

Research Article

Assessment of Juiciness Intensity of Cooked Chicken *Pectoralis Major*

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Abstract

The objectives were to assess sensory descriptive juiciness of cooked chicken breast meat (*pectoralis major*) during the entire process of consumption and to determine the relationship between sensory juiciness intensity scores during eating and raw meat characteristics. Chicken breast fillets were collected from a commercial processing plant and deboned at three different postmortem times (0, 2, and 8 h). Fillets were ground and made into 90-g patties. The patties were stored in a -20°C freezer and were cooked to 78°C directly from the frozen state. The raw meat characteristics were indicated with color, pH, moisture content, and water-holding capacity. Sensory assessment for juiciness was made by a 7-member, trained descriptive panel using a Time-Intensity (TI) method followed by an overall juiciness perception (or sustained juiciness). TI score curves for cooked chicken fillets followed a similar pattern regardless of deboning time. There was no interaction between deboning time and chewing time and no significant effect of deboning time on juiciness ($P > 0.05$) regardless of chewing time. During chewing, the highest scores were noticed between 15 and 25 sec, overall. The intensity scores were lower ($P < 0.05$) at the beginning of consumption and also near swallowing. Juiciness intensity scores in the early evaluation (initial juiciness) were strongly correlated to each other ($P < 0.01$ and $r \geq 0.79$). However, for the intensity scores collected between 20 and 40 bites during chewing, correlations were neither significant ($P > 0.01$) nor strong ($r < 0.70$). Sustained juiciness was strongly correlated ($P > 0.70$) with initial juiciness (< 15 sec). The best linear relationship between juiciness intensity scores and raw meat characteristics measurements was found between the early juiciness scores (< 15 sec) and thaw-cook yield ($r > 0.6$). Using the TI method for descriptive sensory analysis, these results indicated that the sensation of chicken breast meat juiciness changes during chewing but is not affected by deboning times. Any measurement of the initial juiciness provides intensity scores similar to each other and is a good indicator for sustained juiciness in cooked chicken breast meat regardless of deboning time. Furthermore, thaw-cook yield can potentially be used as an indicator of juiciness in cooked chicken breast meat.

Key words: Poultry; Breast Meat; Sensory Descriptive Test; Time-Intensity Evaluation; Water-Holding Capacity

Introduction

Juiciness is one of the most important quality attributes during meat consumption [1]. Meat juiciness is typically measured by sensory evaluation [1], and its definition often varies by study. The term juiciness can refer to the overall impression of moisture perceived in the mouth during chewing (also called sustained juiciness), in which saliva formation could be a factor [2]. Juiciness can also refer to the amount of moisture released from the food after the initial few chews (also called initial juiciness or moisture release), in which juiciness more relies on

moisture in products and saliva formation is not involved [3]. The relationship between these two-evaluation results is not well established in meat. The number of initial chews that should be used before the juiciness score is determined is not well defined and inconsistent in the literature [4-6]. Boneless skinless chicken breast (*pectoralis major*) is the most popular poultry meat product in the U.S. market. Texture is the major quality concern associated with boneless skinless chicken breast [7-9] and is commonly measured in breast meat quality assessments [10-13]. Juiciness is one of the texture attributes included in sensory evaluation of cooked poultry breast meat. Published data have shown that juiciness is typically unaffected by chicken production and processing conditions [6, 10, 14, 15].

However, the methods used to measure the juiciness of cooked chicken breast meat have been limited to the sensory perception at a particular moment or based on a static method [16,17] even though most processes involved in eating, e.g. mastication and salivation, are dynamic processes. Thus, methods acknowledging dynamic properties of eating are likely to produce results more valid than static methods. Time-Intensity (TI) is a technique for recording changes in the intensity of sensory perceptions with respect to time [18]. In meats research, TI has been used to record temporal changes in perception of texture. Duizer et al. (1993) [19] used TI method to measure tenderness of different beef muscles and found that the TI curves could be used to successfully separate muscles and group trained panelists into two clusters based on their TI perception patterns. Bulter et al. (1996) [20] used the TI method to assess the meat texture attribute of tenderness. They concluded that compared with single point assessments by trained panelists (static method), TI results not only were comparable in discriminating the effects of breeds and sample types on the perception of pork tenderness, but also provided a clearer illustration of the nature of the differences. Lorido et al. (2014) [21] found that TI was a suitable technique to assess the impact of composition and structure on both flavor and texture perceptions in a variety of pork meat products and concluded that TI data provided additional insight on sensory perception compared to quantitative descriptive analysis. An evaluation of poultry meat using the TI method has not been reported and may provide new insights into the sensory quality traits of cooked poultry meat products. The objective of the present study was to investigate the juiciness intensity scores during chewing using the TI method and their relationship to moisture release during initial juiciness evaluation, sustained juiciness, and raw meat characteristics in cooked chicken *pectoralis major*. Because Postmortem (PM) deboning time significantly affects texture properties of breast meat, the breast meat used in this experiment were deboned at three different PM times.

