c] | 8.7[d] |
| Food service ground beef alternative | 8.0[d] | 19.8[c] | 42.8[c] | 1.6[c] | 0.7[d] | 4.4[c] | 11.4[c] |
| Traditional ground beef alternative | 17.1[b] | 31.5[b] | 65.3[a] | 5.4[b] | 3.6[b] | 5.5[b] | 3.0[e] |
| Standard error mean (largest) of the least squares means | 0.8 | 0.7 | 1.2 | 0.4 | 0.2 | 0.2 | 0.4 |
| *P*-value | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 |

[1]Texture profile methods as followed from Wilfong, A.K., K.V. McKillip, J.M. Gonzalez, T.A. Houser, J.A. Unruh, E.A.E. Boyle, and T.G. O'Quinn. 2016. Determination of the effect of brand and product identification on consumer palatability ratings of ground beef patties. J. Anim. Sci. 94:4943-4958. doi:10.2527/jas.2016-0894.

[2]Percent juice pressed from sample.

[abc]Least squares means in the same column lacking a common superscript differ ($P < 0.05$).

**Table 3. Patty shrink and cook loss of ground beef and ground beef alternative patties**

| | Patty shrink and cook loss[1] | | |
|---|---|---|---|
| Treatment | Diameter shrink[2] | Thickness shrink[2] | Cook loss[2] |
| Ground beef 90% lean/10% fat | 11.2[b] | 12.2[a] | 17.6[b] |
| Ground beef 80% lean/20% fat | 16.2[a] | 5.8[ab] | 25.9[a] |
| Ground beef 70% lean/30% fat | 15.5[a] | 3.2[b] | 27.5[a] |
| Retail ground beef alternative | 1.0[c] | -10.3[c] | 12.9[c] |
| Food service ground beef alternative | -1.5[d] | -15.3[c] | 8.5[d] |
| Traditional ground beef alternative | 0.4[c] | 3.1[b] | 1.3[e] |
| Standard error mean (largest) of the least square means | 0.64 | 2.55 | 0.65 |
| *P*-value | < 0.01 | < 0.01 | < 0.01 |

[abcde]Least squares means without a common superscript differ ($P < 0.05$).

[1]Negative values indicate patty expansion for both diameter and/or thickness.

[2]Values expressed as % shrink ((raw patty measurement - cooked patty measurement)/raw patty measurement) × 100.