Evaluating Stacked Processing to Improve Wooden Breast Functionality and Tenderness

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Introduction

- Improvements have been made enhancing broiler growth performance to fulfill the increasing demand for chicken meat
- Data from the last decade have linked increased growth rate to an increase in myopathies impacting breast quality
- One myopathy, thoroughly defined as wooden breast (WB), has become prevalent and is characterized by:

  White striping Lipidosis Rigidity Lesions Fibrosis Fiber degeneration

- Though prevalent, the incidence has varied in the literature:
  - WB 5-10%, Poultry World 2018
  - WB 10-40%, Poultry Producer 2020
  - WB 10-20% Brazil
  - WB 42% Italy
  - 50% WS Italy, France, Spain, Brazil
  - Day to day variation of 0-50%
- Wooden breast meat is often discarded or greatly devalued due to quality defects, costing the poultry industry over an estimated $200 mil/year
- Single further process techniques of blade tenderization, tumble marination, multi-needle enhancement have yielded small to moderate improvements
- Little focus on stacked or multiple processing applications to improve WB functionality and tenderness
  - Alnahhas et al. 2016, Lorenzi et al. 2014, Russo et al. 2015, Petracci et al. 2019

Objective:

- Determine if stacked processing of wooden breast fillets with blade tenderization improves marinade retention, tenderness, and textural properties

Methods

Sample Collection & Treatments: (Flow Chart 1)

- Across 3 replications, broiler breast (N = 495) were collected ~ 4 hours postmortem from a commercial poultry facility
- Breast fillets were sorted into 3 WB severity categories via manual palpation and compression:

  Normal (**NOR**; n = 165) Moderate (**MOD**; n = 165) Severe (**SEV**; n = 165)
- 90 breasts from each WB category were randomly sorted into four processing treatments:

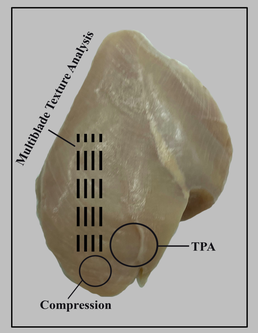
1. Control (**CON**)
2. Blade Tenderization (**BT**)
3. BT, Vacuum Marination (**BTM** – 10% pickup: 0.75% NaCl, 0.3% STP)
4. BT, Injection Enhancement, Vacuum Marination (**BTIM** – 10% pickup: 0.75% NaCl, 0.3% STP)

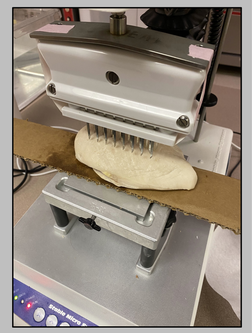
Texture Analysis:

- Breast (n = 15) for each severity*processing treatment were analyzed for:
  - White striping & lesions
  - Raw color
  - Marinade pickup
  - Processed color
  - Cook loss
  - Cooked color
  - TPA
  - Multiblade analysis

Proximate & NMR:

- Breast (n = 15) for each severity were subjected to proximate analysis and collagen content
- After texture analysis all breasts were analyzed for water status via Nuclear Magnetic Resonance (NMR)





Results

Descriptive Characteristics:

- NOR breast was lower than MOD or SEV for: initial weight, WB score, Lesion score, Compression, pH, L*, Moisture, Fat, and Insoluble collagen ($P \leq 0.02$)
- There was no severity by processing treatment interaction or processing main effect for Initial Weight, WB Score, Lesion Score, Compression ($P > 0.24$) (Table 1)

Post Processing Characteristics:

- Total marinade % Pickup had a severity by processing interaction ($P < 0.01$)
- % Pickup for SEV BTM/BTIM was less than NOR BTM/BTIM & MOD BTIM ($P < 0.01$); MOD BTIM was similar to NOR BTM/BTIM ($P > 0.05$) (Figure 1)
- WB severity impacted injection pickup with NOR > MOD > SEV ($P < 0.01$)
- MOD & SEV had greater Overnight purge loss than NOR ($P < 0.01$) (Table 2)

Post Cooking Characteristics:

