EFFECT OF MEAT TEMPERATURE ON MOISTURE LOSS AND WATER PROPERTIES IN BROILER PECTORALIS MAJOR WITH THE WOODY BREAST CONDITION

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I. INTRODUCTION

Cook loss is one of the quality differences between normal and woody breast (WB) meat [1]. Cook loss comes primarily from moisture reduction due to temperature-induced denaturation in meat proteins [2]. The relationship between protein denaturation and meat temperature is well documented. Myosin denaturation starts at 40°C and is complete above 53°C; severe shrinkage of collagen fibers starts at 57°C; and actin denaturation and shrinkage of myofibrils start at 66-73°C [2]. Time-domain proton nuclear magnetic resonance (^{1}H-NMR) has been used to investigate changes in water properties (i.e. mobility and distribution) and establish relationships among moisture loss, muscle protein denaturation, and water properties in cooked meat [3,4]. This technique enhances our understanding of the role that myofibrillar proteins and structure play in meat moisture loss during cooking. The objective of the present study was to investigate the effect of meat temperature (40 to 90°C) on moisture loss and water properties in broiler *Pectoralis major* with the WB condition and to provide insight on how the WB condition alters breast meat cook loss and water-holding capacity.

II. MATERIALS AND METHODS

Broiler *Pectoralis* muscles were collected from a commercial plant and classified into normal (n = 18) and severe WB meat (n = 18). They were split into dorsal and ventral portions. The ventral portion was vacuum-sealed in a cooking bag and immersed in a water bath set at 40, 53, 57, 68, or 90°C until the corresponding core temperature of the meat was reached. Weight changes before and after immersion were used to calculate cooking loss. Water properties were measured at ambient temperature using a time-domain ^{1}H-NMR Analyzer. Distributed exponential fitting analysis of T_2 data was implemented using Dynamic Center software (Bruker Corporation, Billerica, MA, USA) to reveal different transverse relaxation components, relaxation time constants of the intra- and extra-myofibrillar water (T_{21} and T_{22}, respectively) or water mobility and their relative portions (P_{21} and P_{22}) or water distribution. SAS Mixed model was used for statistical analysis and means separation ($P < 0.05$).

III. RESULTS AND DISCUSSION

When compared to normal meat, the WB condition increased cooking loss more than 5% when the endpoint meat temperature reached 68°C and more than 10% when it reached 90°C (Table 1). This is consistent with published results showing that the WB condition causes increased cook loss [1]. Additionally, our data show that in WB meat, moisture loss increased linearly; but moisture loss showed three phases in normal meat, significant loss from 40 to 53°C, no changes from 53 to 68°C, and significant loss from 68 to 90°C. Compared with normal meat, the WB condition resulted in increased T_{21}, T_{22}, and P_{22} and decreased P_{21} in raw meat (22°C). This indicated increased water mobility in the intra- and extra-myofibrillar compartments and increased extra-myofibrillar water and reduced intra-myofibrillar water in raw WB meat. The same finding has been reported in the literature [5]. Increasing temperature from 40 to 90°C resulted in continuous decreases in T_{22} in WB samples; however, in normal samples T_{22} values did not change from 40 to 57°C but dropped significantly at

greater temperatures. These data indicate that cooking temperature continuously affects water mobility in the extra-myofibrillar compartment of WB meat, but water mobility is not affected by temperatures below 68°C in normal meat. Increases in temperature from 53 to 68°C increased P_{22} and decreased P_{21} by >5% in WB samples; however, similar changes were not observed in normal samples. There was very strong correlation ($r > 0.94$) between moisture loss and T_{21} in both normal and WB meat; however, only T_{22} was very strongly correlated ($r > 0.88$) with moisture loss in WB samples (data not shown). In pork, Bertram et al. [3] and Micklander et al. [4] showed an on-going change in the properties of the myofibrillar water and concluded that changes in myofibrillar structures and/or thermal denaturation of muscle proteins were responsible for temperature-induced changes in water properties during heating [3]. Our results demonstrated that, over temperature range of 57 to 68°C, normal meat maintained the ratios of intramyofibrillar water to extramyofibrillar water; however, the ratios were changed in WB meat with a significant increase in P_{22}. This suggests that moisture loss in meat with the WB condition is affected by changes in water holding in both the intra-myofibrillar and extra-myofibrillar compartments. In normal meat, moisture loss is mainly due to denaturation of myofibrillar proteins, myosin and actin, and reduction in the intra-myofibrillar water; however, in WB meat, moisture loss may result from denaturation of collagen as well as myofibrillar proteins and from changes in both the intra- and extra-myofibrillar water properties during cooking.

Table 1 Effect of meat temperature on moisture loss and T_2 relaxation parameters in broiler *Pectoralis major*

°C	Moisture Loss		T_{21} (ms)		T_{22} (ms)		P_{21} (%)		P_{22} (%)	
	Normal	WB	Normal	WB	Normal	WB	Normal	WB	Normal	WB
22	2.59f	4.86f	41.3c	49.4a	106d	147ab	83.0ab	65.6f	17.0fg	34.4b
40	3.23f	5.27f	40.6c	47.9b	113d	154a	82.2abc	70.0e	17.8efg	30.0c
53	17.0d	14.5e	33.2e	40.5c	109d	136bc	77.6d	64.0f	22.4d	36.0b
57	18.8d	18.6d	31.3f	35.9d	108d	127c	79.0bcd	63.4f	21.0def	36.7b
68	18.9d	23.6c	28.1g	31.7ef	88.9f	103de	78.7cd	58.1g	21.3de	41.9a
90	31.9b	45.2a	23.2h	23.4h	92.0ef	79.8f	85.5a	75.6d	14.5g	24.4d
Stderr	1.25		0.75		5.96		1.93		1.49	
P-value	<0.0001		<0.0001		<0.0001		0.0039		0.0039	

a-h means with no common letter within the same parameter differ significantly ($P < 0.05$). Normal = meat without the woody breast condition; WB = woody breast or meat with the woody breast condition; ms = minisecond.

IV. CONCLUSION

The WB condition alters not only the total amount of moisture loss but also the pattern in moisture loss in broiler breast meat during cooking. Alterations in the extra-myofibrillar compartment are responsible for the pattern of moisture loss in WB meat.

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