

**Zamorano University**  
**Food Science and Technology Department**  
**B.S. in Food Science and Technology**



Special Graduation Project  
**Consumer acceptability of pork products fed with three different diets**

Ana Sofía Lagos Mendoza

Advisors

Raúl Espinal, Ph.D.

Bailey Harsh, Ph.D.

Honduras, November 2025

**Authorities**

**KEITH ANDREWS**

President I.A.

**ANA M. MAIER ACOSTA**

Vice President and Academic Dean

**ADELA M. ACOSTA MARCHETTI**

Director of Food Science and Technology Department

**JULIO NAVARRO**

Secretary General

### **Acknowledgments**

My profound gratitude to Dr. Bailey Harsh, Ph.D. and Dr. Anna Dilger, Ph.D. and everyone at the Meat Science Laboratory for their kindness, for their invaluable support, guidance, and mentorship throughout the development of my thesis. Their expertise and willingness to share their knowledge have been fundamental to my academic and professional growth. I am sincerely thankful for the time and dedication they invested in helping me shape this project into a meaningful contribution.

## Table of Contents

Authorities .....	2
List of Tables .....	5
List of Appendices .....	6
Abstract .....	7
Resumen .....	8
Introduction .....	9
Materials and Methods.....	12
Collection of Materials.....	12
Statistical Analysis.....	13
Cooking Method .....	13
Sample Preparation .....	14
Sensory Evaluation Protocol —Overall Liking and Preference Testing Taste Panels.....	15
Assignment of Codification for each Treatment.....	15
Results and Discussion .....	17
Consumer Acceptability and Preference Analysis for Ham Using T-Test and Chi-Square .....	17
Consumer Acceptability and Preference for Bacon using ANOVA and Chi-Square Test .....	20
Consumer Acceptability and Preference for Ground Pork Patties using ANOVA and Chi-Square Test	23
Conclusions .....	27
Recommendations .....	28
References .....	29
Appendices.....	32

### List of Tables

Table 1 Description of Pork Treatments Used in the Evaluation of Consumer acceptability of pork products fed with three different diets .....	13
Table 2 Sensory Evaluation Ballot using a 7-point hedonic scale for Bacon, Ham, or Pork Patties.....	16
Table 3 Overall Acceptability of Ham Samples .....	17
Table 4 Frequency distribution of preference for Ham Samples.....	18
Table 5 Frequency Distribution of Hedonic Scores for Ham Samples .....	18
Table 6 Overall Acceptability of Bacon Samples.....	20
Table 7 Frequency Distribution of Preference for Bacon Samples .....	20
Table 8 Frequency Distribution of Hedonic Scores for Bacon Samples.....	21
Table 9 Overall Acceptability of Ground Pork Patties Samples .....	24
Table 10 Frequency Distribution of Preference for Ground Pork Patties Samples .....	24
Table 11 Frequency Distribution of Hedonic Scores for Pork Patties.....	24

### List of Appendices

Appendix A Sensory Evaluation Ballot Used for Consumer Testing of Pork Products.....	32
Appendix B ANOVA Precision Oven used for Cooking Bacon.....	33
Appendix C Southbend Convection Oven used for Cooking Pork Patties .....	34
Appendix D Crockpot used for Heating Deli Ham.....	35
Appendix E Sensory Evaluation Protocol – Worksheet.....	36
Appendix F American Meat Science Research Association Guidelines for Cookery, Sensory Evaluations, and Instrumental Tenderness Measurements of Meat.....	37

### Abstract

This study evaluated consumer acceptability and preference (determined by the highest rated sample) for bacon, ham, and ground pork patties obtained from pigs fed with three dietary lipid sources: Lipinate (jojoba oil), LIPEX EF 369 (flaxseed oil), and a control (soybean-based diet). A sensory evaluation was conducted with 72 untrained panelists using a 7-point hedonic scale at the University of Illinois at Urbana-Champaign. The sensory analysis followed a Randomized Complete Block Design (RCBD), and acceptance scores for bacon and ground pork patties were analyzed using One-Way ANOVA followed by Duncan's Multiple Range Test for Mean Separation. Ham samples were analyzed using a T-Test and a Chi-squared Test. All products derived from the LIPEX EF 369 diet received significantly higher acceptability scores ( $P \leq 0.05$ ), with 43 panelists preferring samples from this treatment, which is likely due to the omega-3 fatty acid content and their aroma development, to the concentration of volatile compounds. In contrast, products from the Lipinate diet were the least accepted, possibly due to oxidative changes intensified by grinding and cooking. Concerning the patties, the control diet was most preferred. While omega-3 enrichment appeared to enhance acceptability in bacon and ham, this effect was not evident in preference for ground patties, suggesting that sensory outcomes may depend on product type and processing. Overall, dietary lipid inclusion may improve nutritional quality without compromising sensory acceptance.

*Keywords:* dietary lipids, LIPEX EF 369, omega-3, sensory evaluation

## Resumen

Este estudio evaluó la aceptabilidad y preferencia (basada en la puntuación más alta de las opciones) del consumidor de productos cárnicos: tocino, jamón y tortas de carne molida de cerdo obtenidas de cerdos alimentados con tres fuentes de lípidos dietéticos: Lipinate (aceite de jojoba), LIPEX EF 369 (aceite de linaza) y un control (dieta a base de soya). Se realizó una evaluación sensorial con 72 panelistas no capacitados utilizando una escala hedónica de 7 puntos en la Universidad de Illinois en Urbana-Champaign. El análisis sensorial siguió un Diseño de Bloques Completos Aleatorizados (RCBD), y los puntajes de aceptación para las hamburguesas de tocino y carne molida de cerdo se analizaron mediante ANOVA de una vía seguido de la Prueba de Rango Múltiple de Duncan para Separación de Medias. Las muestras de jamón se analizaron mediante una Prueba T y una Prueba de Chi-cuadrado. Todos los productos derivados de la dieta LIPEX EF 369 obtuvieron puntuaciones de aceptabilidad significativamente más altas ( $P \leq 0.05$ ). Cuarenta y tres panelistas prefirieron las muestras de este tratamiento, probablemente debido al contenido de ácidos grasos omega-3 que contribuyen al desarrollo de nuevos aromas intensificados. Por el contrario, los productos de la dieta Lipinate fueron los menos aceptados, posiblemente debido a los cambios oxidativos intensificados por la molienda y la cocción. En el caso de las hamburguesas, la dieta control fue la mayor preferida. Si bien el enriquecimiento con omega-3 pareció mejorar la aceptabilidad en el caso del tocino y el jamón, este efecto no fue evidente en la preferencia por las tortas de carne molidas, lo que sugiere que los resultados sensoriales podrían depender del tipo de producto y su procesamiento. En general, la inclusión de lípidos en la dieta puede mejorar la calidad nutricional sin comprometer la aceptación sensorial.

