

"Understanding Livestock Odors"
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As the size of livestock farms has increased the land base affected by each individual farm's odor emissions has also increased. The odor emission from each livestock farm is uniquely based on species, facility, manure storage and handling methods and the size of manure sources (Jacobson, 2001). Just as livestock units have been increasing in size the number of non-livestock farm rural residences has also increased. These non-livestock rural residences have more available leisure time to enjoy their rural setting. Thus we are at a cross roads of increasing size of livestock units existing with a increasing number of rural residences with expectations of enjoying their rural live style. Understanding the origin of livestock odors along with each individual's reaction to odor may increase livestock producers' ability to rationally communicate with non-livestock farm neighbors.

In the review of the 1992 US Environmental Protection Agency (EPA) survey to determine sensitivity to odors Susan Schiffman of Duke University Medical School reported that there is a large difference in odor offensiveness ratings between individuals (Schiffman, 1998). When individuals determined as "sensitive to odors" were compared to individuals "less sensitive to odors", individuals "sensitive to odors" found more odor sources to be problematic then individuals "less sensitive to odors". The "less sensitive to odors" individuals mainly found cigarette, cigar and pipe smoke, ammonia and diesel exhaust to be problematic (Schiffman, 1998). Given that each individual's response is unique, livestock farms may have neighbors that are "sensitive to odors" who find livestock odors more problematic than other neighbors.

The four major odor sources associated with livestock production are; feeds and feed processing, livestock housing, manure storage and field application of manures. On most swine farms the feeds and feed processing have minimal effect on total farm odor. While hydrogen sulfide and ammonia are the compounds most often associated with livestock odors, over 160 compounds have been identified as contributing to manure odor (Mackie, 1998). These odor-generating compounds are produced during the anaerobic degradation of manure organic matter and include a wide variety of compounds such as volatile fatty acids, aldehydes, alcohols, phenols, indoles, mecaptans and amines (Small, 1999). Table 1 provides the average air concentration and odor threshold for common odorous compounds found within the air space 1.5 meters above the surface of a swine manure storage basin (Zahn, 2001). The "Odor Threshold" is the average air concentration of an odor-causing compound that results in odor panel recognition of odor.

Table 1. Concentration and Odor Threshold of Compounds Found in Swine Manure

Organic Compound	Average Concentration ¹	Odor Characteristic	Odor Threshold ¹
Hydrogen Sulfide	0.090	Rotten Eggs	0.140
Ammonia	3.70	Sharp, Pungent	0.027 - 2.2
Acetic Acid	0.270	Pungent	0.1 - 2.5
Propionic Acid	0.130	Fecal	0.0025
Butyric Acid	0.590	Fecal	0.00072
Phenol	0.025	Aromatic	0.23 - 0.38
4-Methyl Phenol	0.090	Pungent	0.0035 - 0.010
4-Ethyl Phenol	0.004	Fecal	0.0019
Indole	0.002	Fecal, Nauseating	0.0064

¹ Concentrations are expressed in mg/cubic meter

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Ammonia will be sharp and pungent at higher concentrations within the barn and at very high levels is considered toxic, but may actually reduce odor offensiveness at reduced levels outside of the building. With ammonia in many household cleaning products, at low levels it may actually be associated with a clean smell.

While hydrogen sulfide and ammonia have the highest concentration in air emissions from swine operations they also have the highest odor threshold, meaning their overall contribution to swine odor offensiveness may be minimal. Volatile fatty acids, phenols and indoles have much lower concentration in air emissions from swine facilities but their odor threshold is so low that these compounds may make significant concentrations to swine odor offensiveness. Controlling odor is more complicated than reducing hydrogen sulfide and ammonia concentrations.

