Quality traits of plant-based ground beef alternatives in comparison to ground beef of various fat levels

Cattle and Forage Feed Days
August 3, 2021

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Ground Beef

- Most consumed beef product in U.S.
- Americans consume 26 lb of ground beef annually (Beef2Live, 2021)
- Accounts for 63% of beef sales volume at foodservice and 49% at retail (Speer et al., 2015)

Plant-Based Background

- Not a new concept: at least 3 distinctive waves
- First waves targeted vegetarian consumers
- Modern GBA actively targeting beef consumers
PB Ground Beef Alternatives

- Increased in retail sales by more than 45% over the past year (Garver, 2021)
- Increased by more than 20% in market-share in foodservice (KBC, 2021)
- Global market share expected to grow by 318% by 2027 (Grand View Research, 2020)

- Numerous products now available in retail and foodservice
- Most of the “traditional” products were mainly composed of soy or soy-proteins
- Many “modern” products utilize various bean and pea proteins
Research Objective

Our objective was to evaluate many of the quality traits and eating characteristics of three GBA in comparison to ground beef.

- Many of these GBA products market and position themselves as “similar” or “replacements” for ground beef, though these claims have never been evaluated in a scientific study.

Selected Alternatives

3 plant-based ground beef alternatives (GBA)
Product Overview

- Retail GBA - mostly found in retail markets (pea-protein based)
- Food Service GBA - mostly found in food service establishments (soy and potato protein based)
- Traditional GBA - most indicative of a traditional soy-based patty

Methods

- 15 lots each of 70/30, 80/20, 90/10 Ground Beef
- 15 Lots each of RGBA, FGBA, and TGBA
- ¼ lb. hand pressed patties
Consumer Taste Testing

- 120 Consumers (Manhattan, KS area)
- Cooked to 160°F
- Served blind in random order

Traits Evaluated

- Appearance
- Juiciness
- Tenderness
- Texture Liking
- Overall Flavor Liking
- Beef Flavor Liking
- Overall Liking
Trained Sensory Analysis

- Cooked same manner as consumer panels
- Color evaluated in normal light
- All other traits evaluated under red light

Traits Evaluated
- Juiciness
- Tenderness
- Beef Flavor ID
- Beef Flavor Intensity
- Off Flavor
- Texture
- Color
- Beef Odor
- Non-Beef Odor
Objective Measurements

- Shear Force
- Pressed Juice Percentage
- Texture Profile Analysis
- Instrumental Color
- Fat and Moisture Percentage
- Cook Time and Cook Loss

Results
Consumer Ratings for Appearance

Scale: 0 = Dislike Extremely
100 = Like Extremely

Least squares means lacking a common superscript differ (P < 0.05)

Consumer Ratings for Juiciness

0 = Extremely Dry
100 = Extremely Juicy

Least squares means lacking a common superscript differ (P < 0.05)
**Consumer Ratings for Tenderness**

Scale: 0 = Extremely Tough  
100 = Extremely Tender  
Least squares means lacking a common superscript differ (P <0.05)

**Consumer Ratings for Beef Flavor Liking**

Scale: 0 = Dislike Extremely  
100 = Like Extremely  
Least squares means lacking a common superscript differ (P <0.05)
Consumer Ratings for Overall Flavor Liking

Scale: 0= Dislike Extremely
100= Like Extremely

Least squares means lacking a common superscript differ (P <0.05)

Consumer Ratings for Texture Liking

Scale: 0= Dislike Extremely
100= Like Extremely

Least squares means lacking a common superscript differ (P <0.05)
Consumer Ratings for Overall Liking

Scale: 0 = Dislike Extremely
100 = Like Extremely

Least squares means lacking a common superscript differ ($P < 0.05$)

Trained Sensory Results
Trained Panel Ratings for Juiciness

Scale: 0 = Extremely Dry
100 = Extremely Juicy

Least squares means lacking a common superscript differ (P < 0.05)

Trained Panel Ratings for Tenderness

Scale: 0 = Extremely Tough
100 = Extremely Tender

Least squares means lacking a common superscript differ (P < 0.05)
Trained Panel Ratings for Beef Flavor ID

Scale: 0 = Extremely Un-beef-like
100 = Extremely Beef-like

Least squares lacking a common superscript differ (P < 0.05)

Trained Panel Ratings for Beef Flavor Intensity

Scale: 0 = Extremely Bland
100 = Extremely Intense

Least squares means lacking a common superscript differ (P < 0.05)
Trained Panel Ratings for Texture

Scale: 0 = Extremely Soft  
100 = Extremely Hard  
Least squares means lacking a common superscript differ (P < 0.05)

Trained Panel Ratings for Off Flavors

Scale: 0 = None  
100 = Intense  
Least squares means lacking a common superscript differ (P < 0.05)
Trained Panel Ratings for Beef Odor

Scale: 0 = Not prevalent
100 = Extremely Prevalent
Least squares means lacking a common superscript differ (P < 0.05)

Trained Panel Ratings for Non-Beef Odor

Scale: 0 = Not prevalent
100 = Extremely Prevalent
Least squares means lacking a common superscript differ (P < 0.05)
Objective Measure Results

Shear Force

Kg of force

90/10  80/20  70/30  RGBA  FGBA  TGBA

Least squares means lacking a common superscript differ (P < 0.05)
Pressed Juice Percentage

Least squares means lacking a common superscript differ ($P < 0.05$)

Cook Loss

Least squares means lacking a common superscript differ ($P < 0.05$)
Diameter Shrink

Thickness Shrink

Least squares means lacking a common superscript differ ($P < 0.05$)
Cook Time

Least squares means lacking a common superscript differ ($P < 0.05$)

Raw Color

Least squares means in the same group lacking a common superscript differ ($P < 0.05$)
Cooked Surface Color

Least squares means in the same group lacking a common superscript differ \( (P < 0.05) \)

Cooked Internal Color

Least squares means in the same group lacking a common superscript differ \( (P < 0.05) \)
Texture Profile Analysis

Least squares means in the same group lacking a common superscript differ ($P < 0.05$)
Conclusions

GBA differed from ground beef for most traits evaluated.

Few differences among ground beef samples, but substantial differences were found among GBA.

Consumers, retailers, & marketers of GBA should consider these very different products from ground beef.

Future Considerations

• Though our study produced clear, decisive evidence of the difference between the GBA and ground beef and consumers indicated a strong preference for ground beef over the GBA, demand and sales for these products continue to increase.

• This discrepancy between our data and “real world” evidence might be due to the inclusion of these products as an ingredient as opposed to the sole product.

• Further investigation is needed related to how these products perform with other ingredients included (i.e. burgers, tacos, etc.) to help bridge this gap in current knowledge.
Questions?