*Palabras clave:* lípidos en la dieta, LIPEX EF 369, omega-3, evaluación sensorial

## Introduction

Pork quality is influenced by many factors, including genotype (genetic background of the pig), rearing conditions (level of feeding, environmental, and housing system), pre-slaughter handling, slaughter method, storage conditions, and more. (Pandey et al., 2024). Feeding strategies or diets are a factor that is actively used for the management of live animal performance but also has implications for the quality and nutritional value of pork products (Andersen et al., 2005). Consequently, innovative feed ingredients are fundamental for pork producers, as they directly influence carcass weight, muscle growth, lipid content, and composition in terms of nutritional value.

Precision feeding requires developing new feeding strategies to refine the adjustment of nutrient supply to requirements (Gaillard et al., 2020). This approach enables the formulation of diets that can create a more efficient feeding strategy based on the specific production system. The enhancement of meat production through finishing diets ensures pork products meet market expectations for a desirable nutritional profile and high-quality sensory characteristics.

In the U.S., meat consumption has been rising since the 1970s. Pork ranks third in annual U.S. meat consumption, behind beef and chicken, averaging (50.2 pounds per person) in 2023 (Widmar, 2024). Red meat has long been recognized as a significant source of protein, primarily valued for its nutritional benefits. However, the composition of fat in pork specifically is vital for product quality. The composition of fatty acids mainly depends on the genetic origin, age, weight at slaughter, feed composition, and husbandry systems (Morgan et al., 1992).

Pork contains varying amounts of fat. The proportion of fat in pork usually ranges from 10% to 16% but can be much higher depending on the level of trimming and other factors (Arnarson, 2023). Unlike ruminants, monogastric animals like pigs are categorized as homolipid organisms, meaning the fatty acids they deposit into subcutaneous and intramuscular fat are directly proportional to the fatty acid composition of their diet (Dugan et al., 2015).

In swine production, dietary lipids are commonly used throughout all stages of pork production except during gestation. Fat typically adds up to 5% to swine diets. This supplementation offers many benefits, among them improvements in diets with high levels of lactose, growth performance, boosted feed efficiency, and increased dietary energy density (Kansas State University, 2022). This highlights the critical role of feeding strategies in modulating pork fat and content quality depending on the processor's expected outcome.

Fatty acid composition correlates with various meat components such as flavor, juiciness, and texture. Specific dietary lipids influence the sensory characteristics of pork. Lipids contribute to food flavor generation in many ways during different processes, such as heating, cooking, and storage conditions (Shahidi & Hossain, 2022). Diets enriched with unsaturated fats will increase the iodine value and fat softness of pork carcasses. Increasing the concentration of unsaturated fatty acids in pork carcasses results in softer fat, which negatively affects processing characteristics such as the firmness of the belly for bacon products and the ability of pork products to meet export specifications (Carr et al., 2005).

Softer bellies may result in bacon slices sticking together, an oily appearance in the package, separation of fat from lean during slicing, and increased oxidative rancidity (Carr et al., 2005). Therefore, evaluating the sensory characteristics of pork products originating from pigs with different diets becomes essential for understanding the consumer's preference and acceptability of pork products.

Acceptance and preference of the sensory properties of foods are among the most important criteria for determining food choice (Byrne, 2020). A comprehensive understanding of consumer behavior is essential for guiding product development and enhancing new offerings in the market. In the context of pork, understanding and optimizing juiciness, flavor, tenderness, and overall consumer appeal are critical to maximizing gain for both livestock producers and consumers. The intrinsic characteristics of meat are linked to the purchase decision of consumers. Taste/flavor, tenderness,

and leanness are all meat attributes that can be directly influenced by livestock producers through breeding and diet (University of Nevada, 2025).

The present study aimed to evaluate consumer preferences of three different pork products—patties, ham, and bacon—derived from pigs fed a commercial diet containing three different oil sources: Lipinate (jojoba oil), Lipex (flaxseed oil), and soybean meal, and explore potential associations between dietary lipid sources and consumer acceptability of pork products, based on sensory evaluation outcomes.

## Materials and Methods

### Study Location

All meat products were produced by the Meat Laboratory of Iowa State University. The sensory analysis was conducted at the College of Agriculture, Consumer, and Environmental Sciences (ACES) Library of the University of Illinois at Urbana-Champaign. All meat samples were cooked and prepared at the Meat Science Laboratory located in the same institute.

### Collection of Materials

Unsalted crackers and purified water were given to participants and served as a palate cleanser. A sensory evaluation sheet was provided for each participant to record the data.

Ham

Bacon

Ground pork patties

Unsalted Crackers

Water

Demographic survey questions

Sensory evaluation ballots

### Description of Pork Treatments Based on Dietary Lipid Sources

Three dietary treatments were used during the growing phase of pigs in this study, formulated and provided by Pig Hills Farm Company. All diets were formulated with soybean meal, which is the most important protein source in farm animal nutrition due to the high quality of the amino acid profile and the dependable ingredient supply (Panagiota Florou-Paneri, 2014). Treatments A and C followed the farm's standard soybean meal formulation, while Treatment B had a higher soybean meal inclusion. Treatment B also contained LIPEX EF 369, a product made from a proprietary process that encapsulates n-3 PUFA extracted from partially digested whole flaxseeds. This process, in turn, makes the n-3 PUFA more bioavailable in the formulated diet (Gonzalez et al., 2020). In addition,

treatment A contained Lipinate Easy Feed, an additive used to manage carcass fat composition to improve fat quality in finishing swine by reducing iodine values (Elanco Animal Health, n.d).

### Statistical Analysis

A 95% confidence level ( $P \leq 0.05$ ) was used for all statistical analyses. The sensory evaluation was conducted using a 7-point hedonic scale to measure overall acceptance. A one-way ANOVA was used to detect differences among treatments, followed by Duncan's multiple range test for mean separation. The sensory data was analyzed using a Randomized Complete Block Design (RCBD), where panelists were treated as blocks and pork samples as experimental units. Additionally, preference data collected from the ballots were analyzed using chi-squared tests and frequency distributions to assess consumer choice patterns. For pairwise comparisons between two treatments, a t-test was applied.

### Cooking Method

Table 1 provides an overview of the treatments assessed from which ground pork patties, bacon, and ham products were made, and a reference for knowing the dietary lipid sources and the processing conditions for sensory analysis is provided.

**Table 1**

*Description of Pork Treatments Used in the Evaluation of Consumer acceptability of pork products fed with three different diets*

Treatment / Diet	Products	Cooking Method	Serving Size
Control (Standard diet) Lipinate Lipex	Ground Pork Patties	Oven preheated to 204°C, flipped halfway through; removed at 71°C.	Cut into 8 equal portions.
Control (Standard diet) Lipinate Lipex	Bacon	Air fried at 180°C	Served into 1- to 2-inch segments
Control (Standard diet) Lipex	Ham	Slow-cooked in a crockpot until reaching 60°C	Cut into 1x1 cm cubes.