- % Cook loss had a severity by processing interaction ($P < 0.01$) (Figure 2)
- Bound water was greater for NOR & MOD than SEV ($P < 0.01$)
- NOR had greater proportions of intra-myofibrillar and lower proportions of extra-myofibrillar than MOD & SEV ($P < 0.01$)
- Processing did not impact water proportions ($P > 0.23$) (Table 3)

Texture Characteristics:

- There was no severity by processing interaction for objective tenderness or texture ($P > 0.01$)
- NOR required less shear force and total energy than MOD or SEV ($P < 0.01$)
- NOR and MOD were similar ($P > 0.05$) and less than ($P < 0.01$) SEV for Hardness, Adhesion, Resiliency, Cohesion, Springiness, and Chewiness
- BTIM shear force was less than BTM, BT, and CON ($P < 0.02$)
- BTM/BTIM were softer than CON or BT ($P < 0.05$) (Table 4)

Conclusion

Stacked processing was not able to overcome the inherent tenderness hurdles presented by the wooden breast myopathy. However, BTIM was able to increase marinade retention and both BTM and BTIM exhibited less cook loss than non-processed or blade tenderized samples.

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Flow Chart 1

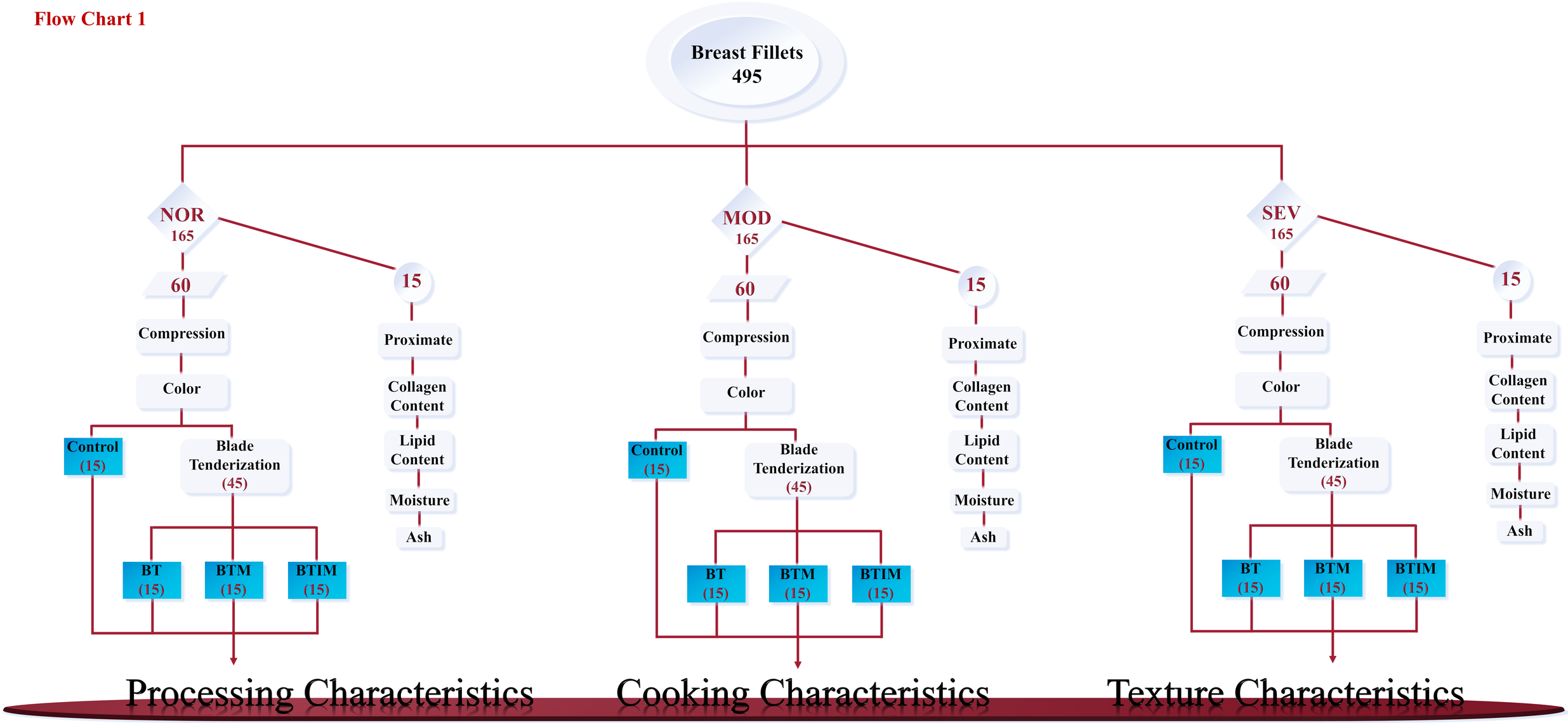

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Table 1. Least Squares Means for the main effect descriptive statistics for NOR, MOD, and SEV wooden breast samples prior to stacked processing including CON, BT, BTM, and BTIM

	Wooden Breast Severity				
Item	NOR	MOD	SEV	SEM	*P*-value
Descriptive					
Initial Wt, g	386.79^{c}	492.50^{b}	537.02^{a}	9.99	<0.0001
Wooden Breast Score	1.03^{c}	1.28^{b}	1.73^{a}	0.06	<0.0001
Hemorrhagic Score	1.00^{b}	1.17^{b}	1.63^{a}	0.09	<0.0001
Compression, N	21.49^{c}	33.37^{b}	50.05^{a}	2.18	<0.0001
pH	5.74^{b}	5.92^{a}	6.00^{a}	0.06	<0.0001
Color[1]					
L*	65.63^{c}	68.64^{b}	69.70^{a}	0.29	<0.0001