Research trials conducted by Emily Otto and others (Otto) during her graduate student training at Michigan State University evaluated swine diets with reduced dietary protein, by replacing soybean meal with synthetic amino acid supplementation. As dietary protein was reduced, diets were supplemented with amino acids such that essential amino acid levels were the same for all diets. The goal of this trial was to evaluate the reduced dietary protein effect on fecal ammonia emission and volatile fatty acid concentration along with the effect on odor offensiveness as determined by an odor panel. The researchers hypothesized that diets with lower total dietary protein would result in reduced fecal ammonia emissions and volatile fatty acid content with a corresponding reduction in odor. Otto was able to significantly reduce the ammonia emissions from swine manure collected from pigs on the amino acid supplemented diets, but did not find a corresponding reduction in volatile fatty acids concentration or odor offensiveness. In fact as amino acid supplementation increased odor panel evaluations determined that fecal odor offensiveness also increased.

In Summary:

- ❖ Odor response is based on each individual's sensitivity to odor. What one person finds offensive may or may not result in a negative response from the next person.
- ❖ On most swine farms there are three major

sources of odor; livestock housing, manure storage and field application. Odor reduction plans need to address the three areas collectively.

- ❖ Odor from swine operations is the combined effect of many odor-causing compounds. Reductions in the air concentrations of one or two of these odorous compounds may or may not result in a corresponding reduction in odor offensiveness.

Current State regulation of odor from livestock facilities in Michigan is addressed in the Michigan Department of Agriculture Generally Accepted Agriculture Management Practices (GAAMP) for Siting New and Expanding Livestock Facilities (MDA) and in the GAAMP for Manure Nutrient Utilization and Application. Individuals responsible for evaluating odor complaints need to be aware of the uniqueness and emotion of each person's response to odor.

Successful reduction in the odor offensiveness associated with swine operations combine technologies that controls odors generated by all three-odor sources (housing, storage and application). Odor reduction also depends on technologies that address all odor-causing compounds collectively. Next Pork Quarterly will review current technologies that are successfully addressing odor emissions from swine operations.

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Management Practices for Manure Nutrient Utilization and Application, and Generally Accepted Management Practices for Siting New and Expanding Livestock Facilities

“Evaluation of Hydrocolloid Ingredients as Purge Controllers in High Moisture Restructured Ham”

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SUMMARY

The objective of this study was to investigate the effects of incorporating hydrocolloid brine solutions into high-moisture (45% added water) restructured ham products on product cook yield, purge, and quality attributes. Hydrocolloid brine solution treatments (TRT) were formulated using methylcellulose (MC), hydroxypropyl methylcellulose (HPMC) and kappa carrageenan (KC): TRT 1) MC 0.4% & KC 0.6%; TRT 2) HPMC 0.6% & KC 0.6%; TRT 3) MC 0.4% & HPMC 0.6% & KC 0.6%; TRT 4) KC 0.6%; and TRT 5) Control: no hydrocolloids. Brine solution treatments were mixed (45% addition wt/wt) into a restructured ham formulation and thermally processed to 70°C. TRT 1 and 3 increased ($P < 0.05$) cook yields and decreased purge values by $> 1.5\%$. TRT 1, 2, and 3 improved ham slice exterior L* surface color and textural values. TRTs containing MC and/or HPMC with KC may control purge and maintain product quality attributes in high-added water restructured hams.

INTRODUCTION

As the amount of added water in high-moisture ($> 45\%$ addition) restructured ham increases, the ability to retain water during thermal processing and minimize purge during storage decreases (Prabhu and Sebranek 1997). The addition of hydrocolloid (gums) non-meat ingredients has been shown to assist in binding, extending, controlling purge, increasing water binding and water retention in meat products. Kappa carrageenan (KC) is a purge controlling hydrocolloid that is readily utilized, industry-accepted, and processor-friendly. Previous studies have shown that the

addition of 0.5% KC improves cook yield, texture, water retention and decreases purge (loss of added water from the packaged product), and improves sliceability in sectioned and formed products (Bater et al., 1993).

