CARCASS CHILLING METHOD EFFECTS ON TEXTURE AND CURED COLOR DEVELOPMENT OF COOKED SOW SAUSAGE

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OBJECTIVES

To determine the effect of the vascular rinsing and chilling of sow carcasses on the texture and cured color development of cooked sausage

MATERIALS AND METHODS

ANIMALS

- Sow (n = 6 per chill method), age 30 months, average hot carcass weight: 237 kg

CARCASS CHILLING METHODS

- Conventional air chilling (CN)
- Rinse & Chill® technology (RC; MPSC Inc.)
  - Delivers cold (3°C) isotonic substrate solution using a cannula inserted into the vascular system of the carcass
  - Vascular rinsing of residual blood early postmortem
  - Isotonic substrate solution: 98.5% water; balance: glucose, polyphosphates, glycerine, and maltose

Figure 1. Shoulder region of the sow carcass (Boston butt and picnic shoulder) deboned to obtain lean trim

MEAT CUT PROCESSING AND STORAGE

- Shoulder, loin, and ham region of the sow's carcass deboned prerigor
- Meat ground (3/8"), salted (1%) and dry ice added
- Vacuum packaged and then stored overnight in the cooler (2°C)
- Reground (3/16") next day and stored in a freezer prior to manufacturing

Figure 2. Dorsal side of sow carcass in which loins and shoulder muscles removed

PROCESSED MEAT MANUFACTURING

- Pre-weighed seasoning: salt, sucrose, garlic powder, white pepper, nutmeg
- Meat and seasoning were mixed (model KV25GOXER, KitchenAid)
  - Cure mix (6.25% $NaNO_2$;156 ppm), dissolved in ice water
- Meat stuffed in cellulose casings (28 mm), stored in cooler (2°C) overnight
- Sausages cooked (George Foreman Grill, 170°F endpoint temperature)

DEPENDENT VARIABLES

- Color measurements (CR-300 Minolta, UV-2501 Shimadzu Reflectance Spectrophotometer with MPC-2200 Integrating Sphere)
  - CIE L*: lightness CIE a*: redness CIE b*: yellowness
  - Deoxymyoglobin (DMb, reflectance estimator %R474nm/%R525nm, AMSA 2012)
  - Nitrosylhemochrome (NITHEM, reflectance estimator %R650nm/%R570nm, AMSA 2012)
- Texture measurement (model TA.HDplus Stable Microsystems Texture Analyser)
  - hardness, springiness, cohesiveness
- pH
- Cooking loss

STATISTICAL ANALYSIS

- Data were analyzed with PROC MIXED procedure of SAS (2010; 9.1.3 Service Pack 3, SAS Institute Inc., Cary, NC). LSD mean separation (SAS) and mean letter assignment (pdmix800 macro; Saxton, 1998). Animal served as experimental unit (replications = 6)

RESULTS

- Carcass Chilling Method Effects
  - RC vs CN ($P>0.05$): cook loss, cooked pH, instrumental texture, NITHEM or DMb
  - RC: lighter, less red ($P<0.05$) cured cooked sausages
- Anatomical Location Effects of Lean on Sausage Properties
  - Shoulder highest pH ($P<0.05$), loin not different than ham
  - Loin lowest ($P<0.05$) cooking loss
  - Loin most firm ($P<0.05$) followed by ham and shoulder
  - Shoulder least cohesive ($P<0.05$), no difference between loin and ham
  - Ham<Shoulder<Loin for springiness ($P<0.05$)
  - Shoulder highest ($P<0.05$) reflectance estimator of NITHEM
  - Ham highest ($P<0.05$) reflectance estimator of DMb
  - Shoulder and loin different ($P<0.05$) in yellowness, ham intermediate

CONCLUSIONS

Sausage manufacturers can use prerigor meat from Rinse & Chill® sow carcasses and produce sausages with comparable textural properties to meat from carcasses conventionally chilled.

Rinse & Chill® only influenced the redness and lightness of cooked cured sausage presumably associated with the removal of more residual hemoglobin.

Future studies should consider evaluating cured color stability of sausages made from carcasses processed with Rinse & Chill® technology with respect to the potential impact of differences in myoglobin and hemoglobin content in comparison to traditionally chilled carcasses.

