INTRODUCTION

Poultry meat is one of the first choices in the American diet. Most consumers purchase fresh chicken breast fillets and freeze them at home for extended shelf-life. A survey performed by Market Force Information to 3,378 consumers in 2010 indicated that 83% of consumers purchase fresh chicken in a 2-mo period and 86% buy fresh chicken from the meat department at the grocery (Flink, 2010). Consumer trends in the consumption of chicken products have also changed over the time. Preference has changes from purchasing poultry as whole carcasses toward purchasing it as boneless meat (Saha et al., 2009). Boneless, skinless breast is the part of the chicken most preferred by consumers with an increase from 59% in 2001 to 65% in 2006 (National Chicken Council, 2006).

Consumption of chicken products may be influenced by the appearance of the bulk-buying phenomenon through which more than 9 of 10 warehouse club store shoppers purchase fresh/frozen meat, poultry, or seafood (ConAgra Foods, 2005). Consumers are interested in individual packages (53% of consumers; Flink, 2010), which allow them to keep fresh only the portion needed and freeze the rest in small portion sizes. As well, 27 percent prefer smaller portion in packages (Flink, 2010).

Freezing is a popular and easy way to extend shelf-life at home. According to USDA (2010), uncooked parts and whole birds can be stored frozen up to 9 and 12 mo, respectively. However, poultry meat quality can be affected by freezing over the time, and the initial quality of the meat must be high to maintain freshness. Freezing rates and the size of the ice crystal influence the extent of damage in meat texture (Alarcon-Rojo and Janacua-Vidales, 2010), and it is recommended to

ABSTRACT Different packaging is available to consumers, and marination is widely applied. However, their effects on the quality of broiler breast fillets during home freezing are not well known to consumers. Therefore, the objective of this study was to evaluate the effect of packaging materials on the quality of chicken breast fillets after 1, 3, and 6 wk storage at −18°C. A total of 256 fillet were randomly placed in tray packs, freezer bags, butcher paper, and nonpackaged controls. Samples were analyzed for raw pH, color, percent moisture content, and TBA reactive substances (TBARS) at d 0 (only nonpackaged controls), wk 1, 3, and 6, and cooked texture and sensory attributes at wk 1 and 6. There were differences ($P < 0.05$) in pH, color, percent moisture content, and texture among the treatments by wk 6, but no differences ($P < 0.05$) in TBARS values and the sensory evaluation (tenderness, juiciness, and overall flavor) were seen. Consumers were not able to detect quality differences ($P < 0.05$) among treatments despite analytical differences. Experiment 2 was conducted to evaluate the effects of marination on the quality of chicken breast fillets after 2 wk of storage in a home freezer ($−18°C$). A total of 240 fillets were used in the treatments: nonmarinated fresh nonfrozen, nonmarinated frozen, marinated fresh nonfrozen, and marinated frozen. Fillets were vacuum-tumbled in a 10% solution yielding a final concentration of 0.45% sodium tripolyphosphate and 0.65% salt in the meat. Raw samples were evaluated for color, TBARS, and thaw loss. Cooked samples after 2 wk of storage were analyzed for cook loss, texture, moisture, and sensory evaluation (color, juiciness, tenderness, overall flavor, and preference). Both marinated samples showed better ($P < 0.05$) quality in terms of L* value, TBARS, cook loss, texture, moisture content, and better sensory attributes (except color) than nonmarinated samples. Quality of marinated samples was not negatively affected by home freezing after 2 wk.

Key words: marination, texture, breast fillet, home freezing, packaging

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freeze chicken at home at 0°F (−18°C) as fast as possible to maintain its quality (USDA, 2010).

