Journal of Animal and Veterinary Advances 10 (1): 60-67, 2011
ISSN: 1680-5593

Comparison of Marinating with Two Different Types of Marinade on Some Quality and Sensory Characteristics of Turkey Breast Meat

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Abstract: Breast meats from Turkeys tumbled with either alkaline phosphate or organic acid solutions in the presence of salt while tumbling of meat with distilled water represent as a control. Chemical composition, marinade and meat pH, color coordinate values (L*, a*, b*), weight changes, textural and sensory properties of treated samples were evaluated. The use of alkaline phosphate cause to increase meat pH and lactic acid significantly decreased the pH of meat due to increased concentration in comparison to control. Tumbling with phosphate did not change L* values of meat however cooking increased L* values. Lactic acid treatments significantly increased L* values. The a* values of phosphate and acid marinated groups decreased after tumbling compared to control. Both alkali and acid treatments reduced shear force values compared to control. The increased concentration of phosphate did not affect the sensorial tenderness and juiciness scores. For acid marination there were differences for tenderness score.

Key words: Tumbling, marination, phosphate, lactic acid, salt, turkey meat, tenderness

INTRODUCTION

Tenderness and juiciness are seems to be the most important criterions of the eating quality of meat by the consumers. Many consumers demand the tender and juicer meat that have motivated meat industries to incorporate food additives into fresh retail cuts as well as further processed products to hold more water (Xu *et al.*, 2009). Currently, marination is widely used by consumers and producers to improve meat tenderness and juiciness (Whipple and Koohmaraie, 1993). Marination is a significant technology in further processing of muscle foods including poultry. Marination of aged poultry produces juicer, more flavorful poultry products which have higher quality and higher yields (Zheng *et al.*, 1999). Marinades can be acidic or alkaline solutions which includes salt, phosphates, organic acids, tenderizers, sugar, seasonings and flavorings (Parks *et al.*, 2000; Smith and Acton, 2001; Xiong and Kupski, 1999). There are several methods used to marinate meat including immersing the meat in the marinade, injecting and tumbling with a marinade or combination of injecting and tumbling (Bauermeister and McKee, 2005).

The functionality of most marinades are directly depend on of their ingredients. The most common and important ingredients of alkaline marinades are salt and phosphate (Lemos *et al.*, 1999). Sodium chloride has been observed to improve the binding properties of poultry meat by increasing the solubility of the myofibrillar proteins. Polyphosphates have a marked effect on the characteristics of poultry products. They help to stabilize color and flavor (Farr and May, 1970) improve the tenderness of chicken breast (Farr and May, 1970) reduce cooking and frying losses (Brotsky, 1976), improve the water holding capacity and emulsification characteristics of ground meats (Farr and May, 1970), increase darkness proportionally to the amount of phosphate added, increase redness in cooked turkey products (Yang and Chen, 1993) and signifcantly reduce TBA values from chicken meat after 1-3 days refrigerated storage (Brotsky, 1976).

Previous studies have demonstrated the synergistic effect of salt and phosphates on meat to decrease cooking losses, improve texture and enhance water-holding capacity (Froning and Sackett, 1985). Sodium acid pyrophosphate, sodium pyrophosphate, sodium tripolyphosphate, sodium hexametaphosphate or some combinations of them are generally used in meat and poultry marination (Trout and Schmidt, 1983). On the other hand most common ingredients of acidic marinades are organic acid solutions (acetic acid, lactic acid, citric acid, etc.), vinegars, wine or fruit juices (Burke and Monahan, 2003; Lewis and Purslow, 1991; Stanton and Light, 1990). The mechanism of the tenderizing action of acidic marinades is believed to involve several factors including weakening of structures due to swelling of the

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meat, increased proteolysis by cathepsins and increased conversion of collagen to gelatin at low pH during cooking (Berge *et al*., 2001; Offer and Knight, 1988). Many studies have shown that low muscle pH after marination had positive effects on texture and resulted in increased water-binding capacity, moisture content and decreased cooking losses. Many physical properties of meat (including color, texture and firmness of raw meat, juiciness and tenderness of cooked meat) are partially dependent on water holding capacity (Aktas *et al*., 2003; Oreskovich *et al*., 1992; Burke and Monahan, 2003).

