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Effects of Washing and Desinewing Treatments on the Composition and Quality Characteristics of Spent Layer Meat

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Abstract

The effects of washing and desinewing on the composition, fuctional properties, storage stability and texture of spent layer meat were investigated. Spent layer meat subjected to treatments involving water washing, bicarbonate washing and desinewing showed increases in moisture content and decreases in protein content, hydroxyproline content and heme pigment content. Increases in salt extractable protein content and water holding capacity and decreases in buffering capacity and emulsifying capacity were also observed. The 2-thiobarbituric acid values of washed and desinwed samples increased slowly during storage indicated the increase in storage stability compared to the control. Sample rolls prepared from bicarbonate washed and desinewed thigh and drumstick meats were scored by trained sensory panelists as less tough than the products made of ground thigh and drumstick meats.
Key words: spent layer meat, washing, desinewing

Introduction

Processing techniques such as desinewing ("a process whereby the major portion of sinew or connective tissue is removed") and restructuring have been utilized to improve the tenderness charateristics of low-grade meat[1]. Washing with phosphate or bicarbonate buffer solutions has proven to be effective in reducing the color intensity of poultry dark meat[2]. It is possible that the combination of these techniques could be an effective solution to the texture problems associated with spent layer meat (meat from old laying hens), especially spent layer dark meat. In this study, the effects of washing and desinewing treatments on the composition and quality characteristics of spent layer meat were investigated in order to examine the feasibility of the treatments as alternative processing methods for the upgraded utilization of spent layer meat.

Materials and Methods

Materials

Spent layers (15 to 17 months old white Leghorns) was slaughtered by severing carotid artery. Birds were scalded, defeathered, eviscerated and chilled overnight in ice water. Carcasses were then individually vacuum packed into Cryovac bags (W.R. Grace and Co., Duncan, SC, USA) and blast frozen (−35℃). Frozen carcasses were thawed at 4℃ overnight and breast meat, thigh meat and drumstick meat were removed from the carcasses by hand. After the removal of skin, the meat was ground using a meat grinder (Hobart, Model 4812) with a 0.48 cm plate.

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Treatments for breast meat

Approximetely 400 g of ground breast meat were desinewed using a lab scale desinewing device (Fig. 1). The pressure required for the up and down movement of the piston was provided by a Carver lab press (F.S. Garver Inc., Summit, NJ). The desinewing process continued until the final pressure reached 25 kg/cm^2. The resulting meat was designated as desinewed breast meat (DB).

Approximately 400 g of ground breast meat were taken and washed with two liters of cold (4-6℃) tap water for 7 min with mild agitation using a spatula. Water was then removed using a triple layer of cheese cloth until the weight of samples returned to the original weight. Samples were transferred into the desinewing device and desinewed as described above. The resulting meat was designated as water-washed and desinewed breast meat (WDB).

Portions of ground breast meat were reground

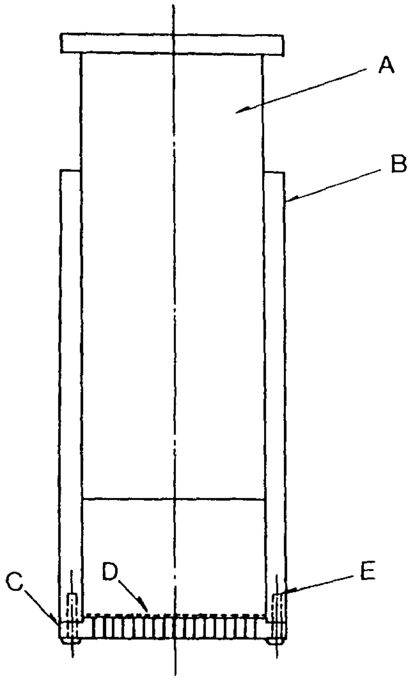

Fig. 1. Laboratory scale desinewing device
A: 110 mm φ stainless steel piston, B: 110 mm φ (I.D.) stainless steel cylinder, C: Perforated disk, hole size 2 mm φ, D: 12 mesh stainless steel wire mesh, E: 5 mm φ bolt

using a 0.32 cm plate and used as the control (ground brease meat, GB).