*Note.* All products were processed under uniform conditions before sensory analysis.

## Sample Preparation

Products were transferred from Iowa State University to the University of Illinois at Urbana-Champaign and stored at  $-18^{\circ}\text{C}$  to ensure long shelf life and quality.

Cured meat products such as bacon and ham were held in refrigeration at  $4^{\circ}\text{C}$  before cooking. Uncured products such as pork patties were defrosted for 24 hours in the cooler at  $4^{\circ}\text{C}$  before the cooking procedures began.

15 ground pork patties were placed in a tray and cooked in the preheated Convection Oven South Bend at  $204^{\circ}\text{C}$ . Once the patties were halfway through, they were flipped and finally removed once the oven reached  $71^{\circ}\text{C}$ . Every treatment was cooked in two full trays, for a total of 6 trays used. Later, the patties were left to cool in the oven and then cut into 8 equal pieces and placed in aluminum trays.

The bacon arrived pre-sliced, but it was still in belly form, meaning the full slab was intact. Therefore, the pieces were separated manually and arranged with approximately 15–16 slices per tray. Then it was taken to be air-fried for approximately 15 minutes in the preheated Anova Precision Oven, cooked at  $180^{\circ}\text{C}$ , and cut and served in 1- to 2-inch segments. 8 trays of bacon were used in total.

Two Deli Hams of each treatment were sliced and cut to produce the 1x1 cm cube samples that were heated in a manual slow cooker crockpot at low temperature to reach  $60^{\circ}\text{C}$ , then cut into.

All products were rotated to minimize differences between samples; they were rotated during baking by interchanging the positions of the trays, moving those from the lower racks to the upper ones and vice versa to prevent the upper patties, bacon, and ham from appearing more visually appealing or overcooked. All cooking temperatures were monitored using a digital thermometer to ensure accuracy, and samples were portioned according to treatment specifications to ensure consistency in serving sizes. All cooked samples were immediately transferred to aluminum trays,

transported in insulated containers and labeled as treatments A, B, and C, and moved to the ACES Library.

### **Sensory Evaluation Protocol —Overall Liking and Preference Testing Taste Panels**

A total of 72 untrained pork consumers were recruited from the university campus to the ACES Library. Participants were all pork consumers and free of dietary restrictions or allergies to pork products.

Five different serving stations were set up, beginning with an opening station that provided instructions to all panelists and assigned each participant a three-digit ID code sticker on their shirt, which they were instructed to record on every ballot received. Additionally, a demographic survey, water was given to each panelist. 3 stations were set up with different pork products (pork patties, bacon, and ham). Each participant received a set of warm pork product category samples on a small plate and sat at the desks in the center of the room. Every desk was provided with pencils, napkins, and unsalted crackers to cleanse the palate between product types and treatments. All stations provided each panelist with a ballot on a 7-point hedonic scale of the product to be evaluated. After completion, the sensory evaluation sheet was returned to the next desk to ensure the proper collection and organization of the data. The last station served as a thank-you station.

### **Assignment of Codification for each Treatment**

Each panelist was assigned a unique, randomly generated three-digit code using an online platform. This code ensured anonymity, allowed consistent tracking throughout the evaluation process, and helped organize the ballots to minimize bias or interference.

Panelists were provided with a sensory evaluation sheet to assess each sample using a 7-point hedonic scale, where 1 = Dislike very much, 2 = Dislike moderately, 3 = Dislike slightly, 4 = Neither like nor dislike, 5 = Like slightly, 6 = Like moderately and 7 = Like very much, in terms of overall acceptability. For preference, the highest score of each panelist was considered the most preferred. The Sensory Evaluation Ballot using a 7-point hedonic scale for bacon, ham, or pork patties is shown in Table 2.

**Table 2**

*Sensory Evaluation Ballot using a 7-point hedonic scale for Bacon, Ham, or Pork Patties*

**BACON/ HAM/ PORK PATTIES**

Panelist ID#:

Please select one of the following for each sample (A, B and C)

Sample	Dislike very much	Dislike moderately	Dislike slightly	Neither like nor dislike	Like slightly	Like moderately	Like very much
A	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
B	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
C	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Panelists were asked to mark an "X" next to the sample they found most pleasant based on their personal preferences.

## Results and Discussion

It is important to highlight that panelists participating in this study were untrained and unaware of the diets behind the treatments. To avoid any bias, no information was provided regarding any nutritional profile/enrichment or formulation. Therefore, the results were influenced by intrinsic characteristics of the products only.

### Consumer Acceptability and Preference Analysis for Ham Using T-Test and Chi-Square

To evaluate the differences among treatments for ham products in terms of consumer acceptability, hedonic scores were analyzed using a two-sample t-test. The analysis revealed a statistically significant difference ( $P \leq 0.05$ ) in overall acceptability, with Sample B (LIPEX-ham-based product) receiving the highest average score ( $5.72 \pm 1.14$ ), while Sample C (standard diet) scored slightly lower ( $5.25 \pm 1.35$ ) (Table 3). Additionally, a chi-squared test was used to identify consumers' frequency of preference between the treatments. Results showed a significant association ( $P \leq 0.001$ ) with 43 panelists preferring sample B (LIPEX EF 369) over sample C (standard diet), with a total of 23 votes, and 6 panelists recording uniform responses for every treatment (Table 4). Overall, these findings suggest that consumers could differentiate between products, with LIPEX EF 369 likely influencing flavor, juiciness, or texture, key standards for preference.

**Table 3**

#### *Overall Acceptability of Ham Samples*

Product	Treatment	Mean Score for Overall Acceptability $\pm$ SD	Probability
Ham	Lipex EF 369	$5.72 \pm 1.14$	0.0249
Ham	Standard	$5.25 \pm 1.35$	

*Note.* Overall Acceptability Mean Score  $\pm$  Standard Deviation represents the sensory evaluation scores recorded on a 7-point scale by untrained panelists.  $P \leq 0.05$  indicates a statistically significant difference between treatments.

**Table 4***Frequency distribution of preference for Ham Samples*

Treatment	Frequency
LIPEX EF 369	43
STANDARD	23
Uniform Responses	6

*Note.* \*Uniform Responses: Panelists who gave the same score for every treatment. Given that the panelists were untrained, responses sometimes consisted of combined letter designations. In cases where panelists selected combined letter preferences (e.g., "B, C"), each letter was treated independently for analysis.  $\chi^2 = P = 0.0138$ , indicating a significant difference in preference distribution among treatments.

Table 5 complements the frequency distribution of preference by displaying the complete distribution of the hedonic scores for each treatment. The distribution aligns with the panelists declared preferences and further supports the overall statistical findings.

