RELATIONSHIPS BETWEEN TEXTURE AND WATER PROPERTY MEASUREMENTS IN RAW INTACT BROILER BREAST FILLETS WITH THE WOODEN BREAST CONDITION

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I. INTRODUCTION

The wooden breast (WB) condition significantly alters tactile characteristics in raw meat, with WB fillets (*Pectoralis major*) being much harder and more rigid [1,2]. Both subjective scoring and instrumental measurements are used to characterize the texture properties of raw WB fillets and have demonstrated texture differences [2]. Changes in connective tissue and collagen content, composition, and structure in muscle tissue are believed to be responsible for the tactile characteristics of WB meat [3]. Research has also demonstrated a relationship between muscle water and the WB condition in raw fillets [4,5]. We hypothesized that water properties may play a role in the altered texture properties of WB meat. The objective of this study was to investigate the relationship between water properties measured by low-field nuclear magnetic resonance (LF-NMR) and tactile characteristics in raw intact broiler fillets with the WB condition.

II. MATERIALS AND METHODS

Boneless skinless broiler breast fillets from 8-9 weeks old birds were collected from a commercial processing plant at approximately 3 h postmortem. Fillets (a total of 72 fillets, 24 for each group) were grouped using a 3-point scale for normal, moderate WB, and severe WB based on palpable hardness and rigidity. The Blunt Meullenet-Owens Razor Shear (BMORS) peak force was measured using a Texture Analyzer. A ¹H-NMR analyzer (LF 90II Proton-NMR, Bruker minispec, Billerica, MA, USA) was used to measure transverse relaxation (T₂) of raw fillets (after texture measurements) with the Carr-Purcell-Meiboom-Gill (CPMG) pulse sequence [τ (90°-180° pulse separation) = 1 ms, 200 echoes, and 16 scans]. The decay curves were processed with the CONTIN regularization algorithm, resulting in the corresponding water properties, time constants (T), proportion (P), and normalized areas (A) for water populations 2b (fast time constant), 21 (medium time constant), and 22 (slow time constant). Spearman correlation coefficients were analyzed for relationships between WB scores and water property parameters (T_{2b}, T₂₁, T₂₂, A_{2b}, A₂₁, A₂₂, P_{2b}, P₂₁, and P₂₂) and Pearson correlation coefficients for relationships between BMORS force and water properties with SPSS software.

III. RESULTS AND DISCUSSION

In the fresh meat samples, there were three water populations observed with time constants (T_{2b} , T_{21} , and T_{22}) of 0.34-0.46, 44.2-67.2, and 156.2-301.9 ms, normalized abundances (A_{2b} , A_{21} , and A_{22}) of 1.3-5.2, 225.9-519.1, and 46.3-510.1 (area/100 g fresh meat weight), and relative proportions (P_{2b} , P_{21} , and P_{22}) of 0.20-1.43, 45.3-86.9, and 12.1-54.5% (data not shown). Table 1 shows both Spearman and Pearson correlations between water property parameters and subjective WB scores or BMORS measurements in raw broiler fillets. There were significant Spearman (|r| = 0.46-0.78, P < 0.001) and Pearson (|r| = 0.45-0.72, P < 0.001) correlations except for A_{21} . Strong and significant Spearman correlations (|r| > 0.60, P < 0.001) were found for T_{21} , A_{22} , P_{21} and P_{22} with P_{21} negatively (r = -0.78) and P_{22} positively (r = 0.77) associated with WB scores. However, a strong and significant Pearson correlation was noted only between BMORS force and T_{21} (r = 0.72, P < 0.001). These results indicate that changes in the abundance of free water and in the mobility and proportion of

immobilized water are strongly associated with palpable hardness and rigidity of raw broiler fillets. However, only the change in mobility of immobilized water is strongly and positively associated with texture characteristics measured with the BMORS method. The Pearson r values for T₂ parameters T_{2b} , T_{21} , T_{22} , A_{2b} , A_{21} , and P_{2b} were similar to the Spearman r values (the differences were < 0.11); however, for T₂ parameters A₂₂, P₂₂, and P₂₁, the r values with BMORS were much smaller than those with WB scores (the differences is > |0.25|). A₂₂, P₂₂, and P₂₁ were moderately (|r| = 0.49-0.50) correlated with BMORS peak force; however, they were strongly correlated with the WB scores (|r| = 0.74-0.78). Since BMORS measurements are the combination of shear and compression and the WB scores rely on both palpable hardness and rigidity, these results further suggest that the WB scores or the specific texture characteristics reflected by the subjective WB scores may be more influenced by the extra-myofibrillar water abundance. Simillarly, Pearce et al. [6] found that the decreased shear force was accompanied by decreases in T_{21} and P_{22} and increases in P_{21} in lamb M. Longissimus dorsi during postmortem aging and concluded that a high amount of intra-myofibrillar water and a low amount of extra-myofibrillar water may be associated with more tender meat.

(Spearman Correlation) or BMORS force (Pearson Correlation) in raw broiler breast fillets									
Texture measurement	Time constant (ms)			Normalized area (area/100g)			Relative area (%)		
	T_{2b}	T ₂₁	T ₂₂	A_{2b}	A ₂₁	A ₂₂	P_{2b}	P ₂₁	P ₂₂
WB score ¹	0.46***	0.69***	0.54***	-0.55***	0.21	0.74***	-0.60***	-0.78***	0.77***
BMORS Force	0.45***	0.72***	0.46***	-0.47***	0.27	0.49***	-0.49***	-0.50***	0.50***

Table 1. Correlation coefficients between water property measurements and subjective WB score

¹ WB score 1 = normal, 2 = moderate WB, and 3 = severe WB. BMORS = Blunt Meullenet-Owens Razor Shear. T_{2b} represents water with fast time constant (bound water). T₂₁ represents water with medium time constant (immobilized water), and T₂₂ represent water with slow time constant (free water). A_{2b}, A₂₁, and A₂₂ represent normalized abundance of water with time constant T_{2b} , T_{21} , and T_{22} , respectively. P_{2b} , P_{21} , and P_{22} represent relative content or proportion of water with time constant T_{2b} , T_{21} , and T_{22} , respectively. $P \le 0.05$, $** P \le 0.01$, $*** P \le 0.001$.

IV. CONCLUSION

- Meat water properties, including population, mobility, and abundance, may be directly involved in the unique texture characteristics of the wooden breast meat or the severity of the wooden breast condition in broiler Pectoralis major.
- 2. Mobility of immobilized water (T_{21}) , indicating the integrity of intramyofibrillar compartment, may be involved in texture hardness of raw WB meat.
- 3. Abundance of free water (A₂₂) may be involved in the rigidity texture attribute of raw WB meat.

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