Packaging is used for keeping the freshness of poultry meat during display in retail stores and storage. Proper packaging is an important point to be considered when freezing poultry products for maintenance of textural properties. Retail store packaging (tray pack; TP) is usually air permeable; thus, the use of other materials [airtight heavy-duty foil, plastic wrap or freezer/butcher paper (BP), or freezer bag (FB)] is recommended before freezing to prevent moisture loss and freezer burn (USDA, 2010). A typical retail TP overwrap for chicken has barrier properties of 2.6 g/100 in²/24 h at 100% RH for water vapor transmission and 13,800 cc³/m²/24 h at 0% RH for oxygen transmission at 0.75 mil thickness (Cryovac, Sealed Air Corporation, Duncan, SC). Ziploc heavy-duty freezer bags (DowBrands L.P. Chemical Co., Indianapolis, IN), which were made of high density polyethylene that has steady state transmission rates for water and oxygen of 1.0 to 1.5 g/100 in²/24 h at 100% RH and 17,000 cc³/m²/24 h at 0% RH, respectively, at 2 mil thickness. There is very little information about butcher paper and the barrier properties associated with it; however, it is estimated to be similar to a low-density polyethylene, which has a water vapor transmission rate of 2.0 to 2.5 g/100 in²/24 h at 100% RH at 2 mil thickness. These barrier properties would indicate that the butcher paper has slightly higher barrier properties than overwrap and lower barrier properties than FB.

Marination is another practice in the poultry industry. Marination produces juicier, more flavorful poultry products that have higher quality and higher yields (Zheng et al., 1999). Marinades commonly are prepared with water, phosphates, and salt. Sodium tripolyphosphate (STP) is one of the most commonly used phosphates (Zheng et al., 2000). This alkaline phosphate helps in protein extraction, increases water-holding capacity (WHC), and retards oxidative rancidity (Keeton, 2001). Sodium chloride, or salt, has a prooxidant effect in meat and meat products depending on its concentration (Rhee and Ziprin, 2001). The salt acts as a synergist with STP increasing WHC by protein extraction (Keeton, 2001). The increase in WHC results in a reduction of cook loss, increase of tenderness and juiciness of the meat product (Desmond, 2006), as well as moisture retention (Young et al., 1987).

Some studies (Yoon, 2002; Galobart and Moran, 2004; Lee et al., 2008) have researched changes on textural properties of chicken breast fillets, with or without enhancement (by dipping in salt and phosphate solutions) and long-term frozen storage (up to 8 mo) in commercial freezers, but no studies have been conducted mimicking real consumer conditions, which include home-packaging and home-freezing of fresh or enhanced chicken meat in short-term frozen storage. This study evaluates the effects of packaging materials and marination on the quality of home-frozen breast fillets.

**MATERIALS AND METHODS**

**Experiment 1**

Fresh boneless and skinless chicken breast fillets deboned at 6 h PM were obtained from a local processing plant at 24 h postmortem (PM) and stored at 4°C before the experiment. A total of 256 fillets were used in 2 trials with 3 replications each. The following treatments were used: TP, FB, BP, and nonpackaged controls (NP). The TP consisted of fillets placed in polystyrene trays sealed with a plastic wrap; FB consisted of fillets packed in quart-size heavy-duty Ziploc freezer bags and sealed; and BP consisted of fillets wrapped in nonwax butcher paper. Controls (NP) consisted of one set of fillets that was used allowing the textural properties of the other treatments to be compared at each time point with those of the corresponding fresh samples (fresh, nonpackaged, nonstored) at d 0. Chicken breast fillets were randomly distributed among the treatments. All packed fillets were subsequently placed in a regular home-freezer (Upright Freezer Model 253.28062801, Kenmore, Sears, Roebuck and Co., Hoffman Estates, IL) set at −18°C for 6 wk.

At each storage time, frozen breast fillets were thawed for 48 h at 4°C prior analysis. Raw fillet samples from TP, BP, and FB treatments were analyzed for pH, color, moisture content, and TBA reactive substances (TBARS) at wk 1, 3, and 6. These time points were chosen because poor quality can begin to develop within 4 to 6 wk of freezing especially in packages with increased space and free moisture present (nonvacuum packages). The NP was evaluated for the same parameters on d 0. The pH values were monitored using the piercing probe method (pH 05-SS, IQ-200 Scientific Instruments Inc., San Diego, CA); color was determined for L*, a*, and b* values (Minolta Chroma Meter Model CR-400, Minolta Corp., Ramsey, NJ); moisture content (%) was determined by the AOAC Official Method 950.46 and 934.01 (AOAC International, 1996); and TBARS was determined according to a rapid direct colorimetric/extraction procedure (Spanier and Traylor, 1991).