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Table 1. Type III Test of Fix Effects and Least Square Means of Color Measurements Associated with Carcass Chilling Method[1] and Anatomical location[2]

Dependent Variable[3]	Shoulder CN	Shoulder RC	Shoulder avg	Loin CN	Loin RC	Loin avg	Ham CN	Ham RC	Ham avg	S.E.	Chill treatment (trt)	Anatom-ical (A)	Interac-tion trt*A
NITHEM	3.07	2.92	2.99[x]	2.27	2.24	2.25[y]	2.07	1.98	2.02[y]	0.1975	0.5373	<.0001	0.943
DMb	1.05	1.03	1.04[y]	1.02	1.02	1.02[y]	1.43	1.41	1.42[x]	0.1446	0.9089	0.0062	0.9974
CIE L*	50.00	52.82	51.41[z]	60.85	61.80	61.33[x]	56.81	56.80	56.80[y]	0.6329	0.0102	<.0001	0.0508
CIE a*	18.77	18.09	18.43[x]	15.41	14.91	15.16[z]	17.53	17.18	17.35[y]	0.2571	0.0141	<.0001	0.786
CIE b*	7.30	7.57	7.44[x]	6.83	1.44	7.00[y]	7.48	7.14	7.31[xy]	0.1717	0.5129	0.0231	0.0739

[1]Carcass chilling method: CN=conventionally chilled, control; RC=vascularly rinsed and chilled with isotonic substrate solution
[2]Anatomical location (A): three areas independently deboned to obtain lean trim (shoulder, loin, ham)
[3]Dependent variables: NITHEM=nitrosylhemocrhome (reflectance estimator %R650nm/%R570nm; higher ratio more), DMb=deoxymyoglobin (reflectance estimator %R474nm/%R525nm, higher ratio more), CIE L*=lightness, CIE a* redness, CIE b* yellowness)
[xy]Means within a dependent variable with unlike superscript letters are different (P<0.05)

TOP LINE RESULT POINTS:

- ❑ RC resulted in lighter and less red (P<0.05) cured cooked sausage than CN
  - Erazo-Castrejon et al. (2017) found that RC resulted in less hemoglobin
  - In contrast with bison study (Mickelson and Claus, 2016)
    - Projects used different meat animal species
    - Color measured on cooked sausage versus raw meat
- ❑ No interactions were found (P>0.05) between carcass chilling treatment and anatomical location.

- ❑ Sausages that used shoulder lean had the highest (P<0.05) reflectance estimator of NITHEM
- ❑ Sausage from the ham had the highest (P<0.05) reflectance estimator of DMb
- ❑ Sausage from the shoulder and loin were different (P<0.05) in yellowness with the ham being intermediate

Table 2. Type III Test of Fix Effects and Least Square Means of pH, Cooking Loss, and Texture Measurements Associated with Carcass Chilling Method[1] and Anatomical location[2]

Dependent Variable[3]	Shoulder			Loin			Ham				Chill	Anatom-ical	Interac-tion
	CN	RC	avg	CN	RC	avg	CN	RC	avg	S.E.	Treatment (trt)	(A)	trt*A
pH	6.26	6.27	6.26[x]	6.00	6.05	6.02[y]	6.00	6.01	6.01[y]	0.0818	0.6104	0.0005	0.925
Cook loss (%)	16.28	16.26	16.27[x]	13.92	13.36	13.64[y]	15.45	14.80	15.13[x]	0.745	0.4261	0.001	0.8589
Hardness	102.88	103.53	103.21[z]	160.00	173.63	166.82[x]	139.63	129.29	134.46[y]	5.714	0.7647	<.0001	0.0973
Cohesiveness	43.98	44.77	44.37[y]	48.01	50.78	49.40[x]	48.63	47.38	48.01[x]	0.963	0.3102	<.0001	0.1041
Springiness	1.40	1.40	1.40[y]	1.44	1.44	1.44[x]	1.34	1.36	1.35[z]	0.0207	0.6835	0.0002	0.8819

[1]Carcass chilling method: CN=conventionally chilled, control; RC=vascularly rinsed and chilled with isotonic substrate solution
[2]Anatomical location (A): three areas independently deboned to obtain lean trim (shoulder, loin, ham)
[3]Dependent variables: Hardness (peak force a first compression, N), Cohesiveness (ratio of area under second compression divided by area under first compression * 100), Springiness= ???
[xyz]Means within a dependent variable with unlike superscript letters are different (P<0.05)

TOP LINE RESULT POINTS:

- RC did not affect (P>0.05) cook loss, cooked pH and instrumental texture (hardness, cohesiveness, springiness)
- Sausage from the shoulder lean had the highest pH (P<0.05) with no difference between the loin and ham (6.02, 6.01; respectively). Those from the loin had the lowest (P<0.05) cooking loss
- Sausage from the loin was the most firm (P<0.05) followed by the ham and shoulder
- Sausage from the shoulder was the least cohesive (P<0.05) sausage with no difference between loin and ham
- Sausages varied (P<0.05) in springiness associated with each anatomical location of the lean (ham<shoulder<loin)
- No interactions were found (P>0.05) between carcass chilling treatment and anatomical location.