EFFECT OF POST-PACKAGING STEAM PASTEURIZATION ON QUALITY AND CONSUMER ACCEPTANCE OF FULLY COOKED VACUUM-PACKAGED SLICED TURKEY BREAST

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Abstract – The effect of post-packaging steam pasteurization (PPP) on the quality and consumer acceptability of fully cooked vacuum-packaged turkey breast (TB) during 12 weeks refrigerated storage was evaluated. Measurements included pH, purge, expressible moisture, textural properties (bind, shear force), and colour (CIE L*a*b* values) during simulated retail display. The product's microbial [total aerobic plate count (APC); coliforms; lactic acid bacteria, (LAB); *Salmonella* spp.; *Listeria monocytogenes* (LM)] and oxidative stability after chilled storage were also examined. Consumer acceptance of sliced TB aroma, appearance, colour, flavour, juiciness, texture, and overall acceptability was evaluated on 9-point hedonic scales. Generally, PPP samples were darker and redder in appearance (increased a* and decreased hue angle values) and had more purge in packages than control samples. PPP treatment resulted in LAB and APC counts of TB at near the detectable level (one log CFU/g) up to 12 wk; whereas microbial counts of the samples not subjected to steam pasteurization reached maximum numbers after 8 wk of refrigerated storage. Post-package steam pasteurization did not negatively affect sensory attributes indicating it can extend shelf-life of the product without compromising eating quality.

Key Words – Shelf-life, purge, sensory.

I. INTRODUCTION

Thermal processing requirements result in processed meat products free of pathogens. However, outbreaks of foodborne illness have been associated with ready-to-eat (RTE) meat products due to the presence of *Listeria monocytogenes* (LM). Efforts have been made to improve pasteurization processes and to eliminate LM from meat products; however, recontamination occurs after cooking, during slicing and preparation for final packaging. Consequently, the risk of LM contamination in packaged and sliced RTE meat products still exists. Many technologies such as high pressure processing [1], hot water or steam treatments can be used as post-cooking interventions against LM [2,3,4]. It is possible that post-packaging thermal processing is a viable alternative to pre-packaging treatments. Since the products are in their individual final packages there is no chance for contamination if the individual packages are not damaged, so post-packaging thermal process treatment can potentially eliminate LM from RTE meats.

Thermal processes are cost effective and easily applied by the average meat processor, therefore may be more practical than other interventions. However, RTE meats are fully cooked and a second thermal treatment may cause quality deterioration. It is very important to limit to minimize the negative effect of heating on the quality of the RTE meat products. Thus, the objective of this study was to evaluate the effect of post-packaging steam pasteurization on quality and consumer acceptability of fully-cooked sliced turkey breast (TB).

II. MATERIALS AND METHODS

Commercially prepared samples of baked TB were received from an industry partner (Lilydale Inc., Edmonton, Canada). The bulk meats were re-packaged to contain 5 slices and vacuum (~0.8 bar) packaged in high-barrier, nylon/ polypropylene pouches (Sealed Air/Cryovac, Mississauga ON, Canada) using a thermo-forming packaging machine (Ulma TF-Supra packaging machine, CyE.S. Coop Ltd., Onati, Spain).
All vacuum-packaged samples were randomly assigned to two groups: control and post-

packaging pasteurization (PPP) batches. The PPP batches were immediately subjected to steam heat treatment at 95°C for 9 min. using an industrial continuous pasteurizing system (Koppens, model HLT 6000). Preliminary experiments on LM inoculated TB samples showed that PPP of TB slices to an end point temperature of 75°C resulted in a 3 log decrease but an endpoint temperature of 80°C resulted in >4.5 log decrease in numbers of LM. The amount of purge that accumulated in the package increased substantially above 75°C. The steam pasteurization conditions were selected to achieve a minimum internal temperature of 75°C. After pasteurization products were immediately chilled in ice water to an internal temperature of 4°C. The samples were randomly allocated to storage interval subgroups (0, 4, 8, 12 weeks), placed into boxes and stored at 4°C until evaluation.

At each storage time analyses of pH, purge, expressible moisture, CIE L* (lightness), a* (redness) and b* (yellowness) colour during simulated retail display, and textural characteristics of PPP and control products were performed. The effect of PPP on microbial counts (APC, coliforms, LAB, *Salmonella* spp. and LM) and oxidative stability after chilled storage was determined. Consumer acceptance of TB appearance, colour, aroma, flavour, juiciness, texture, and overall acceptability was evaluated on 9-point hedonic scales.

