REVISITING FAT STABILIZATION IN COMMINUTED MEAT PRODUCTS

A revised theory of fat-binding by meat gels

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INTRODUCTION

Finely comminuted meat products, like frankfurters and luncheon meats, typically contain 20-30% fat. **Early workers proposed that classic emulsion theory explains fat holding ability during cooking (FHA)**, where solubilized myofibrillar proteins (MFP) stabilize the fat/water interface to form an interfacial protein film (IPF) that prevents fat coalescence and flow. **Recently more emphasis has been placed on 'entrapment' of fat within the protein gel matrix** formed upon cooking. Even with this understanding, however, a major role of the IPF in fat stabilization is generally accepted. **We instead postulate that FHA is directly linked to water-holding ability during cooking (WHA), which in turn is mediated primarily by capillary pressure**, a function of the gel matrix structure/composition (pore size, surface properties, and dissolved solutes) according to the Jurin rule. An IPF likely exists at the fat:matrix interface, but we believe at most it plays a minor role in determining FHA. Others have shown close correlation of WHA with FHA in cooking of sausages, and the present work further investigates this correlation.

MATERIALS & METHODS

Meat batters were formulated with skinless/boneless chicken breast (51.17%; w/w), salt (2%; w/w), sugar (1.7%; w/w), trisodium phosphate (0.3%), pork lard (20%; w/w), and added water (24.83%; w/w). A meat paste control treatment was also prepared which had identical ingredients, minus the fat, all held at the same ratios as in the fat-containing formulation.

The content of MFP (all from lean chicken breast) of a standard frankfurter batter (minus added fat) was adjusted successively downward by addition of 0, 15% or 30% whey protein isolate (WPI) in substitution of MF protein, holding moisture content constant. Thus 'meat blocks' of three different 'bind quality' levels would be simulated; **WPI** (low calcium) **serves as a substitute for sarcoplasmic meat proteins and is essentially non-gelling below 70 ˚C**. Pork lard (20% w/w) was added to two additional sets of these three batters, as either a pre-emulsion (PE) prepared with a portion of the salted chicken meat, or directly (non-pre-emulsion; NPE).

Meat batters (and pastes without fat) were prepared by chopping ingredients in a Stephan UM-5 vacuum cutter-mixer (Stephan Machinery Corp., Columbus, Ohio, U.S.A.) at 3000 rpm for 8 min under vacuum condition. Endpoint chopping temperature did not exceed 9 ˚C±1 ˚C. Raw batters/pastes were stuffed into casings and ramp heated in a programmable water bath at 0.5 ˚C/min to an endpoint temperature of 70 ˚C. After heating, all gels were immediately cooled in an ice bath.

IPF formation was simulated by pouring liquified lard (25 ˚C.) vs water (control) onto the surface of a raw meat paste wherein the content of MFP was varied by addition of WPI and heating to 75 ˚C at 0.5 ˚C/min.

WHA (and FHA, for fat-containing batters) were measured during cooking (as cook losses), plus water holding capacity (WHC) and fracture stress/strain of cooked, cooled gels were measured by micro-centrifuge at 153 ×g for 10 min and torsion in triplicate, respectively. The SAS General Linear Model procedure was used for analysis of variance. Tukey multiple comparison analysis was performed to separate the means ($P < 0.05$).

Gel morphology and pore size were examined by confocal laser scanning microscope (CLSM) and variable pressure scanning electron microscope (VP-SEM). Simulation of IPF formation was studied by transmission electron microscopy (TEM).

RESULTS: Microstructure (VP-SEM)

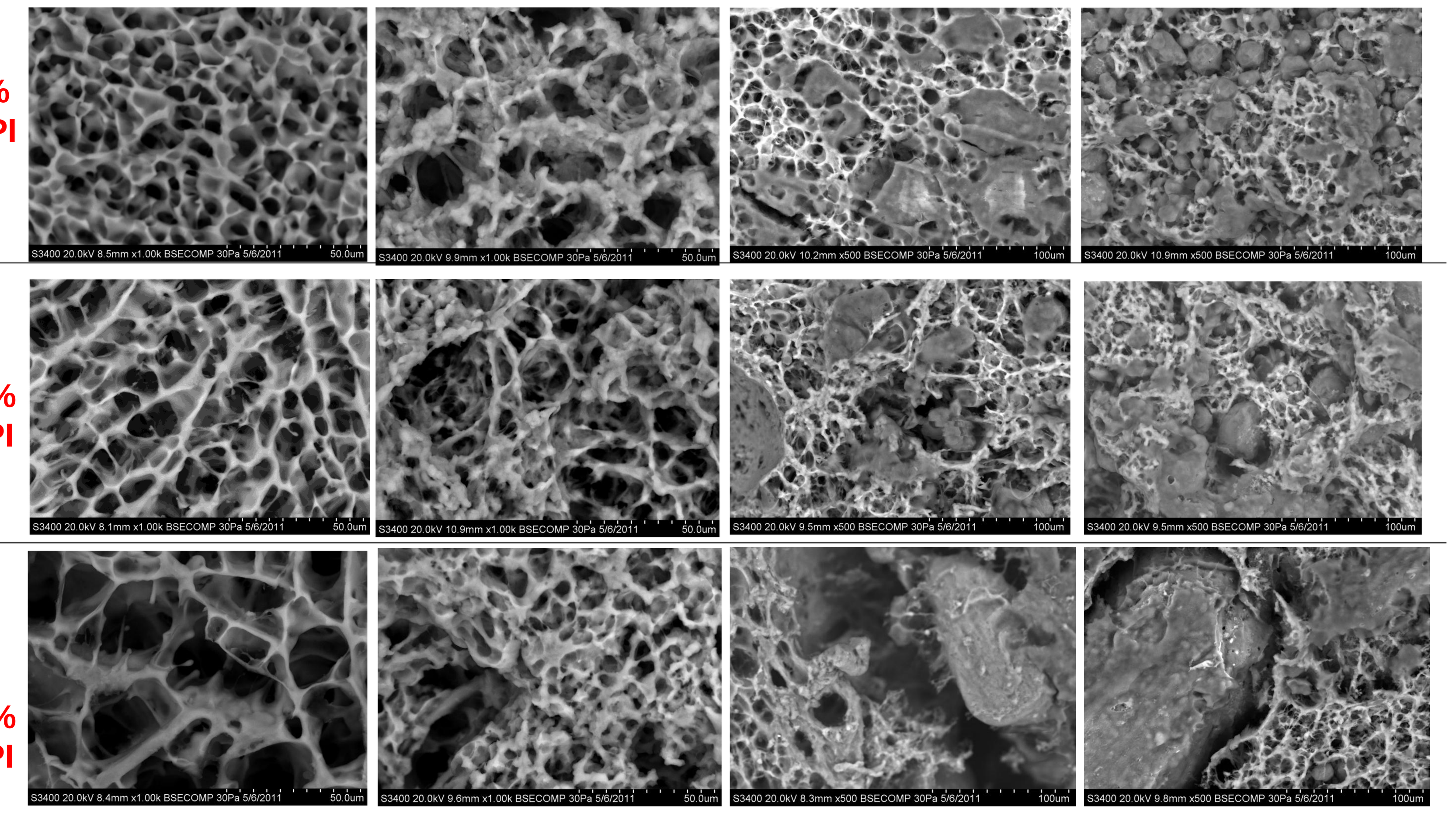

Fig 1: SEM micrographs

RESULTS: Microstructure (CLSM)

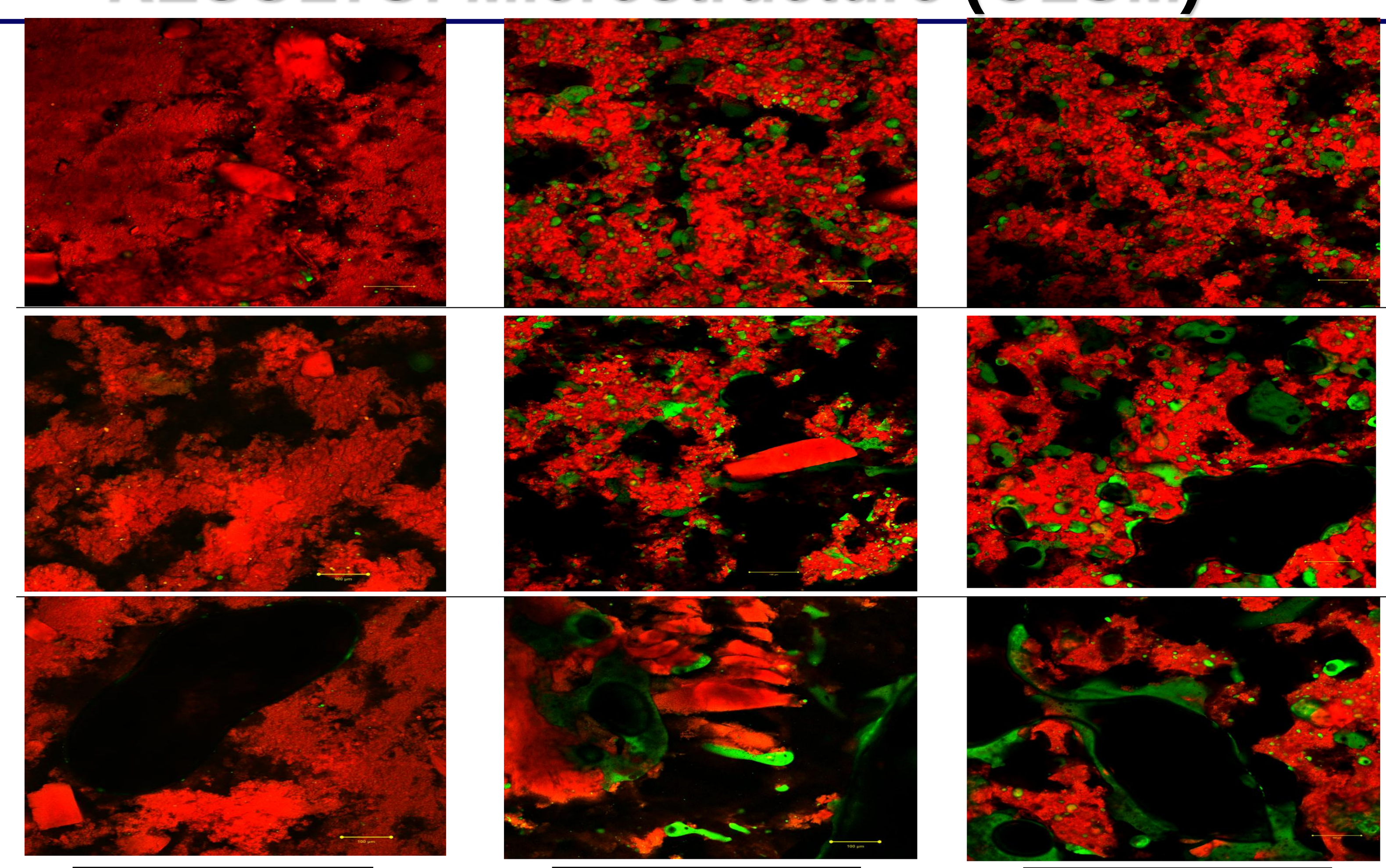

Fig 2:CLSM micrographs (10 X)

RESULTS: IPF Simulation (TEM)

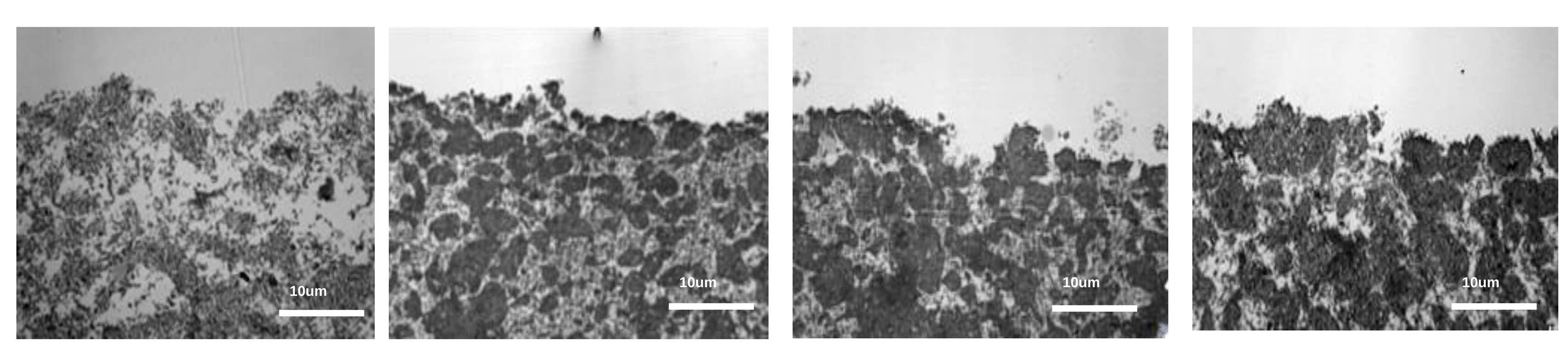

Fig 3: IPF TEM micrographs (1800 X)