The objective of this study was to investigate the effect of two different types of marinade (alkaline or acidic) on the physical, chemical and sensory characteristics of turkey breast meat.

MATERIALS AND METHODS

Raw materials and chemicals: Turkeys processed in a local poultry plant under normal operating conditions were obtained as fully aged and refrigerated cut-up parts as a skinless deboned breast meat placed on ice and transported to the laboratory. Sodiumtripolyphosphate (STPP) were purchased from Sigma/Aldrich (St. Louis, MO), lactic acid from Merck (Darmstadt, Germany) and table salt (NaCl) from a local market.

Marinating process: A modified drum tumbler was used for marination and properties of it were as follows. Tumbler was made of stainless steel which has three baffles, 20 cm diameter, 15 cm depth and 7 L capacity, adjustable speed, worked at atmospheric conditions. Turkey breast meats cut into 150-250 g pieces and were tumbled with different concentrations of alkali or acidic marinades at refrigerated conditions (+4±1°C) for 2 h with alternate 10 min of tumbling followed by 10 min of rest set at 30-35 rpm.

Tumbling of meat with distillated water represent as a control. After tumbling marinated fillets were immediately placed in a plastic filter and waited for 5 min to drain for excess marinade. A marination solution comprised of meat and marinade (1:1) was added to tumbler. Treatments, codes, marinade formula and marinade pH are shown in Table 1.

Table 1: Treatments, codes, marinade formula and marinade pH values

Treatments	Code	Marinade formula	Marinade pH
Phosphate/Control	PC	Distillated water	6.95
Phosphate/Treatment 1	PT1	1% STPP+2% NaCl	8.85
Phosphate/Treatment 2	PT2	2% STPP+2% NaCl	8.97
Phosphate/Treatment 3	PT3	2% STPP+3% NaCl	8.90
Acid/Control	AC	Distillated water	6.95
Acid/Treatment 1	AT1	0.5% lactic acid+2% NaCl	2.40
Acid/Treatment 2	AT2	1% lactic acid+2% NaCl	2.25
Acid/Treatment 3	AT3	0.5% lactic acid+3% NaCl	2.30

Proximate analysis: Moisture and ash content of each treated sample were determined by using AOAC (1990) procedures. Fat content was determined by chloroform-methanol extraction according to Flynn and Bramblett (1975). Protein content (N×6.25) was determined by a modified form of Kjeldahl procedure (Anonymous, 1979).

pH: pH was measured directly using a probe type electrode before and after marination and after cooking according (Landvogt, 1991).

Color: Objective measurement of color lightness (L*), redness (a*), yellowness (b*) was performed at the surface of raw, marinated and cooked meats using a HunterLab spectrocolorimeter (Mini Scan XE, HunterLab Co., USA) equipped with a light source illuminant D65 (10° standard observer). Before each measurement, the apparatus was standardized against a black and white tile. Five readings were taken for each treatment.

Weight changes: Marinade absorption, drip loss, cooking loss and yield were calculated as (Young and Buhr, 2000):

$$\text{Absorption} = 100\times(wt_m - wt_i)/wt_i$$
$$\text{Drip loss} = 100\times(wt_m - wt_d)/wt_m$$
$$\text{Cooking loss} = 100\times(wt_d - wt_c)/wt_d$$
$$\text{Yield} = 100\times(wt_c/wt_i)$$

wt_I = Initial weight
wt_m = Marinated weight
wt_d = Weight after dripping
wt_c = Cooked weight

Cooking: Marinated meats were covered with aluminum foil and than cooked in 180°C conventional oven for 35 min which determined by a preliminary study to ensure an internal temperature of 80°C. After cooking, samples were cooled at room temperature for 1 h and then analyzed for sensory and textural (shear values) properties.

Shear force: Meat tenderness was evaluated by shear force using a TA-XT2 texture analyzer (Stable Micro Systems, UK) with muscular fibers almost parallel to the force direction as it normally occurs during chewing. For texture assessment by using a 19 mm round sample probe, a piece removed from the thickest part of the muscle. Then has a 10 mm thickness parts cut by a sharp knife from this sample part.