**Table 5***Frequency Distribution of Hedonic Scores for Ham Samples*

Treatment	1	2	3	4	5	6	7	Total
LIPEX EF 369	0	0	0	0	7	21	15	43
Standard	0	0	0	1	3	9	10	23
Uniform Responses	0	0	0	0	1	3	2	6
Total	0	0	0	1	10	30	25	72

*Note.* Each number represents the score for each treatment preferred. Total represents the number of panelists who evaluated each treatment.

The enhanced acceptability in LIPEX-ham-based diets may be induced by the increased concentration of omega-3 fatty acids. According to a prior study on the effects of LIPEX as a finishing diet regimen, pigs fed on the LIPEX feeding regimen had more polyunsaturated fatty acids (PUFA), primarily  $\alpha$ -linolenic acid (C18:3n3), eicosapentaenoic acid (C20:5), and docosapentaenoic acid (C22:5) while also decreasing the n-6:n-3 ratio (Gonzalez et al., 2020). PUFAs, which contain two or more double bonds, are crucial sources of aroma volatiles in cooked meat (Elmore & Mottram, 2009).

Consequently, this lipid profile could enhance more desired flavors and influence the development of the ham during cooking.

However, in ham, high levels of polyunsaturated fatty acids (PUFAs), which are extremely sensitive to oxidative deterioration—a chemical process where PUFAs react with oxygen, leading to the degradation of lipids (Amaral et al., 2018)—have been related to rancid odors and may have a critical relevance for consumer cooked ham acceptance (Estévez et al., 2003). Additionally, (Romans et al., 1995) reported that the addition of flaxseed to corn-based diets, which are already high in unsaturated fatty acids, is typically expected to negatively influence the consumer decision, since it can increase softer carcass fat.

Contrary to these concerns, LIPEX-based ham maintained a higher acceptability rate and preference. This outcome may be attributed to the low LIPEX concentration rate of 7.5%, which seems to prevent any noticeable sensory defect. Furthermore, the LIPEX formulation with microencapsulated oil, a process that encapsulates bioactive compounds within a thin film coat (Yakdhane et al., 2021), may improve lipid oxidation by reducing the exposure of unsaturated fatty acids to heat and oxygen.

Warnants et al. (1998) reported that a PUFA content exceeding 23% in fat may lead to undesirable flavor changes when linoleic acid is the predominant PUFA. In line with this, Müller Richli, M. & Scheeder, M (2019) suggested that a lower limit should be considered when linolenic acid predominates, since it is more prone to oxidation than linoleic acid (Ahn et al., 1996). Supporting these outcomes, the results from Müller Richli, M. & Scheeder, M (2019) noted that PUFA content in fat above 18% may lead to perceptible sensory differences. However, it also suggests that a PUFA content of 18.3% is still too low, and the resulting sensory differences are too small to show a negative effect on consumer acceptance. Previous studies have found that only considerably higher contents of PUFA are problematic for sensory acceptance (Meier et al., 2021).

Overall, the findings suggest that omega-3 enrichment in ham, when applied under controlled levels and proper processing conditions, can improve acceptability and enhance the nutritional value of the products without compromising the organoleptic characteristics.

### Consumer Acceptability and Preference for Bacon using ANOVA and Chi-Square Test

The results of the sensory evaluation revealed significant differences in overall acceptability of the scores among treatments ( $P \leq 0.05$ ). According to Duncan's Multiple Range Test (DMRT), the bacon formulated with LIPEX EF 369 received the highest mean score overall ( $5.58 \pm 1.40$ ) (Table 6) but also was identified as the top choice for 43 panelists, indicating a more enhanced profile. In contrast, the bacon samples derived from Lipinate ( $4.76 \pm 1.47$ ) and the standard diet ( $5.11 \pm 1.45$ ) received the lowest mean score and were both selected as the least preferred sample (19 and 22 votes) (Table 7). However, these treatments were not different from each other ( $P \geq 0.05$ ). In the same way, a chi-square test was run to evaluate if there was a significant difference in preference distribution among treatments ( $P \leq 0.001$ ).

**Table 6**

#### *Overall Acceptability of Bacon Samples*

Product	Treatment	Mean Score Overall Acceptability $\pm$ SD	CV
Bacon	LIPEX EF 369	$5.58 \pm 1.40^a$	25.52
Bacon	Standard	$5.11 \pm 1.45^b$	
Bacon	Lipinate	$4.76 \pm 1.47^b$	

*Note.* Overall Acceptability Mean Score  $\pm$  Standard Deviation represents the sensory evaluation scores recorded on a 7-point scale by untrained panelists. Different letters in the same column indicate significant differences ( $P \leq 0.05$ ). CV= Coefficient of Variation.

**Table 7**

#### *Frequency Distribution of Preference for Bacon Samples*

Treatment	Frequency
LIPEX EF 369	43
Standard	22
Lipinate	19
Uniform Responses	2

*Note.* Uniform Responses= Panelists who gave the same score for every treatment. Given that the panelists were untrained, responses sometimes consisted of combined letter designations. In cases where panelists selected combined letter preferences (e.g., “B, C”), each letter was treated independently for analysis.  $\chi^2 = P \leq 0.0001$ , indicating significant differences in preference distribution among treatments.

The hedonic score distribution (Table 8) supported these findings, as most of the scores from Sample B corresponding to the preferred treatment were concentrated in the upper range between scores 6 and 7, suggesting a more favorable bacon perception with omega-3 enrichment.

**Table 8**

*Frequency Distribution of Hedonic Scores for Bacon Samples*

Treatment	1	2	3	4	5	6	7	Total
LIPEX EF 369	0	0	0	3	6	11	23	43
Standard	0	0	0	0	3	9	10	22
Lipinate	0	0	0	2	5	2	10	19
Uniform Responses	0	0	0	0	1	0	1	2
Total	0	0	0	5	14	22	43	84

*Note.* Each number represents the score for each treatment preferred. Total represents the number of panelists who evaluated each treatment.

The repeated preference for LIPEX-derived products in ham and bacon suggests that the impact of omega-3 enrichment, when controlled in quantity, does not act as a limitation for a specific pork product, but it rather can enhance the nutritional profile and sensory perception of the product. LIPEX EF 369 key components are flaxseeds. “Flaxseed is one of the richest plant sources of the  $\omega$ -3 fatty acid alpha-linolenic acid (ALA, C18:3  $\omega$ -3)” (Rodriguez-Leyva et al., 2010). ALA, a precursor to omega-3 fatty acids like docosahexaenoic acid (DHA [22:6n-31]) and eicosapentaenoic acid (EPA [20:5n-31]), enriches the fatty acid profile of meat, creating a healthier balance. Including 10–15% flaxseed in monogastric diets has demonstrated improvements in omega-3 deposition and reductions in omega-6 concentrations (Prates, 2025).