RESULTS: Cook Loss

(During cooking)

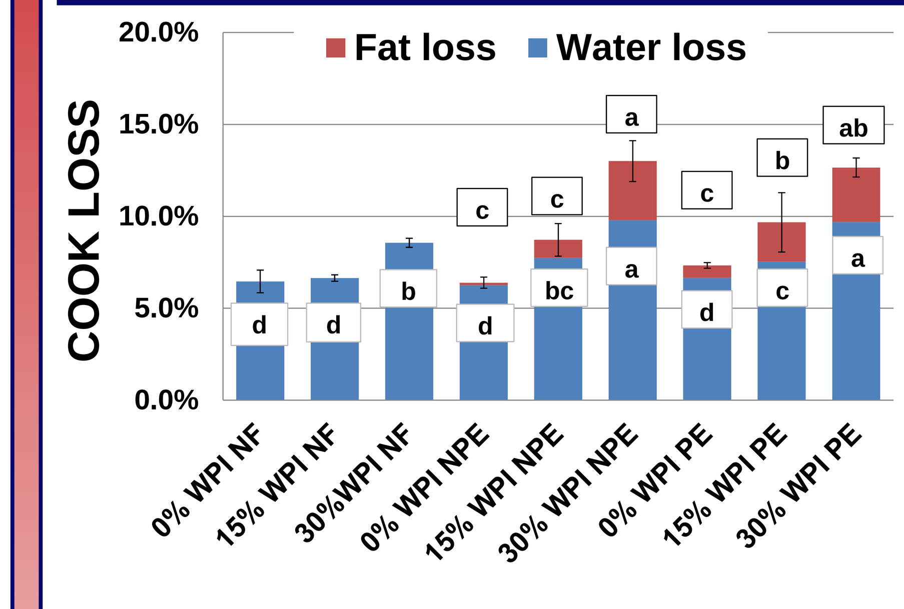

Fig 4: Cook losses (%) of chicken batters (or pastes) during slow gradual (ramp) heating, as WHA & FHA

RESULTS: WHC

(By micro-centrifuge)

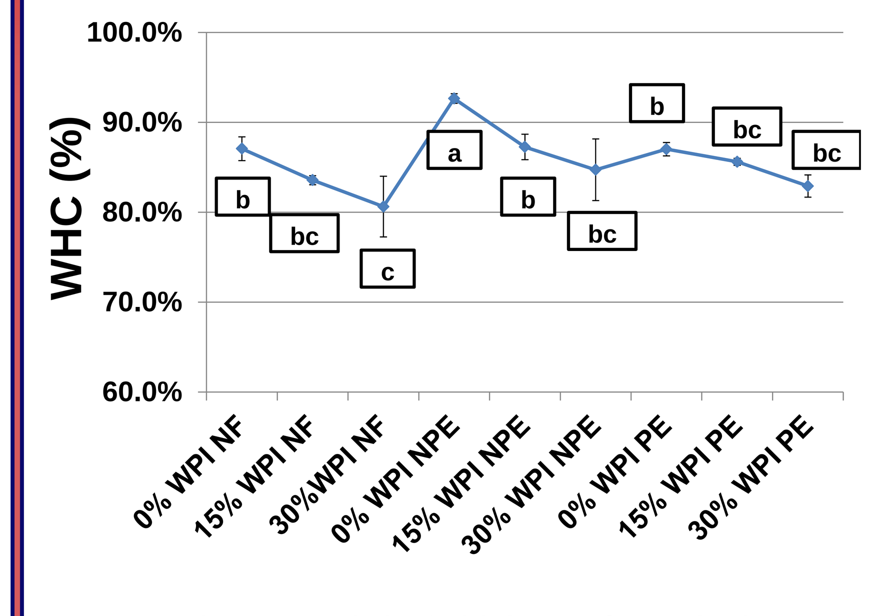

Fig 5: WHC(%) of chicken gels cooked by slow gradual (ramp) heating regimes

RESULTS: Fracture

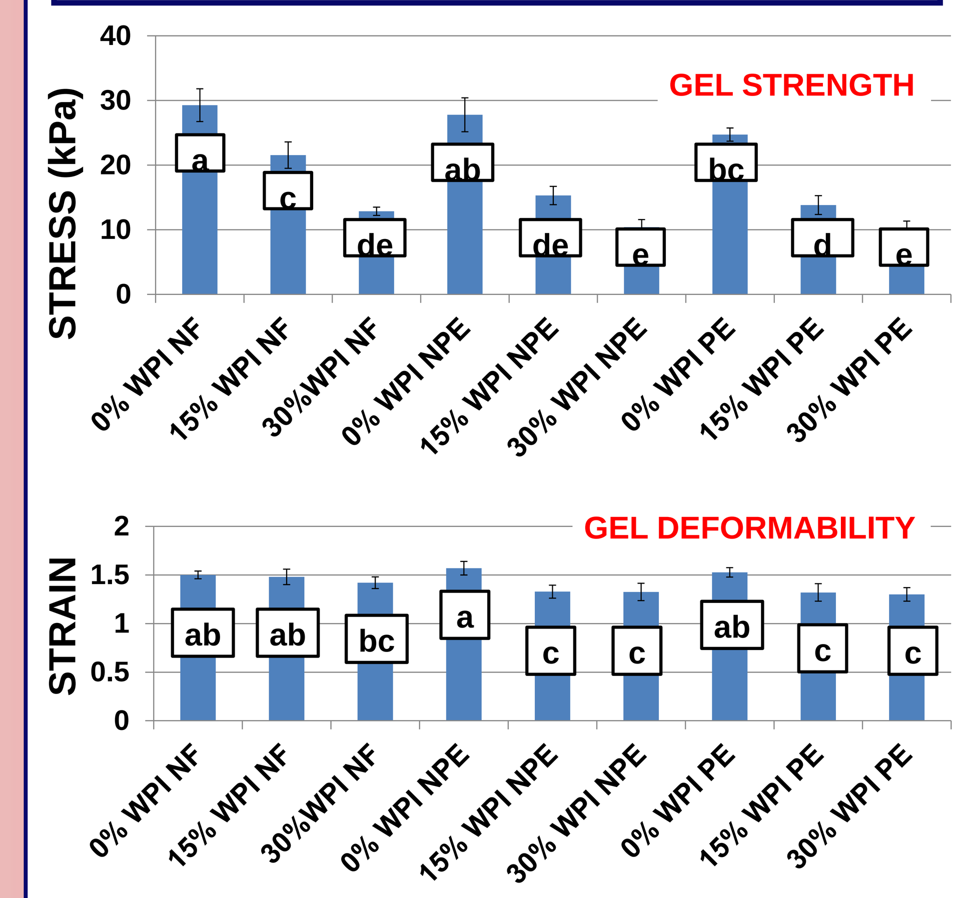

Fig 6: Torsion fracture stress and strain of chicken gels cooked by slow gradual (ramp) heating

Gel Pore Formation

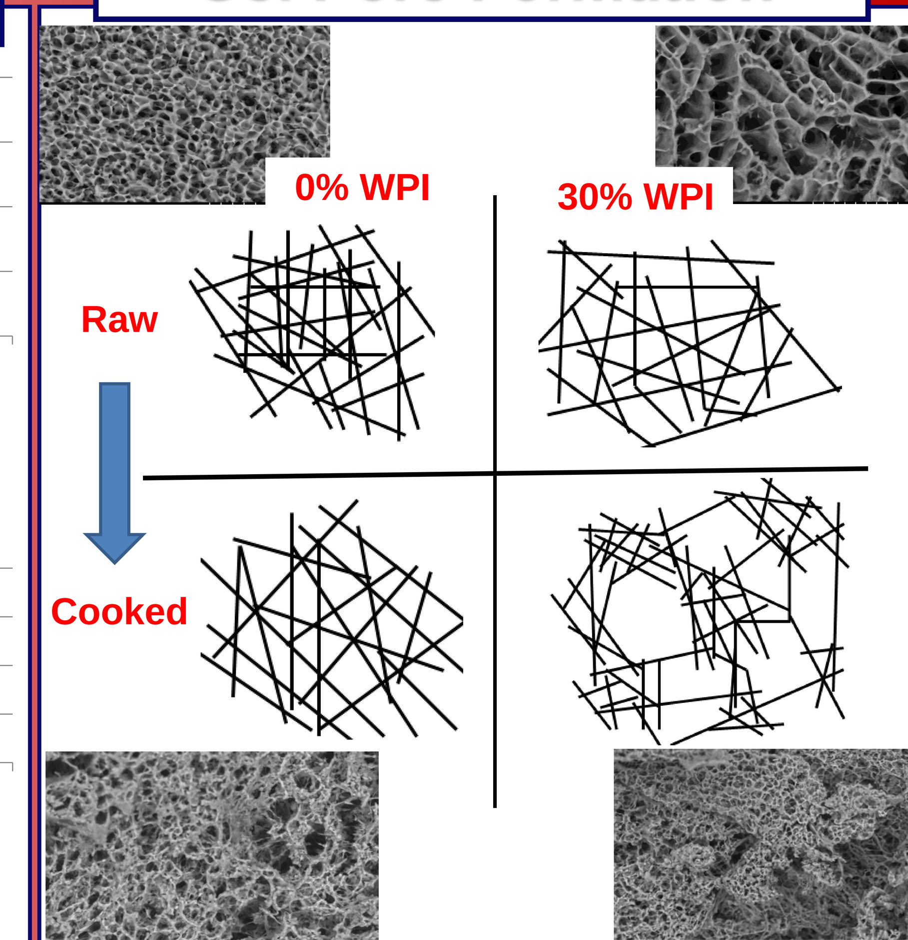

Fig 7: Gel formation diagram and SEM graphs of raw and cooked gels

SUMMARY OF FINDINGS

1) **The paste has a gel network structure even before cooking** (Fig. 1, NF raw paste).

2) **Pore size of the raw paste gel seems predictive for WHA & WHC of non-fat cooked gels** (Fig. 4, 5); **and the WHC, WHA & FHA in fat-containing gels** (Fig. 4), as diagrammed (Fig. 7). More coarse-stranded (larger pore) gels were formed when more WPI was substituted for MFP from chicken meat (Figs. 1, 2).

3) FHA is highly correlated ($P<0.001$) with WHA during cooking; this suggests that ***water, held in pores by capillary forces, blocks loss of liquid fat during cooking.***

4) Fine-stranded gels at low WPI substitution produced stronger, more deformable gels (Fig. 6).

5) TEM showed similar formation of an IPF when the raw NF paste was brought in contact with liquid fat (Fig. 3), regardless of the gel composition.

6) PE of fat imparted no additional stability to fat-containing gels as compared to NPE.

FHA corresponds directly to WHA during cooking, and a fine-stranded, strong/deformable gel matrix which exhibits high WHA and WHC will also exhibit high FHA.

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Effects of Noni pulp and juice on Lee-Kramer shear force, cooked color and consumer acceptability of ground beef patties

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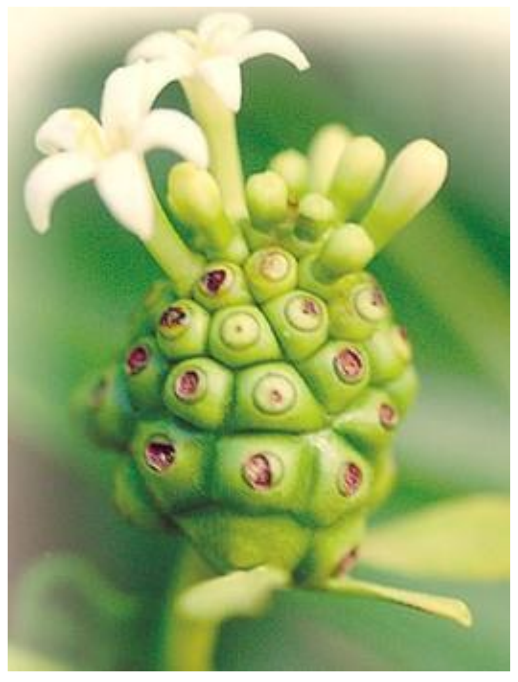
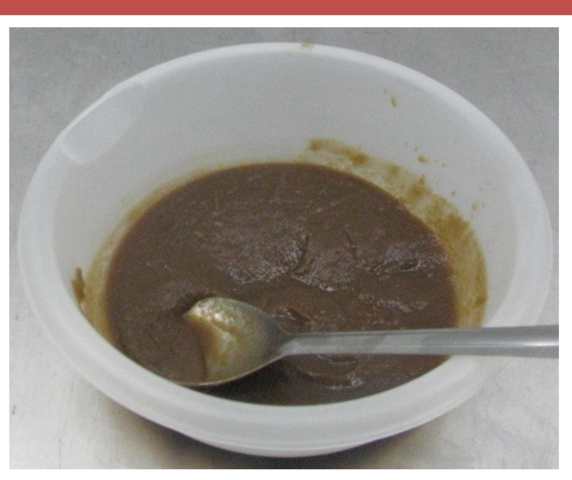
What is Noni?