The test cell consisted of a 3 mm thick steel blade which had a 73°V cut into its lower edge as it called Warner-Bratzler blade and was fitted through a 4 mm wide slit in a small table. The meat sample to test was placed on the table, under the V blade and was cut through as the blade down with a constant speed through the slit of the table (assay parameters were: pre-test speed: 3.0 mm sec^{-1}; test speed: 1.0 mm sec^{-1}; post test speed: 3.0 mm sec^{-1}; cell load: 25 kg; sensivity: 0.1 g). Down stroke, distance was between 25 and 35 mm as the probe should cut meat completely. The resistance of the meat sample to shearing was recorded every 0.01 sec and plotted by a computer in a force deformation plot. The parameter recorded was the maximum shear force results have been expressed as shear force (De Huidobro *et al*., 2005). Each sample was assessed 6 times.

Sensory evaluation: Sensory evaluations of marinated meats were conducted using a semi-trained panel of panelists. Panelists were recruited from students in the Department of Food Engineering, the University of Pamukkale. Panelists were trained in three sessions before the tests. In the first session panelists were reached a consensus rating for four basic flavor (saltiness, bitterness or soapiness, sweetness and sourness) and tenderness with reference sample scale. In the second session were given the definition and examples of descriptive tests and point scales to the panelists. In the last session cooked breast meat without marination were given as a standard reference to calibrate panelist's judgments, evaluated the test samples and compared the responses for consensus intensity ratings. The reference score was established after evaluation and discussion by the panelists.

For sensory evaluation, marinated meats were cooked as previously described and cut into 2×2×2 cm cubes and keep worm until served. Samples from each treatment were randomly pooled and placed in a three digit coded cup. Tenderness, juiciness, saltiness, sourness (for acid marination), soapiness (for alkali marination), aroma and overall acceptance evaluated giving scores of 1-7.

Statistical analysis: All the analysis were performed in triplicate. Results were expressed as means±standard deviation. The data was analyzed by one-way ANOVA using the Minitab software version 13.0 (Minitab, 2000). Differences between means were detected by ANOVA by multiple comparisons using the Least Significant Difference (LSD) test ($p<0.05$).

RESULTS AND DISCUSSION

Proximate composition: Mean percentages of moisture, protein, fat and ash content of the acid and phosphate marinated products are shown in Table 2. Both for the alkaline and acidic marination, moisture and ash values were significantly higher ($p<0.05$), protein and fat values were significantly lower ($p<0.05$) in treatment groups than control group.

The increasing in moisture content of phosphate treated groups (77.04-82.50) were higher than acid treated groups (77.06-78.42). Similarly, uses of alkaline marinades with poultry meats are increased moisture and decreased protein percentages of treatment groups (Lyon, 1983; Lyon and Magee, 1984). Aktas *et al*. (2003) found similar changes of moisture percentages in marinated beef meats with organic acids.

pH changes: The pH values of acidic and alkaline marinated meats before marination after marination and after cooking are shown in Table 3. The uses of alkaline phosphate caused to increase meat pH significantly ($p<0.05$) and this led to increase water binding properties of meat via increasing ionic strength and interacting with actomyosin. At pH values above or below the meat isoelectric point the water binding properties of meat increases (Wong, 1989). The highest increment was observed in P T2 (5.99-6.35) and this led to highest

Table 2: Proximate composition of phosphate and acid marinated turkey breast meat