The incorporation of methylcellulose (MC) and hydroxypropyl methylcellulose (HPMC) into high-moisture restructured products may also reduce purge while enhancing product tenderness and juiciness. It has been noted that the addition of 1% HPMC to lean ground beef patties can increase tenderness and juiciness, while adding 0.5 and 1.0% MC can decrease the hardness values for structured beef rolls. Chicken patties with 0.25 and 0.5% MC were rated as more tender and juicy (Steinke 2001). However, limited data is available that assesses the ability of methylcellulose and hydroxypropyl methylcellulose to reduce purge in high-moisture restructured meat products.

MATERIALS AND METHODS

The experimental design for this study was a one-way analysis of variance utilizing five brine treatments with or without hydrocolloid ingredients (TRT): TRT 1: 0.4% MC/0.6% KC; TRT 2: 0.6% HPMC/0.6% KC; TRT 3: 0.4% MC/0.6% HPMC/0.6% KC; TRT 4: 0.6% KC and TRT 5: Control (no hydrocolloids).

Fresh pork semimembranosus muscle (IMPS 402F) with the gracilis muscle removed were sorted into 12.5 lb. No off-flavors were detected for TRT 4 and 5 by the trained sensory panel (Table 3). TRT 3 was perceived to

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batches per restructured ham treatment. The ham muscles were further divided into three 4.2 lb. batches for grinding into three different particle sizes (Prabhu and Sebranek 1997). One 4.2 lb. kg batch was ground through a 2-inch grinder plate, the second batch was ground through a 1-inch plate and the last batch was ground through a 3/8-inch plate. The ground ham muscles and 5.7 lb. of the designated treatment brine solution were placed into a modified double axle paddle mixer and mixed for 10 min. The mixed restructured ham batter was placed into a vacuum stuffer and stuffed into pre-soaked 4.5-inch x 30 inch fibrous, non-perforated casings. The casings were clipped to form ham chubs weighing approximately 5.5 lb. each (3 chubs per treatment). Restructured ham chubs were weighed, hung on smoke sticks and placed on a smoke truck for thermal processing.

Thermal processing was achieved utilizing a one-truck smokehouse and cooking the hams to an internal temperature of 158°F. Following the shower cycle, the restructured hams were removed from smokehouse once an internal product temperature of 120°F was reached. The hams were allowed to equilibrate to an internal temperature of 90°F (~30 min) and were reweighed to determine product cook yields.

Chilled restructured hams were sliced into 1/2-inch thick slices, vacuum packaged and stored (40°F) until analyzed for pH, cooked proximate composition (moisture, fat and protein), lipid oxidation, color and purge (7, 14, 21, 28, and 56 days of refrigerated (40°F) storage), trained sensory panel evaluation, and textural and shear force analysis. Color readings were taken for day 0, 7, 14, 21, and 28 of refrigerated storage. Lipid oxidation tests were performed to determine the amount of 2-thiobarbituric acid reactive substance (TBARS) present at each day of storage to monitor oxidative rancidity.

Percent moisture, fat, and protein were determined for each restructured ham treatment. The 2-cycle compression test method was used to evaluate the textural attributes of circular ham slice samples. Hardness, springiness, cohesiveness, chewiness, and resilience were determined by compressing each sample to 25% of its original height (75% compression). The Kramer 5-blade shear force test method was used to determine the force required to shear (an indicator of tenderness) through each restructured ham slice.

A trained sensory panel (n=6) was utilized to determine specific sensory attributes of each restructured ham product. An 8 point hedonic scale was used where 1=extremely soft and 8=extremely hard, 1=extremely dry and 8=extremely juicy, 1=no residue/mouth coating and 8=abundant residue/mouth coating, 1=no off-flavor detected and 8=abundant off-flavor. Samples were prepared by cutting 1/2 in³ cubes from the center portion of each ham slice and were served cold (40-42°F).

RESULTS AND DISCUSSION

Treatment brine solutions (TRT) used within this study were: TRT 1: MC/KC at 0.4/0.6%, TRT 2: HPMC/KC at 0.6/0.6%; TRT 3: MC/HPMC/KC at 0.4/0.6/0.6%, TRT 4: KC at 0.6%, and TRT 5: the control brine with no added hydrocolloid. Differences ($P < 0.05$) between treatments were observed for proximate composition, cook yield, percent purge, color, objective textural measurements and sensory attributes. Days of storage significantly ($P < 0.05$) affected purge loss, lipid oxidation and color (a^*).