- *Morida citrifolia*
- Evergreen shrub native to Southeast Asia (Tahiti)
- Used for centuries as homeopathic remedy to treat…
  - ✓ Muscle sprains
  - ✓ Diabetes
  - ✓ Headaches
  - ✓ Heart disease
- Currently marketed in beverages as health food
- Action largely attributed to antioxidant properties
- Shown to improve growth and health in growing cattle



Noni pulp (puree)



- Successfully incorporated into ground beef to improve shelf life and color stability
- Trained panelists found less beef flavor and increased off-flavors with increasing Noni (Tapp et al., 2010)

Clarified Noni Juice

- Derived from filtration and re-pasteurization of Noni pulp
- Less viscous and milder aroma than pulp
- Previous research showed improved TBARS (reduced lipid oxidation) in ground beef over 5 d in display (Ahrens et al., 2011)

Objective

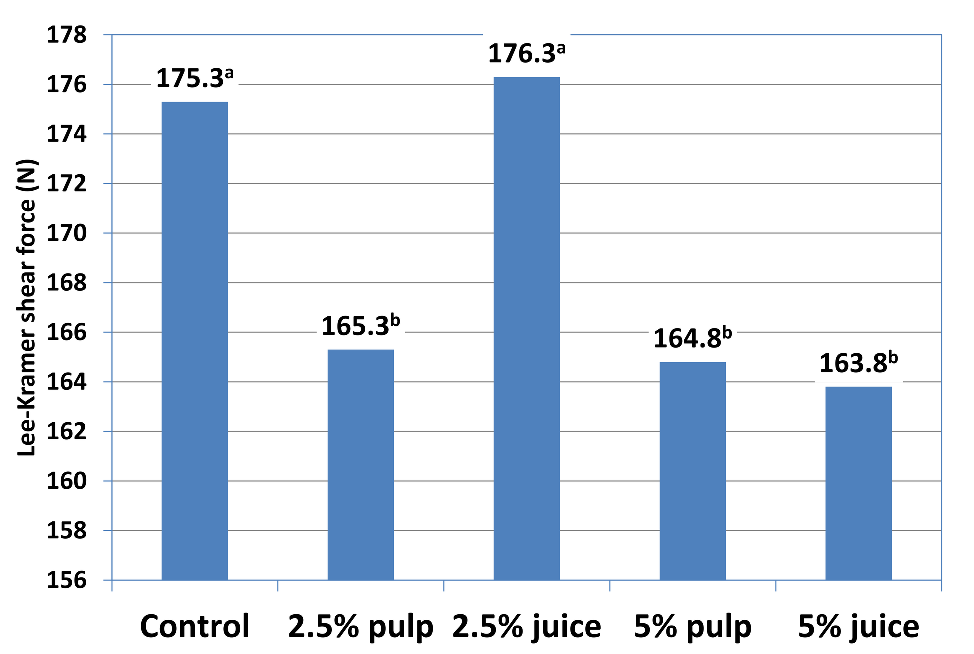
To determine and compare the effects of Noni pulp and clarified Noni juice on objective tenderness measurements, internal cooked color, and consumer acceptability of beef patties

Materials and methods

- Ground beef (85% lean)
- 5 treatments (5 batches/treatment)
  - Control
  - 2.5% Noni Pulp
  - 5% Noni Pulp
  - 2.5% clarified Noni juice
  - 5% clarified Noni juice
- Formed into 113-g patties (Vacuum packaged & frozen)
- Lee-Kramer shear (cooked to 71° C on electric griddles)
- Cooked color
  - Cooked to 71° C on electric griddles
  - Chilled in ice-bath
  - Sliced perpendicular to surface
  - Measured w/ Hunter MiniScan
- Cooking loss
- Consumer panel
  - 150 consumers (ate beef 3 or more times per week)
  - Cooked to 71° C on electric griddles
  - Added 0.4-g seasoning/ patty (Grill Mates® Montreal Steak Seasoning)
  - Patties cut into 4 sections and served warm

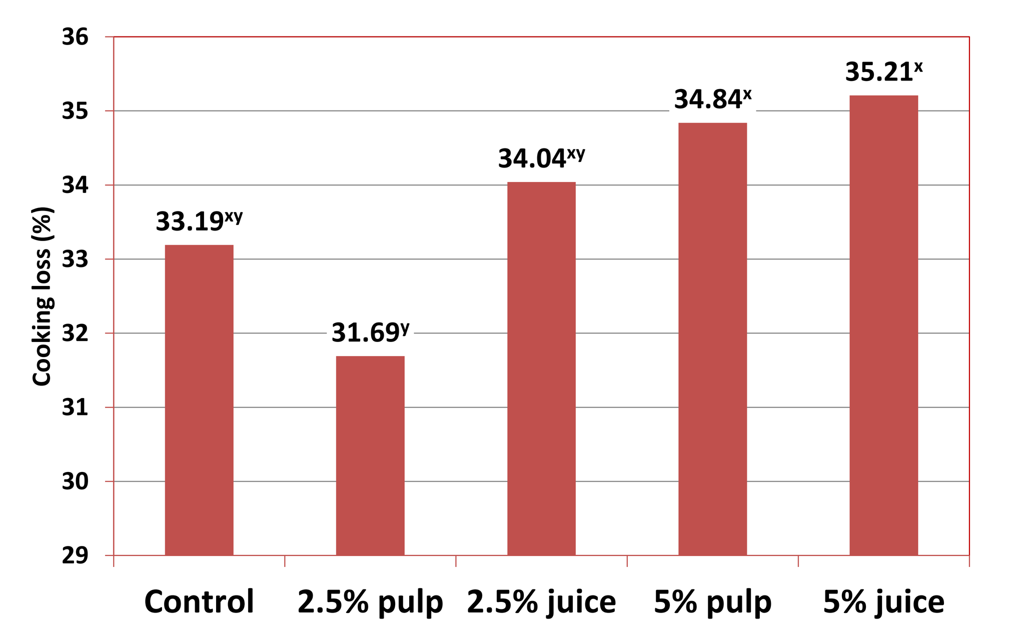
Results

Figure 1. Mean values of Lee-Kramer shear force of ground beef patties treated with 0, 2.5, or 5% Noni pulp or juice



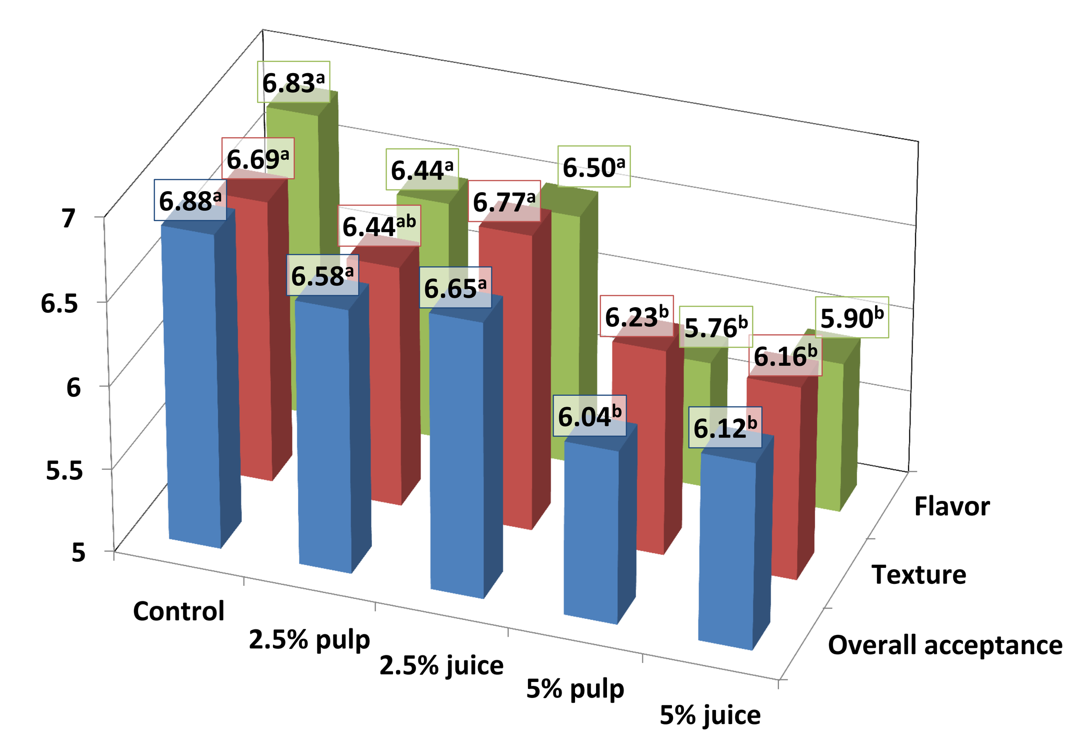
a,b Means with different superscript letters differ ($P < 0.05$)

Figure 2. Mean values of cooking losses of ground beef patties treated with 0, 2.5, or 5% Noni pulp or juice



x,y Means with different superscript letters differ ($P < 0.10$)

Figure 3. Mean values of consumer panel responses of ground beef patties treated with 0, 2.5, or 5% Noni pulp or juice



a, b Means, within an attribute, with different superscript letters differ ($P < 0.05$)
[1] Overall acceptance, texture, and flavor were evaluated on a 9-point scale, where 1 = dislike extremely and 9 = like extremely

Table 1. Mean values of cooked color measurements of ground beef patties treated with 0, 2.5, or 5% Noni pulp or juice.

		2.5%		5%			Contrast Statements[1]			
	Control	Pulp	Juice	Pulp	Juice	*P* value	C vs.N	J vs. P	Level	Int.
Lightness (L*)	61.86	61.10	61.33	60.38	61.21	0.124	0.053	0.167	0.266	0.426
Redness (a*)	14.47	14.75	15.62	12.35	14.31	0.148	0.829	0.119	0.045	0.535
Yellowness (b*)	16.29^{xy}	16.11^{xy}	16.88^{x}	15.53^{y}	17.23^{x}	0.069	0.756	0.008	0.786	0.270
Hue angle[2]	48.68	47.70	47.51	51.66	50.51	0.298	0.712	0.677	0.039	0.765
Chroma[3]	21.85^{xy}	21.90^{xy}	23.07^{x}	19.86^{y}	22.44^{x}	0.068	0.975	0.021	0.089	0.359
Red-brown ratio[4]	1.77	1.83	1.93	1.55	1.76	0.202	0.964	0.166	0.051	0.661

x,y Means, within a row, with different superscript letters differ ($P < 0.10$)
[1] Contrast statements were calculated to determine specific differences between control versus all Noni products (C vs. N), clarified Noni juice versus Noni pulp (J vs. P), 2.5% versus 5% inclusion levels (Level), and the interaction of Noni product source and level with the exclusion of the control (Int.)
[2] Hue angle was calculated $\tan^{-1}(b^*/a^*)$. Zero was the true red axis and 90 was the true yellow
[3] Chroma was calculated $\sqrt{(a^{*2} + b^{*2})}$. Larger numbers indicated a more saturated, vivid coloration.
[4] Red-brown ratio is the ratio of the reflectance values at 630 nm / 580 nm. Larger numbers reflected a redder color.

Table 2. Mean values of consumer panel responses of ground beef patties treated with 0, 2.5, or 5% Noni pulp or juice.