Phosphate marination					Acid marination				
Codes	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Codes	Moisture (%)	Protein (%)	Fat (%)	Ash (%)
PC	77.04 ± 0.05^{c}	20.17 ± 0.02^{a}	1.70 ± 0.05^{a}	0.76 ± 0.03^{c}	AC	77.06 ± 0.03^{d}	18.67 ± 0.06^{a}	2.30 ± 0.13^{a}	1.16 ± 0.05^{b}
PT1	81.50 ± 0.05^{b}	16.42 ± 0.02^{b}	1.55 ± 0.05^{b}	0.85 ± 0.01^{b}	AT1	78.02 ± 0.02^{b}	18.06 ± 0.03^{b}	2.01 ± 0.07^{b}	1.28 ± 0.07^{ab}
PT2	82.40 ± 0.09^{a}	15.14 ± 0.02^{c}	1.30 ± 0.05^{c}	0.97 ± 0.01^{a}	AT2	77.73 ± 0.06^{c}	18.24 ± 0.12^{b}	2.26 ± 0.07^{ab}	1.39 ± 0.03^{a}
PT3	82.50 ± 0.05^{a}	15.03 ± 0.03^{c}	1.30 ± 0.05^{c}	0.89 ± 0.03^{b}	AT3	78.42 ± 0.02^{a}	17.80 ± 0.05^{c}	2.13 ± 0.12^{ab}	1.20 ± 0.05^{b}

Means (± standard deviation) within same column with different letters (a-c) are significantly different ($p<0.05$)

Table 3: pH values of phosphate and acid marinated turkey breast meat before marination after marination and after cooking

Phosphate marination				Acid marination			
Codes	Before marination (%)	After marination (%)	After cooking (%)	Codes	Before marination (%)	After marination (%)	After cooking (%)
PC	6.12 ± 0.02^{a}	6.18 ± 0.02^{b}	6.42 ± 0.02^{a}	AC	6.10 ± 0.02^{a}	6.14 ± 0.03^{a}	6.23 ± 0.02^{a}
PT1	6.08 ± 0.04^{ab}	6.23 ± 0.04^{b}	6.29 ± 0.02^{b}	AT1	6.02 ± 0.02^{bc}	4.65 ± 0.01^{c}	5.98 ± 0.01^{c}
PT2	5.99 ± 0.02^{bc}	6.35 ± 0.02^{a}	6.45 ± 0.02^{a}	AT2	6.04 ± 0.01^{b}	4.81 ± 0.01^{b}	6.02 ± 0.02^{b}
PT3	5.27 ± 0.08^{c}	6.20 ± 0.07^{b}	6.35 ± 0.04^{b}	AT3	5.98 ± 0.01^{c}	4.63 ± 0.02^{c}	5.90 ± 0.02^{d}

Means (±standard deviation) within same column with different letters (a-d) are significantly different ($p<0.05$)

marinade absorption (Table 4). Sheard and Tali (2004) reported phosphate and bicarbonate alone or in combination, increased the pH of pork meat. Similar increases in pH have been reported by others for alkaline phosphates (Baublits *et al*., 2005; Murphy and Zerby, 2004; Wynveen *et al*., 2001).

Lactic acid significantly decreased ($p<0.05$) the pH of turkey meat due to increased concentration in comparison to control (Table 3). Aktas *et al*. (2003) reported that when compared to citric acid, samples marinated with lactic acid had lower pH values because of lactic acid had lower pKa value.

It is obvious that to obtain lower pH values below the isoelectric point especially <4.6 can cause positive effect on meat texture (Gault, 1985). In this study, the uses of lactic acid at low concentrations did not ensure pH values below 4.6 and it is not effective to improve tenderness as expected (Table 4).

The increase in pH value of cooked meat is probably caused by a reduction in available carboxylic groups on proteins and also through the liberation of calcium and magnesium ions from proteins as proposed by Medynski *et al*. (2000).

Color: Instrumental color values of unmarinated, marinated and cooked meat for alkaline and acid treatments are shown in Table 4 and 5, respectively.

According to Table 4, tumbling with phosphate and salt did not change L* values of turkey meats except control. Similar results were found by Carroll *et al*. (2007). However, cooking increased L* values (lightness) due to protein denaturation. In Table 5, lactic acid treatments significantly increased L* values of meats. This result can be related to denaturation of myoglobin by organic acids due to decreased pH. For both of alkaline and acid marinated groups a* color values significantly decreased after tumbling (Table 4 and 5). These data conflicted with the findings of Yang and Chen (1993) in which lower lightness and higher redness values of broiler breast fillets were found after marination with 1 and 2% trisodium phosphate. After cooking a* values increased again for acid marination and decreased for alkaline marination. Although, tumbling with phosphate significantly increased b* values but tumbling with acids had no effects on b* values of meat. Contrary to Allen *et al*. (1998) found that significant decreases for b* values after marination in which they used STPP and NaCl for marinating broiler meats. Also after cooking b* values of meats for both marinade type were increased significantly ($p<0.05$). Similar results were obtained by Aktas and Kaya (2001).