Consumers’ craving for leaner meat has, over the years, reduced the chemical fat content of pork belly from up to about 74% (Smith et al., 1975) to today's 45–55% (Scramlin et al., 2008),

accounting for about 29% less fat compared with 40 years ago, with a corresponding increase in unsaturated fatty acid (UFA) (Trusell et al., 2011). This trend challenges the processors to address new diet ideas that can be related to product processing and shelf-life stability. As a result, softer bellies may lead to an oily appearance in the bacon retail package, affecting the slicing efficiency of bacon slabs and significantly reducing the product's shelf life due to poor oxidative stability (Soladoye et al., 2015).

Despite the accelerated rate of lipid oxidation due to PUFA content in pork meat, the results of this study demonstrate that the enrichment of PUFAs can turn bacon into a more desirable product, translating into greater consumer acceptability and preference. This concurs with the observation of a study in the UK, which evaluates the effect of flaxseed in the diet of finishing pigs on growth performance and the quality and fatty acid composition of various tissues. Results mention there was no effect of increasing the concentration of unsaturated fatty acids by increased inclusion of flaxseeds in the diet on the firmness of the fat. Furthermore, it is clear from the results shown that flaxseeds can be fed to pigs under controlled conditions without incurring any effects on production or carcass quality variables (Matthews et al., 2000).

Besides, (Romans et al., 1995) results concord with the research evaluated when grow-finishing pigs were fed from three different concentrations of flaxseed (5, 10, and 15%) and did not encounter any processing problems due to lack of firmness. Therefore, it is assumed that using PUFA supplementation in the diet is a safe and useful strategy to improve pork quality and, without concentration, to obtain the best results when increasing IMF content. This outcome may become an effective method for producing high-quality pork in the pig industry, but the estimation of PUFA supplementation concentration needs to be further studied (Matthews et al., 2000).

Likewise, the concentration of the added PUFAs is crucial to understanding any significant differences among treatments. An earlier study suggests that PUFA supplementation has beneficial influences on improving the meat quality of pigs, which mainly emerges in increasing Intramuscular

Fat (IMF) content in finishing pigs without considering breeds. Supporting these results, the increase in IMF due to the PUFAs could be highly related to the consumer acceptability and preference of the product derived from LIPEX EF 369, as intramuscular fat (IMF) has been identified as a critical contributor to pork eating quality characteristics through the development of flavor and juiciness. (Wood et al., 2004). In the same way, the addition of ALA can induce a change in flavor, as fatty acids have been widely known as flavor precursors (Meinert et al., 2009).

Nevertheless, although the analysis revealed a significant difference among treatments enriched with Omega-3, the lack of sensory description traits (specific texture, flavor, juiciness, and mouthfeel traits) during the sensory analysis and other measurements of the meat, such as IMF, fatty acid analysis, and oxidative stability tests of Thiobarbituric Acid Reactive Substances (e.g., TBARS) limits the conclusion of the study for a specific cause of acceptability and preference for the best-ranked treatment.

Overall, the sensory analysis data demonstrates that omega-3 implementation via flaxseed enhances the characteristics of ham and bacon; this leads to a possible improvement of IMF and/or fatty acid profile, which induces and contributes to a better perceived aroma, flavor, and juiciness obtained.

#### **Consumer Acceptability and Preference for Ground Pork Patties using ANOVA and Chi-Square Test**

The sensory analysis of ground pork patties, determined by an ANOVA, revealed a statistical difference ( $P \leq 0.05$ ) among the three treatments: Lipinate, with the lowest mean score ( $2.81 \pm 1.55$ ) while LIPEX (B) ( $3.60 \pm 1.45$ ) and the Standard Diet (C) ( $3.49 \pm 1.64$ ) scored higher (Table 9). However, there were no significant differences observed between LIPEX (B) and Standard Diet (C) ( $P \geq 0.05$ ), suggesting that both treatments obtained equal levels of acceptability from the panelists. In contrast, the preference distribution analyzed using a chi-square test revealed a significant difference ( $p \leq 0.001$ ). Patties derived from Lipinate were the least preferred product overall compared to pork

patties derived from LIPEX EF 369 (B) and Standard Diet (C), while a greater number of panelists selected the Standard Diet (C) as their preferred product (Table 10).

**Table 9**

*Overall Acceptability of Ground Pork Patties Samples*

Product	Treatment	Mean Score Overall Acceptability $\pm$ SD	CV
GPP	LIPEX EF 369	3.60 $\pm$ 1.45 <sup>a</sup>	32.95
GPP	Standard	3.49 $\pm$ 1.64 <sup>a</sup>	
GPP	Lipinate	2.81 $\pm$ 1.55 <sup>b</sup>	

Note. Overall Acceptability Mean Score  $\pm$  Standard Deviation represents the sensory evaluation scores recorded on a 7-point scale by untrained panelists. a-b: Different letters in the same column indicate significant differences ( $P \leq 0.05$ ). GPP= Ground Pork Patties. CV= Coefficient of Variation.

**Table 10**

*Frequency Distribution of Preference for Ground Pork Patties Samples*

Treatment	Frequency
Standard	42
LIPEX EF 369	33
Lipinate	9
Uniform Responses	5

Note. Uniform Responses = Panelists who gave the same score for every treatment. Given that the panelists were untrained, responses sometimes consisted of combined letter designations. In cases where panelists selected combined letter preferences (e.g., "B, C"), each letter was treated independently for analysis.  $\chi^2 = P \leq 0.0001$ , indicating significant differences in preference distribution among treatments.

Table 11 complements the preference results shown in Table 9 by showing the distribution of hedonic scores for each treatment. This distribution supports the previous findings and confirms the variation in consumer preferences among treatments.

**Table 11**

*Frequency Distribution of Hedonic Scores for Pork Patties*

Treatment	1	2	3	4	5	6	7	Total
Standard	2	4	5	15	8	7	1	42
LIPEX EF 369	0	4	7	9	8	3	2	33

Lipinate	0	0	0	3	2	3	1	9
Uniform Responses	2	1	0	1	1	0	0	5
Total	4	9	12	28	19	13	4	89

*Note.* Each number represents the score for each treatment preferred. Total represents the number of panelists who evaluated each treatment.

Mechanical processes in meat production, such as grinding, boning, cutting, and cooking, lead to membrane rupture, exposing phospholipids to oxygen and increasing the contact surface area, which accelerates the oxidative rancidity rate (Amaral et al., 2018). In the case of ground pork patties, grinding and forming patties may increase the lipid oxidation reaction, which consists of the production of hydroperoxides, which are found to be odorless; however, their high instability makes them decompose rapidly, turning them into the secondary compounds of the reaction, which include hydrocarbons, aldehydes, ketones, alcohols, esters, and acids, responsible for the appearance of off-flavors and off-odors in meat (Domínguez et al., 2019).