Materials and Methods

Broiler Breast Fillet Samples

During each of 4 replications, commercially processed and eviscerated pre-chill carcasses from broilers (approximately 42 d old) were obtained from a local processing plant (Athens, GA). Carcasses were placed in coolers and transported to the laboratory within 20 min. Breast fillets from three carcasses were removed from bones pre-chill (about 45 min PM). Carcasses used for 2 and 8h samples were chilled in a pre-chill water tank at 14 C for 0.25 h followed by submersion in water immersion chill tanks at 0-4 C for 60 min. Three immersion-chilled carcasses were deboned at 2 h PM and three chilled carcasses were placed in ziploc freezer bags (1 carcass/bag) and held at 1-2°C in a refrigerator for 6 h before being deboned 8 h PM.

Meat Quality Characteristics (Color, pH, Moisture, and Water-Holding Capacity)

Surface color (CIE L*a*b*) of skinless boneless broiler breast were measured with a Minolta spectrophotometer CM-2600d (Konica Minolta, Ramsey, NJ) with settings of illuminant 10°C observer, specular component excluded, and an 8-mm aperture. Surface measurement areas were selected to avoid obvious defects (bruises, discolorations, hemorrhages, or any other conditions that might have prevented uniform color readings). Three measurements were taken on the bone or medial side of the fillet. Each measurement was the result of 3 averaged readings by the spectrophotometer. The pH of the fillets was determined at the cranial end with a Sentron model 2001 pH meter and a Lance FET piercing probe (Sentron, Gig Harbor, WA). Moisture content was measured by the AOAC method [22]. Breast meat (25 g) was minced with a one-touch chopper (The Black & Decker Corporation, Towson, Maryland, USA) for one minute. Five grams of minced meat was dried in an aluminum pan at 100°C for 18 h. The sample was weighed after being cooled to room temperature in a desiccator. Water-Holding Capacity (WHC) was estimated in the fillets using the filter paper press method, a swelling/centrifugation method, and a cooking method. The filter papers method described by Honikel and Hamm (1994) [23] was used to determine the amount of expressible fluid. Three hundred mg of meat tissue from the cranial end of fillets was placed on filter paper (11 cm diameter Whatman No. 1 filter paper) and pressed at 50 kg (a 50 kg-load cell) for 5 min by a TA-XTPlus Texture Analyzer (Stable Micro Systems, Surrey, UK). The wet filter paper was then scanned into a computer using Canon scanner (Model: CanoScan LIDE 60, Canon USA, Inc. Lake Success, NY 11042). The meat area and the total fluid area were measured using the computer with Adobe Photoshop software (CS3 Extended, San Jose, CA 95110). The results were expressed as a ratio of fluid area over total fluid area (Kauffman et al., 1986) [24] to estimate amount of expressible fluid (fpWHC) in meat. A swelling/centrifugation method similar to that developed by Wardlaw et al. (1973) [25] was used for estimation of water uptake by the fresh meat. Ten grams of the minced meat sample (from the meat chopped for moisture analysis) and 15 mL of 0.6 M NaCl solution were added into a 50-mL centrifuge tube and mixed with a Vortex mixer for 1 min. The tube was then refrigerated at 4°C for 15 min before being centrifuged at 4°C at 3,000 g for 15 min. The water uptake (% scWHC) was determined by the formula: % salt-induced water uptake = $100 \times (W_{\text{pellet}} - W_{\text{sample}}) / W_{\text{sample}}$

Where W_{sample} represents initial muscle sample weight and W_{pellet} refers to the solid material at the bottom of the tube after centrifugation. For the cooking method, the patties were cooked in individual vacuum-sealed bags. Cook yield included both thaw yield and cook yield and was calculated by $100 \times (W_{\text{cooked}} /$

Wfresh), where Wcooked represents sample weight after cooking and Wfresh refers to the initial sample weight before freezing at -20°C.

Sample Preparation and Cooking

Composite patties (3 patties/deboning time/rep) were prepared by grinding the remaining portions of the breast fillets with a Megaforce 3000 series TM air cooled electric meat grinder with a chopper plate of 1/4" square hole. After grinding, the meat was manually homogenized and circular 90-gram composite patties (9 cm in diameter and 0.5 cm thick) were formed using a round Ateco cutter (August Thomsen Corp, Glen Cove, N.Y. N.Y. 11542). Patties were then individually placed in polymeric cooking bags (Seal-a-Meal, The Holmes Group, El Paso, Tex., U.S.A.) and stored at -20°C before use. All samples were cooked directly from the frozen state to an internal temperature of 78- 80°C in a Henny Penny MCS-6 combi oven (Henny Penny Corp. Eaton, OH 45320) set at 85°C on the tender steam setting. Internal temperatures were checked with a hand- held Digi-Sense digital thermometer fitted with a Physitemp hypodermic needle microprobe. The purpose to use chicken breast patties in this study was to reduce variations in sensory juiciness intensity evaluation.