Weight changes and shear values: Marinade absorption, drip loss, cooking loss, yield and shear values are shown Table 6. When measuring moisture absorption, cooking

Table 4: Color values of phosphate marinated turkey breast meat before marination, after marination and after cooking

	L* values			a* values			b* values		
Codes	Before marination	After marination	After cooking	Before marination	After marination	After cooking	Before marination	After marination	After cooking
PC	45.83±3.02^{aB}	56.68±2.67^{aA}	58.23±0.68^{aA}	3.97±1.89^{aA}	2.37±0.99^{aB}	1.15±0.66^{aC}	11.20±2.62^{aB}	12.96±0.49^{aB}	15.88±2.60^{aA}
PT1	46.25±4.38^{aB}	46.42±2.65^{bB}	62.66±1.95^{aA}	3.95±1.69^{aA}	2.81±0.52^{aB}	0.44±0.27^{aC}	10.13±2.93^{aB}	10.45±1.40^{abB}	14.22±0.88^{aA}
PT2	43.49±6.94^{aB}	47.20±1.60^{bB}	59.03±3.25^{aA}	4.48±2.53^{aA}	1.74±1.63^{aB}	1.63±1.62^{aB}	11.79±1.76^{aB}	8.74±1.59^{bC}	17.46±2.38^{aA}
PT3	44.31±5.50^{aB}	47.22±3.73^{bB}	62.30±1.40^{aA}	3.70±1.43^{aA}	2.62±0.56^{aB}	0.32±1.16^{aC}	11.38±1.20^{aB}	9.65±0.93^{bC}	15.24±1.28^{aA}

Means (±standard deviation) within same column with different letters (a-c) are significantly different ($p<0.05$); Means (±standard deviation) within same row between groups with different letters (A-C) are significantly different ($p<0.05$)

Table 5: Color values of acid marinated turkey breast meat before marination after marination and after cooking

	L* values			a* values			b* values		
Codes	Before marination	After marination	After cooking	Before marination	After marination	After cooking	Before marination	After marination	After cooking
AC	43.39±0.69^{aB}	54.91±2.90^{aA}	56.28±0.40^{aA}	3.39±0.67^{aA}	0.82±0.33^{aC}	2.67±0.55^{aB}	9.53±0.37^{aC}	10.91±0.63^{aB}	17.38±1.82^{aA}
AT1	44.90±3.80^{aB}	59.66±3.97^{aA}	58.45±0.95^{aA}	3.09±0.31^{aA}	1.12±0.96^{aC}	2.18±0.90^{aB}	8.38±2.04^{aB}	9.08±1.94^{aB}	18.64±3.30^{aA}
AT2	43.48±1.34^{aC}	61.00±4.62^{aA}	55.09±1.61^{aB}	3.36±0.59^{aA}	0.67±0.12^{aC}	2.02±1.49^{aB}	10.62±0.73^{aB}	9.75±1.05^{aB}	16.60±2.36^{aA}
AT3	42.72±1.36^{aB}	55.49±3.48^{aA}	56.59±3.70^{aA}	3.55±1.11^{aA}	1.82±1.51^{aB}	1.83±0.74^{aB}	10.16±1.16^{aB}	9.87±0.60^{aB}	17.64±1.17^{aA}

Means (±standard deviation) within same column with different letters (a-c) are significantly different ($p<0.05$). Means (±standard deviation) within same row between groups with different letters (A-C) are significantly different ($p<0.05$)

Table 6: Effects of phosphate and acid marination on the marinade absorption, drip loss, cooking loss, yield and shear force of the turkey breast meat