Texture was analyzed at wk 1 and 6 for all the packaged samples. Fillets were cooked in an air-convection oven (Blodgett Zephyr G-1 speed, Blodgett Oven Co., Burlington, VT) to an internal end-point temperature of 72°C. Following cooking, fillets were cooled to room temperature for 1 h, individually wrapped in aluminum foil, labeled, and stored overnight at 4°C for texture analysis. Allo-Kramer shear value was determined using an Instron Universal Testing Machine (Instron 5542, Instron, Grove City, PA) equipped with a 10-blade Kramer shear compression cell according to Sams (1990).

Sensory evaluation of the breast fillets was conducted after cooking. Cooking of fillets was performed as described above. Juiciness, tenderness, and overall flavor
were the sensory attributes evaluated on cooked breast fillets at wk 1 and 6. Sixty-six consumers were recruited from the community by poster advertisement and personal contact to perform a consumer testing at wk 1 and 30 consumers at wk 6 (Prell, 1976). The tests were conducted in controlled lighting and positive airflow sensory rooms for evaluating one treatment at the time. Each consumer was provided with samples consisted of three 1.25-cm² warm cubes of breast fillets that were identified by a random 3-digit code (Meilgaard et al., 1999). Unsalted crackers and distilled water at room temperature were also provided for palate cleansing between samples. Treatment order per panelist was randomized. The untrained panel was given a ballot and was asked to evaluate the samples for tenderness, juiciness, and overall flavor on a 9-point hedonic scale with 1 = dislike extremely and 9 = like extremely.

Experiment 2

A total of 240 fresh chicken breast fillets deboned 6 h PM were obtained from a local processor at 24 h PM. The 4 treatments used were nonmarinated nonfrozen (NM-NF), nonmarinated frozen (NM-F), marinated nonfrozen (M-NF), and marinated frozen (M-F). Fillets were marinated using a 10% solution yielding a final concentration of 0.48% STP and 0.75% salt in the meat as per industry standard. Marination of fillets was conducted in a vacuum tumbler (model HVI 30, Hollymatic Corp., Countryside, IL) set at 25 mmHg pressure, 14 rpm, 30 min, 4°C. Marinated and nonmarinated samples, subjected to frozen storage, were randomly placed in heavy-duty freezer bags (17.7 cm × 19.5 cm, quart size, Ziploc) and stored at −18°C in a home freezer (Upright Freezer Model 253.28062801, Kenmore, Sears, Roebuck and Co.). Nonfrozen samples consisted of marinated and nonmarinated controls prepared at the end of the frozen storage for immediate evaluation.

At the end of the storage period, samples from the frozen treatments were thawed for 48 h at 4°C, weighed, and compared with the nonfrozen treatments. Raw samples were analyzed for color L* value (Minolta Chroma Meter Model CR-200, Minolta Corp., Ramsey, NJ), TBARS according to the procedure indicated by Spanier and Traylor (1991). Percent pick-up and thaw loss (%) were calculated. Percent pick-up was determined as the percentage of the weight gain after marination from all marinated fillets, whereas thaw loss was calculated based on the weight loss after thawing. At wk 2, chicken breast fillets were cooked in an air-convection oven (Blodgett Zephaire G-1 speed, Blodgett Oven Co., Burlington, VT) to an internal temperature of 72°C. Cook loss was calculated as a percentage of the original uncooked weight. Shear value was measured by the Meullenet-Owens razor shear (MORS) method (Cavitt et al., 2004). Moisture content (%) of cooked fillets was evaluated by the AOAC Official Method 950.46 and 934.01 (AOAC International, 1996).

Seventy-four consumers were recruited from the community to perform consumer testing at wk 2. Recruiting of panelists and preparation of samples was performed as described in experiment 1. The 4 treatments were presented simultaneously and consumers were asked to assign a ranking of their preference. Three 1.25-cm² cubes of chicken breast per treatment were provided to consumers during the evaluation so, if required subjects, could come back and taste the sample a second time. Serving order was randomized and indicated by a 3-digit numerical code per sample. Color, juiciness, tenderness, overall flavor, and preference were evaluated by an untrained panel with a ranking scale as follows: flavor attributes, 1 = least intensity and 4 = most intensity; preference, 1 = most preferred, 4 = least preferred; tenderness, 1 = most tender, 4 = least tender.

