

Sensory Effects of Gamma, X-ray and E-beam Irradiation on Hamburger and Poultry

Abstract:

Objective

To evaluate the sensory characteristics of irradiated chicken breasts and hamburger patties, to determine if differences exist between cooked treated and control samples, and if so, whether they are technology or dose related, using a trained descriptive sensory panel.

Sensory Evaluation

A trained sensory descriptive panel evaluated the appearance of the poultry, and texture and flavor of the chicken and beef. Color (internal pinkness) of the chicken was visually measured by the panel.

Irradiation Treatments

Three irradiation technologies [gamma ray, x-ray, electron beam (e-beam)] were applied to the meats at 1, 2, and 3 kiloGrays (kGy); controls (no irradiation treatment) were included for both types of meat.

Results

No statistically significant and meaningful sensory differences were found for the hamburger patties. Color of the irradiated chicken was slightly more pink relative to the control. No other sensory differences were noted for chicken.

Table 1. Acceptable Dosages Approved by the FDA and USDA.

Irradiation Doses—Food Applications		
Food Product	Approved Dose Range	Approved Purpose
Poultry	3.0 kGy max	Bacterial Pathogen Reduction
Red Meat	4.5 kGy max for Fresh	Bacterial Pathogen Reduction
	7.0 kGy max for Frozen	

- Consumer awareness and acceptance of irradiated food products has increased. Now industry can turn from its primary concern of food safety to take interest in the effects on sensory characteristics.
- While food safety is still the primary concern, industry strives to deliver safe foods while maximizing consumer appeal.
- This research was conducted to investigate what, if any, sensory effects result from the application of gamma, x-ray, and e-beam at three different dosage levels on chicken breasts and hamburger patties.

Methodology

Study Variables

- Meats (chicken and beef) from the same production lot were shipped directly from suppliers to IBA's Food Safety Division for treatment. The control samples were not treated (Fig. 1).

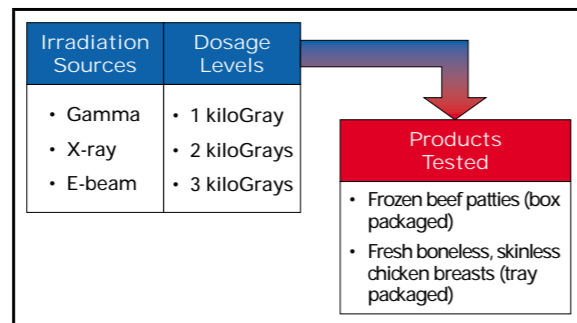


Fig. 1. Research Variables were Meat Type, Irradiation Technology and Dosages Level.

Sample Storage

- Upon receipt at TIAX LLC, products were refrigerated (chicken) or frozen (beef) until evaluated by the sensory panel.
- Frozen beef samples were placed in a refrigerator the day prior to panel evaluation to thaw.

Experimental Design

- Three variables were examined in the design—technology, dosage levels, and location within the package, using Analysis of Variance (ANOVA).
- > **Chicken**—all technologies and dose levels.
- > **Beef**—all irradiation treatments and dosages with the exception of no 3 kGy level for the gamma technology.
- Placement in the original packaging (left, middle, and right) was recorded and represented the three replicates.

Cooking Protocol

- Procedures were established and food safety practices were followed.
- > Gloves were worn when handling the food.
- > Cross-contamination was prevented by using clean cooking utensils/dishes or washing between samples.
- > A clam-shell style electric grill was used to cook all samples; placement of the meat on the grill was standardized.
- > A temperature probe was used to ensure an internal serving temperature of 170°F. The probe was inserted into the center of the meat, and then other areas were checked to ensure proper temperature before serving.

Sensory Method [Profile Attribute Analysis (PAA)]

- PAA is a quantitative descriptive sensory method used by a trained panel for evaluating products.
- Attributes were quantified on a 1–7 point integer scale and results were used to test for treatment differences.