Phosphate marination						Acid marination					
Codes	Marinade absorption (%)	Drip loss (%)	Cooking loss (%)	Yield (%)	Shear force (N)	Codes	Marinade absorption (%)	Drip loss (%)	Cooking loss (%)	Yield (%)	Shear force (N)
PC	21.52±7.67^{b}	5.33±0.31^{a}	50.98±4.65^{a}	58.41±8.33^{b}	24.16±0.11^{a}	AC	13.84±0.99^{b}	4.27±2.08^{a}	47.97±2.24^{a}	66.35±4.63^{a}	28.24±0.07^{a}
PT1	27.14±7.21^{b}	4.37±0.86^{a}	41.69±5.55^{ab}	73.29±6.18^{ab}	17.06±0.36^{ab}	AT1	15.45±2.72^{ab}	3.04±0.03^{a}	42.89±1.84^{b}	60.42±4.34^{a}	23.76±0.48^{ab}
PT2	39.93±7.26^{a}	3.87±0.54^{a}	38.36±1.99^{ab}	83.40±10.91^{a}	14.71±0.43^{bc}	AT2	17.70±0.40^{ab}	4.14±0.78^{a}	47.16±0.69^{ab}	59.60±0.46^{a}	26.86±0.50^{a}
PT3	37.26±9.11^{a}	4.14±0.52^{a}	33.89±7.43^{b}	84.53±9.98^{a}	9.16±0.17^{c}	AT3	22.26±3.86^{a}	4.34±0.42^{a}	47.21±2.73^{ab}	61.67±1.46^{a}	17.59±0.09^{b}

Means (±standard deviation) within same column with different letters (a-c) are significantly different ($p<0.05$)

loss and yield values for alkali marination, a significant difference ($p<0.05$) was found between all treatment groups when compared to control groups. However, no significant differences were between treatments as drip loss values ($p>0.05$). This result is in contrast to previous studies (Reddy and Narahari, 1990; Young and Buhr, 2000). To obtain for higher marinade absorption and lower cooking loss values 2% phosphate plus 2% salt content would be recommended. As a result, salt and phosphate together show synergistic effects on weight changes. As has been widely reported previously (Farr and May, 1970; Mahon, 1962; Trout and Schmidt, 1984; Young and Lyon, 1986; Young *et al*., 1987), the STPP treatment significantly increased marinade absorption and decreased cooking losses. In contrast Trout and Schmidt (1984) reported increased cook yields by increasing levels of sodium chloride from 0.95-1.65% with a constant level of STPP or by increasing STPP levels at a constant sodium chloride level. For acidic marination, concentration of acid had significant ($p<0.05$) effect on marinade absorption and cooking loss (Table 4). Gault (1984) observed similar effects to the results using acetic acid as tenderizing agent. There are no significant differences between treatments as drip loss and yield values ($p>0.05$). Burke and Monahan (2003) evaluated three different organic acids (acetic, lactic and citric) and they showed that citric acid was more effective as a tenderizing agent than acetic or lactic acid.

The water binding of proteins is better below or above the isoelectric point (approximately pH 5.2). Marination should make the meat remain juicy. When compared together with alkali and acidic marination for weight changes the uses of phosphate had relatively good results to lactic acid.

Polyphosphate and salt combinations, regardless of concentration, significantly reduced shear values ($p<0.05$) when compared to controls (Table 4). Similarly many studies have shown decreased shear force values when phosphate-based solutions were incorporated into meat (Vote *et al*., 2000; Zheng *et al*., 2000). These results would suggest that tumbling of meat with STPP and sodium chloride significantly decreases shear values. Acid marinated meat had lower shear values (more tender) than untreated meat. Several researchers have reported improved sensory tenderness in association with a decrease in shear force values in meats due to marination with food acids (Wenham and Locker, 1976; Gault, 1985; Gault, 1991; Seuss and Martin, 1993). According to Offer and Knight (1988), one proposed mechanism for the tenderizing effect of acidic marinades is that the swelling of muscle fibers and connective tissue dilutes out the amount of load-resisting material so that tenderness and swelling reach a maximum under the same conditions.

Sensory properties: Sensory evaluation results of alkali and acid marinated turkey meats are shown in Table 7. The increased concentration of phosphate and salt did not affect the sensorial tenderness and juiciness scores ($p>0.05$). This result is contrast to instrumental shear force values (Table 6). Although, it is expected significant differences among treatments with tenderness and juiciness scores but it is not realized. This result may be related to lack of sensitivity to tenderness and juiciness. Similarly, Toledo utilizing poultry meats found no significant differences in tenderness and juiciness between treatments. The uses of phosphate and salt did not affect saltiness and soapiness scores of turkey breast meats. However, there were significant differences ($p<0.05$) for flavor and overall acceptance among treatments according to control.