Treatments for thigh meat and drumstick meat

Approximately 400 g of ground thigh meat and approximately 400 g of ground drumstick meat were each washed with two liters of cold (4-6℃) 0.05 M sodium bicarbonate solution (pH 8.3) for 7 min with mild agitation using a spatula. Fat particles floating on top of the solution were removed using a spatula during the washing procedure. The solution was removed using a triple layer of cheese cloth until the weights of samples reached the original weights. The samples were then transferred into the desinewing device and desinewedd until the final pressure reached 90 kg/cm^2. After desinewing, samles were removed and rinsed with two liters of cold (4-6℃) tap water for 7 min with mild agitation using a spatula. Water was then removed using a triple layer of cheese clothas described above. Samples were then desinewed again using the lab scale desinewing device. The final pressure of 90 kg/cm^2 was also used as an end point for the completion of the second desinewing step. The resulting meats were designated as bicarbonate-washed and desinewed thigh meat (BDT) and bicarbonate-washed and desinewed drumstick meat (BDD), respectively. The final yield of samples was approximately 80% of the original weight. Portions of the ground thigh meat and drumstick meat were reground using a 0.32 cm plate and used as controls (Ground thigh and ground drumstick meat, abbreviated as GT and GD, respectively).

Analyses

Immediately after the treatment, the pH and color values of samples were measured. The samples were then put into Whirl-pak bags (Pioneer Containers Corp., Cedarburg, WI) and kept frozen at −20℃ until being analyzed.

Proximate composition

AOAC[3] procedures were followed for the determination of moisture, crude fat and protein content (macrotjeldahl, conversion factor=6.25) of the samples.

Hydroxyproline content

A spctrophotometic method described by Stegemann and Stalder[4] was followed.

Color characteristics

Color values of samples were measured on a Hunter Lab Tristimulus Colorimeter (Model D25 L-9, Hunter Associates Laboratory Inc., Reston, VA) using the L, a, b scale. Total pigment content was measured following a procedure described by Richansrud and Henrickson[5].

pH

The pH of the samples was measured following the method desribed by Yu and Lee[6].

Buffering capacity

Fifteen g of sample were homogenized with 150 m*l* of deionized water at room temperature (20-22℃) for 2 min in a Waring blender at low speed. After homogenization, the initial pH of the samples was measured. Then, 0.25 m*l* of 1N HCl was added to the homogenates with constant mixing and the pH was recorded. Acid was added to the homogenates until a pH of 5.0 was reached. The procedure was repeated and the homogenates were titrated with 1

N NaOH up to pH 9.0. A plot of pH versus the amount of acid and base was constructed and the amount of HCl and NaOH (mmole) required for 1 unit change of pH per kg sample was calculated from the slope of a regression line. The obtained values were reported as buffering capacity as suggested by Honikel and Hamm[7].

Salt extractable protein

Salt extraction of proteins was performed following the method described by Regenstein and Stamm[8] with slight modifications. One and a half g sample were homogenized with 28.5 m*l* of 0.1 M NaCl using a Waring blender with microcup for 1 min at low speed. Homogenates were transferred into polycarbonate tubes and held in an ice bath for 1 hr then centrifuged at 1,500×G for 15 min. After decanting the supernatants, 30 m*l* of extraction buffer (0.6 M NaCl, 50 mM phosphate, pH 7.0) were added to each tube and the precipitates were susended into the buffer using a spatula. The contents in the tubes were transferred into a Waring blender with a microcup and subjected to a brief homogenization (15 sec at low speed). Homogenates were then transferred back to the tubes and the extraction was carried out at 4℃ for 24 hrs. After the extraction, samples were centrifuged at 3,500×G for 20 min and the supernatants and free flowing layers on the top of the firm debris layer (pellet) were collected into preweighed polycarbonate tubes. The weight of collected samples was recorded and the samples were thoroughly mixed with a spatula. The protein content in the sample solutions was determined using a macrokjeldahl procedure[3]. The factor 6.25 was used to convert mg nitrogen to mg protein.