In this context, the lower preference for the pork patties derived from the Lipinate Easy Feed formulation may be partially explained by its unique lipid composition. Lipinate formulation is mainly composed of jojoba seed oil; this liquid wax ester, often called oil, is rich in monounsaturated fatty acids. Its fatty acid profile contains a combination of long-chain fatty acids: Eicosenoic acid (C20:1): 65-80%, Docosenoic acid (C22:1): 10-20%, and oleic acid (C18:1): 5-15%. Eicosenoic acid and docosenoic acid are both monounsaturated fatty acids, which are known to provide the oil with its stability and resistance to oxidation (The Formulary, 2025). However, the presence of long-chain fatty acids and alcohols may have also contributed to a waxy-greasy mouthfeel during consumption as long-chain monounsaturated fatty acids and alcohols can remain semi-solid at oral temperatures, leaving a persistent coating on the palate. While these effects have been observed in formulated food products, the impact of wax esters delivered through animal diet (as in the case of jojoba oil) on the sensory characteristics of meat remains unexplored.

In contrast, the LIPEX EF 369 formulation includes flaxseed-derived lipids rich in PUFAs such as alpha-linolenic acid (ALA) and would typically be more susceptible to lipid oxidation. Despite this,

the LIPEX formulation had high sensory acceptance, comparable to the standard diet, which was also highly preferred by panelists. The high acceptance of the ground pork patties enriched with Omega-3 may be attributed to its low inclusion level of LIPEX, which likely limited the perception of oxidative-derived and off-flavor attributes, particularly in untrained panelists. As Melton (1990) points out, perhaps because pork fat is already unsaturated compared to other red meats, oxidative rancidity is part of acceptable or intense pork flavor. Therefore, it is possible that if any lipid oxidation occurred, it was likely subtle and not perceived negatively by the panelists.

Meanwhile, the standard diet, based on conventional ingredients such as corn and soybean meal, received the highest acceptability scores. This could be attributed to the familiarity with the sensory characteristics of the ground pork patty presented. The traditional formulation may have produced a better mouthfeel for the consumer, contributing to desirable juiciness and flavor release during cooking. In ground patties, where fat is finely distributed and emulsified into the meat matrix, such characteristics are critical to flavor perception and consumer acceptance. These results suggest that the ground pork patty matrix can tolerate moderate alterations in dietary lipid composition if off-notes are minimized as fat functionality is preserved.

### **Conclusions**

Pork products (bacon and ham) from pigs fed with Lipex EF 369 received the highest consumer acceptability.

The Lipinate Easy Feed (jojoba-oil) formulation was the least preferred treatment for, possibly due to its waxy mouthfeel linked to the presence of the long-chain fatty acids and alcohols.

The finding suggests that alternative oil-derived sources in finishing pigs can be selectively implemented, as their impact on consumer acceptability depends on the specific pork product and oil source.

### **Recommendations**

A preference test with a forced-choice design should be applied to provide more information on subtle differences among products for panelists who rated all samples equally.

Conduct specific sensory analysis of detailed attributes such as texture, color, juiciness, mouthfeel, and flavor for a more precise evaluation.

Implement a fatty acid profile analysis, intramuscular fat content (IMF), and lipid oxidation (TBARS) evaluations on each product of every treatment to better understand the relationship between biochemical processes and sensory perceptions.

Perform a cost-benefit analysis of using alternative oil sources in commercial pig feeding systems.

### References

- Ahn, D. U., Lutz, S., & Sim, J. S. (1996). Effects of dietary  $\alpha$ -linolenic acid on the fatty acid composition, storage stability and sensory characteristics of pork loin. *Meat Science*, 43(3-4), 291–299. [https://doi.org/10.1016/S0309-1740\(96\)00001-0](https://doi.org/10.1016/S0309-1740(96)00001-0)
- Amaral, A. B., Da Silva, M. V., & Da Lannes, S. C. S. (2018). Lipid oxidation in meat: mechanisms and protective factors. *Food Science and Technology*, 38(suppl 1), 1–15. <https://doi.org/10.1590/fst.32518>
- Andersen, H. J., Oksbjerg, N., Young, J. F., & Therkildsen, M. (2005). Feeding and meat quality - a future approach. *Meat Science*, 70(3), 543–554. <https://doi.org/10.1016/j.meatsci.2004.07.015>
- Arnarson, A. (2023). Pork 101: Nutrition Facts and Health Effects. *Healthline*. <https://www.healthline.com/nutrition/foods/pork>
- Byrne, D. V. (2020). Current Trends in Multidisciplinary Approaches to Understanding Consumer Preference and Acceptance of Food Products. *Foods (Basel, Switzerland)*, 9(10). <https://doi.org/10.3390/foods9101380>
- Carr, S. N., Rincker, P. J., Killefer, J., Baker, D. H., Ellis, M., & McKeith, F. K. (2005). Effects of different cereal grains and ractopamine hydrochloride on performance, carcass characteristics, and fat quality in late-finishing pigs. *Journal of Animal Science*, 83(1), 223–230. <https://doi.org/10.2527/2005.831223x>
- Domínguez, R., Pateiro, M., Gagaoua, M., Barba, F. J., Zhang, W., & Lorenzo, J. M. (2019). A Comprehensive Review on Lipid Oxidation in Meat and Meat Products. *Antioxidants (Basel, Switzerland)*, 8(10). <https://doi.org/10.3390/antiox8100429>
- Dugan, M. E. R., Vahmani, P., Turner, T. D., Mapiye, C., Juárez, M [Manuel], Prieto, N., Beaulieu, A. D., Zijlstra, R. T., Patience, J. F., & Aalhus, J. L [Jennifer L.] (2015). Pork as a Source of Omega-3 (n-3) Fatty Acids. *Journal of Clinical Medicine*, 4(12), 1999–2011. <https://doi.org/10.3390/jcm4121956>
- Elanco Animal Health. (n.d). *Grow-Finish Solutions*. <https://assets.elanco.com/7eafa302-37b3-00f8-2e74-bb902d1a0ba2/1c01453e-8d21-46af-83dd-abadfd48d2bb/Elanco%20Grow-Finish%20Portfolio%20of%20Solutions.pdf>
- Elmore, J. S., & Mottram, D. S. (2009). Flavour development in meat. In *Improving the Sensory and Nutritional Quality of Fresh Meat* (pp. 111–146). Elsevier. <https://doi.org/10.1533/9781845695439.1.111>
- Estévez, M., Morcuende, D., Ventanas, S., & Cava, R. (2003). Analysis of volatiles in meat from Iberian pigs and lean pigs after refrigeration and cooking by using SPME-GC-MS. *Journal of Agricultural and Food Chemistry*, 51(11), 3429–3435. <https://doi.org/10.1021/jf026218h>
- The Formulary. (2025). *Jojoba Oil Refined*. [https://www.theformulary.co.uk/product/jojoba-oil/#:~:text=INCI:%20Sinesis%20chinesis%20\(jojoba\),isn't%20actually%20an%20oil.](https://www.theformulary.co.uk/product/jojoba-oil/#:~:text=INCI:%20Sinesis%20chinesis%20(jojoba),isn't%20actually%20an%20oil.)
- Gaillard, C., Brossard, L., & Dourmad, J.-Y. (2020). Improvement of feed and nutrient efficiency in pig production through precision feeding. *Animal Feed Science and Technology*, 268, 114611. <https://doi.org/10.1016/j.anifeedsci.2020.114611>