For acid marination there were significant differences ($p<0.05$) for tenderness score. Berge *et al*. (2001) found similar results as the investigations which they applied lactic acid injection to beef meat. The use of lactic acid did not change juiciness score of meat. This can be related the more water release among treatments during cooking. There were significant differences ($p<0.05$) for saltiness and sourness scores depend on increased acid and salt concentration. Acidic marination affected the flavor and overall acceptance according to control. It seems the most efficient combination for acidic marination is 0.5% lactic acid plus 3% salt. When compared acid and alkali marination for sensory scores alkali marinated meats seems more preferable than acid marinated meats. Scanga *et al*. (2000) reported that beef steaks marinated with calcium chloride, phosphate and beef flavoring had

Table 7: Effects of phosphate and acid marination on sensory properties of turkey breast meat*

	Phosphate marination							Acid marination					
Codes	Tenderness	Juiciness	Saltiness	Soapiness	Flavor	Overall acceptance	Codes	Tenderness	Juiciness	Saltiness	Sourness	Flavor	Overall acceptance
PC	3.22±0.29^{a}	3.14±0.17^{a}	5.33±0.11^{a}	5.51±0.22^{a}	3.29±0.06^{b}	3.48±0.57^{b}	AC	3.57±0.19^{ab}	3.42±0.18^{a}	5.60±0.25^{a}	5.19±0.06^{a}	2.80±0.06^{b}	3.05±0.06^{c}
PT1	3.9±0.286^{a}	3.84±0.06^{a}	4.55±0.55^{a}	5.44±0.33^{a}	4.07±0.35^{a}	4.59±0.55^{a}	AT1	3.04±0.31^{b}	3.50±0.25^{a}	4.60±0.25^{ab}	4.45±0.18^{c}	3.94±0.27^{a}	3.81±0.19^{ab}
PT2	4.36±0.45^{a}	4.44±0.39^{a}	4.40±0.25^{a}	5.21±0.40^{a}	4.44±0.22^{a}	4.70±0.25^{a}	AT2	3.25±0.25^{ab}	4.06±0.75^{a}	4.72±0.44^{ab}	4.06±0.06^{d}	3.80±0.06^{a}	3.61±0.34^{b}
PT3	4.47±0.89^{a}	4.18±1.02^{a}	4.03±0.81^{a}	5.22±0.19^{a}	4.58±0.12^{a}	4.55±0.22^{a}	AT3	3.75±0.01^{a}	3.91±0.75^{a}	4.41±0.64^{b}	4.80±0.06^{b}	3.75±0.01^{a}	4.12±0.01^{a}

Means (±standard deviation) within same column with different letters (a-d) are significantly different ($p<0.05$); *Intensity scales, Tenderness: 1 = Extremely tough, 7 = Extremely tender;Juiciness: 1 = Extremely dry, 7 = Extremely juicy; Saltiness: 7 = Not at all salty, 1 = Very salty; Soapiness: 7 = Not at all soapy, 1 = Very soapy; Sourness: 7 = Not at all Sour, 1 = Very Sour; Flavor: 1 = Slight flavor, 7 = Strong flavorOverall acceptance: 1 = Dislike extremely, 7 = Like extremely higher consumer ratings than controls. Finally it can be suggest 2% STPP plus 2% salt for alkali marination and 0.5% lactic acid plus 3% salt combinations for acid marination.

CONCLUSION

Results of the present study indicate that different types of marinade affected the chemical and physical properties of turkey meat. Particularly changes in pH values above or below isoelectric point, marination improved instrumental tenderness, cooking loss, yield and some of sensory properties (saltiness, sourness and flavor). When compared alkali and acid marination, alkali marinated meats have some better results according to acid marination.

ACKNOWLEDGEMENT

This research was part of a (FBE20031) funded by University of Pamukkale Scientific Researches Unit.

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