Water holding capacity (WHC)

The centrifuge method described by Balmaceda *et al.*[9] was followed. The WHC of samples were calculated using the following formula:

$$\mathrm{WHC}=\left(1-\frac{\text{weight loss (g)}}{\text{moisture in sample (g)}}\right)\times 100$$

TBA test

TBA values of samples were measured using a procedure described by Tarladgis *et al.*[10] in order to estimate the storage stability or samples after heat treatment (internal temperature 75℃).

Texture (toughness) measurements

Approximately 600 g of samples meat were mixed with 1.5% of NaCl (w/w) using a Hobart Kitchen Aid table top mixer (Model K5-A, Hobart Int., Troy, OH) at a speed of approximately 120 rpm for 5 min. After mixing, the contents of the bowl were hand stuffed into 5 cm (folded width) artificial casings. Stuffed rolls were then immediately put into a hot water bath (88℃) and cooked until the internal temperature reached 83℃. Samples were diced into 1 cm cubes and the toughness of samples were evaluated by nine trained panelists using a hardness reference scale[11].

Three to four pieces of 10 mm thick slices were also taken from each roll and cut into 3 cm wide strips. The shear force required to rupture the strips was measured using a texture press (Model TP-2, Food Technology Corp., Rockville, MD) with a single blade shear cell (Model CA-1) at a ram speed of 30 cm/min. Shear measurements were then standardized using the cross-sectional area (cm^2) of samples.

Statistical analysis

Analysis of variance (AOV) tests were performed using the general linear model program developed by SAS (Statistical Analysis System Institute Inc., Cary, NC). The mean difference were examined using the Student-Newman-Keuls test, a part of the SAS program.

Regressional analyses were performed using the Minitab program developed by Minitab Inc. (University Park, PA).

Results and Discussion

Proximate composition

Desinewed breast meat showed no significant ($p>0.05$) difference in proximate composition compared to ground breast meat. Water-washed and desinewed breast meat, bicarbonate-washed and desinewed thigh meat and bicarbonate-washed and desinewed drumstick meat had significantly ($p<0.05$) higher moisture contents and significantly ($p<0.05$) lower protein contents compared to the corresponding controls (ground breast, ground thigh or ground drumstick), respectively (Table 1).

The higher moisture content and the lower protein content of the washed and desinewed samples is not unexpected. The influx of the washing solutions into the meat structure with the removal of sarcoplasmic components is assumed to be the causative factor.

Table 1. Comparisons of proximate composition and hydroxyproline content of treated samples with those of ground breast, ground thigh and ground drumstick[a]

Sample treatment	Proximate composition			OH-Proline content	
	Moisture (%)	Protein (%)	Fat (%)	mg/g Sample	mg/g Solid
Ground breast (GB)	75.59 b	22.40 a	1.33 d	0.83 d	3.38 d
Desinewed breast (DB)	75.94 b	22.13 a	2.12 cd	0.76 d	3.17 d
Water-washed and desinewed breast meat (WDB)	82.29 a	16.42 d	1.48 d	0.81 d	4.50 d
Ground thigh (GT)	73.73 c	18.74 c	7.10 a	2.64 b	9.87 b
Bicarbonate-washed and desinewed thigh meat (BDT)	83.05 a	13.33 e	3.22 b	1.22 d	7.13. c
Greound drumstick (GD)	76.30 b	20.18 b	2.64 bc	3.29 a	13.88 a
Bicarbonate-washed and desinewed drumstick meat (BDD)	82.76 a	15.47 e	1.58 d	1.80 c	10.74 b

[a]Values represent means of three replications. Within each column, means having the same letter (a-e) are not significantly different ($p>0.05$)

Bicarbonate-washed and desinewed thigh meat and bicarbonate-washed and desinewed drumstick meat also had significantly ($p<0.05$) lower fat contents compared to the corresponding controls (ground thigh and ground drumstick, respectively). This may have been caused by the removal of intramuscular fats, since substantial amounts of fat particles were removed during the washing step (refer to Materials and Methods).

The compositional changes due to the treatment were generally in agreement with the results reported by Ball and Montejano[12]. Significant ($p<0.05$) increases in moisture content and significant ($p<0.05$) decreases in fat and protein contents were observed when strips of broiler thigh meat were washed with sodium bicarbonate or sodium acetate buffers.