Brine pH measurements between treatments ranged from 7.27 to 7.43 (Table 1). Restructured ham raw pH values ranged from 6.42 to 6.47 and cooked ham pH values ranged from 6.50 to 6.53. It is important to note that as the pH of meat products increases, so does water binding capacity.

Proximate composition for raw restructured ham formulations indicated that TRT 5 had the highest percent moisture, while TRT 1 had the highest percent protein. All formulations were similar in fat content (Table 1). The lower levels of protein observed in the raw restructured ham formulations are due to the dilution of meat protein by the 45% brine addition. Cooked ham percent moisture content varied by more than 3% between TRTs. TRT 4 (KC at 0.6%) had the highest cooked moisture composition at 77.0%.

Cook yield values between the treatments ranged from 83.1 to 91.9% (Table 2). TRT 1 and 3 had the highest cook yield values at 91.9 and 91.6% respectively, significantly higher than TRT 2 and 5. TRT 5 had the lowest cook yield value at 86.1% and TRT 2 was similar to TRT 5 at 83.2%. TRT 1 and 3 may demonstrate a synergistic or additive effect between MC and KC that

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allows for increased water binding. The decrease in cook yields due to the addition of HPMC was also observed in previous experiments. However, there is no additional research data available investigating combining MC and/or HPMC with KC to substantiate the cook yield results found in this study.

Purge values between treatments ranged from 4.3 to 0.9% while length of storage resulted in ranging from 2.0 to 2.5% (Table 2). TRT 2 had the lowest percent purge at 0.90%, a 3.4% greater ($P < 0.05$) reduction in purge compared to TRT 5 (4.3%) and greater than 1.9% purge reduction when compared to TRT 4 (2.8%). Increasing the length of storage resulted in an overall increase in purge loss. Ham slices stored for 56 days had the greatest amount of purge loss compared to shorter storage times. TRT 4 purge values were similar to high-moisture ham manufactured with 1.5% KC in a study conducted by Prabhu and Sebranek (1997). TRT 1, 2, and 3 were the most effective at decreasing purge loss. TRT 1 combined the highest cook yield value (91.9%) with a purge loss value of 1.5%. These values were significantly better than TRT 5 (Control). TRT 1 decreased purge loss by 2.8% when compared to the TRT 5 and 1.3% when compared to TRT 4. Decreasing product purge by 2.8% and increasing cook yields by 5.8% may prove to be beneficial to meat processors. Additionally, the increase in water binding and retention potentially decreases product cost. Although greater water binding to improve cook yields is a positive product attribute from the meat processor perspective, consideration must be given to the impact of added water on the flavor profile of the product to ensure that the product is not too "bland" in taste.

Lipid oxidation (TBARS) values ranged from 0.08 to 0.114 for all treatment and storage days indicating very little lipid oxidation (Table 2). No significant differences between treatments were observed ($P > 0.05$). Although length of storage was significant ($P < 0.05$) for lipid oxidation of vacuum packaged ham slices, the values are so small that they are not considered to be of practical significance.

Treatment brine solutions significantly impacted the color of ham slices ($P < 0.05$) for lightness (L^*), redness (b^*), and yellowness (a^*) (Table 2). These variations in color may be due to the particle size differences within the sliced ham surface. The inside ham muscles (whole) were ground

(restructured) into 3 different particle sizes (2, 1 and 3/8 inch). This creates a very non-homogenous surface area compared to emulsified products (i.e., frankfurters). During color analysis, ham slices would be expected to vary in the proportion of particle sizes displayed within the cut surface of each individual ham slice, resulting in color variation. Lightness (L^*) measurements for TRT 4 and 5 tended to be lighter in color (Table 3).