- Gonzalez, J. M., Houser, T. A., O'Quinn, T. G., Nuttelman, D. E., Odgaard, R. L., Coulter, J. M., Faltys, G., Stelzleni, A. M., & Azain, M. J. (2020). The effects of the LIPEX finishing diet regimen on pork quality, fatty acid profile, palatability, and color stability. *Translational Animal Science*, 4(1), 339–351. <https://doi.org/10.1093/tas/txz149>
- Kansas State University. (2022). *Fats and oils*. Kansas State University. [https://www.asi.k-state.edu/extension/swine/swinenutritionguide/general\\_nutrition\\_principles/fatsandoils.html](https://www.asi.k-state.edu/extension/swine/swinenutritionguide/general_nutrition_principles/fatsandoils.html)
- Matthews, K. R., Homer, D. B., Thies, F., & Calder, P. C. (2000). Effect of whole linseed (*Linum usitatissimum*) in the diet of finishing pigs on growth performance and on the quality and fatty acid composition of various tissues. *The British Journal of Nutrition*, 83(6), 637–643. <https://doi.org/10.1017/s0007114500000817>
- Meier, C., Harms, E., Früh, B., Stoffers, H., Bee, G., Hugelshofer, D. H., Quander-Stoll, N., & Stolz, H. (2021). The effect of polyunsaturated fatty acids (PUFA) and organic labeling on Swiss consumers' acceptance of pork salami. *Organic Agriculture*, 11(4), 519–537. <https://doi.org/10.1007/s13165-021-00369-9>
- Meinert, L., Tikk, K., Tikk, M., Brockhoff, P. B., Bredie, W. L. P., Bjerregaard, C., & Aaslyng, M. D. (2009). Flavour development in pork. Influence of flavour precursor concentrations in longissimus dorsi from pigs with different raw meat qualities. *Meat Science*, 81(1), 255–262. <https://doi.org/10.1016/j.meatsci.2008.07.031>
- Melton, S. L. (1990). Effects of feeds on flavor of red meat: a review. *Journal of Animal Science*, 68(12), 4421–4435. <https://doi.org/10.2527/1990.68124421x>
- Morgan, C. A., Noble, R. C., Cocchi, M., & McCartney, R. (1992). Manipulation of the fatty acid composition of pig meat lipids by dietary means. *Journal of the Science of Food and Agriculture*, 58(3), 357–368. <https://doi.org/10.1002/jsfa.2740580310>
- Müller Richli, M. & Scheeder, M (2019). Pork: good finishing results despite reduced crude protein content in the feed. *Agrarforschung Schweiz*, 10, pp. 156–163. [https://www.agrarforschungschweiz.ch/wp-content/uploads/2019/12/2019\\_04\\_2464.pdf](https://www.agrarforschungschweiz.ch/wp-content/uploads/2019/12/2019_04_2464.pdf)
- Panagiota Florou-Paneri (2014). Alternative protein sources to soybean meal in pig diets. *Journal of Food, Agricultural & Environment*, 12, pp. 650–660. [https://www.researchgate.net/publication/265592380\\_Alternative\\_protein\\_sources\\_to\\_soybean\\_meal\\_in\\_pig\\_diets](https://www.researchgate.net/publication/265592380_Alternative_protein_sources_to_soybean_meal_in_pig_diets)
- Pandey, S., Kim, S., Kim, E. S., Keum, G. B., Doo, H., Kwak, J., Ryu, S., Choi, Y., Kang, J., Kim, H., Chae, Y., Seol, K.-H., Kang, S. M., Kim, Y., Seong, P. N., Bae, I.-S., Cho, S.-H., Jung, S., & Kim, H. B. (2024). Exploring the multifaceted factors affecting pork meat quality. *Journal of Animal Science and Technology*, 66(5), 863–875. <https://doi.org/10.5187/jast.2024.e56>
- Prates, J. A. M. (2025). Enhancing Meat Quality and Nutritional Value in Monogastric Livestock Using Sustainable Novel Feed Ingredients. *Foods (Basel, Switzerland)*, 14(2). <https://doi.org/10.3390/foods14020146>
- Rodriguez-Leyva, D., Dupasquier, C. M. C., McCullough, R., & Pierce, G. N. (2010). The cardiovascular effects of flaxseed and its omega-3 fatty acid, alpha-linolenic acid. *The Canadian Journal of Cardiology*, 26(9), 489–496. [https://doi.org/10.1016/s0828-282x\(10\)70455-4](https://doi.org/10.1016/s0828-282x(10)70455-4)