Panel Details

- Samples were randomized and presented blinded using three-digit codes.
- Four-five samples were evaluated per panel.
- Samples were served immediately after cooking at 170°F.
- Each sample was evaluated by panelists following a standardized procedure and associated definition (Fig. 2) for the following categories:
 - > Appearance (on chicken only)
 - > Texture
 - > Flavor

Internal Pinkness (chicken only) measures the pink color of the interior section of the meat when cut. The scale ranges from none to much.

Toughness measures the length of time or number of chews needed before swallowing. The scale ranges from tender to tough.

Juiciness is a measure of the amount of fluid released from the meat when chewed. The scale ranges from dry to juicy.

Balance is a measure of the degree of blend or the balance of the character notes in the flavor complex.

Fullness refers to the fullness and body of flavor or the degree of complexity.

Chicken Aromatics (chicken only) intensity is a measure of the strength and type of the chicken characteristics, i.e., cooked chicken, fat and brothy. The scale ranges from none to strong.

Meat Aromatics Intensity (hamburger only) is a measure of the strength and type of meat/fat aromatics. Descriptor comments include cooked beef and beef fat. The scale ranges from none to strong.

Decayed Protein is a measure of the degradation of the meat protein. The scale ranges from none to strong.

Sweet intensity is a measure of the level of sweet basic taste. The reference standards are sucrose solutions and the scale ranges from none to strong.

Sour intensity is a measure of the level of sour basic taste. The reference standards are citric acid solutions and the scale ranges from none to strong.

Salty is a measure of the level of salt basic taste. The reference standards are sodium chloride solutions and the scale ranges from none to strong.

Bitter intensity is a measure of the level of bitter basic taste. The reference standards are caffeine solutions and the scale ranges from none to strong.

Mouthfeel is a measure of the perceived amount of trigeminal effects such as drying, fatty mouthfeel or serummy mouthfeel. The scale ranges from none to strong.

The **Others** attribute includes basic tastes of aromatics (often off-flavors) that are not measured in any of the previous attributes. The others are rated none-to-strong and may include metallic, cardboard and/or livery.

Package Effects measures the perceived amount of plastic and styrene aromatics. The scale ranges from none to strong.

The **Aftertaste** attribute measures any basic tastes, aromatics or mouthfeels remaining in the mouth one minute after swallowing.

Fig. 2. The Profile Attributes for Hamburger Patties and Chicken Breasts.

Scales

- A seven-point integer scale was used to measure attribute intensities (Fig. 3 and Fig. 4).

Type	Attributes	Descriptors Recorded	Scale
			1 2 3 4 5 6 7
Texture	Toughness		Tender ← → Tough
	Juiciness		Dry ← → Juicy
Flavor	Balance		Unbalanced ← → Balanced
	Fullness		Thin ← → Full
	Meat Aromatics Intensity	✓	None ← → Strong
	Decayed Protein	✓	None ← → Strong
	Sweet		None ← → Strong
	Sour		None ← → Strong
	Salty		None ← → Strong
	Bitter		None ← → Strong
	Mouthfeel	✓	None ← → Strong
	Others	✓	None ← → Strong
	Package Effects		None ← → Strong
	Aftertaste		None ← → Strong

✓ Panelists record word descriptors for the indicated attributes.

Fig. 3. Attributes Defined for the Hamburger Patty Evaluation Using Profile Attribute Analysis.

Type	Attributes	Descriptors Recorded	Scale
			1 2 3 4 5 6 7
Appearance	Internal Pinkness		None ← → Much
Texture	Toughness		Tender ← → Tough
	Juiciness		Dry ← → Juicy
Flavor	Balance		Unbalanced ← → Balanced
	Fullness		Thin ← → Full
	Chicken Aromatics Intensity	✓	None ← → Strong
	Decayed Protein	✓	None ← → Strong
	Sweet		None ← → Strong
	Sour		None ← → Strong
	Salty		None ← → Strong
	Bitter		None ← → Strong
	Mouthfeel	✓	None ← → Strong
	Others	✓	None ← → Strong
	Package Effects		None ← → Strong
	Aftertaste		None ← → Strong

✓ Panelists record word descriptors for the indicated attributes.