All data were subjected to ANOVA using the GLM procedure of SAS (SAS Institute, 1990), and the means were separated using Duncan’s multiple range test with a significance level of P < 0.05 (SAS Institute, 1990). Because no significant trial × treatment or replication × treatment interactions were detected in any parameter measured, the data were pooled by treatment.

RESULTS AND DISCUSSION

Experiment 1

The L*, a*, and b* represent the lightness, redness, and yellowness of chicken breast fillets, respectively. The NP fillets that correspond to fresh samples had higher (P < 0.05) L* values compared with TP and BP by wk 1 (Table 1). By wk 3, there were no differences among the treatments. However, by wk 6, there were differences (P < 0.05) among all the treatments with NP (control) as the treatment with highest L* and BP as the one with the lowest L* value. The 3 packaging treatments were darker than the control at the end of the storage time (wk 6). This darkness could be due to dehydration of the meat from freezer burn. A decrease in lightness in breast fillets over frozen storage (6 mo) was also observed by Lee et al. (2008); however, these samples were vacuum sealed and frozen in a blast freezer (−28°C) prior to being placed in a freezer at −18°C. A combined effect of freezing and packaging may affect the color (L*) of chicken samples. Freezing results in concentration of solutes (George, 1993; Sebranek, 1996), and dehydration or water loss can be expected (George, 1993). Because color measurement is based on reflectance colorimetry, these physical changes in frozen meat could lead to color differences between control (fresh sample) and the remaining treatments. In addition, even though these packaging properties differed in barrier properties, there was still oxygen and water vapor transmission occurring over the 6-wk storage time. Therefore, quality is expected to decrease in objective measurements. However, it is important to note that though there were significant differences in color within treatment and a trend of decreasing L* value over time,
these differences were not enough to be observed by consumers (Table 5).

The pH is one of the main indicators of quality in poultry meat (Carroll and Alvarado, 2008; Owens et al., 2009). There were no differences ($P < 0.05$) in pH through wk 3 among TP, FB, and BP (Table 1). However, compared with NP, BP and FB presented higher ($P < 0.05$) pH values. Low pH values have been associated with paleness of meat products resulting from the extensive protein denaturation due to rapid metabolism early PM. By the wk 6, the pH was higher ($P < 0.05$) for both FB and TP treatments compared with BP and NP (control). The pH values obtained for the 4 treatments in this study were within or closer to the pH range provided by Gorsuch and Alvarado (2010) for normal fillets, 5.95 to 6.18. Even though there were differences ($P < 0.05$) in pH among the treatments, these changes were not enough to negatively affect the meat quality of the samples as may be perceived as color and WHC.

The control sample, NP, had a significantly higher value of moisture compared with the BP treatment in the 3 storage times (Table 1). By wk 3, NP and FB treatments showed higher values than the other 2 packaging treatments. This difference could be due to the high water transmission barrier properties of the FB compared with the TP. However, by wk 6, the 3 packaging treatments presented lower ($P < 0.05$) values of moisture content compared with NP. These results showed that even though packaging method can minimize moisture loss, some loss is still expected possibly due to ice crystal formation in muscle during freezing, which is associated with lower WHC (Yoon, 2002). Likewise, home freezers have a quick freeze option that may reduce the formation of larger ice crystals; however, they are not able to replicate fast freezing as commercial blast freezers.

Poultry meat is susceptible to oxidation because of high unsaturated lipid content. Food scientists use TBARS as a method for estimating lipid peroxidation in food. During the third week, TBARS corresponding to BP and TP decreased, whereas TBARS for FB increased (Table 1). However, there were no significant differences ($P < 0.05$) in TBARS among the treatments by wk 6. Some studies have reported significant increases in TBARS, in breast meat, between d 0, mo 3, and mo 6 (Soyer et al., 2010), significantly higher malondialdehyde (MDA) equivalents in chicken breast resulted at $-18^\circ$C for 6 mo (Pikul et al., 1984), and higher MDA concentrations were found at 13 mo (Igene et al., 1979). In the current study, 6 wk of frozen storage were not sufficient time to result in significantly higher lipid oxidation in chicken fillets as breasts are known for possessing lower fat content.