Sensory Evaluation

Samples were analyzed by a 7-member trained panel with more than 100-h training and more than 2-years experience in sensory evaluation of cooked chicken meat. Cooked patties were portioned using an apple wedge cutter. Each panelist received one wedge. TI-juiciness of the meat samples was assessed for 40 seconds on 0-15 point line scale using a Spectrum™ like approach. Trained assessors chewed at a rate of one chew/sec and selected zero when samples were ready to swallow. Overall juiciness, as a sustained

juiciness assessment [26], was scored following TI assessments.

Statistics

Statistical analyses were conducted using SAS (SAS version 9.4, SAS Institute Inc., 2013, Cary, NC). Meat quality characteristics were analyzed as a one-way ANOVA (deboning time) using PROC GLM. For sensory data, the means of intensity scores collected from individual panelists were first calculated for each patty. Then they subjected to a two-way ANOVA with PROC GLM procedure with deboning (hot-boned, 2h, or 8h), chewing time (overall, 1, 2, 5, 10, 15, 20, 25, 30, 35, or 40sec), and their interaction as main effects in addition to replication. Means were separated with the Tukey option at a significance level of 0.05. Pearson’s correlations between measurements were determined via PROC CORR with a determinant of significance at $P < 0.01$.

Results and Discussion

Tables 1 and 2 show the broiler carcass weights and the meat quality characteristics of the chicken breast fillets used in this study. Average carcass weight was 1521 g and L* and pH values of broiler breast meat were 50.9 and 5.96 (Table 1). There were no significant differences ($P > 0.05$) in carcass weight, thaw-cook yields, or fpWHC between the three deboning times. However, significant differences ($P < 0.05$) were noted for CIE L*a*b* values, pH, moisture content, and scWHC among the three deboning times. L* values of 2h and 8h samples were significantly higher than hot-boned fillets and pH values of 8h samples were significantly lower than hot-boned and 2h samples. It has been well documented that there are a positive relationship between L* values of chicken breast fillet surfaces and aging time and negative relationships between pH values and aging time and between pH and L* values during the early postmortem period [27-31].

DEBONING TIME	Carcass weight (g)	CHICKEN BREAST FILLET			
		L* (lightness)	a* (redness)	b*(yellowness)	pH
Hot-boned	1497 ^a ± 51	47.2 ^b ± 0.4	-0.26 ^b ± 0.23	8.7 ^b ± 0.4	6.14 ^a ± 0.04
2 h	1497 ^a ± 49	51.6 ^a ± 0.7	0.55 ^a ± 0.22	10.8 ^a ±0.6	6.01 ^a ± 0.04
8 h	1570 ^a ± 38	53.9 ^a ± 1.1	0.04 ^a ± 0.22	9.5 ^a ± 0.5	5.73 ^b ± 0.06

^{a,b}Mean values with no common superscript in the same column are significantly different ($P < 0.05$).

Table 1: Raw weight of broiler carcasses and color and pH of raw broiler fillets (*pectoralis major*) deboned at different postmortem times (mean ± SE, n = 12).

DEBONING TIME	WATER-HOLDING CAPACITY			
	Moisture content (%)	Thaw-cook yield	scWHC (% increase)	fpWHC (Ratio)
Hot-boned	75.7 ^b ± 0.1	75.4 ^a ± 0.5	26.9 ^b ± 3.4	0.77 ^a ± 0.01
2 h	76.2 ^a ± 0.1	75.7 ^a ± 1.4	62.6 ^a ± 12.1	0.76 ^a ±0.01
8 h	76.5 ^a ± 0.1	76.5 ^a ± 1.0	71.9 ^a ± 9.6	0.76 ^a ± 0.01

^{a,b} Mean values with no common superscript in the same column are significantly different ($P < 0.05$).

Table 2: Moisture content and water-holding capacity of broiler fillets (*pectoralis major*) deboned at different postmortem times (mean \pm SE, n = 12).