Overall, TRT 1, 2, and 3 exhibited acceptable cured meat color over a 56-day storage time. This is a valuable attribute since ham with 45% added water is initially lighter in color. Generally, as the length of storage increased, redness values also increased for ham slice surfaces. These results suggest future research needs to be conducted to identify why TRT 1, 2, and 3 retained a redder ham slice surface compared to TRT 4 and 5. Yellowness (b^*) values for TRT 1, 2, and 3 were higher than TRT 4 and 5 for ham slice surface color.

Hardness (kg/g sample) values ranged from 0.16 to 0.34 (Table 3). TRT 2, 4 and 5 were harder than TRT 3 (0.4% MC/0.6% HPMC/0.6% KC). Treatment 5 exhibited the highest values for springiness, cohesiveness, chewiness, and resilience while TRT 3 exhibited the lowest values. These results indicate that the addition of MC and/or HPMC may create a softer, more loosely bound product that is less resilient to external forces.

Kramer shear force (kg/g) values ranged from 0.37 to 0.50 with TRT 3 requiring the least amount of force to shear through the ham slice (Table 3) compared to the other treatments. These results suggest that the addition of MC and HPMC in combination (TRT 3) results in increased tenderness, even in the presence of KC (0.5%). The addition of hydrocolloids to the formulation dilutes the amount of meat protein in the product, thereby decreasing protein-protein interactions by creating a less rigid protein network after thermal processing which decreases product bind. These same trends indicate that the addition of 0.4% MC and 0.6% KC (TRT 1) may increase the tenderness of a finished product by the creation of protein-hydrocolloid interactions rather than protein-protein interactions.

Sensory hardness, juiciness, mouth residue/coating and intensity of off-flavor values are shown in Table 3.

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Hardness values ranged from 2.2 to 3.3 on an 8-point hedonic scale, with TRT 4 and 5 being the hardest and TRT 2 the softest in texture. In general, TRT 1, 2, and 3 were softer than the TRT 5. Additionally, perceived hardness by the sensory panel and hardness results from texture profile analysis suggests that with an increase in hydrocolloid gum levels (TRT 1, 2, and 3) there is a decrease in firmness.

Juiciness values ranged from 2.0 to 3.7 with TRT 4 and 5 (3.7 and 3.5) being evaluated the as the juiciest. When comparing juiciness between treatments, ham slices containing MC and/or HPMC (TRT 1, 2, and 3) scored significantly lower in juiciness values.

Mouth coating/residue values ranged from 1.5 to 4.1 on an 8-point hedonic scale (Table 3). Treatment 3 had the highest (4.1) perceived mouth residue/coating with TRT 2 (3.7) being similar in mouth-residue to TRT 3. These results were expected as MC and/or HPMC can form a slick coating on the meat product surface.

No off-flavors were detected for TRT 4 and 5 by the trained sensory panel (Table 3). TRT 3 was perceived to have the most off-flavor (1.4) between the treatments. Off-flavor intensity and residue/mouth coating may be the biggest drawbacks of using MC and HPMC in combination as it may lower consumer acceptability.

CONCLUSIONS

The results of this study indicate that the addition of MC and/or HPMC with KC may aid in controlling purge in restructured high-moisture hams. Specifically, TRT 1 demonstrated high cook yield values and decreased purge values when compared to TRT 4 and 5. Additionally, TRT 1 had a positive effect upon color (L^* , a^* , b^*) values and meat color stability. Lightness values of TRT 1, 2, and 3 decreased over a 28-day storage period when compared to TRT 4 and 5. Texture profile analysis and Kramer shear values also indicated that TRT 3 required less force to shear and was evaluated by the trained sensory panel as more tender. The addition of MC with KC (TRT 1) demonstrated its potential as a purge controller. However, the use of MC and/or HPMC in brine solutions did create a detectable off-flavor. Based on these results, TRT 1 (0.4% MC/0.6% KC) should be considered as a potential brine solution for restructured meat products based on its purge controlling attributes

and minimal negative impact on product attributes.