The shear force values for wk 1 and 6 (Table 2) were determined by the Allo-Kramer method. These results indicated that there were differences ($P < 0.05$) among the 3 packaging treatments in wk 1 and 6. In both storage times, TP treatment was the toughest (highest

<table>
<thead>
<tr>
<th>Parameter measured</th>
<th>Wk 1</th>
<th>Wk 3</th>
<th>Wk 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>6.06a</td>
<td>6.10a</td>
<td>6.14a</td>
</tr>
<tr>
<td>L*</td>
<td>58.96a</td>
<td>59.99a</td>
<td>60.83a</td>
</tr>
<tr>
<td>a*</td>
<td>2.07a</td>
<td>2.10a</td>
<td>2.12a</td>
</tr>
<tr>
<td>b*</td>
<td>4.72a</td>
<td>5.01a</td>
<td>5.03a</td>
</tr>
<tr>
<td>Moisture (%)</td>
<td>75.74a</td>
<td>75.26a</td>
<td>75.85a</td>
</tr>
<tr>
<td>TBARS (MDA, eq/kg)</td>
<td>2.44a</td>
<td>1.51a</td>
<td>1.43a</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Wk 1</th>
<th>Wk 3</th>
<th>Wk 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>NP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FB</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1NP = nonpackaged; TP = tray pack; BP = butcher paper; FB = freezer bag.
2n (pH, L*, a*, b*) = 12; n (Moisture, TBARS) = 12.
3TBARS = TBA reactive substances; MDA eq = malondialdehyde equivalents.
shear force) and BP was the most tender (lowest of the shear force) of the 3 treatments. This difference could be due to the higher barrier properties (water and oxygen) of the BP compared with the TP. The higher barrier properties of the BP could have prevented evaporation of water and freezer burn.

Sensory attributes such as tenderness, juiciness, and overall flavor, evaluated by a consumer panel, were not significantly different among the treatments up to wk 6. The results indicated that the scores corresponded to dislike very much to dislike moderately by consumers (Table 3). The lower scores observed in this study may be expected as no seasoning was used during the preparation of the samples for the sensory analysis, nonenhanced samples. Saha et al. (2009) reported that the majority of the consumer in their study (52.95%) disliked (hedonic scale rating ≤4) the nonmarinated control treatment when evaluating its overall impression.

### Experiment 2

Marination pick-up of vacuum-tumbled chicken breast fillets (10% marinade) was 7.45%. It is possible that marination through the use of small tumblers in several batches of fillets could have caused marinated fillets not to absorb all 10% of the marinade solution.

There were significant differences \((P < 0.05)\) in \(L^*\) values between both marinated treatments. Marinated fillets also presented lower \(L^*\) than nonmarinated fillets. There were no differences in \(L^*\) values between NM-F and NM-NF. A significant decrease was observed between M-NF and M-F with the M-F having a lower \(L^*\) value. This difference could be due to the freezing process. As product freezes slowly as in a home freezer, larger ice crystals develop, which can damage the muscle structure and cause a decrease in water-binding and lighter meat. A decrease in \(L^*\) after marination was also reported by Gorsuch and Alvarado (2010) when STP was used in the marinade. The addition of salt and phosphates increased the WHC within the sample. This increase possibly does not allow the sample to reflect too much light; instead, it would absorb more light, resulting in a darker appearance which could be reflected on lower \(L^*\) values. Lee et al. (2008) reported that frozen fillets tended to be darker than control samples. Although the Lee et al. study did not include marination on frozen fillets, these observations may explain the negative effect of 2 wk of frozen storage on marinated breast fillets as indicated by the decrease in \(L^*\) values (lightness) in the present study.

As expected, M-F also presented lower \((P < 0.05)\) thaw loss compared with the NM-F. Cook loss values were different \((P < 0.05)\) among the 4 treatments and the M-F presented the lowest value for this parameter (Table 4). Likewise, M-F showed the highest \((P < 0.05)\) moisture content. The ingredients salt and phosphate present in the marinade prevented the loss of water in the marinated samples after thawing as well as increased the ability of the muscle to retain water during cooking (Alvarado and Sams, 2004), which may result in improvement of meat juiciness. Yoon (2002) reported that STP prevents ice crystal formation within the chicken fillet, improving the water-binding ability, by dipping samples in phosphate solution and storing at \(-20^\circ\text{C}\).