Data were subject to analysis of variance using the PROC MIXED procedure of SAS (v. 9.2, SAS Institute Inc., Cary, NC) including main effects (PPP treatment, storage time), and their interaction in the model. Panelist was included in the model as a random effect. When the analysis showed significant ($p \leq 0.05$) treatment effects, a Tukey test was used for separation of means.

III. RESULTS AND DISCUSSION

There was no difference between control and PPP samples in numbers of total aerobic bacteria (APC) and LAB at the beginning of storage (Fig. 1). Total APC, LAB and coliforms were below detectable levels for both control and PPP samples. None of the sliced TB samples tested positive for *Salmonella* spp. or LM. PPP had a significant influence on the microbial counts of the RTE TB during refrigerated storage. Microbial analysis indicated no meaningful differences between counts of total aerobic bacteria and LAB in PPP samples at all times (Fig. 1). Numbers of total aerobic bacteria and LAB in controls increased significantly during 4 wk of storage and remained at ca. 7 log CFU/g thereafter. Counts in samples subjected to PPP remained below or slightly above detectable level.

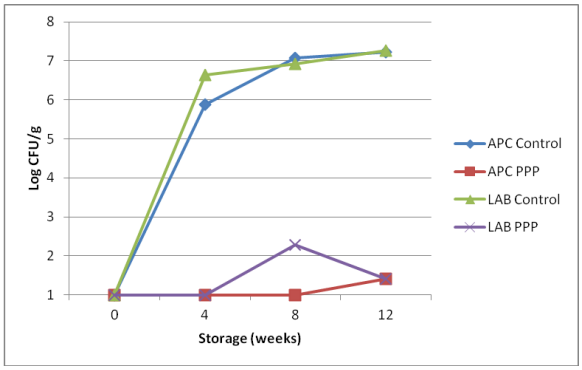

Figure 1. Total aerobic plate (APC) and lactic acid bacteria (LAB) counts in TB samples during storage at 4°C

There was no significant differences in purge loss as a function of storage time; however, purge losses were significantly ($P<0.05$) higher for PPP samples compared to the control packages at each storage time (Table 1).

Purge loss by the sliced TB subjected to PPP was almost 3 times higher than that of the control samples. The large amount of fluid in vacuum bags would be very unappealing to the consumer and could shorten shelf-life due to the presence of free liquid in the package. For whole muscle products amount of liquid lost during storage is typically related to the free water content between the meat tissue fibers, and an increase in the amount of fluid indicates a decrease in water holding capacity of the products. Expressible moisture denotes the ability of meat to hold water, which affects many quality attributes of meat products including texture, tenderness and juiciness. Analysis of expressible moisture revealed no significant difference between control and PPP samples in packaged TB slices (Data not shown).

Table 1. pH, purge, TBARS and textural properties of turkey breast

	pH	Purge, %	TBARS	Bind, N	KSF, N
Treatment					
Control	6.0	4.5	0.16	2.6	117.8
PPP	6.1	8.3	0.19	2.7	110.2
P	*0.35*	*0.01*	*0.16*	*0.56*	*0.46*
Storage (wks)					
0	6.3a	6.1	0.26[a]	2.7	110.3
4	6.2ab	6.3	0.14[b]	2.4	110.7
8	6.0bc	6.6	0.17[b]	2.7	112.9
12	5.8c	6.7	0.13[b]	2.7	122.2
p	*0.00*	*0.34*	*0.00*	*0.56*	*0.79*

[ab]Means with different letters in the same column (within the main effect) are significantly different ($p < 0.05$); TBARS=Thiobarbituric acid reactive substances (mg malonaldehyde eq./kg); KSF=Kramer shear force

PPP treatment had no significant effect on the pH of sliced TB samples. There was a gradual decrease in pH of sliced TB over 12 wk of storage, from 6.27 to 5.84.

PPP treatment did not affect (p>0.05) the bind strength of the TB samples (Table 1). Storage time had no significant effect on textural properties of packaged sliced product. The product used in this study was fully cooked prior to pasteurization and the denaturation of proteins had already occurred so the additional heating of the fully cooked sliced TB during post-process steam pasteurization did not cause drastic textural changes.