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Table 1
Least square means for pH and proximate composition of high-moisture restructured ham manufactured with varying combinations of hydrocolloid brines.

Treatment ^e	Hydrocolloid Type ^d					SEM ^a
	1	2	3	4	5	
	MC/KC	HPMC/KC	MC/HPMC/KC	KC	Control	
Level ^f	0.4 / 0.6	0.6 / 0.6	0.4 / 0.6 / 0.6	0.6	0.0	
pH						
Brine pH ^g NS	7.43	7.37	7.40	7.27	7.30	0.07
Raw pH ^h NS	6.47	6.45	6.47	6.43	6.42	0.01
Cooked pH ⁱ NS	6.52	6.53	6.53	6.52	6.50	0.01
Proximate Composition^j						
Raw						
% Moisture	79.2 ^c	80.5 ^{bc}	80.0 ^{bc}	81.3 ^{ab}	82.0 ^a	0.4
% Fat ^{NS}	1.4	1.3	1.4	1.3	1.4	0.1
% Protein	16.5 ^a	15.4 ^{ab}	15.5 ^{ab}	15.1 ^b	16.0 ^{ab}	0.3
Cooked						
% Moisture	75.7 ^a	73.3 ^b	73.2 ^b	77.0 ^a	75.3 ^{ab}	0.5
% Fat	1.6 ^b	2.3 ^{ab}	2.1 ^{ab}	2.2 ^{ab}	2.5 ^a	0.2
% Protein	20.5 ^{bc}	22.5 ^a	22.3 ^a	19.5 ^c	21.3 ^{ab}	0.4

^{a-c} Means having different superscripts within rows are significantly different (p<0.05).

^d Hydrocolloid Type: kappa carrageenan Gelcarin® ME 6910, methylcellulose (MC): METHOCEL™ A4M, hydroxypropyl methylcellulose (HPMC): METHOCEL™ F4M.

^e Treatment identification of brine solution.

^f Level (0.0, 0.4 & 0.6%) of hydrocolloid type added to brine solution and meat model.

^g pH measurement of brine at 5°C.

^h pH measurement of raw ham samples at 40°F, 1 week post-processing.

ⁱ pH measurement of cooked ham samples at 40°F, 1 week post-processing.

^j Proximate Composition: Percent moisture, fat, and protein of raw and cooked high-moisture restructured ham samples.

^k Standard error of the mean (SEM).

^{NS} Not significant (P>0.05).

TM = Trademark of Dow Chemical Company, Midland, MI.

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Table 2

Least square means for TBARS, percent purge, percent cook yield and ham slice color of high-moisture restructured hams manufactured with varying combinations of hydrocolloid brines.

Treatment ^f	Hydrocolloid Type ^e					Days ^l						SEM ^l
	1	2	3	4	5							
	MC/KC	HPMC/KC	MC/HPMC/KC	KC	Control							
Level ^g	0.4 / 0.6	0.6 / 0.6	0.4 / 0.6 / 0.6	0.6	0.0	0	7	14	21	28	56	
% Cook Yield ^h	91.9 ^a	83.2 ^c	91.6 ^a	90.0 ^{ab}	86.1 ^{bc}							0.9
% Purge ⁱ	1.49 ^c	0.90 ^d	1.31 ^c	2.79 ^b	4.31 ^a	-	2.0 ^b	2.2 ^{ab}	2.1 ^b	2.1 ^b	2.5 ^a	0.1
TBARS ^j	0.09	0.011	0.01	0.09	0.01	0.08 ^b	-	0.11 ^a	-	0.10 ^{ab}	0.11 ^a	0.01
Surface Color ^k												
L*	68.2 ^{cd}	67.3 ^d	68.3 ^{bc}	69.2 ^a	69.1 ^a	-	68.8	68.3	68.4	68.3	68.4	0.2
a*	18.1 ^{bc}	18.4 ^{ab}	18.9 ^a	17.8 ^c	18.0 ^{bc}	-	17.8 ^a	18.1 ^{ab}	18.4 ^a	18.5 ^a	18.5 ^a	0.1
b*	4.34 ^c	4.53 ^b	4.71 ^a	3.86 ^d	3.60 ^e	-	4.10	4.26	4.22	4.20	4.25	0.04

^{a-d} Means having different superscripts within rows for a specific main effect (treatment or days) are significantly different (P<0.05).