### Table 2

<table>
<thead>
<tr>
<th>Parameter measured</th>
<th>Treatment(^1)</th>
<th>Wk 1</th>
<th>Wk 6</th>
<th>Pooled SEM(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allo-Kramer shear force (kg/g)</td>
<td>TP</td>
<td>BP</td>
<td>FB</td>
<td>TP</td>
</tr>
</tbody>
</table>

\(^{a}\) Means within a row and week with different superscripts are significantly different \((P < 0.05)\).

\(^{1}\) TP = tray pack; BP = butcher paper; FB = freezer bag.

\(^{2}\) \(n = 12\).

### Table 3

<table>
<thead>
<tr>
<th>Parameter measured</th>
<th>Treatment(^2)</th>
<th>Wk 1</th>
<th>Wk 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tenderness(^3)</td>
<td>TP</td>
<td>BP</td>
<td>FB</td>
</tr>
<tr>
<td>Juiciness(^3)</td>
<td>3.4</td>
<td>3.7</td>
<td>3.9</td>
</tr>
<tr>
<td>Overall flavor(^3)</td>
<td>3.7</td>
<td>3.4</td>
<td>3.5</td>
</tr>
</tbody>
</table>

\(^{1}\) 9-point hedonic scale (1 = dislike extremely, 9 = like extremely).

\(^{2}\) TP = tray pack; BP = butcher paper; FB = freezer bag.

\(^{3}\) \(P > 0.05\).
Lower thaw loss and percent cook loss, and higher moisture content in marinated samples were expected because of the added moisture from the marinade solution and the increased WHC effect of phosphates and salt in the muscle (Sams, 2001). Alvarado and Sams (2004) reported an increase in cook moisture of chicken breast fillets when vacuum tumbling with phosphate. It is possible that marination and freezing together had a positive influence on WHC of chicken breast fillets as indicated by the M-F data: higher moisture and lower cook loss in comparison with M-NF fillets.

Marinated fillets presented lower (\(P < 0.05\)) values of TBARS in comparison with nonmarinated fillets (Table 4). These results in TBARS confirmed early findings that marination resulted in antioxidant properties (Ang and Young, 1987). The antioxidant effect of phosphates may be possible by chelation of metal ions (Sofos, 1986).

Higher values of tenderness (\(P < 0.05\)) were obtained through the razor shear force (Table 4). Marination has also resulted in improvement of tenderness on breast fillets (Palladino and Ball, 1979; Goodwin and Maness, 1984). Due to its ionic action, salt, or NaCl, acts to solubilize the functional myofibrillar proteins to increase the water-binding and tenderness of the meat product. In addition, it has been reported that phosphates, such as STP, significantly reduced the toughness of chicken breast (Zheng et al., 2000). Although marinated fillets presented lower values of razor shear force compared with nonmarinated ones (Table 4), the data for the 4 treatments would correspond to a classification of extremely tender in a 9-point hedonic scale, according to Cavitt et al. (2005). As well, Saha et al. (2009) reported significantly greater total energy from the MORS for nonmarinated control fillets compared with marinated treatments.

Even though there were differences (\(P < 0.05\)) in the objective analysis for color (\(L^*\)), there were no differences (\(P < 0.05\)) in color among the treatments during the sensory evaluation. In addition, the M-F sample showed the highest (\(P < 0.05\)) scores (ranking scale) for juiciness, overall flavor, and preference, and it was the tenderest (Table 5). The NM-F was the sample with the lowest intensity in all the attributes. Results from