		2.5%		5%			Contrast Statements[1]			
	Control	Pulp	Juice	Pulp	Juice	*P* value	C vs.N	J vs. P	Level	Int.
Beef flavor[2]	2.65	2.57	2.51	2.53	2.58	0.590	0.166	0.875	0.793	0.372
Juiciness[2]	2.77	2.77	2.77	2.79	2.79	0.993	0.810	1.000	0.686	0.893
Off-flavor[3]	1.75^{a}	1.72^{a}	1.69^{a}	1.50^{b}	1.55^{b}	<0.001	0.001	0.795	<0.001	0.260

a, b Means, within a row, with different superscript letters differ ($P < 0.05$)
[1] Contrast statements were calculated to determine specific differences between control versus all Noni products (C vs. N), clarified Noni juice versus Noni pulp (J vs. P), 2.5% versus 5% inclusion levels (Level), and the interaction of Noni product source and level with the exclusion of the control (Int.)
[2] Beef flavor and juiciness were evaluated on a 5 point, just-about-right scale where 1 = much too dry/ weak beef flavor, 3 = just about right, 5 = much too juicy/ strong beef flavor
[3] Off-flavor was evaluated as a yes or no question, for analysis 1 = yes and 2 = no

Conclusions

- Noni pulp and juice did not significantly affect cooked color in ground beef patties
- Patties with 2.5% Noni were similar to controls for all consumer-assessed sensory attributes
- Control patties had greater Lee-Kramer shear values, but consumers scored the texture of patties with 5% Noni lower than controls

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Controlling Pink Color Defect in Cooked Turkey Product Using a Dehydrated Whey Protein Concentrate

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Introduction

Cooked, uncured turkey products are susceptible to pink color defect (PCD), a condition which makes them undesirable to consumers. This defect can be caused by multiple mechanisms, making it difficult to pinpoint its source. Some whey protein concentrates (WPCs) have demonstrated potential in combating pink color defect. WPCs contain a number of helpful compounds ideal for prevention of PCD, including calcium, citrate, and lactoferrin. Because WPCs are a heterogeneous mixture and can contain drastically different quantities of these components, the precise levels of each compound that are most helpful in pink color prevention are unknown. Indeed, some WPCs will induce pink color when added. An untested WPC containing calcium, citrate and lactoferrin was added to turkey breast at 2% inclusion to determine if this WPC could be effective in preventing pink color. Further, the turkey breast was treated with pink-generating ligands (PGL) to induce the pink color defect. The addition of WPC to the turkey breast and the resulting redness values are of particular interest to this study.

Objectives

- Determine the efficacy of a dehydrated WPC on cooked ground turkey breast without PGL.
- Induce pink color defect and note the ability of the WPC to curtail the effects of PGL.

Materials and Methods

Table 1. Formulations used for the production of cooked ground turkey breast control and WPC-containing treatments.

Ingredient	Control	TRT1	TRT2	TRT3
Turkey	2000 g	2000 g	2000 g	2000 g
Water (20%)	400 g	400 g	400 g	400 g
Salt (2%)	40 g	40 g	40 g	40 g
STP (0.5%)	10 g	10 g	10 g	10 g
WPC	0%	2%	2%	2%
Nicotinamide	0%	0%	1%	0%
Sodium Nitrite	0%	0%	0%	10 ppm

Processing Steps

- Frozen turkey breasts were thawed at 4°C for 72hrs, then ground using a 3.2mm (1/8") plate.
- Turkey was mixed with 0.5% sodium tripolyphosphate (STP) dissolved in 200g water for 1min. Salt was added and mixed for 1min. PGLs were added (TRT2 and TRT3) and mixed for an additional 1min. WPC was added (TRT1, 2, and 3) and mixed for 3min.
- Turkey was stuffed into 50 ml conical tubes and centrifuged at 2000x*g* for 10min.
- Turkey was stored at 4°C overnight and cooked to an internal temperature of 77°C the next day.
- Cooked turkey was stored at 4°C overnight and analyzed the next day.

Materials and Methods

Sample Testing

- pH: precook and cooked ground turkey breast was diluted, homogenized, and measured using a glass pH electrode.
- Turkey was removed from conical tubes and sliced open.
- Minolta Colorimeter (Minolta Corp., Osaka, Japan) was used for colorimetric analysis values: CIE *L** (lightness), *a** (redness), *b** (yellowness), and *Chroma C** (saturation value).
- Ultraviolet/visible scanning spectrophotometer (Shimadzu Inc., Kyoto, Japan) was used to determine:
  - Nicotinamide hemochrome (rNIC): percent reflectance ratio of %R537nm/%R553nm
  - Nitrosyl hemochrome (rNIT): percent reflectance ratio of %R650nm/%R570nm
- Cook yield was determined by the amount of product left post-cooking and drying on a paper towel.
- Moisture content (AOAC).

Results and Discussion

Meat Attributes

- **Cook Yield**
  - Addition of WPC in all TRTs increased cook yield ($p<0.001$) compared to C.
- **Moisture Content**
  - C had a higher moisture content ($p<0.05$) compared to TRT1 and TRT2, but was similar to TRT3.

Table 2. Least square means of percentage cook yield and moisture content of cooked ground turkey breast samples formulated with and without WPC and PGLs.

TRT	TRT Descriptor	Dependent Variables[1] Cook Yield	Moisture
C	No WPC	94.39[a]	79.40[b]
1	2% WPC	96.26[b]	78.35[a]
2	2% WPC, 1% nicotinamide	97.22[c]	78.38[a]
3	2% WPC, 10ppm sodium nitrite	96.20[b]	78.64[ab]
Std. error		0.20	0.36

[a-c]Means within a dependent variable with unlike superscript letters are different ($p<0.05$).
[1]Dependent Variables = Cook Yield: percentage mass remaining following cook; Moisture Content: percentage moisture following drying in 100°C oven.

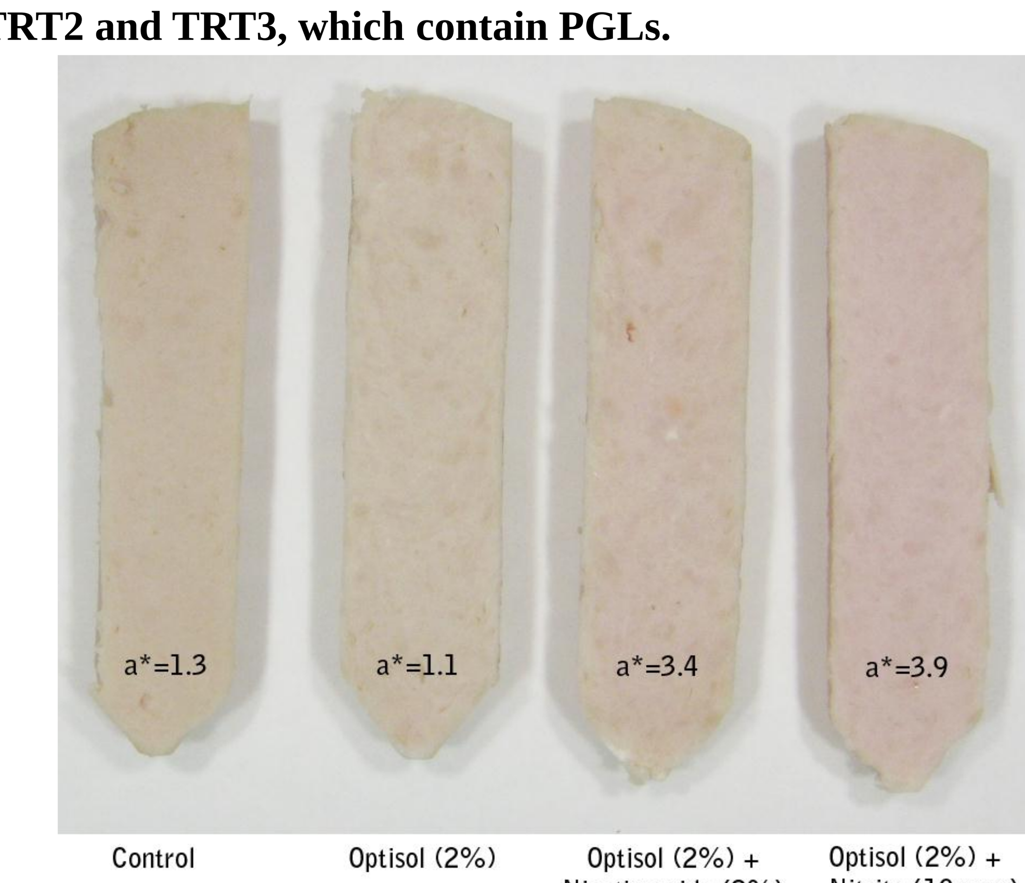
- **pH**
  - Precook pH was similar among C and all TRTs.
  - Cooked pH was similar among C and all TRTs.

Table 3. Least square means of pH values of cooked ground turkey breast samples formulated with and without WPC and PGLs.

TRT	TRT Descriptor	pH Dependent Variables[1] Precook	Cooked
C	No WPC	5.83[a]	6.24[a]
1	2% WPC	5.85[a]	6.23[a]
2	2% WPC, 1% nicotinamide	5.85[a]	6.24[a]
3	2% WPC, 10ppm sodium nitrite	5.83[a]	6.24[a]
Std. error		0.02	0.01

[a-c]Means within a dependent variable with unlike superscript letters are different ($p<0.05$).
[1]Dependent Variables = Cook Yield: percent mass remaining following cook; Moisture content: percentage moisture following drying in 100°C oven; Precook pH: pH of meat block prior to cook; Cooked pH: pH of mixture following cook.

Figure 1. Representative image of turkey samples and their corresponding CIE *a values. Note the increased *a** values of TRT2 and TRT3, which contain PGLs.**



Results and Discussion

Color Analyses

- ***L**** **Values**
  - All TRTs were lighter ($p<0.0001$) than C.
  - TRT2 and TRT3 had similar lightness values.
- ***a**** **Values**
  - C and TRT1 had similar redness values.
  - TRT2 and TRT3 had higher redness values ($p<0.0001$) than C and TRT1.
  - While other research has shown that some WPCs increase CIE *a** value and others decrease CIE *a** value, our WPC (TRT1) only slightly decreases redness compared to C.
- ***b**** **Values**
  - C and TRT1 had similar yellowness values.
  - C and TRT1 had higher yellowness values ($p<0.0001$) than TRT2 and TRT3.
- ***Chroma C**** **Values**
  - TRT2 and TRT3 had higher saturation values ($p<0.05$) than C and TRT1.
  - C and TRT1 had similar saturation values.

Table 4. Least square means of CIE values of cooked ground turkey breast samples formulated with and without WPC and PGLs.

TRT	TRT Descriptor	Dependent Variables[1] CIE values *L**	*a**	*b**	*Chroma C**
C	No WPC	91.02[a]	1.27[a]	3.88[c]	4.17[a]
1	2% WPC	92.98[c]	1.10[a]	3.93[c]	4.18[a]
2	2% WPC, 1% nicotinamide	92.01[b]	3.42[b]	2.70[b]	4.48[b]
3	2% WPC, 10ppm sodium nitrite	92.43[b]	3.86[c]	1.97[a]	4.64[b]
Std. error		0.18	0.11	0.10	0.09

[a-c]Means within a dependent variable with unlike superscript letters are different ($p<0.05$).
[1]Dependent Variables = *L**: lightness; *a**: redness; *b**: yellowness; *Chroma C**: saturation value.

Pigment Analyses

- Nicotinamide hemochrome pigment: PGL increased ($p<0.05$) pigment in TRT2 and TRT3 compared to C and TRT1.
- WPC was unable to prevent pink color induced by nicotinamide. TRT2 was higher ($p<0.001$) than TRT1.
- Nitrosylhemochrome pigment: PGL increased ($p<0.05$) pigment in TRT2 and TRT3 compared to C and TRT1.
- WPC was unable to prevent pink color induced by sodium nitrite. TRT3 was higher ($p<0.001$) than TRT1.
- TRT2 showed the highest nicotinamide pigment level.
- TRT3 showed the highest nitrosylhemochrome pigment level.
- Higher pigment values relate to a more pink product. The added PGL increase their respective pigment.

Table 5. Least square means of nicotinamide hemochrome and nitrosylhemochrome of cooked ground turkey breast samples formulated with and without WPC and PGLs.

TRT	TRT Descriptor	Dependent Variables[1] Reflectance rNIC	rNIT
C	No WPC	1.01[a]	1.20[a]
1	2% WPC	1.00[a]	1.20[a]
2	2% WPC, 1% nicotinamide	1.07[c]	1.24[b]
3	2% WPC, 10ppm sodium nitrite	1.02[b]	1.47[c]
Std. error		0.013	0.005

[a-c]Means within a dependent variable with unlike superscript letters are different ($p<0.05$).
[1]Dependent Variables: rNIC: nicotinamide hemochrome; rNIT: nitrosylhemochrome.

Conclusions

- WPC influenced color attributes of ground, cooked turkey breast, in particular *L** and *a**.
- WPC addition decreased *a** value in TRT1 compared to C, indicating that it may aid in reduction of pink color in fresh turkey breast.
- WPC was unable to eliminate pink color induced by PGLs, possibly due to their high inclusion level.

Effect of Dried Fruit Seed Powders on Color Stability of Ground Turkey Meat

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Introduction

• Ground turkey meat is susceptible to lipid and color oxidation which can lead to undesirable appearance, off odors, and off flavors.

• Fruit seeds have been shown to have high levels of antioxidant phytochemical concentrations (ex. Anthocyanins)

• The addition of natural antioxidant compounds to ground meat may reduce undesirable side effects of lipid oxidation and prolong color stability

Objective

The objective of this study was to evaluate the effect of novel inclusion of fruit seed powders with high antioxidant phytochemical concentrations in white, dark, and 1:1 composite blend blocks of ground turkey meat on objective color characteristics.