Fig. 4. Attributes Defined for the Chicken Breast Evaluation Using Profile Attribute Analysis.

Statistical Analysis

- Repeated measures ANOVA with Duncan's Multiple Comparison test.

Results—Chicken Breasts

Sensory characteristics for the control chicken breasts were not different from the irradiated samples, with the exception of internal pinkness (Fig. 5).

Table 2. Mean Values for Chicken Internal Pinkness Attribute

Dose	Internal Pinkness (1 = none, 7 = much)
Control	1.39 a
1 kGy	2.36 b
2 kGy	2.36 b
3 kGy	2.58 b

Means sharing a common letter are not significantly different at the 95% confidence level based on Duncan's Multiple Comparison test.

- Color (Internal Pinkness)
 - > The control was very slightly less pink than treated chicken (Table 2).
 - > Results show a dose dependency effect for color (more pink at a dose of 3 kGy than 1 kGy), but was never higher than a slight amount.
- No other attributes measured showed meaningful effects due to technology, dose level, or package location.

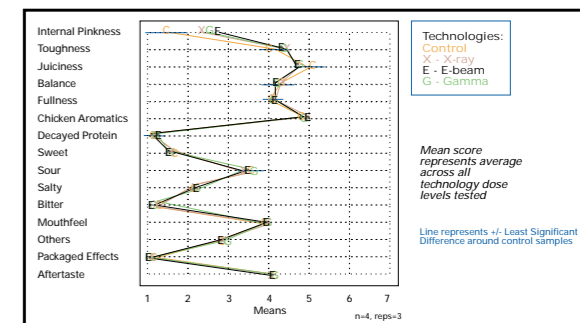


Fig. 5. Sensory Profile Plot for Chicken Breasts.

Results—Hamburger Patties

No statistically significant sensory differences were found for the hamburger patties using a trained descriptive panel (Fig. 6).

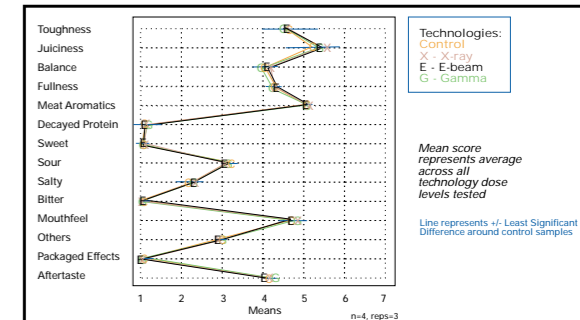


Fig. 6. Sensory Profile Plot for Hamburger Patties.

Discussion

- In this study, overall sensory ratings for the attributes tested does not appear to be strongly affected by the type or amount of irradiation applied to frozen beef patties or fresh chicken breasts.
- A character note which did show some difference between the treated and control samples was the appearance character "pinkness" for the chicken. Irradiated chicken samples were judged to be very slightly more pink than untreated. Given consumers' sensitivity to color when determining "doneness" of meats, this factor should be part of the education campaign of the irradiation industry.

Conclusions

- Results from this research indicate that at average application doses of irradiation, fresh and frozen meat products will not be adversely affected in texture or taste.
- This information can be used to support the use of food irradiation in meat and poultry to advance food safety practices.
- In addition, it may be used for consumer education purposes to generate awareness and a positive message regarding this food safety technology.

References

Food Irradiation: Applications and Barriers To Use in the Global Food Marketplace. *Food Chemical News* (1998).
Zammer, C.M. (2003). A Matter of Taste. *Food Processing*, pp. 42–46.