### Table 4. Quality of marinated and nonmarinated chicken breast fillets stored at −18°C for 2 wk (experiment 2)

<table>
<thead>
<tr>
<th>Parameter measured</th>
<th>NM-NF</th>
<th>NM-F</th>
<th>M-NF</th>
<th>M-F</th>
<th>Pooled SEM²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw meat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(L^*)</td>
<td>54.29(^a)</td>
<td>53.78(^a)</td>
<td>47.48(^b)</td>
<td>45.31(^c)</td>
<td>0.28</td>
</tr>
<tr>
<td>Hue</td>
<td>37.83(^c)</td>
<td>40.14(^b)</td>
<td>181.42(^a)</td>
<td>266.89(^a)</td>
<td>7.39</td>
</tr>
<tr>
<td>Chroma</td>
<td>4.96(^c)</td>
<td>6.17(^a)</td>
<td>4.98(^b)</td>
<td>5.42(^b)</td>
<td>0.08</td>
</tr>
<tr>
<td>Thaw loss (%)</td>
<td>8.58(^a)</td>
<td>—</td>
<td>2.30(^b)</td>
<td>2.60(^b)</td>
<td>0.32</td>
</tr>
<tr>
<td>TBARS</td>
<td>4.41(^a)</td>
<td>4.30(^a)</td>
<td>—</td>
<td>—</td>
<td>0.32</td>
</tr>
<tr>
<td>Cooked meat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cook loss (%)</td>
<td>27.10(^b)</td>
<td>29.46(^a)</td>
<td>19.47(^c)</td>
<td>15.24(^d)</td>
<td>0.48</td>
</tr>
<tr>
<td>Moisture (%)</td>
<td>69.37(^c)</td>
<td>68.35(^d)</td>
<td>71.84(^b)</td>
<td>73.52(^a)</td>
<td>0.18</td>
</tr>
<tr>
<td>MORS³ force (N)</td>
<td>4.27(^a)</td>
<td>4.45(^a)</td>
<td>3.62(^b)</td>
<td>3.23(^b)</td>
<td>0.07</td>
</tr>
</tbody>
</table>

³MORS = Meullenet-Owens razor shear.

### Table 5. Sensory attributes¹ of cooked chicken breast samples stored at −18°C for 2 wk (experiment 2)

<table>
<thead>
<tr>
<th>Sensory attribute</th>
<th>NM-NF</th>
<th>NM-F</th>
<th>M-NF</th>
<th>M-F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
<td>2.4</td>
<td>2.3</td>
<td>2.7</td>
<td>2.6</td>
</tr>
<tr>
<td>Juiciness</td>
<td>2.1(^b)</td>
<td>1.6(^c)</td>
<td>2.8(^a)</td>
<td>3.0(^a)</td>
</tr>
<tr>
<td>Tenderness</td>
<td>2.3(^b)</td>
<td>2.1(^b)</td>
<td>3.0(^a)</td>
<td>3.1(^a)</td>
</tr>
<tr>
<td>Overall flavor</td>
<td>1.8(^b)</td>
<td>1.7(^b)</td>
<td>3.0(^a)</td>
<td>3.1(^a)</td>
</tr>
<tr>
<td>Preference</td>
<td>2.0(^b)</td>
<td>1.9(^b)</td>
<td>2.9(^b)</td>
<td>3.0(^b)</td>
</tr>
</tbody>
</table>

¹Means within a row with different superscripts are significantly different (\(P < 0.05\)).

¹Ranking scale (color, overall flavor, 1 = most intense, 4 = least intense; preference, 1 = most preferred, 4 = least preferred; tenderness, 1 = most tender, 4 = least tender).

²\(n = 74\) panelists.

³NM-NF = nonmarinated nonfrozen; NM-F = nonmarinated frozen; M-NF = marinated nonfrozen; M-F = marinated frozen.
this study agree with the findings of Saha et al. (2009), who reported that consumer acceptance was improved when broiler breast fillets were marinated.

The results of these studies indicate that even though there were some significant objective differences in pH, color, moisture, and texture at the end of the storage period (6 wk) in experiment 1, subjective differences (consumer sensory attributes) were not significantly different. Therefore, quality differences among the different packaging treatments were not perceived through wk 6 of frozen storage in the consumer sensory analysis. In the second experiment, marinated samples (fresh or frozen) were more preferred than the nonmarinated samples. As well, freezing in a home freezer for 2 wk did not negatively affect the quality in the marinated fillets but did decrease quality in the nonmarinated fillets as observed in the higher values of thaw loss, TBARS, cook loss, and shear force, and lower value of moisture.

REFERENCES


Prell, P. A. 1976. Preparation of reports and manuscripts which include sensory evaluation data. Food Technol. 30:40–52.