a*	9.89^{c}	10.61^{b}	11.16^{a}	0.14	<0.0001
b*	15.22^{b}	17.12^{a}	17.82^{a}	0.26	<0.0001
Proximate analysis					
Moisture, %	75.48^{c}	76.42^{b}	77.37^{a}	0.23	<0.0001
Protein, %	22.03^{a}	20.83^{b}	19.87^{c}	0.21	<0.0001
Fat, %	1.26^{b}	1.58^{ab}	1.67^{a}	0.14	0.0229
Ash, %	1.23^{a}	1.17^{ab}	1.09^{b}	0.02	0.0008
Collagen[5]					
Insoluble, mg/g	5.55^{b}	6.30^{b}	7.87^{a}	0.34	<0.0001
Soluble, mg/g	2.57	2.79	3.04	0.18	0.2108

	Processing Treatment					
	CON	BT	BTM	BTIM	SEM	*P*-value
Descriptive						
Initial Wt, g	470.06	480.82	470.44	467.08	10.95	0.7198
Wooden Breast Score	1.24	1.42	1.42	1.31	0.07	0.2407
Hemorrhagic Score	1.24	1.29	1.27	1.27	0.10	0.9810
Compression, N	34.50	37.15	35.33	32.90	2.38	0.4562
Color[1]						
L*	68.42	68.03	67.75	67.76	0.34	0.4369
a*	10.40^{ab}	10.85^{a}	10.69^{ab}	10.27^{b}	0.17	0.0455
b*	16.86	17.21	16.70	16.11	0.30	0.0731

^{abc}Means within a row with differing superscripts are different, $P < 0.05$.

Table 2. Least Squares Means for the main effect processing characteristics for NOR, MOD, and SEV wooden breast samples after stacked processing including CON, BT, BTM, and BTIM)

	Wooden Breast Severity				
Item	NOR	MOD	SEV	SEM	*P*-value
Initial Processing Wt, g	385.52^{c}	488.73^{b}	533.20^{a}	10.31	<0.0001
Post Processing Wt, g	400.62^{c}	505.13^{b}	546.32^{a}	11.15	<0.0001
Injection Pickup, %	6.76^{a}	5.80^{b}	4.96^{c}	0.23	<0.0001
Total Pickup, %	4.14^{a}	3.31^{b}	2.47^{c}	0.44	<0.0001
Purge Loss[1], %	0.32^{b}	0.76^{a}	0.71^{a}	0.13	0.0022

	Processing Treatment					
	CON	BT	BTM	BTIM	SEM	*P*-value
Initial Processing Wt, g	467.77	477.62	467.36	463.85	11.23	0.7256
Post Processing Wt, g	467.78	477.82	494.02	496.47	12.07	0.0921
Total Pickup, %	0.00^{c}	0.00^{c}	5.97^{b}	7.25^{a}	0.46	<0.0001
Purge Loss[1], %	0.45	0.65	0.63	0.66	0.14	0.4834

^{abc}Means within a row with differing superscripts are different, $P < 0.05$.