PPP treatment had no significant (p>0.05) effect on the oxidative stability of sliced products during refrigerated storage. There was a slight variation in TBARS values over time but differences in the amount of detected malonaldehyde (MDA) were less than 0.1 mg/kg and thus would not affect the oxidative stability. TBARS were lower for samples that were stored at 4°C than for the samples at the time of packaging. This might be due to the depletion of oxygen available within the package, since the products were vacuum packed. Nolan *et al.* [5] also noticed less oxidation in vacuum-packed turkey meat compared with other packaging treatments.

Overall, levels of lipid oxidation in control and PPP samples were very low ranging from 0.1 to 0.5 mg MDA/kg. Gray *et al.* [6] suggested a threshold value of 1 mg MDA/kg muscle for organoleptic detection of rancidity. This suggested limit was in excess of lipid oxidation values observed in the present study.

Changes in colour characteristics (L*, a*, b*) of TB slices as a function of simulated retail display storage are shown in Table 2. PPP treatment resulted in a decreased colour lightness (L* value) and led to a redder appearance (increased a* and decreased hue angle values) of sliced TB. With an increase in duration of display there was a general decline in a*and b* values, and an increase in lightness and hue angle values due to colour fading. There was no significant (p>0.05) interaction between treatments and storage time for any of the instrumental colour parameters, indicating that colour stability was not negatively affected by PPP.

Table 2. Effect of PPP treatment and storage on colour parameters of TB during retail display

	*L**	*a**	*b**	Chroma	Hue
Treatment					
Control	78.7	7.0	10.1	12.3	55.3
PPP	76.5	7.9	10.1	12.8	52.1
P	*0.05*	*0.04*	*0.99*	*0.34*	*0.06*
Storage (wks)					
0	77.3[b]	7.8[a]	10.3[a]	12.9a	53.0
4	77.7[ab]	7.3[ab]	9.8[b]	12.3[b]	53.3
8	77.8[a]	7.2[b]	10.2[ab]	12.5[ab]	54.8
P	*0.045*	*0.044*	*0.040*	*0.040*	*0.040*

[ab]Means with different letters in the same column (within the main effect) are significantly different ($p < 0.05$)

Post-package steam pasteurization did not affect consumer acceptance of sliced turkey breast appearance, colour, aroma, juiciness or texture, and overall acceptability of the product (Table 3). The flavour acceptability of PPP treatments was slightly, but significantly, higher than that of the unheated control samples.

There was a slight decrease in overall acceptability and acceptability of aroma and flavour after 4 and 8 weeks of storage. However, a PPP treatment x storage time interaction was not significant (p>0.05) for any of the sensory attributes indicating that post-package steam pasteurization does not compromise consumer acceptance of turkey roast during storage.

Table 3**.** Mean scores for main effects of steam pasteurization and storage period for various sliced turkey breast acceptability characteristics

Treatment	Acceptability scores[1]						
	Appearance	Colour	Aroma	Flavour	Juiciness	Texture	Overall
Treatment							
Control	7.0	6.9	6.4	6.4	6.9	6.8	6.4
PPP	6.9	6.9	6.6	6.7	7.0	7.0	6.7
P-value	*0.57*	*0.83*	*0.10*	*0.03*	*0.22*	*0.18*	*0.09*
Storage (wks)							
0	7.1	7.1	6.9a	6.9a	7.1	7.1	7.0a
4	6.8	6.8	6.3b	6.4b	6.9	6.7	6.3b
8	6.8	6.9	6.4b	6.3b	6.9	6.9	6.5b
P-value	*0.08*	*0.31*	*0.00*	*0.01*	*0.38*	*0.13*	*0.00*

[1]Scored on 9-point hedonic scales where 1=dislike extremely, 2=dislike very much, 3=dislike moderately, 4=dislike slightly, 5=neither like nor dislike, 6=like slightly, 7=like moderately, 8=like very much, 9=like extremely

a, b, Within a column and within a treatment effect, mean values followed by different letters are significantly different ($P \leq 0.05$)

IV. CONCLUSIONS

PPP treatment resulted in LAB and APC counts of TB remaining at about 1 log CFU/g for up to 12 weeks; whereas microbial counts of the samples not subjected to steam pasteurization were above acceptable limits for RTE foods after 8 weeks of refrigerated storage. Generally, PPP samples were darker and redder in appearance and released a larger amount of purge than control samples. However, PPP did not negatively affect sensory attributes, indicating it can extend shelf-life of the product without compromising consumer acceptance.

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