Hydroxyproline content

Significant ($p<0.05$) decreases in hydroxyproline content due to the treatment were observed among the thigh and drumstick meat samples (Table 1). Bicarbonate-washed and desinewed thigh meat and bicarbonate-washed and desinewed drumstick meat showed a 53% and a 47% decreases in hydroxyproline content, respectively, on a sample basis compared to the corresponding controls (ground thigh and ground drumstick). These changes were a 27% and a 25% decreases, respectively, on g solid basis. It was concluded that substantial amount of connective tissues were removed from the thigh and drumstick meat due to the treatments.

The hydroxyproline content of desinewed breast meat and the water washed and desinewed breast meat samples was not significantly ($p>0.05$) different from that of ground breast meat. This indicated that the desinewing process was not effective for the removal of connective tissues in breast meat. Another aspect, which may be related to the inefficiency, is the structure of breat meat itself. Connective tissues in breast meat are mostly peri-and endomysial connective tissues which have a thin and flexible netwerk-like structure[13]. Therefore, it was postulated that the majority of the connective tissue passed through the device. This may explain the non-significant effect of the desinewing process on breast meat observed in this study.

Color characteristics

As shown in Table 2, significant ($p<0.05$) increases in the "L" value (lightness) and decreases in the "a" value (redness) were observed among the washed and desinewed sample. Water-washed and desinewed breat meat showed a 24% increase in lightness and a 37% decrease in redness when compared to ground breast meat. In the case of the thigh and drumstick meat samples, the increases in lightness were approximately 20% for each and the decreases in redness were 34% and 37%, respectively.

Water-washed and desinewed breast meat, bicarbonate-washed and desinewed thigh meat and bicarbonate-washed and desinewed drumstick meat had significantly ($p<0.05$) lower total pigments (hemoglobin and myoglobin) contents compared to the corresponding controls (Table 2). Water-washed and desi-

Table 2. Comparisons of color values and total pigments content of treated samples with those of ground breast, ground thigh and ground drumstick[a]

Sample treatment	Hunter scale			Total pigments[b]	
	"L" Value[c]	"a" Value[d]	"b" Value[e]	mg/g Sample	mg/g Solid
Ground breast (GB)	61.70 bc[a]	7.26 c	14.00 a	0.20 d	0.80 e
Desinewed breast (DB)	62.70 b	7.13 c	14.15 a	0.19 d	0.79 d
Water-washed and desinewed thigh meat (WDB)	76.27 a	4.49 d	13.12 b	0.12 e	0.68 e
Ground thigh (GT)	49.80 e	13.06 a	13.10 b	0.78 b	3.03 b
Bicarbonate-washed and desinewed thigh meat (BDT)	60.52 c	8.59 b	14.21 a	0.20 d	1.27 d
Ground drumstick (GD)	48.64 e	13.13 a	11.83 c	1.11 a	4.76 a
Bicarbonate-washed and desinewed drumstick meat (BDD)	58.62 d	8.21 b	13.63 ab	0.25 c	1.52 c

[a]Values represent means of three replicates. Within each column, means having the same letter (a-e) are not significantly different ($p>0.05$)
[b]Total pigments = Myoglobin + Hemoglobin
[c]"L" value, light reflectance where a score of 100 indicates, 'perfect white' and 0 indicates blackness
[d]"a" value, when positive, indicates redness. When negative, indicates greenness
[e]"b" value, when positive, indicates yellowness. When negative, indicates blueness

Table 3. Comparison of pH values and buffering capacity of treated samples with those of ground breast, ground thigh and ground drumstick[a]

Sample treatment	pH	Buffering capacity (mmole/kg/pH)[b]	
		As is	Dry wt
Ground breat (GB)	5.73 d[a]	50.3 a	207 a
Desinewed breat (DB)	5.75 d	50.1 a	209 a
Water-washed and desinewed breast meat (WDB)	5.72 d	30.0 b	168 bc
Ground thigh (GT)	6.03 c	31.7 b	123 cd
Bicarbonate-washed and desinewed thigh meat (BDT)	6.80 b	22.4 c	143 c
Ground drumstick (GD)	6.08 c	26.2 bc	113 d
Bicarbonate-washed and desinewed drumstick meat (BDD)	6.95 a	17.9 c	108 d