[1]Purge loss percentage is the amount of moisture loss occurring during an 8-hr rest between processing treatment application and cooking.

Figure 1

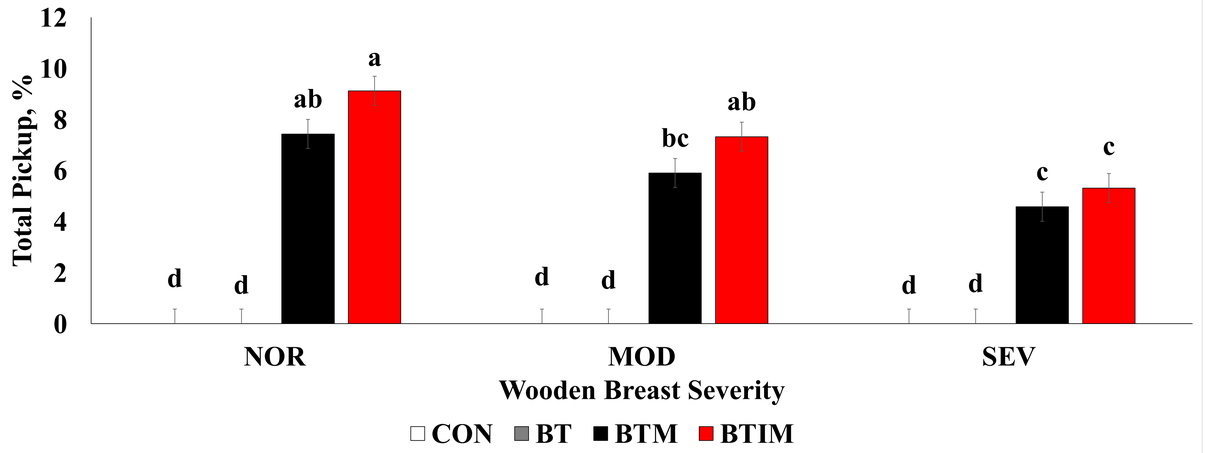

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Table 3. Least Squares Means for the main effect cooking characteristics for NOR, MOD, and SEV wooden breast samples after stacked processing including CON, BT, BTM, and BTIM

	Wooden Breast Severity				
Item	NOR	MOD	SEV	SEM	*P*-value
Pre-cook Wt, g	399.41^{c}	503.13^{b}	541.55^{a}	11.34	<0.0001
Post-cook Wt, g	332.91^{b}	408.33^{a}	416.94^{a}	9.47	<0.0001
Cook Time, min	42.82^{b}	54.21^{a}	54.00^{a}	1.80	<0.0001
Cook Loss, %	16.56^{c}	19.06^{b}	23.05^{a}	0.49	<0.0001
NMR Water[1]					
P2B, %	0.49^{a}	0.45^{a}	0.37^{b}	0.03	<0.0001
P21, %	63.72^{a}	60.94^{b}	59.79^{b}	1.84	0.0029
P22, %	35.78^{b}	38.58^{a}	39.84^{a}	1.81	0.0022

	Processing Treatment					
	CON	BT	BTM	BTIM	SEM	*P*-value
Pre-cook Wt, g	465.68	472.63	492.58	494.57	12.23	0.0639
Post-cook Wt, g	358.57^{b}	359.11^{b}	403.56^{a}	423.00^{a}	10.26	<0.0001
Cook Time, min	51.98	50.46	50.53	48.41	1.89	0.1772
Cook Loss, %	22.54^{a}	23.56^{a}	17.84^{b}	14.28^{c}	0.57	<0.0001
NMR Water[1]						
P2B, %	0.41	0.44	0.45	0.46	0.03	0.2332
P21, %	60.55	61.72	62.45	61.22	1.86	0.5413
P22, %	39.01	37.84	37.09	38.32	1.84	0.5383

^{abc}Means within a row with differing superscripts are different, $P < 0.05$.