These relationships are generally attributed to glycolysis and the formation of lactic acid in muscles after slaughter [32]. The results in the current study are well in line with published data, indicating that there were differences in the fillet properties between the three PM deboning times. Average TI-curves for the three deboning treatments and the TI juiciness intensity scores extracted from the TI curves are shown in Figure 1 and Table 3, respectively. The perception of juiciness in cooked breast meat deboned at the three different PM times followed similar patterns throughout the duration of eating (Figure 1). The average intensity scores reached 3.3-3.7 after the first second of bites. After that, only slight increases were noticed in the intensity scores and the changes varied with PM deboning time. After 30 sec of chewing, however, the intensity scores dropped rapidly from > 3.7 to 1.4 regardless of deboning time. Although the specific patterns might differ from panelist to panelist [33,34], a similar overall pattern in the juiciness intensity scores has also been found during chewing of different meat samples [21,35,36]. In the literature, the sudden drop in the intensity juiciness score at the end of the evaluation of a meat sample has been called a ‘ski jump’ effect and attributed to the fact that juiciness, unlike tenderness, persisted throughout the mastication to the point of swallowing and thus terminated abruptly [34].

JUICINESS ASSESSMENT/SECOND	DEBONING TIME			OVERALL
	Hot-boned	2 h	8 h	
One (initial juiciness)	3.3	3.3	3.7	3.4d
Two (initial juiciness)	3.6	3.6	3.9	3.6cd
Five (initial juiciness)	3.8	3.9	4.2	3.9abc
Ten	4	4.1	4.3	4.0ab
Fifteen	4.1	4.2	4.5	4.2a
Twenty	4.1	4.1	4.4	4.1ab
Twenty five	4.2	4.2	4.2	4.1ab
Thirty	3.9	3.9	3.7	3.8bc
Thirty five	3.1	2.8	2.5	2.8e
Forty	1.8	1.5	1.4	1.6f
Overall (sustained juiciness)	3.9	4.1	4.2	4.0ab
Level of significance (P)	<.0001 (TI time)	0.0867 (Debone)	0.1208 (TI time X Deboning)	

^{a-f} Mean values with no common superscript are significantly different ($P < 0.05$).
¹ Intensities with a higher number are stronger (16-point scales). SE = standard error.
 Error mean square (EMS) was 0.1 for deboning time X chewing time means and 0.2 for overall means.

Table 3: Average intensity scores of descriptive sensory texture attribute juiciness of broiler breast muscle meat (*pectoralis major*) deboned at different postmortem times (mean \pm SE, n = 12)¹.

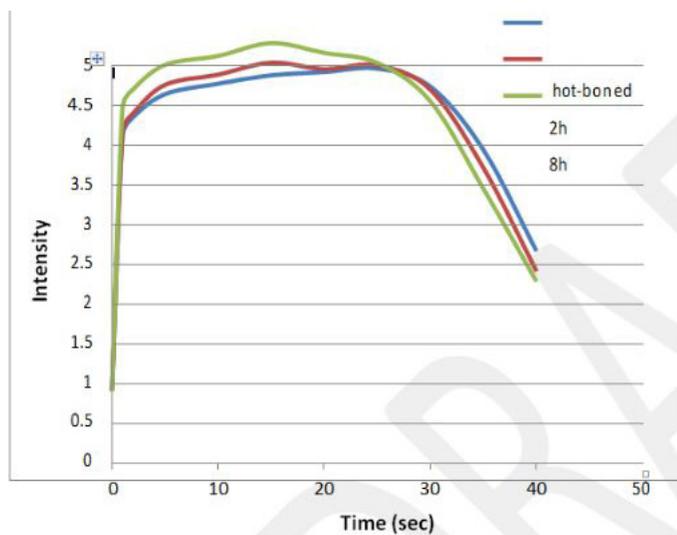


Figure 1: Time intensity curves for juiciness intensity scores of cooked chicken breast meat deboned at three different postmortem times. The curves are combined means of 4 replications with 7 trained sensory panelists in each replication.

There were no significant differences in average juiciness intensity scores between the three deboning times regardless of chewing time (Table 3). However, there were significant differences in the scores during chewing (Table 3). Overall, the highest intensity score was after 10 sec (or bites), which was significantly higher than the score at the first and second sec and the scores after 30 sec. There were also no differences ($P > 0.05$) between the overall juiciness (sustained juiciness) intensity scores and the juiciness intensity scores after 2 sec and before 30 sec. However, there were differences ($P < 0.05$) between the sustained juiciness scores and the scores before 2 sec and after 30 sec. Juiciness has been one of the most commonly evaluated sensory attributes for cooked chicken breast meat. However, it is hardly affected by chicken production practices [14,15] or primary processing techniques [37,38]. Zhuang et al. (2007) [6] randomly collected 6 different brands of boneless skinless chicken breast products (without additives), which could have been processed and handled very differently, from local grocery stores in Athens, GA, and did not find any significant difference in average intensity scores of juiciness between the brands. Cavitt et al. (2005) and Xiong et al. (2006) [10,12] measured juiciness intensity scores of cooked broiler breast fillets deboned at 9 different times within 24 h PM and found no differences between those deboning times. Our re-