Materials and Methods

Animals and Diets

• 225 turkey hens of the same age (2 years) and diet were humanely harvested at the University of Minnesota Meats Laboratory

• Breasts and thighs were removed from a random subset (n = 90) 24 hours post mortem

Treatments

• White breast meat and dark thigh meat were uniformly ground separately into 27 kg batches

• White and dark meat were divided in half with one portion from each batch being blended for a 1:1 composite meat block

•Three meat blocks (white, dark, composite) were formed

• Each batch was divided and assigned randomly to one of four seed powder antioxidant treatment groups (Control, Cranberry, Grape, Raspberry)

• 3 x 4 factorial design

• Seed powders were added at 500 ppm and blended for five minutes

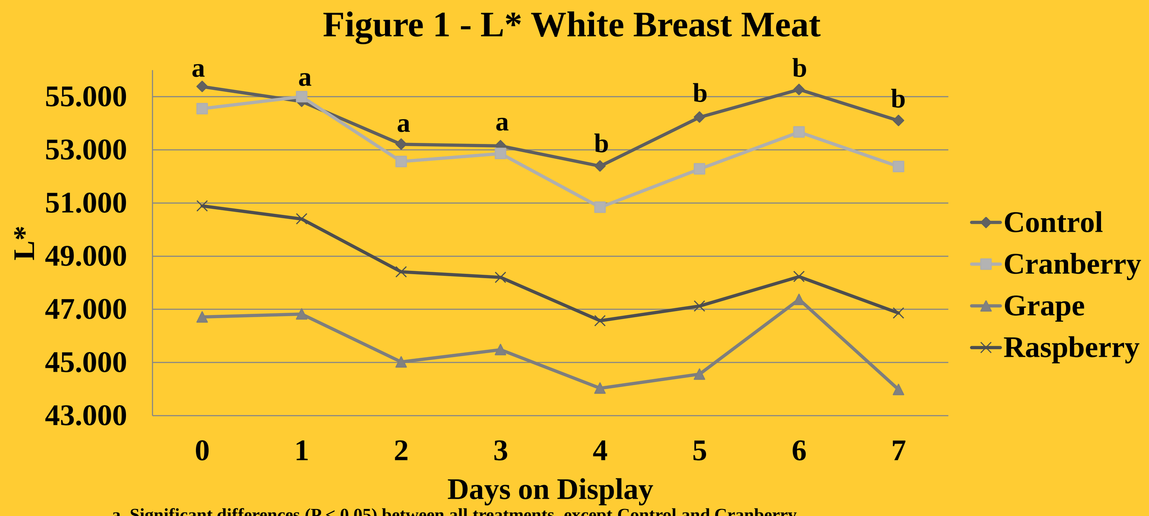
Objective Color

• One kg sample of each treatment (n = 12) were overwrapped and stored at 4°C under cool white fluorescent lighting for seven days with six replications per treatment

• Objective color values (L*, a*, b*) were taken at six locations on each package daily

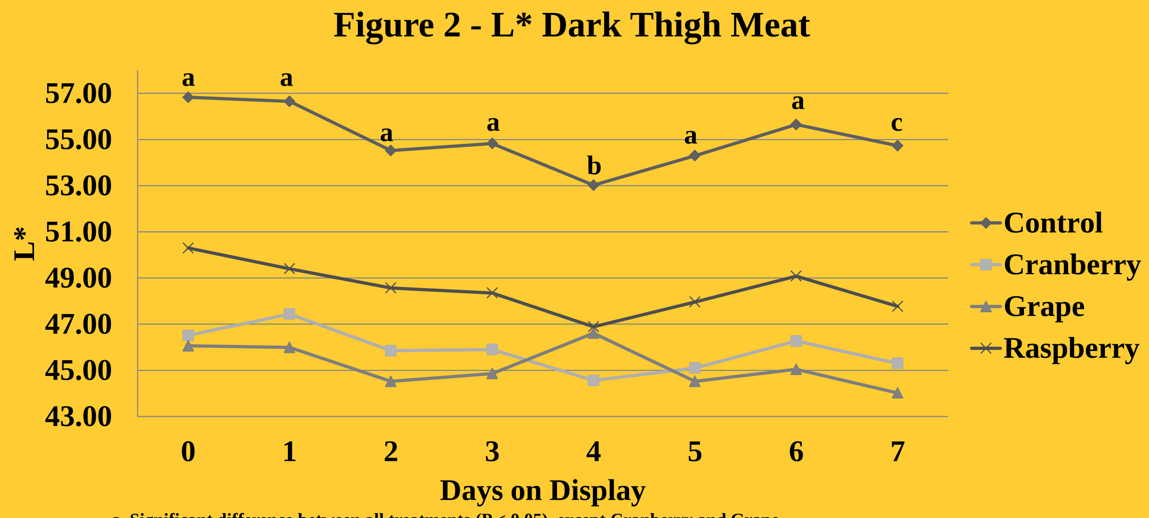
Results

Figure 1 - L* White Breast Meat



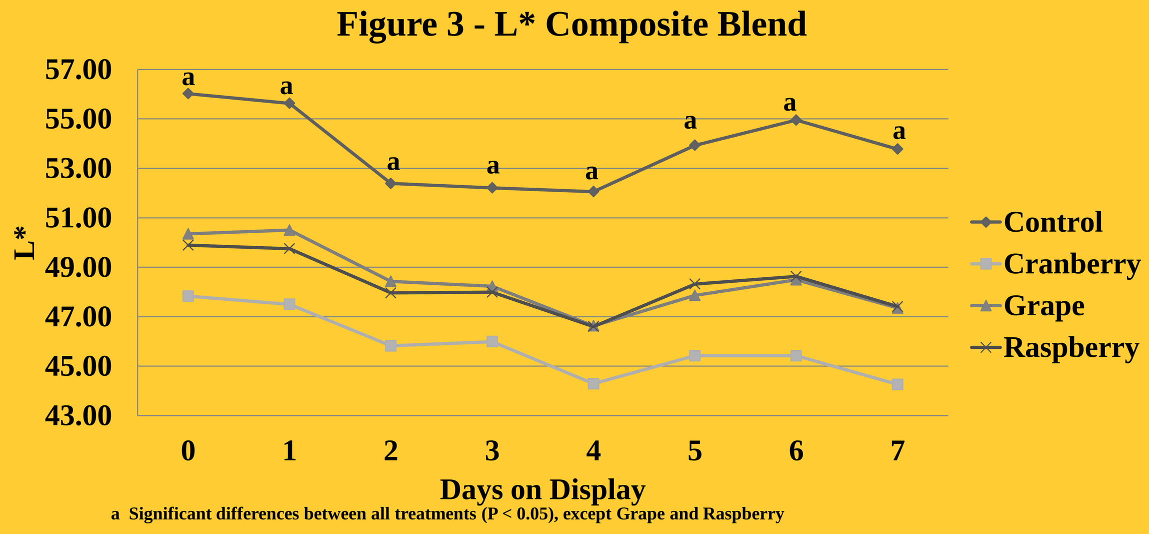
a Significant differences (P < 0.05) between all treatments, except Control and Cranberry
b Significant differences (P < 0.05) between all treatments

Figure 2 - L* Dark Thigh Meat



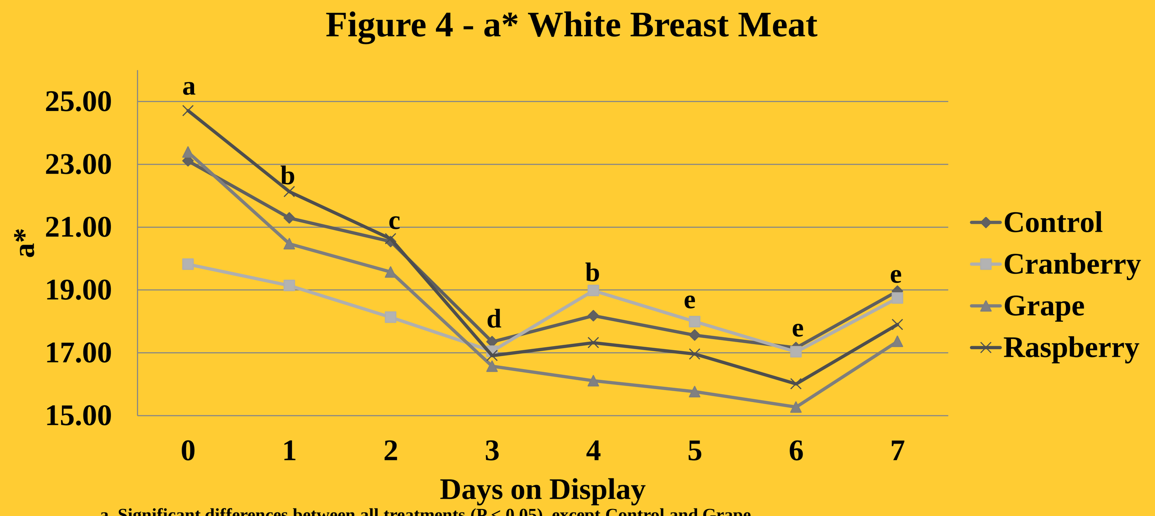
a Significant difference between all treatments (P < 0.05), except Cranberry and Grape
b Significant differences between all treatments (P < 0.05), except Grape and Raspberry
c Significant difference between all treatments (P < 0.05)

Figure 3 - L* Composite Blend



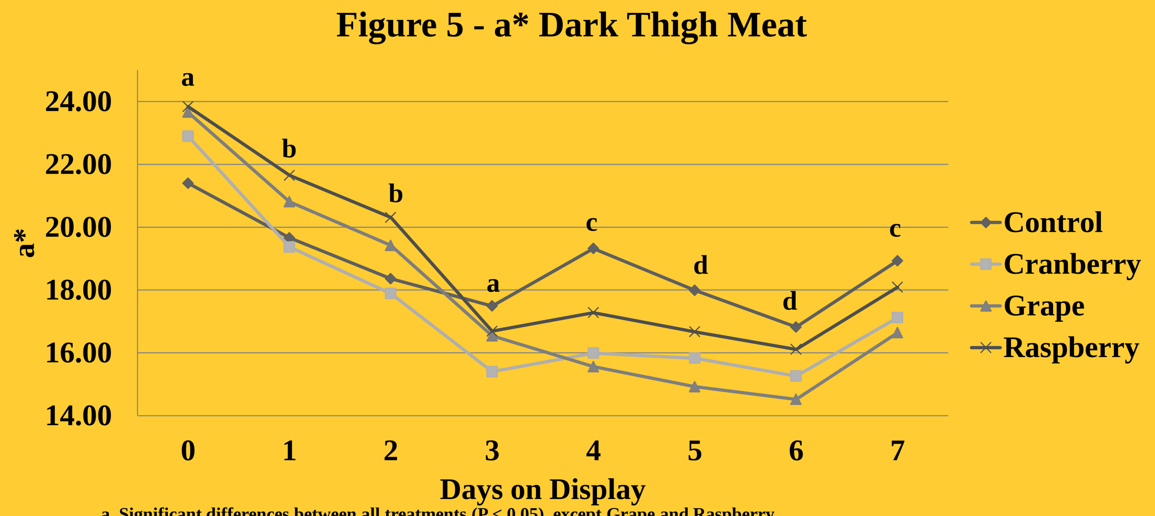
a Significant differences between all treatments (P < 0.05), except Grape and Raspberry

Figure 4 - a* White Breast Meat



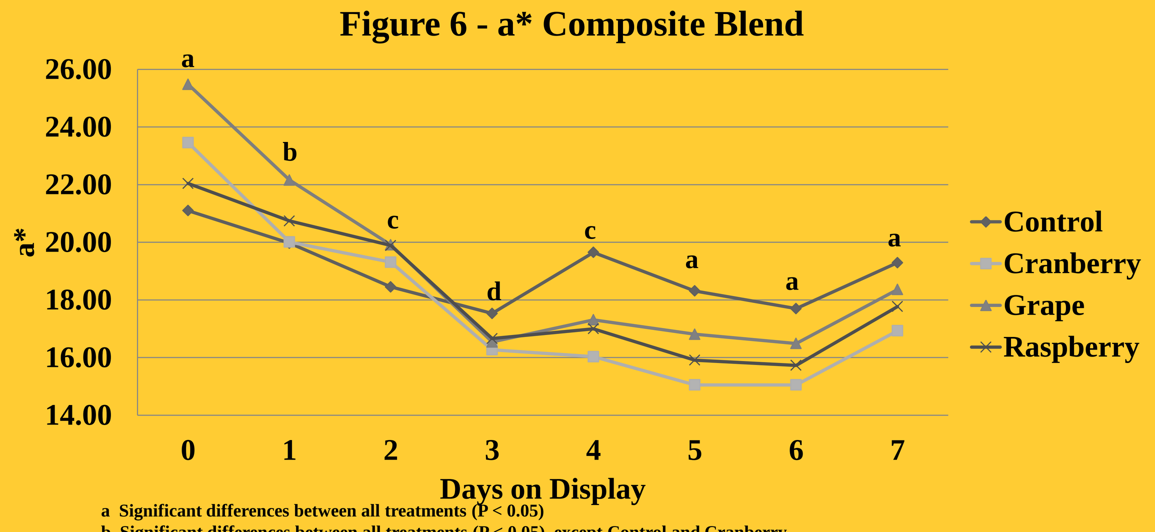
a Significant differences between all treatments (P < 0.05), except Control and Grape
b Significant differences between all treatments (P < 0.05)
c Significant differences between all treatments (P < 0.05), except Control and Raspberry
d Control and Grape are independently similar to Cranberry and Raspberry (P < 0.05), but differ from each other
e Significant differences between all treatments, except Control and Cranberry (P < 0.05)