^e Hydrocolloid Type: kappa carrageenan Gelcarin® ME 6910, methylcellulose: METHOCEL™ A4M, hydroxypropyl methylcellulose: METHOCEL™ F4M.

^f Treatment identification of brine solutions.

^g Level (0.0, 0.4 & 0.6%) of hydrocolloid type added to brine solution and meat model.

^h % Cook yield= Cooked weight/Raw weight*100. Restructured hams cooked to 158°F.

ⁱ % Purge = dry sample wt + dry bag wt. / total sample package (sample + bag) weight.

^j TBARS = 2-Thiobarbituric acid reactive substances test evaluating mg malonaldehyde/kg of restructured ham sample per treatment and on day 0, 14, 28 and 56.

^k Color (Commission Internationale De L'Eclairage) (CIE); reflectance (L*), redness (a*), yellowness (b*) of ham slice surface at 40°F.

^l Days of storage at 40°F

^m Standard error of the mean (SEM).

TM = Trademark of Dow Chemical Company, Midland, MI.

Table 3
Least square means for TPA, Kramer shear and sensory attributes of high-moisture restructured hams manufactured with varying combinations of hydrocolloid brines.

Treatment ^f	Hydrocolloid Type ^e					SEM ^l
	1	2	3	4	5	
	MC/KC	HPMC/KC	MC/HPMC/KC	KC	Control	
Level ^g	0.4 / 0.6	0.6 / 0.6	0.4 / 0.6 / 0.6	0.6	0.0	
TPA ^a						
Hardness (kg/g sample) ^b	0.26 ^{ab}	0.32 ^a	0.16 ^b	0.34 ^a	0.34 ^a	0.02
Springiness (mm/kg) ^c	0.88 ^a	0.86 ^{ab}	0.78 ^b	0.91 ^a	0.93 ^a	0.02
Cohesiveness ^d	0.59 ^b	0.55 ^{bc}	0.52 ^c	0.70 ^a	0.71 ^a	0.01
Chewiness (kg) ^k	0.53 ^{bc}	0.62 ^{ab}	0.24 ^c	0.82 ^a	0.84 ^a	0.08
Resilience ^l	0.26 ^b	0.23 ^b	0.19 ^c	0.35 ^a	0.36 ^a	0.01
Kramer Shear ^m						
Force (kg/g) ^{NS}	0.42	0.48	0.37	0.50	0.41	0.04
Sensory Attributes ⁿ						
Hardness	2.4 ^{bc}	2.2 ^c	2.4 ^{bc}	3.3 ^a	3.0 ^{ab}	0.2
Juiciness	2.6 ^b	2.4 ^b	2.0 ^b	3.7 ^a	3.5 ^a	0.2
Mouth Residue/Coatingj	2.9 ^b	3.7 ^{ab}	4.1 ^a	1.5 ^d	2.0 ^{cd}	0.2
Intensity of Off-Flavor	1.1 ^b	1.2 ^{ab}	1.4 ^a	1.0 ^b	1.0 ^b	0.1

^{a-d} Means having different superscripts within rows are significantly different (P<0.05).

^e Hydrocolloid Type: kappa carrageenan Gelcarin® ME 6910, methylcellulose: METHOCEL™ A4M, hydroxypropyl methylcellulose: METHOCEL™ F4M.

^f Treatment identification for the brine solutions.

^g Level (0.0, 0.4 & 0.8%) of hydrocolloid type added to brine solution and meat model.

^h Texture profile analysis: 2-cycle compression using a 5 kg load cell, 75 mm plate and a heavy duty platform.

ⁱ Hardness: peak force (kg) during first compression / sample weight (kg).