[1]Nuclear Magnetic Resonance P2B – bound, P21 – intra-myofibrillar, P22 – extra-myofibrillar.

Figure 2

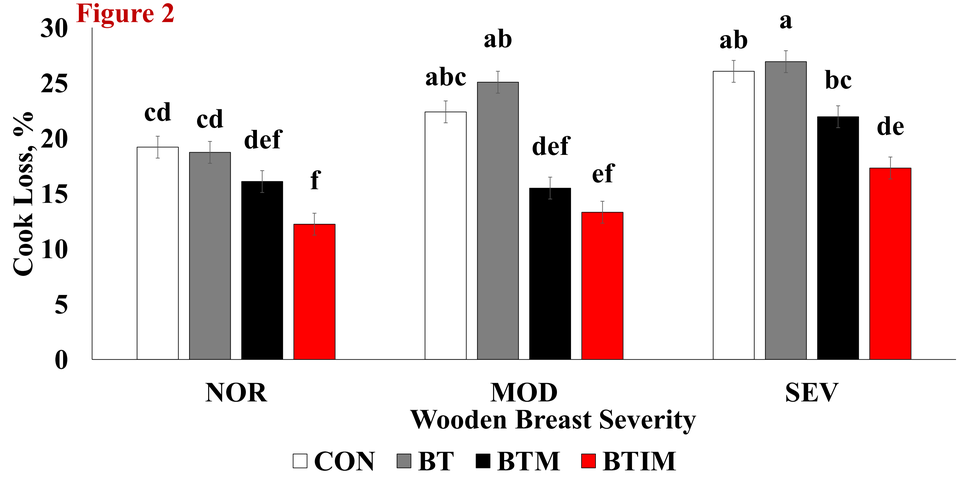

Table 4. Least Squares Means for the main effect of objective tenderness and texture for NOR, MOD, and SEV wooden breast samples after stacked processing including CON, BT, BTM, and BTIM

	Wooden Breast Severity				
Item	NOR	MOD	SEV	SEM	*P*-value
Objective Tenderness					
Multiblade Shear, N	33.53^{c}	42.97^{b}	57.64^{a}	2.58	<0.0001
Total Energy, N.mm	170.04^{c}	246.16^{b}	312.92^{a}	22.13	<0.0001
Objective Texture					
Hardness, N	19.83^{b}	18.30^{b}	22.32^{a}	1.28	<0.0001
Adhesion, N.sec	-0.06^{b}	-0.04^{b}	0.00^{a}	0.01	<0.0001
Resiliency, %	35.81^{b}	36.91^{b}	42.05^{a}	1.01	<0.0001
Cohesion	0.69^{b}	0.70^{b}	0.74^{a}	0.01	<0.0001
Springiness, %	84.78^{b}	84.35^{b}	89.30^{a}	1.02	<0.0001
Chewiness	11.71^{b}	10.66^{b}	14.69^{a}	1.15	<0.0001

	Processing Treatment					
	CON	BT	BTM	BTIM	SEM	*P*-value
Objective Tenderness						
Multiblade Shear, N	45.38^{a}	48.29^{a}	44.08^{a}	41.11^{b}	2.71	0.0195
Total Energy, N.mm	235.65	256.57	250.23	229.71	22.73	0.2519
Objective Texture						
Hardness, N	21.01^{ab}	21.35^{a}	18.99^{b}	19.25^{b}	1.33	0.0448
Adhesion, N.sec	-0.02	-0.04	-0.03	-0.04	0.01	0.6187
Resiliency, %	38.58^{a}	35.49^{b}	38.61^{a}	40.36^{a}	1.05	<0.0001
Cohesion	0.72^{ab}	0.69^{b}	0.70b	0.73^{a}	0.01	0.0006
Springiness, %	85.57^{a}	83.51^{b}	87.56^{a}	87.94^{a}	1.12	0.0048
Chewiness	12.98	12.38	11.71	12.34	1.18	0.3855

^{abc}Means within a row with differing superscripts are different, $P < 0.05$.