[a]Values represent means of three replications. Within each column, means having the same letter (a-d) are not significantly different ($p>0.05$)
[b]Calculated from the slope of pH vs. added acid/base line

newed breast meat contained 40% less pigments on a g sample basis (14% less on g solid basis) compared to the ground breast meat. Bicarbonate-washed and desinewed thigh meat and bicarbonate-washed and desinewed drumstick meat had 74% and 77% less pigments, respectively, compared to corresponding controls.

The total pigments content of the sample showed the same trend as shown by the "a" values. This indicated that the L, a, b index may be a valid estimator of the pigment content for these products.

A slight increase in the "b" values of samples due to washing was also observed in this study. A similar trend (increase in yellowness) was observed by Hernandez *et al.*[14] among mechanically deboned turkey meat samples washed with various strengths of phosphate buffers.

pH and buffering capacity

The pH and buffering capacity of desinewed breast meat were not significantly ($p>0.05$) different from those of the ground breast meat (Table 3).

The pH of water-washed and desinewed breast meat was not significantly different (p>) from that of ground breast meat, althogh the buffering capacity showed a 40% decrease on g sample basis. The pH values of bicarbonate-washed and desinewed thigh meat and bicarbonate-washed and desinewed drumstick meat were close to 7.0 and the buffering capacity of the same samples were 29% and 32% lower,

Table 4. Comparisons of salt extractalbe protein content, water holding capacity and hydration ratio of treated samples with those of ground breast, ground thigh and ground drumstick[a]

Sample treatment	$\frac{\text{Extracted protein}}{\text{Total protein}}\times 100$	WHC[b] (%)	Hydration ratio[c]
Ground breast (GB)	39.6 b[a]	89.5 a	3.80 bc
Desinewed breast (DB)	40.2 b	90.5 a	3.82 bc
Water-washed and desinewed thigh meat (WDB)	49.1 a	71.6 b	4.16 b
Ground thigh (GT)	24.7 c	81.1 a	3.23 c
Bicarbonate-washed and desinewed thigh meat (BDT)	37.5 b	84.7 a	5.23 a
Ground drumstick (GD)	17.1 d	87.3 a	3.78 bc
Bicarbonate-washed and desinewed drumstick meat (BDD)	27.2 c	89.3 a	5.21 a

[a] Values represent means of three replications. Within each column, means having the same letter (a-e) are not significantly different (p>)

[b] $\left[1-\frac{\text{weight loss (g)}}{H_2O\text{ in sample (g)}}\right]\times 100$

[c] Weight of pellet (g) after cooking and centrifuge/g solid

respectively, compared to the controls.

Honikel and Hamm[7] reported that water soluble compounds account for approximately half of the buffering capacity of a muscle tissue. Since the removal of the sarcoplasmic component was evident, as shown by the proximate composition and total pigments content of the samples (Tables 1 and 2), the decrease in buffering capacity of the treated samples (WDB, BDT and BDD) was the reflectin of the loss of sarcoplasmic components.

The pH values of bicarbonate washed samples were significantly ($p<0.05$) higher than those of the controls. The high pH of the samples may be due to the residual bicarbonate ions in the samples. However, more extensive removal of acidic sarcoplasmic components, for example, lactate, may party account for the high pH observed among the samples.

Changes in pH values and buffering capacity of the samples have practical meaning, since these factors are closely related to the final pH and yield of a product. For example, phosphates are added to products to increase water holding and binding. Although different function such as the pH-buffering effect, sequestering of divalent ions, action as a ATP analog and the contribution to the increase in ionic strength are listed as the causative factors for the increases in water holding and binding, the pH-buffering effect of phosphate is recognized as the principal contributing factor[15]. Treated samples showed higher pH and lower buffering capacity values. Therefore, it is evident that the desired pH and yield of the product could be obtained by incorporating a smaller amount of phosphates.