Figure 5 - a* Dark Thigh Meat



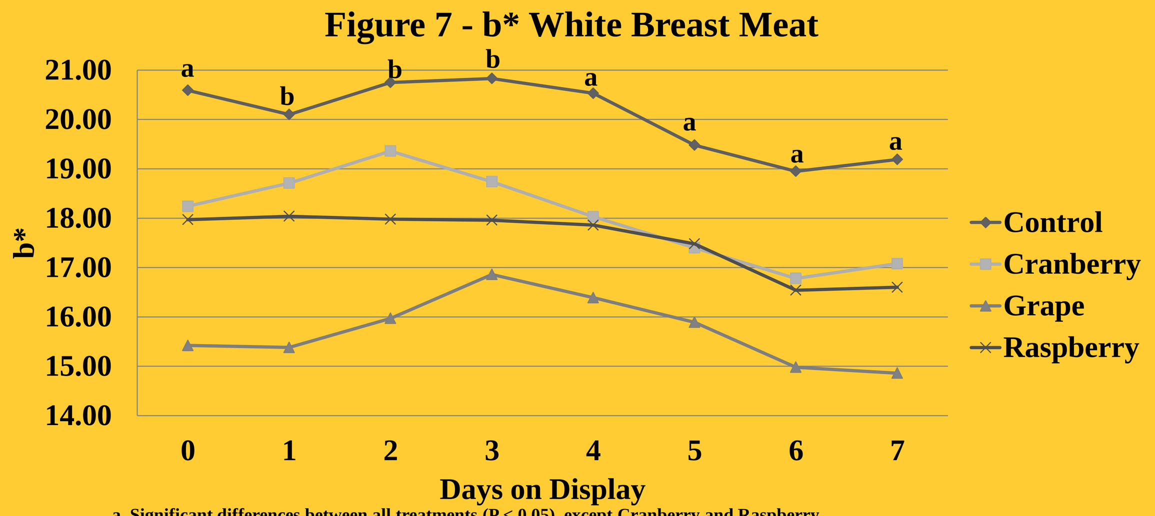
a Significant differences between all treatments (P < 0.05), except Grape and Raspberry
b Significant differences between all treatments (P < 0.05), except Control and Cranberry
c Significant differences between all treatments (P < 0.05), except Cranberry and Grape
d Significant differences between all treatments (P < 0.05)

Figure 6 - a* Composite Blend



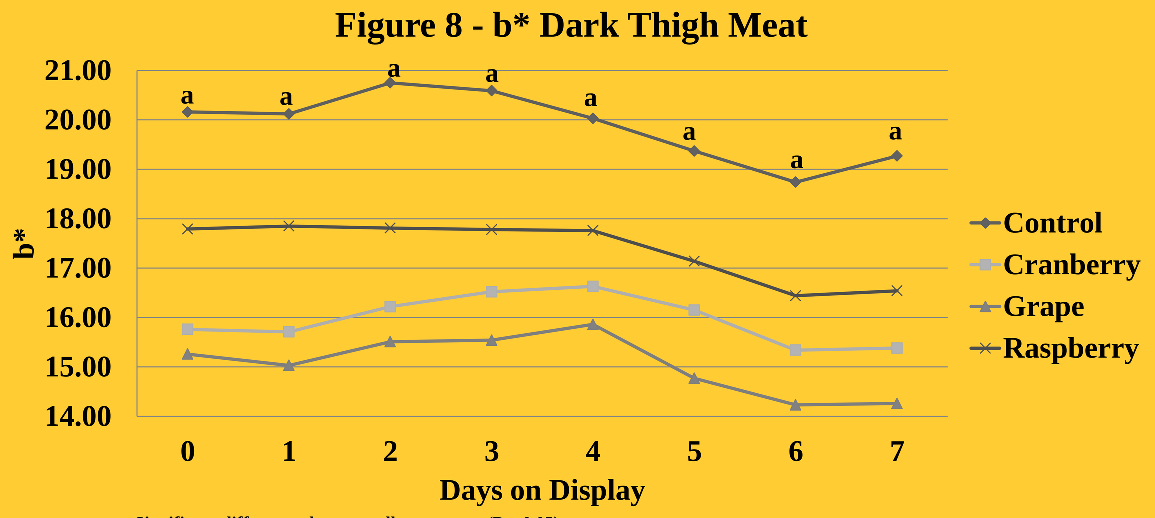
a Significant differences between all treatments (P < 0.05)
b Significant differences between all treatments (P < 0.05), except Control and Cranberry
c Significant differences between all treatments (P < 0.05), except Grape and Raspberry
d Control differences significantly from all treatments (P < 0.05)

Figure 7 - b* White Breast Meat



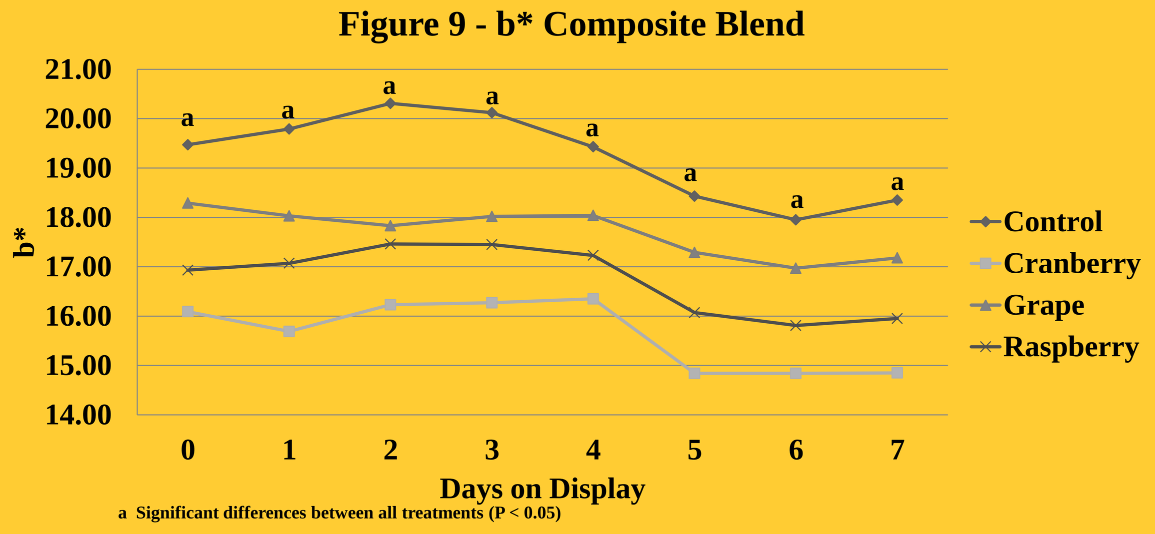
a Significant differences between all treatments (P < 0.05), except Cranberry and Raspberry
b Significant differences between all treatments (P < 0.05)

Figure 8 - b* Dark Thigh Meat



a Significant differences between all treatments (P < 0.05)

Figure 9 - b* Composite Blend



a Significant differences between all treatments (P < 0.05)

IMPACT OF ROSEMARY AND GREEN TEA EXTRACT ON THE OXIDATIVE AND FLAVOR STABILITY OF COOKED GROUND CHICKEN PATTIES

INSPIRED MOLECULAR SOLUTIONS™

Kristen Robbins. Kemin Food Technologies, Inc., Des Moines, IA.

INTRODUCTION

- Rosemary extract and green tea are effective at extending the shelf life of meat, and as natural plant extracts, they have a highly positive consumer image.
- O'Sullivan et al. reported that cooked chicken breast/thigh (1:1) patties had TBARS values 30-fold higher than raw patties with a similar composition; however, this difference was reduced to a 10-fold difference when the chicken patties were treated with natural extracts such as rosemary and green tea.[1]

OBJECTIVE

- This study was conducted to compare the performance of a combination of rosemary and green tea extracts with rosemary extract alone in delaying oxidative and flavor changes in cooked chicken patties.

METHODS

- A 1:1 mixture of breast and thigh meat was used to ensure that lipid oxidation would escalate quickly enough to display treatment effects during refrigerated storage.
- The skinless chicken breasts were air-chilled. The thighs contained skin, with <5% water added.
- Two replicates of each treatment: (1) untreated control, (2) 0.2% rosemary extract (RE), (3) 0.2% rosemary and green tea extracts (RGT). Additives were calculated based on finished weight. Sodium chloride (0.5%) was added to all patties.
- Additives were mixed with salt , added to cubed meat, and ground through a 6 mm plate.
- Patties (20 g) were formed, cooked on a griddle (176℃) until reaching 74℃ internal temperature.
- Patties were stored in zip-top polyethylene bags, in the refrigerator (2-4℃), for 14 days.

ANALYSES

- TBARS: Oxidative changes were measured by the thiobarbituric acid reactive substance method (TBARS, mg/kg sample).[2]
- Hexanal and 2,4-decadienal (secondary oxidative byproducts) were measured using gas chromatography.
- Sensory: Samples were reheated to an internal temperature of 60°C in a microwave oven. Panelists (n=4) evaluated the flavor on a 9-point hedonic scale to the nearest 1 point, where 1=dislike extremely, 5=neither like nor dislike, and 9=like extremely.
- Data Analysis: Analysis of Variance (ANOVA) was conducted using the STATGRAPHICS® Plus Centurion XV software package.[3] Means were separated by using least significant differences ($p<0.05$).

RESULTS

- The RGT and RE treated patties had lower ($p<0.05$) TBARS (Fig. 1) than the untreated control throughout the entire study.
- The RGT patties had lower TBARS ($p<0.05$) than the RE patties on day 4, 6, 11, and 14.

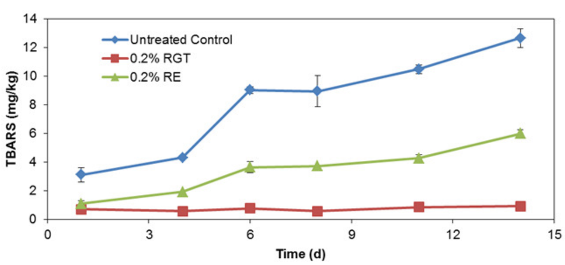


Figure 1. TBARS (mg/kg) of cooked chicken patties during refrigerated storage. Error bars = ± SE.

- Treatment with RE and RGT reduced ($p<0.05$) the secondary oxidative byproduct hexanal (Fig. 2) from day 6 onward, and the natural extracts reduced 2,4-decadienal (Fig. 3), from day 4 onward.
- There were no differences between RE and RGT patties for both hexanal and 2,4-decadienal.
- TBARS were correlated ($p<0.001$) with both hexanal (r=0.9233) and 2,4-decadienal (r=0.8764), and 2,4-decadienal and hexanal were also correlated (r=0.9783).

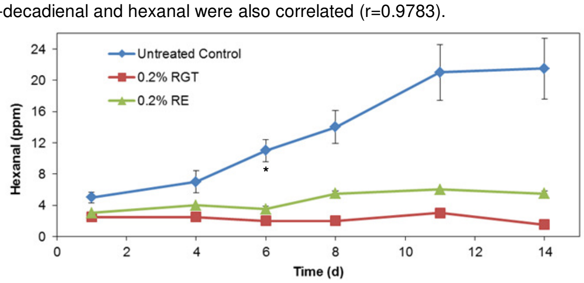


Figure 2. Hexanal content (ppm) in cooked chicken patties during refrigerated storage. Error bars = ± SE. * indicates the onset of a difference from control.

RESULTS (cont'd)

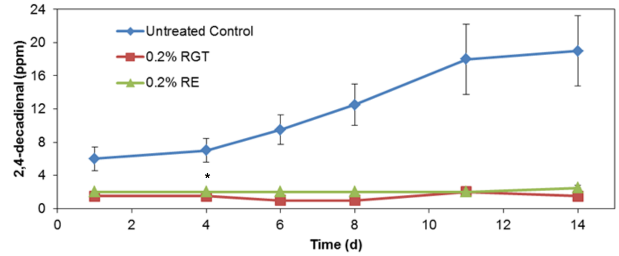


Figure 3. 2,4-decadienal content (ppm) in cooked chicken patties during refrigerated storage. Error bars = ± SE. * indicates the onset of a difference from control.