sults, in agreement with those data, further demonstrate that PM deboning time does not significantly alter the juiciness perception of cooked chicken breast meat at any evaluation point throughout mastication. However, average values of juiciness intensity scores for cooked chicken breast meat could differ depending upon the time during chewing at which juiciness is recorded. For cooked chicken breast fillets, the perception between 5 sec and 30 sec for juiciness intensity were similar to each other and sustained juiciness scores are similar to these juiciness scores. Table 4 shows the descriptive statistics for the variables measured in this study. For juiciness intensity scores, relatively more variation (coefficient of variation was greater than 12%) was observed at the beginning (fewer than 10 sec or bites) and end (more than 30 sec or bites) of mastication compared with those between 20 and 25 sec (coefficient of variation was less than 8%) of TI evaluation. In a study on the sensory perceptions of tenderness and juiciness of cooked beef and pork using TI methodology, Brown et al. (1996) [33] made the comparison of the perceptions of juiciness by seven individual panelists during mastication. Their data showed more variations in the juiciness perception at the beginning (less than 10 sec of chewing) and end (more than 20 sec) of mastication among the panelists. Zimoch and Gullett (1997) [34] attributed the variability in TI perception of juiciness among trained sensory panelists to different chewing behavior. Our data here also indicate that it could reduce the variability in juiciness intensity scores if trained sensory panelists were asked to record their perception after more than 10 sec of chewing or to use sustained juiciness in the evaluation of cooked chicken breast meat. Table 5 shows significant ($P < 0.01$) and strong ($r \geq 0.79$) correlations between the juiciness intensity scores evaluated before 15 sec. Scores given at 20 sec were significantly correlated with those at 2 through 15 sec of chewing ($P < 0.005$) but the correlation coefficients were less than 0.70. Strong correlations ($P < 0.01$) were observed between TI juiciness scores that were recorded close to each other. There were no significant correlations between juiciness scores collected after 20 sec of mastication and scores before 15 sec of mastication, with the exception of 15 versus 25 sec. There were significant ($P < 0.0001$) and strong ($r > 0.70$) correlations between initial juiciness scores (collected before 15 sec) and sustained juiciness scores. There were significant ($P < 0.01$) but not strong correlations ($r < 0.7$) between sustained juiciness and juiciness scores collected between the 20 and 25 sec of chewing. However, no significant correlations were found between sustained juiciness and TI scores from greater than 25 sec.

JUICINESS ASSESSMENT/SECOND	Observations	Minimum	Maximum	Mean	Std. deviation
One	36	1.99	4.533	3.376	0.632
Two	36	2.221	4.729	3.602	0.624
Five	36	2.427	4.791	3.921	0.556
Ten	36	2.641	4.835	4.046	0.513
Fifteen	36	2.866	4.966	4.185	0.467
Twenty	36	3.253	4.741	4.132	0.329
Twenty five	36	3.381	4.743	4.12	0.312
Thirty	36	2.339	4.487	3.779	0.532
Thirty five	36	2.066	4.034	2.813	0.544
Forty	36	0.905	2.621	1.559	0.515
Overall	36	2.719	4.776	4.007	0.438
L	36	44.073	60.643	50.881	3.816
a	36	-1.383	1.813	0.109	0.819
b	36	6.277	13.793	9.677	1.908
Moisture	36	75.141	77.241	76.117	0.531
pH	36	5.35	6.35	5.963	0.237
Carcass weight	36	1215	1887	1521.1	159.88
Thaw-cook yield	36	68.732	85.339	75.86	3.555
scWHC	36	6.194	153.62	53.795	36.516
fpWHC	36	0.689	0.798	0.766	0.023

Table 4: Descriptive statistics of observations, range, mean, and standard deviation for 20 different variables in broiler breast meat (pectoralis major).

SECOND/CHEW	One	Two	Five	Ten	Fifteen	Twenty	Twenty Five	Thirty	Thirty five	Forty	Overall
One	1										
Two	0.98***	1									
Five	0.93***	0.97***	1								
Ten	0.86***	0.91***	0.95***	1							
Fifteen	0.79***	0.84***	0.89***	0.94***	1						
Twenty	0.4	0.42*	0.47*	0.49*	0.67***	1					
Twenty five	0.25	0.25	0.28	0.27	0.46*	0.73***	1				
Thirty	-0.05	-0	0.02	0	0.14	0.43*	0.52**	1			
Thirty five	-0.28	-0.3	-0.23	-0.25	-0.27	0.002	0.14	0.54**	1		
Forty	-0.35	-0.4	-0.34	-0.34	-0.36	-0.12	0.17	0.51*	0.79***	1	
Overall	0.73***	0.78***	0.83***	0.85***	0.92***	0.67***	0.56**	0.27	-0.18	-0.19	1

Table 5: Pearson’s correlation coefficients between sensory juiciness intensity scores (n = 36).