Appopriate changes in the product formula would be necessary when treated materials are incorportated into products.

Salt extractable protein content and water holding capacity

In the present study, the changes in salt extractable protein content and water holding capacity of the samples were measured in order to estimate the binding characteristics and yield of a product when treated meat was incorporated as a raw material.

Water-washed and desinewed breast meat showed a 49% extraction compared to a 40% extraction for the ground breast (Table 4). Bicarbonate-washed and desinewed thigh and bicarbonate-washed and desinewed drumstick meat showed a 37% and a 27% extraction, respectively, compared to the 25% and 17% extraction in case of the corresponding control samples (ground thigh and ground drumstick).

The increases in the salt extraction were more prominent in case of the thigh and drumstick meat. These increases were assumed to be related to the increase in the proportion of myofibrillar proteins due to the removal of the sarcoplasmic proteins. However, the observed increase in salt extractability of proteins exceeded the level estimated by the increase in the proportion of myofibrillar proteins. The slightly higher pH of the samples may partly account for the increase in salt extractable protein content

Table 5. TBA values of samples before and after heat treatment

Sample treatment	Before heat treatment	After heat treatment (days) 0	2	5	7
		(mg Malonaldehyde/1000 g Sample)			
Ground breast (GB)	0.6 abz	2.6 bcy	8.2 bx	11.7 cw	12.5 bv
Desinewed breast (DB)	0.7 abz	3.2 aby	8.8 bx	11.5 cw	13.2 bc
Water-washed and desinewed breast meat (WDB)	0.5 bz	2.2 cdy	4.9 cx	7.0 dw	7.8 cv
Ground thigh (GT)	1.2 az	3.5 aby	9.0 bx	13.3 bw	15.4 av
Bicarbonate-washed and desinewed thigh meat (BDT)	0.8 abz	1.4 dy	2.3 dx	3.0 ew	3.7 dv
Greound drumstick (GD)	1.2 abz	2.7 ay	10.7 ax	14.7 aw	16.4 av
Bicarbonate-washed and desinewed drumstick meat (BDD)	0.8 abz	1.4 dy	2.2 dx	3.0 ew	3.5 dv

[a]Values represent means of three replications. Within each column, mean having the same letter (a-d) are not significantly different ($p>0.05$). Within each row means having the same letter (x-y) are not significantly different ($p>0.05$)
[b]Internal temperature: 75℃

in addition to the increase in myofibrillar protein content. However, this does not provide a satisfactory explanation since the possible variance due to the difference in pH was eliminated during the extraction procedure. Therefore, it was postulated that a substantial part of the increase may have been caused by some other factors which have not been considered in the previous discussions, for example, the disruption of muscle integrity due to desinewing and possible structural changes of sarcomere due to bicarbonate-washing. This aspect was further investigated using differential scanning calorimetry (DSC), gel electrophoresis and transmission electron microscopy (TEM) in a following study.[16]

Water holding capacity (%) of water-washed and desinewed breast meat was significantly ($p<0.05$) lower than that of ground breast or desinewed breast meat (Table 4). Bicarbonate-washed and desinewed thigh and bicarbonate-washed and desinewed drumstick meat did not show any significant ($p>0.05$) differences in water holding capacity (%) compared to the corresponding controls (ground thigh and ground drumstick). The hydration ratio of the samples, calculated by dividing the weight of the pellet with the solid weight of the samples showed different trends. Bicarbonate-washed and desinewed thigh and bicarbonate-washed and desinewed drumstick meat retained significantly ($p<0.05$) higher amounts of water on a g solid basis, compared to the corresponding controls.

The pattern of change in the hydration ratio due to the treatments was similar with that of the salt extractable protein content of the samples. This indicated that the changes may have been caused by a common causative factor. The changes in myofibrillar structure was also assumed to be related to the increases in the hydration ratio.