- The sensory acceptance scores (Fig. 4) followed trends similar to the TBARS, with more change in acceptability over time for the control compared with the natural extracts.
  - RGT > RE at each sampling period except day 6.
  - RE > untreated patties at all times except day 4.
- At the beginning, some panelists detected a slight herbal flavor in the RE patties, but not the RGT patties; however, the flavor faded as time progressed.
- On day 11, most panelists commented that the untreated control samples were inedible because of extreme rancidity. The RE patties were scored as "neither like nor dislike", and their flavor was bland and slightly cardboard-like, but not rancid.
- On day 11, the RGT patties still retained their characteristic meaty flavor notes, and they received scores between "like slightly" and "like moderately".
- Rhee et al. noted in a 6-day evaluation of cooked-refrigerated chicken breast patties and chicken thigh patties by a trained sensory panel, that rancid/cardboard-like flavor intensity was strongly correlated (r=0.90, $p<0.05$) with TBARS.[4] The sensory panel used in this study had similar conclusions, as their progressively lower acceptance scores for the untreated control followed the trend of the rising TBARS during storage.

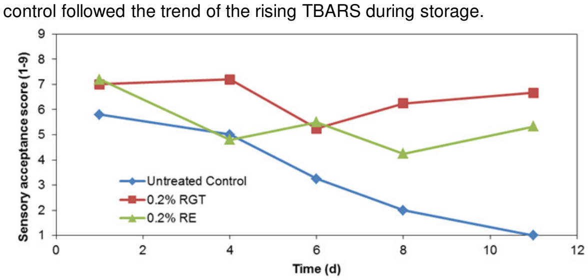


Figure 4. Sensory acceptance scores of cooked chicken patties during refrigerated storage. 1= dislike extremely, 5 = neither like nor dislike, 9= like extremely.

- The natural extracts had no visible impact on the appearance of the chicken patties (Fig. 5).

Figure 5. Cooked chicken patties (L-R): Untreated control, 0.2% RGT, 0.2% RE.

CONCLUSIONS

- The results indicated that RE and RGT extracts had a positive impact on the flavor and oxidative stability of refrigerated, cooked chicken patties. Furthermore, when used at the same level, RGT extract was slightly more effective than RE extract at retaining the positive flavor attributes and preventing the increase in TBARS.
- RGT extract has a lower percent of rosemary extract than RE extract alone, and the green tea extract that replaced the rosemary extract in RGT contributes antioxidant activity with minimal flavor.
- The increased flavor threshold of RGT permits the use of higher application rates, which should further increase the shelf life of the treated foods. Although it is likely that the refrigerated results translate to frozen cooked chicken, a confirmatory study is in progress.

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3. STATPOINT TECHNOLOGIES, INC. 2006. STATGRAPHICS© Centurion XV. Version 15.2.06. Warrenton, VA.
4. Rhee, K.S., Anderson, L.M., Sams, A.R. (2005). Comparison of flavor changes in cooked-refrigerated beef, pork and chicken meat patties. *Meat Science* 71, 392-396.

EFFECT OF PACKAGING METHOD ON THE SHELF-LIFE OF MEATBALL MADE FROM SUCUK DOUGH

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1. INTRODUCTION

Turkish style meatballs (koefte) are produced mainly from ground meat (beef and/or lamb), fat (beef fat and/or lamb tallow fat), various spices and/or moistened bread and called by different names depending on the local area (Adana koefte, Tekirdağ koefte, Inegöl koefte ect.). Turkish soudjouk (sucuk) is a popular fermented meat product (sausage) in Turkey and is basically a traditional fermented dry sausage, mostly produced in small-scale enterprises by drying in air. Its formula contains beef, beef back fat, tail fat, salt, sugar, garlic, nitrite and/or nitrate and various spices.. Then, the resultant sucuk dough is put into natural or artificial casings and aged at certain relative humidity and temperature. Since Turkish sucuk is a highly demanded meat product in our country, innovative processed meat products from sucuk dough such as sucuk doner and sucuk meatball are produced. In this study, the effects of different packaging methods namely aerobic packaging (AP), vacuum packaging (VP) or modified atmosphere packaging (MAP) on the shelf life of sucuk meatballs were investigated.

2. MATERIALS AND METHODS

2.1. Formulation and processing of beef patties

Beef as boneless rounds was obtained from the Ikbal Meat Company Inc. in Afyonkarahisar, Turkey. All subcutaneous fat and intermuscular fat was removed from the muscles and used as the fat source. The lean beef (max 1.5% fat) and fat sources were separately ground in a 3 mm plate meat grinder. The meatball formulation included 0.9-kg meat (15% fat), 0.11-kg adipose tissue separated from the tail of sheep, 1.8% NaCl, 1.5% garlic, %0.4 sucrose, 0.7% hot red pepper, 0.4% sweet red pepper, 0.7% black pepper, 0.75% cumin, 0.2% allspice.

Fig 1. Meatball made from sucuk dough

The resultant mixture and frozen fat were ground through 12-mm plate. Meatball dough coming from the grinding machine was refrigerated at 4C for 8 h. The mix was kneaded for 15 min by hand then were shaped (1.0 cm thick and 30 mm diameter) by using a metal shaper. Sucuk meatball weighed approximately 30 g each.

Fig 2. Cooked Sucuk Meatball

2.2. Packaging of Meatballs

The meatballs were packaged as 120 g portions as follows.

a) For AP, meatballs were packaged in bags (80% polyethylene and 20% polyamide, b) For VP, sucuk meatballs were put into Styrofoam trays which were then placed in bags and vacuum sealed using Multivac vacuum packager., c) For MAP, sucuk meatballs were put into gas impermeable trays. Packages were evacuated, filled with a modified atmosphere containing 65% nitrogen and 35% carbon dioxide and automatically heatsealed by a Multivac packaging unit with a high barrier film.

2.2. Methods

Moisture and pH value were determined according to Association of Official Analytical Chemists methods (AOAC 1990). The TBARS test was performed according to Tarladgis *et al*. (1960), as modified by Shahidi *et al*. (1985). L*, a*, b* values were determined with a colorimeter (Minolta CR 300, Osaka, Japan). For Microbiological analyses Mesophilic aerobic bacterial counts, Lactic acid bacteria, *Enterobacteriaceae*, Yeast and molds were performed. Panelists were asked to evaluate the samples for color, taste, appearance, texture and express their general acceptability.

3. RESULTS AND DISCUSSION

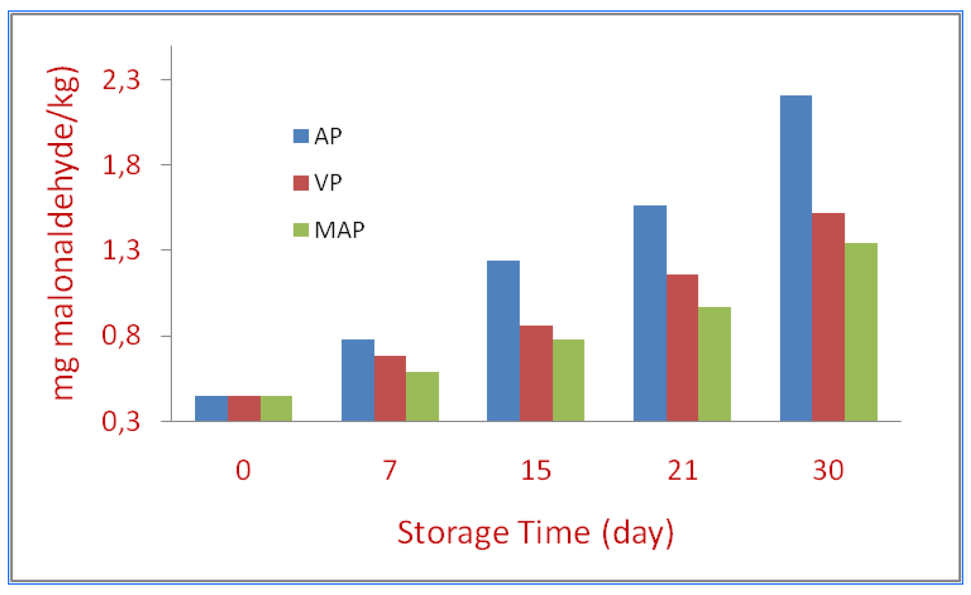

Fig 3. Effect of packaging systems on TBARS values.
AP: aerobic packaging, VP: vacuum packaging, MAP: modified atmosphere packaging

The 2-thiobarbituric acid reactive substances (TBARS) increased with storage time with the highest increase observed for samples packaged with AP and with the lowest increase observed for those packaged with MAP

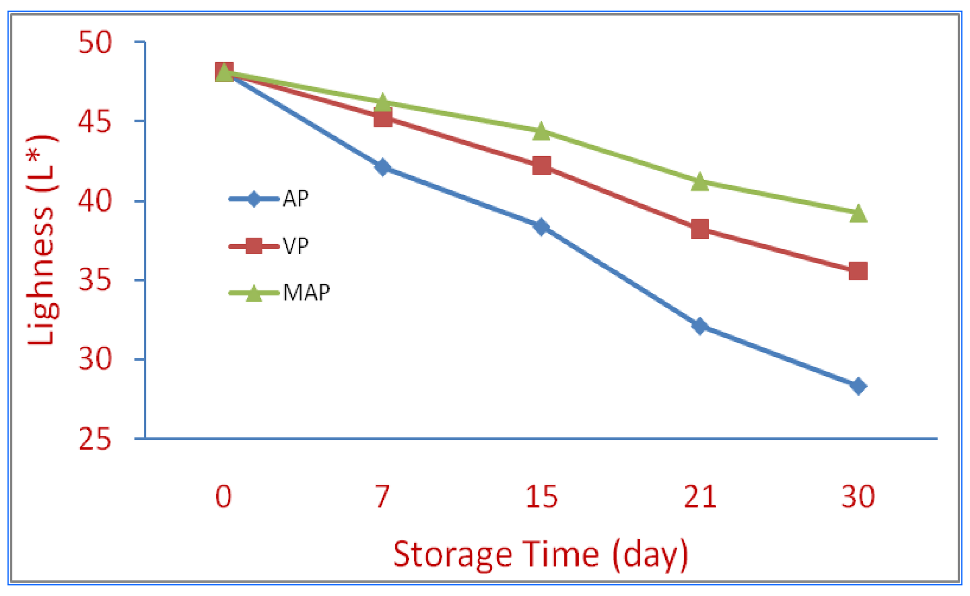

Fig 4. Effect of packaging systems on lightness (L*)

The L* values ranged from 28.24 to 48.12 with L* values declining with increased storage time and Lightness (L*) values for all samples decreased (p<0.05) with storage time and MAP preserved color better than AP or VP.

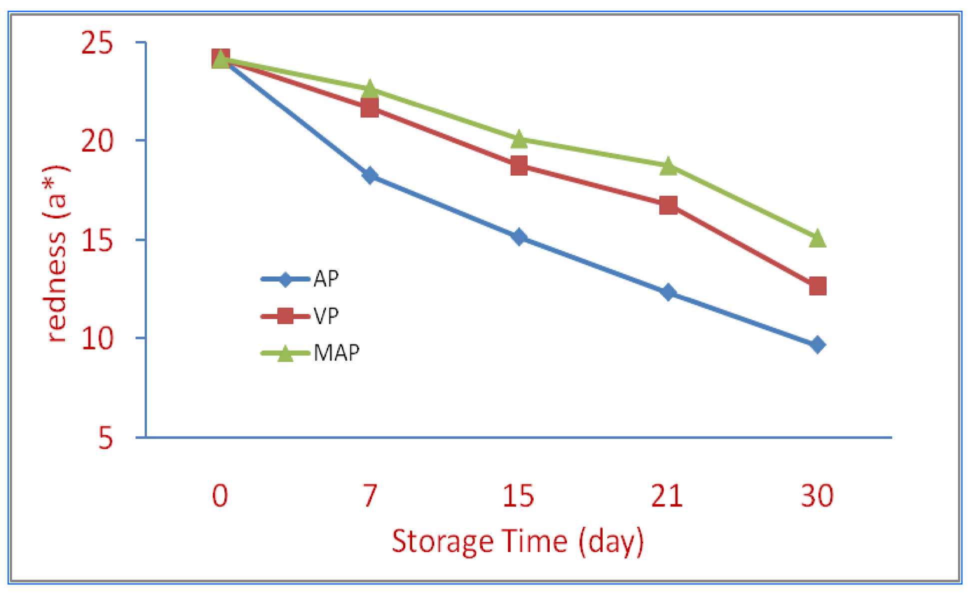

Fig 5. Effect of packaging systems on redness (a*)

The a* values ranged from 9.68 to 24.16. Redness values for all samples decreased (p<0.05) with storage time and MAP preserved color better than AP or VP . As far as color of meatballs are concerned, obviously, MAP should be preferred over VP or AP for meatballs based on our findings since it preserved typical cured meat color better than either VP or AP.