In sensory evaluation, juiciness is typically assessed by one of two criteria: initial juiciness/wetness release or sustained juiciness. Initial juiciness is the wetness during the first few chews produced by a rapid release of meat juices and sustained juiciness is caused by fat in the sample that causes a slow release of saliva after continued mastication [39]. For cooked beef, the principle sources of juiciness reside in the water and intramuscular lipids. When heated and masticated, the broth then promotes saliva production. Therefore, juiciness has been attributed to the flow of juices from the actual meat and the moisture produced by saliva in the mouth during mastication [1,40]. Because of its low fat content (less than 3%), saliva formation stimulated by intramuscular lipids may not play a role in sustained juiciness in chicken breast meat. In the current study, this assertion is supported by the observations that there were no great increases

in juiciness intensity scores after the first few bites (Figure 1). These results also demonstrate that the perceptions of both initial and sustained juiciness are similar in cooked chicken breast meat. For cooked chicken breast meat, the juiciness or moisture release intensity scores collected from the initial 15 bites or within TI 15 sec during chewing can be used to predict each other as well as sustained juiciness scores. Thus, any of the scores within 15 sec can be used as meat juiciness measurements without affecting the results. Overall, the initial moisture release (≤ 15 bites) has more impact on the panel's overall juiciness perception than those after 20 sec of chewing.

Table 6 shows that there were no significant linear relationships between any of the juiciness intensity score (regardless of TI time) and the measurement of color, moisture content, pH, carcass weight, or fpWHC. However, initial juiciness scores (1-15 sec) and sustained juiciness were significantly correlated with thaw-cook yield ($P < 0.01$, $r > 0.60$) and scWHC ($P < 0.01$, $r > 0.50$). Despite the fact that juiciness is one of the most commonly evaluated sensory attributes for cooked meat products, standard instrumental methods for measuring juiciness have not been established like they have for tenderness. Although raw breast meat characteristics are often measured, these parameters are rarely related to sample juiciness in cooked meat, especially to sensory juiciness intensity scores. Liu et al. (2004) [32] carried out a principal component analysis of meat characteristics (pH, color, cook loss, and shear force) and sensory measurements of cooked chicken breast deboned at different PM times and found that among the quality characteristics, the highest r value (although it was very weak) existed between cook yield and juiciness intensity scores. With beef steak, Lucherker et al. (2017) [41] assessed the relationships between objective measurements and sensory juiciness ratings and found that of the 21 objective measurements (such as marbling score, CIE L*a*b*, pH, free water, bound water, protein swelling, drip loss, expressible moisture, fpWHC, and water activity) in raw meat, only cook loss was strongly associated with initial and sustained juiciness intensity scores ($r > 0.70$) followed by fpWHC ($r < 0.30$). The correlation coefficients for pH, color, drip loss, and expressible moisture were less than 0.22. Our data are consistent with these findings and demonstrate that cook yield may be used to indicate juiciness intensity perception of cooked chicken breast meat. The effect of cook yield/loss on sensory juiciness perception has been attributed to the water loss in raw meat resulting from cooking [4,41].

	One	Two	Five	Ten	Fifteen	Twenty	Twenty Five	Thirty	Thirty five	Forty	Overall
L	-0	-0.09	-0	-0.01	0.07	0.16	-0.05	-0.05	-0.29	-0.25	-0.05
a	0.1	0.13	0.2	0.14	0.17	0.32	0.36	0.26	0.21	0.04	0.17
b	0	0.01	0	-0.07	-0.04	0.13	0.25	0.37	0.3	0.26	0.02
mois	0.1	0.09	0.1	0.19	0.33	0.45*	0.28	0.11	-0.27	-0.14	0.35
pH	-0	-0.07	-0	-0.13	-0.2	-0.29	-0.05	0.22	0.32	0.23	-0.16
Carcass wt	0	0.01	0	-0.06	-0.03	0.04	0	0.09	-0.12	-0.17	-0.14
Thaw- cook yield	0.67***	0.71***	0.68***	0.70***	0.65***	0.15	-0.01	-0.22	-0.37	-0.41*	0.63***
scWHC	0.53**	0.53**	(0.50)*	0.53**	0.57**	0.23	0.09	-0.19	-0.42*	-0.42*	0.58**
fpWHC	-0	-0.17	-0	-0.03	0.03	0.22	0.37	0.02	0.11	0.12	0

*** $P < 0.0001$; ** $P \leq 0.001$; * $P \leq 0.01$.

Table 6: Pearson's correlation coefficients between sensory juiciness intensity scores of broiler breast meat and instrumental measurements in broiler breast fillets (n = 36).