TBA

In this study, TBA values of the samples before and after heat treatment (internal temperature: 75℃) and during storage (0, 2, 5, 10 days) were examined to compare the storage stability of the samples. Before heat treatment, the samples showed no significant ($p>0.05$) differences in TBA value, except for a difference between the washed and desinewed breast meat and the ground thigh meat (Table 5). After heating, however, water-washed and desinewed breast meat, bicarbonate-washed and desinewed thigh and bicarbonate-washed and desinewed drumstick meat had significantly ($p<0.05$) lower TBA values compared to the corresponding control sample (ground breast, ground thigh and ground drumstick, respectively). This indicates that the treated samples are less susceptible to lipid oxidation than are the controls under the same storage conditions.

It has been shown that Fe^{2+} ions released from heme pigments serve as active catalysts for lipid oxidation[17]. Since significant ($p<0.05$) reductions in the total pigments content due to the treatments were observation in this case, it was concluded that the lower TBA values observed among the treated samples may have been caused by the removal of heme pigments. The reduction of fat content due to the

Table 6. Toughness of breast, thigh and drumstick meat sample rolls[a]

	Sensory score[b]	Shear force (N/cm^2)
	Breast	
Ground breat (GB)	5.4 a[a]	9.71 a
Desinewed breat (DB)	5.5 a	9.61 a
Water-washed and desinewed breast (WDB)	5.2 a	9.61 a
Grund broiler breast	3.7 b	5.10 b
	Thigh and drumstick	
Ground thigh (GT)	5.2 b	9.90 b
Bicarbonate-washed and desinewed thigh meat (BDT)	3.1 c	7.84 b
Ground drumstick (GD)	6.2 a	13.73 a
Bicarbonate-washed and desinewed drumstick meat (BDD)	5.2 b	12.65 a
Ground broiler thigh	3.3 c	5.10 c
Ground broiler drumstick	3.3 c	3.43 c

[a]Values represent means of three replications (total of 27 observations in case of sensory and total of 12 to 15 observations in case of shear). Within each column of each group, means having the same letter (a-c) are not significantly different ($p>0.05$)
[b]Refer to the hardness reference scale[11]

treatments (Table 1) was also considered as a causative factor for the lower TBA values of treated samples since it implies the reduction of substrate for the oxidation.

Toughness measurements

The average toughness scores of the rolls prepared from bicarbonate-washed and desinewed thigh meat and bicarbonate-washed and desinewed drumstick meat were significantly ($p<0.05$) lower than those of the rolls prepared from control samples (ground thigh and ground drumstick) (Table 6). However, shear values measured by a texture press showed no significant ($p>0.05$) reduction due to the treatments.

The shear measurements, in the case of meat, consist of compression, extrusion and tensile strength in addition to the true sheat force[18]. Furthermore, the compression of a meat creates a movement against binding or cohesion[19]. The increase in the concentration of salt extractable proteins, which are the major components contributing to the binding of a product[20,21], were observed in this study. Therefore, it was assumed that the shear values may have been influenced by the changes in other texture characteristics, especially binding. This may explain the non-significant differences in shear values of the treated and control samples.

Differences in toughness were not detected among the breast meat samples by either sensory panels or shear measurement (Table 6). This may be explained by the fact that the connective tissue contents of breast meat samples were not significantly ($p<0.05$) reduced by the treatment (Table 1).

References

1. Cross, H.R., Berry, B.W., Nichols, J.E., Elder, R.S. and Quick, J.A.: Effect of desinewing versus grinding on textual properties of beef. *J. Food Sci.*, **43**, 1507(1978)
2. Acton, J.C., Bowie, B.M. and Dick, R.L.: Alteration of color properties of dark meat of poultry. Paper presented at the 76th Ann. Meeting of the Poultry Science Association (1987)
3. A.O.A.C.: *Official Methods of Analysis*, 14th ed., Association of Official Analytical Chemists, Washington, D.C., p. 431(1984)
4. Stagemann, H. and Stalder, K.: Determination of hydroxyproline. *Clin. Chim. Acta*, **18**, 267(1967)
5. Rickansrud, D.A. and Henrickson, R.L.: Total pigments and myoglobin concentration in four bovine muscles. *J. Food Sci.*, **32**, 57(1967)
6. Yu, L.P. and Lee, Y.B.: Effects of postmortem pH and temperature on bovine muscle structure and meat tenderness. *J. Food Sci.*, **51**, 774(1986)
7. Honikel, K.O. and Hamm, R.: Uber das Pufferungsvermogen des Fleisch und seine Veranderungen post mortem. *Z. Lebens. Unters. Forsch.*, **156**, 145(1974)
8. Regenstein, J.M. and Stamm, J.R.: Factors affecting the sodium chloride extractability of muscle proteins from chiken breast, trout white and lobster tail muscles. *J. Food Biochem.*, 3, 191(1979)
9. Balmaceda, E.A., Kim, M.K., Franzer, R., Mardones, B. and Lugay, J.C.: Protein functionality methodology-standard tests. In *Food Protein Chemistry*, Regenstein, J.M. and Regenstein, C.E. (ed), Academic Press, New York, p. 278(1984)