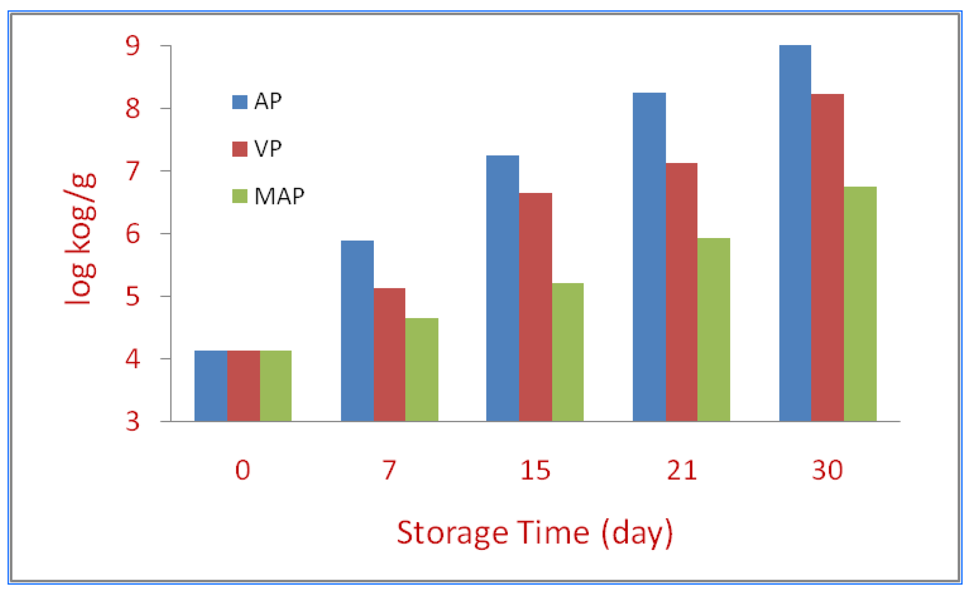

Fig 6. Effect of packaging systems on mesophilic aerobic bacteria

The highest microbial counts were determined for samples packaged in AP, while the lowest microbial counts were determined for samples packaged in MAP (p<0.05). Samples packaged in AP and VP reached the spoilage limit (7 log cfu/g) on the 15th and 21rd days of storage, respectively. However, samples packaged in MAP did not reach this spoilage limit.

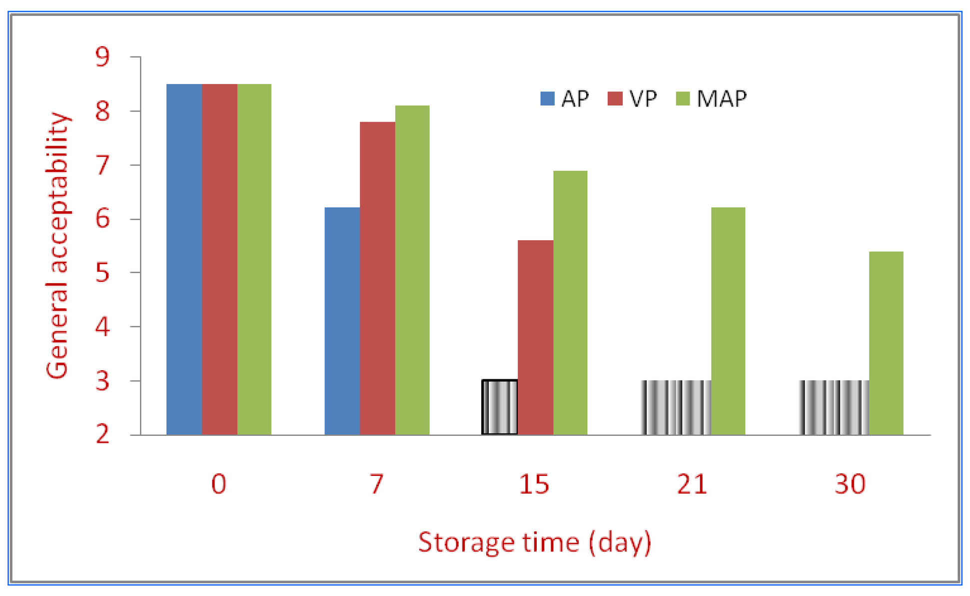

Fig 7. Effect of packaging systems on general acceptability

: not acceptable

Sensory analysis showed that sucuk meatballs packaged in MAP were given higher sensory ratings than those packaged in VP or AP. Therefore, microbiologically, shelf-life of sucuk meatballs stored in AP was about 15 days, while samples packaged in VP had a shelf life up to 21 days. Samples packaged in MAP were still microbiologically and sensorially acceptable after 30 days of storage. Therefore, MAP should be preferred choice of packaging for sucuk meatballs.

Effects of Mixing Time and a Buffered Vinegar/Lemon Juice Concentrate on Textural and Sensory Traits of Cooked Natural Roast Beef and Turkey Rolls

A.F. VanDeWalle*, D.E. Burson, R.W. Mandigo, and H. Thippareddi

INTRODUCTION

- Consumers are demanding meat and poultry products which are classified as organic or natural with commonly recognized ingredient lists (Bacus 2007, Sebranek and Bacus 2007). In addition ready-to-eat meat products need to address post lethality contamination with Listeria monocytogenes. As a result processors are seeking antimicrobial ingredients to meet consumer demands as well as pathogen contamination. One antimicrobial is a solution of buffered vinegar and lemon juice.
- In addition, mixing time is an important aspect to consider when making restructured meat products as it can have an effect on cook yields, bind strength and sensory palatability (Booren et al., 1981, Noble et al., 1985, Pepper and Schmidt 1975)
- Limited research has been published evaluating the effect of mixing time on the quality of products containing natural antimicrobials.

MATERIALS AND METHODS

- Skinless turkey breasts and beef inside rounds (cap off) were ground through a ¾" plate. The treatments were formulated to achieve 18% added brine to the meat block (Control (C): water, 1.5% sea salt, 0.5% turbinado sugar; -Buffered vinegar and lemon juice (LV): water, 2.5% LV, 1.5% sea salt, 0.5% turbinado sugar). The meat and brine added to mixer and both C and LV were mixed for the following times: Beef (2.5, 5, 10, 15, 20 mins), Turkey (5,10, 15, 20 mins)
- After mixing meat was stuffed into a 2.5 cm fibrous casing and thermally processed: Beef rolls were heated to 60°C and held for 12 minutes to achieve medium-rare, Turkey rolls were heated to 74°C. The turkey and beef rolls were cooled for 24 hrs at 2°C.
- After chilling 13 mm slices were sliced from the rolls and assigned to different analysis: pH, objective color analysis, Lee-Kramer Shear Force, double compression and consumer sensory panels. Treatments were replicated on three production days.
- Statistical analysis was done using GLIMMIX procedure of SAS.

OBJECTIVE

The objective of this study was to evaluate the length of mixing time on processed meat quality of beef and turkey rolls formulated with or without a commercial blend of a buffered vinegar and lemon juice concentrate.

RESULTS

Table 1. Least Square Means for HunterLab L*, a*, b* of Turkey or Beef Slices For Mixing Times and Antimicrobial Ingredient.

	Turkey			Beef		
Treatment	L *	a *	b *	L *	a *	b *
Mixing Time						
2.5				53.29^{c}	12.23^{a}	14.29
5	80.97^{a}	4.35	13.76	53.84^{bc}	11.80^{ab}	14.20
10	81.74^{ab}	4.29	13.78	54.54^{ab}	11.36^{b}	14.24
15	82.04^{b}	4.35	13.69	54.68^{a}	11.43^{b}	14.37
20	82.40^{b}	4.19	13.55	54.75^{a}	10.82^{c}	14.42
SEM	0.321	0.121	0.108	0.284	0.165	0.059
P-value	0.021	0.783	0.450	0.001	<.0001	0.073
Antimicrobial						
Control	82.44^{a}	4.47^{a}	13.38^{a}	55.04^{a}	12.36^{a}	14.57^{a}
LV	81.14^{b}	4.12^{b}	14.01^{b}	53.40^{b}	10.70^{b}	14.03^{b}
SEM	0.022	0.086	0.076	0.179	0.104	0.037
P-value	0.0002	0.005	<.0001	<.0001	<.0001	<.0001

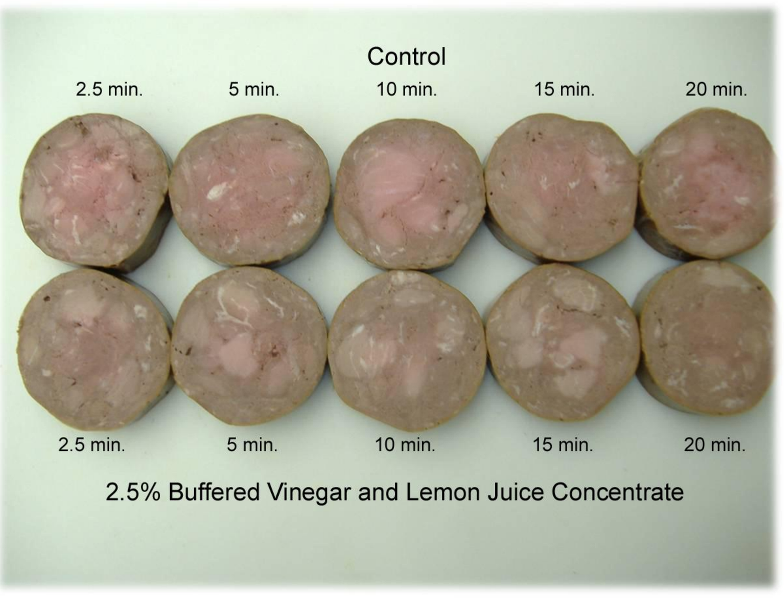

Table 2. Least Square Means Double Compression and Lee Kramer Shear of Turkey or Beef Slices For Mixing Times and Antimicrobial Ingredient.

	Turkey		Beef	
Treatment	Springiness	kgf	Springiness	kgf
Mixing Time				
2.5			9.16^{b}	131.73
5	10.32	72.33	9.23^{b}	119.92
10	10.18	70.12	9.36^{ab}	124.39
15	10.14	65.97	9.24^{b}	110.60
20	10.14	64.18	9.51^{a}	122.43
SEM	0.123	3.46	0.070	5.980
P-value	0.687	.088	0.010	<0.180
Antimicrobial				
Control	10.21	66.08	9.21^{a}	118.29
LV	10.18	70.22	9.39^{b}	125.34
SEM	0.086	1.730	0.044	3.780
P-value	0.764	0.099	<0.004	0.194

Table 3. Least Square Means for Sensory Analysis of Flavor attributes of Turkey or Beef Slices For Antimicrobial Ingredient.

Antimicrobial Treatment	Turkey or Beef Flavor	Sweetness	Saltiness	Tartness	Overall Flavor
Turkey					
Control	8.77^{a}	6.40^{a}	6.84^{a}	5.66^{a}	8.87
LV	8.18^{b}	7.05^{b}	7.41^{b}	6.83^{b}	8.98
SEM	0.174	0.174	0.150	0.168	0.189
P-value	0.011	0.005	0.004	<0.0001	0.660
Beef					
Control	7.67	6.57^{a}	6.72	6.49^{a}	7.45^{a}
LV	7.73	7.58^{b}	6.78	6.98^{b}	8.01^{b}
SEM	0.200	0.169	0.152	0.168	0.188
P-value	0.796	<0.0001	0.751	0.019	0.016

Table 4. Least Square Means for Sensory Analysis of Texture attributes of Turkey or Beef Slices For Mixing Times.

	Turkey			Beef		
Treatment	First Bite	Tough /Tender	Overall Texture Acceptability*	First Bite	Tough /Tender	Overall Texture Acceptability*
Mixing Time						
2.5				6.81^{a}	6.09^{a}	7.98
5	7.41	5.96	8.96	6.93^{a}	5.96^{a}	8.39
10	7.11	5.51	9.31	7.09^{a}	5.89^{a}	8.55
15	7.31	5.40	9.43	7.11^{a}	5.96^{a}	8.42
20	7.56	5.32	9.47	8.50^{b}	7.00^{b}	7.87
SEM	.31	.22-.23	.27-.28	.39-.40	0.310	.23-.26
P-value	0.766	0.171	0.520	0.008	0.043	0.389

CONCLUSIONS

- Increasing mixing time can affect color and texture of restructured turkey and beef. Increased mixing time makes the final product color lighter and decreases the redness in beef. In addition increased mixing time can make restructured beef tougher and drier.
- The addition of a lemon juice and vinegar antimicrobial can enhance the flavor of turkey rolls and contributes to the overall flavor of beef rolls. The lemon juice and vinegar also increases the perception of sweetness, saltiness and tartness in turkey and beef.