Conclusions

Although juiciness in cooked chicken breast meat has been reported frequently in conjunction with tenderness, an in-depth understanding of this sensory attribute and its assessment has been previously lacking. In the present study, sensory juiciness intensity of cooked chicken breast meat was targeted specifically using TI methodology and its relationships with raw meat characteristics were assessed. Results demonstrated that juiciness intensity perception of cooked chicken breast meat follows a similar pattern during mastication regardless of deboning time. Average juiciness intensity scores depend upon the time during mastication at which juiciness is determined, but are not affected by postmortem deboning time regardless of the TI evaluation time. Juiciness intensity perception is not always linearly correlated between different chewing moments. However, there are strong relationships amongst initial juiciness scores and between initial juiciness scores and sustained juiciness scores indicating that they provide similar juiciness attribute assessments in cooked chicken breast meat. Our data also provide evidence that cook yield/loss of raw chicken breast meat could be an indicator for the juiciness perception in sensory evaluation.

References

1. Winger RJ, Hagyard CJ (1994) Juiciness - its importance and some contributing. Quality attributes and their measurement in meat, poultry and fish products. Pg No: 94-124.
2. Bratzler L (1960) Palatability characteristics of meat. In: Price JF, Schweigert BS (ed.). The Science of Meat and Meat Products. (3rd Edition), Food & Nutrition Press. Pg No: 328-348.
3. Zimoch J, Findlay CJ (1998) Effective discrimination of meat tenderness using dual attribute time intensity. J Food Sci 63: 940-944.
4. Aaslyng MD, Bejerholm C, Ertbjerg P, Bertram HC, Andersen HJ (2003) Cooking loss and juiciness of pork in relation to raw meat quality and cooking procedure. Food Qual Pref 14: 277-288.
5. Cavitt LC, Youm GW, Meullenet JF, Owens CM, Xiong R (2004) Prediction of poultry meat tenderness using razor blade shear, Allo-Kramer shear, and sarcomere length. J Food Sci 69: SNQ11-SNQ15.
6. Zhuang H, Savage EM, Kays SE, Himmelsbach DS (2007) A survey of the quality of six retail brands of boneless, skinless chicken breast fillets obtained from retail supermarkets in the Athens, Georgia area. J Food Qual 30: 1068-1082.
7. Lyon CE, Hamm D, Thomson JE (1985) pH and tenderness of broiler breast meat deboned various times after chilling. Poult Sci 64: 307-310.
8. Stewart MK, Fletcher DL, Hamm D, Thomson JE (1984) The effect of hot boning broiler breast meat muscle on postmortem pH decline. Poult Sci 63: 2181- 2186.
9. Sams AR (1999) Meat quality during processing. Poult Sci 78: 798-803.
10. Cavitt LC, Meullenet JFC, Xiong R, Owens CM (2005) The relationship of razor blade shear, Allo-Kramer shear, Warner-Bratzler shear and sensory tests to changes in tenderness of broiler breast fillets. J Muscle Foods 16: 223-242.
11. Lyon BG, Lyon CE (2001) Meat Quality: Sensory and instrumental evaluations. Poultry Meat Processing 7: 97-120.
12. Xiong R, Cavitt LC, Meullenet JF, Owens CM (2006) Comparison of allo-kramer, warner-bratzler and razor blade shears for predicting sensory tenderness of broiler breast meat. J Texture Stud 37: 179-199.
13. Zhuang H, Savage EM (2011) Effect of postmortem deboning time on sensory descriptive flavor and texture profiles of cooked boneless skinless broiler thighs. LWT-Food Sci Tech 44: 2087-2090.
14. Fanatico AC, Pillai PB, Emmert JL, Gbur EE, Meullenet JF, et al. (2007) Sensory attributes of slow- and fast-growing chicken genotypes raised indoors or with outdoor access. Poult Sci 86: 2441-2449.
15. Horsted K, Henning J, Hermansen JE (2005) Growth and sensory characteristics of organically reared broilers differing in strain, sex and age at slaughter. Acta Agric Scand A-Anim Sci 55: 149-157.
16. Piggott JR (2000) Dynamism in flavour science and sensory methodology. Food Res Int 33: 191-197.
17. Dijksterhuis GB, PIGGOTT JR (2001) Piggott. Dynamic methods of sensory analysis. Trends Food Sci Technol 11: 284-290.