10. Tarladgis, B.G., Watts, B.M. and Younathan, M.T.: A distillation method for the quantitative determination of malonaldehyde in rancid foods. *J. Ami. Oil Chem. Soc.*, 37, 44(1960)
11. Munoz, A.M.: Development and application of texture reference scales, *J. Sensory Studies*, 1, 55(1986)
12. Ball, H.R. and Montejano, J.G.: Composition of washed broiler thigh meat. Paper presented at 73rd Ann. Meeting of the Poultry Science Association, Ontario, Canada (1984)
13. Dutson, T.R. and Carter, A.: Microstructure and biochemistry of avian muscle and its relevance to meat processing industry. *Poultry Sci.*, 64, 1577(1985)
14. Hernandez, A., Baker, R.C. and Hotchkiss, J.H.: Extraction of pigments from mechanically deboned turkey meat. *J. Food Sci.*, 51, 865(1986)
15. Lewis, D.F., Groves, K.H.M. and Holgate, J.H.: Action of polyphosphate in meat products. *Food Microstructure*, 5, 53(1986)
16. Yi, S. and Mast, M.G.: The effect of bicarbonate and phosphate buffer treatments on the structure and thermal stability of spent layer meat. *Korean J. Food Sci. Technol.*, 23, 000(1991)
17. Igene, J.O., King, J.A., Pearson, A.M. and Gray, J.I.: Influence of heme pigments, nitrite and non-heme iron on development of warmed-over flavor (WOF) in cured meat. *J. Agric. Food Chem.*, 27, 838(1979)
18. Stanley, D.W.: A review of the muscle cell cytoskeleton and its possible relation to meat texture and sarcolemma emptying. *Food Microstructure*, 2, 99(1983)
19. Segars, R.A. and Kapsalis, J.G.: Texture, Rheology, Phycophysics, Ch. 7. In *Objective Methods in Food Quality Assessment*, Kapsalis, J.G. (ed), CRC Press, Inc., p. 155 (1987)
20. Vadehra, D.V. and Baker, R.C.: The mechanisms of heat initiated binding of poultry meat. *Food Technol.*, 24, 42 (1970)
21. Asghar, A., Samejima, K. and Yasui, T.: Functionality of muscle proteins in gelation mechanisms of structured meat products. *CRC Critical Reviews in Food Science and Nutrition*, 22(1), 27(1985)

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세척 및 결체조직 제거 처리가 노계육의 성분 및 품질 특성에 미치는 영향

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세척 및 결체조직 제거 처리가 노계육의 성분, 기능적 성질, 저장성 및 조직감에 미치는 영향이 조사되었다. 수세처리, 중탄산용액 세척 처리 및 결체조직 제거 처리를 거친 노계육 시료의 경우 수분의 증가와 단백질, hydroxyproline 및 heme 색소 함량의 감소가 관찰되었고 염용성 단백과 보수력의 증가 및 완충력과 유화력의 감소가 관찰되었다. 또한 처리 시료의 경우 대조구에 비하여 저장 중 TBA 값의 증가가 완만하여 저장성의 증가가 시사되었다. 중탄산 용액 세척 처리 및 결체조직 제거 처리를 거친 thigh육 및 drumstick육을 사용하여 제조한 시료 roll의 경우 대조 시료에 비하여 질긴 감이 적은 것으로 훈련된 관능평가 요원들에 의하여 판정되었다.