- Romans, J. R., Johnson, R. C., Wulf, D. M., Libal, G. W., & Costello, W. J. (1995). Effects of ground flaxseed in swine diets on pig performance and on physical and sensory characteristics and omega-3 fatty acid content of pork: I. Dietary level of flaxseed. *Journal of Animal Science*, *73*(7), 1982–1986. <https://doi.org/10.2527/1995.7371982x>
- Scramlin, S. M., Carr, S. N., Parks, C. W., Fernandez-Dueñas, D. M., Leick, C. M., McKeith, F. K., & Killefer, J. (2008). Effect of ractopamine level, gender, and duration of ractopamine on belly and bacon quality traits. *Meat Science*, *80*(4), 1218–1221. <https://doi.org/10.1016/j.meatsci.2008.05.034>
- Shahidi, F., & Hossain, A. (2022). Role of Lipids in Food Flavor Generation. *Molecules (Basel, Switzerland)*, *27*(15). <https://doi.org/10.3390/molecules27155014>
- Smith, G. C., West, R. L., & Carpenter, Z. L. (1975). Factors Affecting Desirability of Bacon and Commercially-Processed Pork Bellies. *Journal of Animal Science*, *41*(1), 54–65. <https://doi.org/10.2527/jas1975.41154x>
- Soladoye, P. O., Shand, P. J., Aalhus, J. L. [J. L.], Gariépy, C., & Juárez, M. [M.] (2015). Review: Pork belly quality, bacon properties and recent consumer trends. *Canadian Journal of Animal Science*, *95*(3), 325–340. <https://doi.org/10.4141/cjas-2014-121>
- Trusell, K. A., Apple, J. K., Yancey, J. W. S., Johnson, T. M., Galloway, D. L., & Stackhouse, R. J. (2011). Compositional and instrumental firmness variations within fresh pork bellies. *Meat Science*, *88*(3), 472–480. <https://doi.org/10.1016/j.meatsci.2011.01.029>
- University of Nevada. (2025). *Consumer Preferences for Meat Attributes*. University of Nevada, Reno. <https://extension.unr.edu/publication.aspx?PubID=2282#:~:text=Taste%2Fflavor%2C%20tenderness%20and%20leanness,this%20is%20an%20average%20rating.>
- Warnants, N., van Oeckel, M. J., & Boucqué, C. V. (1998). Effect of incorporation of dietary polyunsaturated fatty acids in pork backfat on the quality of salami. *Meat Science*, *49*(4), 435–445. [https://doi.org/10.1016/s0309-1740\(98\)00011-4](https://doi.org/10.1016/s0309-1740(98)00011-4)
- Widmar, D. (2024). US beef consumption stable in 2024, pork and poultry expected to increase. *Michigan Farm News*. <https://www.michiganfarmnews.com/us-beef-consumption-stable-in-2024-pork-and-poultry-expected-to-increase>
- Wood, J. D., Nute, G. R., Richardson, R. I., Whittington, F. M., Southwood, O., Plastow, G., Mansbridge, R., Da Costa, N., & Chang, K. C. (2004). Effects of breed, diet and muscle on fat deposition and eating quality in pigs. *Meat Science*, *67*(4), 651–667. <https://doi.org/10.1016/j.meatsci.2004.01.007>
- Yakdhane, A., Labidi, S., Chaabane, D., Tolnay, A., Nath, A., Koris, A., & Vatai, G. (2021). Microencapsulation of Flaxseed Oil—State of Art. *Processes*, *9*(2), 295. <https://doi.org/10.3390/pr9020295>



**Appendix B**

*ANOVA Precision Oven used for Cooking Bacon*



**Appendix C**

*Southbend Convection Oven used for Cooking Pork Patties*



**Appendix D**

*Crockpot used for Heating Deli Ham*



## Appendix E

### Sensory Evaluation Protocol – Worksheet

1

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Meat Science Laboratory

#### WORK SHEET

**DATE:** 10/04/2025

**SAMPLE TYPE:** Pork Patties, Bacon, Ham

**# PANELISTS:** 72

**Test Requested:** 7-Point Hedonic Scale

#### Sample Coding

Each panelist was assigned a unique three-digit ID code generated online, which had to be written on every ballot sheet. This code was used only for organizing the data and was independent of the random three-digit codes assigned to the samples. The following code numbers are the ones used for the panelists.

1	433	7	555	13	939	19	573	25	681	31	807	37	732	43	128	49	403	55	123	61	274	67	994
2	929	8	400	14	487	20	794	26	597	32	325	38	477	44	628	50	746	56	282	62	146	68	100
3	485	9	825	15	699	21	866	27	435	33	977	39	697	45	464	51	654	57	553	63	240	69	769
4	362	10	140	16	188	22	211	28	779	34	778	40	392	46	554	52	953	58	457	64	715	70	280
5	943	11	608	17	828	23	431	29	822	35	222	41	426	47	773	53	206	59	148	65	285	71	711
6	808	12	756	18	569	24	329	30	287	36	147	42	541	48	847	54	709	60	998	66	241	72	174

#### SAMPLE HANDLING AND SERVING INSTRUCTIONS

Pork patties were cooked at 204°C in a convection oven until reaching 71°C internal temperature, then cut into 8 equal pieces.

Bacon slices were air-fried at 180°C for 15 minutes, then cut into 1–2-inch segments.

Ham was cut into 1×1 cm cubes and heated in a slow cooker to 60°C.

All trays were rotated during cooking to avoid differences in appearance or doneness.

Samples were served at the correct temperature, handled with gloves, masks, and clean utensils.

Sample identity was not revealed; all portions were coded as A, B, or C.

Each panelist received:

- A set of coded samples for evaluation.
- Unsalted crackers were given to cleanse the palate between samples.
- A glass of water was given to reduce fatty flavors.

After tasting each sample, panelists completed the 7-point hedonic scale ballot for overall liking and preference.

Completed ballots were collected; utensils and leftover samples were discarded.

## Appendix F

### *American Meat Science Research Association Guidelines for Cookery, Sensory Evaluations, and*

#### *Instrumental Tenderness Measurements of Meat*

#### VI. PREPARATION AND PRESENTATION OF SAMPLES TO THE PANEL

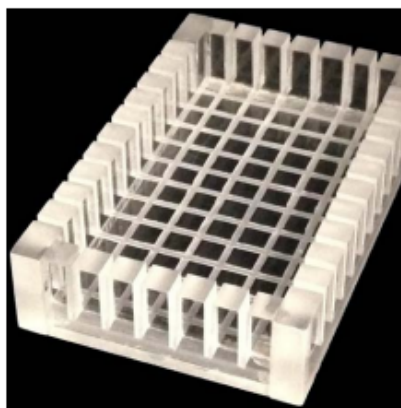
### VI. PREPARATION AND PRESENTATION OF SAMPLES TO THE PANEL

#### A. Preparation of Sensory Samples

Selection of sample preparation method and serving size should be determined based on project objectives and the amount of variation between and within treatments. It is critical that each panelist receive a standardized amount of each sample. Standardization of samples should be not only by weight or dimensions but also by temperature.

##### 1. Trained panel evaluations

In order to account for the moderate to sometimes high degree of variability between and within treatments, meat samples often are cut into cubes, and each panelist receives two to three cubes from different locations within the piece of meat. For steaks, chops, and roasts, cubes that are 1.27 cm × 1.27 cm × the thickness of the cooked cut are suggested. If cooking procedures result in variation in cut thickness and charred surfaces, however, the thickness dimension should be standardized and cooked surfaces removed from cuts. After the hot sample is trimmed of all bone and epimysia connective tissue, it is placed in the plexiglass sample sizer (Figure 2). The sample sizer should have dimensions of 14 cm long × 12 cm wide × 4 cm deep to accommodate large cuts. On each side, the slots are spaced 1.27 cm apart and have an opening of 3 mm to allow the knife to cut the sample in each direction. For beef patties (depending on the size of beef patties being evaluated [91.5 or 113.5 g]), cooked patties can be cut into six or eight pie-shaped samples as shown in Figure 3. Even with thicker or larger-sized patties, cutting patties into cubes might result in breakage and the inability to obtain equal-sized pieces to serve the panelists. Cutting patties into pie-shaped or wedge samples is recommended.



**Figure 2.** Sensory sample sizer for steaks or chops



**Figure 3.** Sectioning beef patties for sensory evaluation.