18. Cliff M, Heymann H (1993) Development and use of time-intensity methodology for sensory evaluation: A review. Food Res Int 26: 375-385.
19. Duizer LM, Gullett EA, Findlay CJ (1993) Time-intensity methodology for beef tenderness perception. J Food Sci 58: 943-947.
20. Butler G, Posh LM, Mackie DA, Jones A (1996) Time-intensity as a tool for the measurement of meat tenderness. Food Qual Pref 7: 193-204.
21. Llorido L, Estévez M, Ventanas S (2014) A novel approach to assess temporal sensory perception of muscle foods: Application of a time-intensity technique to diverse Iberian meat products. Meat Sci. 96: 385-393.
22. AOAC(1990)OfficialMethodsOfAnalysis.(15thedition).Washington,DC.
23. Honikel KO, Hamm R (1994) Measurement of water-holding capacity and juiciness. Quality Attributes and Their Measurement in Meat, Poultry and Fish Products. Pg No: 125-161.
24. Kauffman RG, Eikelenboom G, van der Wal PG, Engel B, Zaar M (1986) A comparison of methods to estimate water-holding capacity in post-rigor porcine muscle. Meat Sci 18: 307-322.
25. Wardlaw FB, McCaskill LH, Acton JC (1973) Effect of postmortem muscle changes on poultry meat loaf properties. J Food Sci 38: 421-423.
26. Pieterse E, Pretorius Q, Hoffman LC, Drew DW (2014) The carcass quality, meat quality and sensory characteristics of broilers raised on diets containing either *Musca domestica* larvae meal, fish meal or soya bean meal as the main protein source. Anim Prod Sci 54: 622-628.
27. Brewer VB, Emmert JL, Meullenet JF, Owens CM (2012) Small bird programs: Effect of phase-feeding, strain, sex, and debone time on meat quality of broilers. Poult Sci 91: 499-504.
28. Brewer VB, Kuttappan VA, Emmert JL, Meullenet JF, Owens CM (2012) Big-bird programs: Effect of strain, sex, and debone time on meat quality of broilers. Poult Sci 91: 248-254.
29. Huang JC, Huang M, Wang P, Zhao L, Xu XL, et al. (2014) Effects of physical restraint and electrical stunning on plasma corticosterone, postmortem metabolism, and quality of broiler breast muscle. J Anim Sci 92: 5749- 5756.
30. Khan AW, Nakamura R (1970) Effects of pre- and postmortem glycolysis on poultry tenderness. J Food Sci 35: 266-267.
31. Pedrão MR, Kato T, Soares AL, Ida EI, Garcia Coró FA, et al. (2015) Influence of Cooling on the Glycolysis Rate and Development of PSE (Pale, Soft, Exudative) Meat. Braz Arch Biol Technol 58: 272-277.
32. Liu Y, Lyon BG, Windham WR, Lyon CE, Savage EM (2004) Principal component analysis of physical, color, and sensory characteristics of chicken breasts deboned at two, four, six, and twenty-four hours post-mortem. Poult Sci 83: 101-108.
33. Brown WE, Gerault S, Wakeling I (1996) Diversity of perceptions of meat tenderness and juiciness by consumers: a time-intensity study. J Texture Stud 27: 475-492.
34. Zimoch J, Gullett EA (1997) Temporal aspects of perception of juiciness and tenderness of beef. Food Qual Pref 8: 203-211.
35. Fuentes V, Ventanas J, Morcuende D, Ventanas S (2013) Effect of intramuscular fat content and serving temperature on temporal sensory perception of sliced and vacuum packaged dry-cured ham. Meat Sci 93: 621-629.
36. Ventanas S, Puolanne E, Tuorila H (2010) Temporal changes of flavor and texture in cooked bologna type sausages as affected by fat and salt content. Meat Sci 85: 410-419.

37. Zhuang H, Savage EM, Smith DP, Berrang ME (2009) Effect of dry-air chilling on sensory descriptive profiles of cooked broiler breast fillets. Poultry Sci 88: 1282-1291.
38. Zhuang H, Savage EM (2010) Comparisons of sensory descriptive flavor and texture profiles of cooked broiler breast fillets categorized by raw meat color lightness values. Poultry Sci 89: 1049-1055.
39. San Francisco WH, Freeman Co, Bratzler LJ (1971) Palatability factors and evaluations. In: Price JF, Schweigert BS, Freeman WH (ed.). The Science of Meat and Meat Products. (2nd edition), San Francisco, USA. Pg No: 328-348.
40. Gullett EA, Rowe DL, Hines RJ (1984) Sensorial assessment of the eating quality of meat. Can Inst Food Sci Technol J 17: 229-236.
41. Lucherk LW, O'Quinn TG, Legako JF, Rathmann RJ, Brooks JC, et al. (2017) Assessment of objective measures of beef steak juiciness and their relationships to sensory panel juiciness ratings. J Anim Sci 95: 2421-2437.