^j Springiness: height the food recovers between the first and second compression.

^k Cohesiveness: ratio of positive force area during the 2nd compression to that during the first compression (A₂/A₁).

^l Chewiness is the product of Hardness* Cohesiveness* Springiness.

^m Resilience is the ratio of the area during the 1st plate withdrawal over the 1st plate penetration.

ⁿ Kramer Shear: utilizing 50 kg load cell, 5-blade attachment, and heavy duty platform.

^o Trained sensory panel of attributes based on an 8 point hedonic scale: 1=extremely soft/extremely dry/ no residue/ no off-flavor; 8= extremely hard/ extremely juicy/ heavy residue/ high intensity. Evaluation temperature = 40°F.

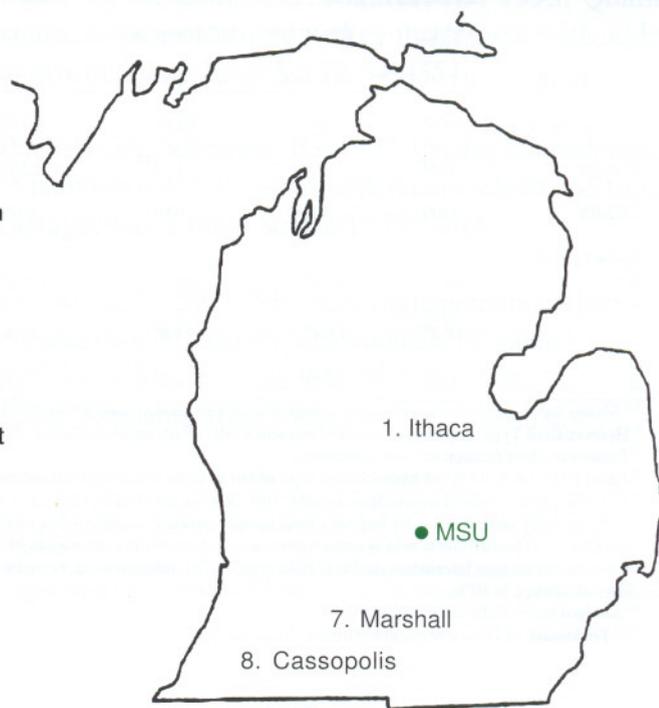
^l Standard Error of the Mean (SEM).

^{NS} Not significant (P>0.05).

TM = Trademark of Dow Chemical Company, Midland, MI.

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All comments and suggestions should be directed to:



PORK 101™

Exploring Quality, Consistency & Value

What is PORK 101?

A three-day, hands-on educational opportunity to update interested participants on quality and consistency issues in the pork industry. It includes insight on value differences in swine, pork carcasses, pork primals and processed pork products due to quality variation.

Unique Features

Through PORK 101, you will have the chance to evaluate live hogs. The animals will be processed during the class with participants learning about grading, food safety and product processing. Finally the class will make and sample processed product from the hogs including pumped loins, bacon, hams and sausage.

Who will benefit from attending PORK 101?

Anyone involved in the production, processing and marketing of pork will benefit from attending this course.

How to register:

A registration brochure and agenda (Adobe pdf file) is available at <http://www.meatscience.org/meetings/>

pork101/. Reservations can be made directly by calling the American Meat Science Association at 217-356-3182. The cost is 450.00 per person and includes all meals and breaks. Once you have registered you will receive hotel information. For the Michigan State Pork 101 workshop lodging has been coordinated with the Clarion Hotel located at 3600 Dunckel (517-351-7600). The contact person for the MSU Pork 101 is Wes Osburn (Ph. 517-33-8452, ext. 202). The MSU Meat Science Team encourages you to participate in this great learning experience!

PORK 101 is sponsored by Elanco Animal Health and Townsend Engineering Company. AMSA members coordinate the classes in cooperation with the National Pork Board.

2003 Schedule:

August 19-21
Michigan State University
East Lansing, Michigan

September 8 - 10
Oklahoma State University
Stillwater, Oklahoma