Potassium carbonate improves fresh pork quality

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Abstract – Phosphate is a component used to enhance meat products that improves color, water holding capacity, and tenderness. However, phosphate is under scrutiny creating a need for an alternative. One potential replacement is potassium carbonate (K_2CO_3). A study was conducted where boneless pork loin chops were subjected to one of six enhancement treatments. The chops were placed under simulated retail display and analyzed for color, pH, cook loss, and tenderness. The 0.3% and 0.5% K_2CO_3 treatments increased pH, decreased lightness, maintained redness, decreased yellowness, reduced cook loss, and improved tenderness. Additionally, both 0.3% and 0.5% K_2CO_3 maintained or improved pork quality compared to the positive control phosphate treatment. Thus, K_2CO_3 may function as a phosphate alternative for fresh pork quality.

Key Words –cook loss, color, pH, tenderness

I. INTRODUCTION

The pork industry utilizes enhancement mechanisms to increase or maintain quality of pork products. Phosphate is a compound in enhancement strategies that can extract myofibrillar myosin which allows for swelling in the myofibril [1]. The swelling of the myofibril and solubilization of myosin increases the water holding capacity of muscle tissue and therefore increases perceived tenderness [2]. Phosphate also increases pH, improves pork color stability, and maintains a darker, redder product. Despite the many benefits of phosphate, its use in food products is under scrutiny and consumers are requesting an alternative. Thus, identifying an alternative is critical for the sustainability of the pork industry. One potential alternative to phosphate is potassium carbonate (K_2CO_3). This compound is currently used in the food industry and is allowed at levels 'sufficient for purpose' according to USDA-FSIS standards [3]. Yet, there is limited information evaluating its use as an enhancement compound in fresh meat products. Therefore, a titration study was conducted evaluating the impact of K_2CO_3 on fresh pork quality.

II. MATERIALS AND METHODS

Enhancements: Boneless, center-cut pork loins were acquired from a USDA-FSIS inspected processor weekly for eight weeks. Baseline measurements for pH and color (CIELAB) were taken before random assignment to one of six treatments. Loins were enhanced at 10% uptake (except unenhanced), vacuum-sealed, and equilibrated overnight according to the treatments in Table 1. After the equilibration period, the pork loins were cut into 2.5 cm chops, weighed, and color measurements were taken in duplicate similar to previously established methods [4]. The pork chops were placed on styrofoam trays and sealed with oxygen semipermeable PVC overwrap. The sealed pork chops were placed in a simulated retail case at 4°C for 0, 1, 2, 3, 7 and 10 days. Each sampling day, both chops were measured for color, but only one was used for pH analysis and one for cook loss and shear force.

Treatment	NaCl (%)	Phosphate (%)	Potassium carbonate (%)
Unenhanced	0%	0%	0%
NaCl	0.18%	0%	0%
PO_4	0.18%	0.3%	0%
0.1% K_2CO_3	0.18%	0%	0.1%
0.3% K_2CO_3	0.18%	0%	0.3%
0.5% K_2CO_3	0.18%	0%	0.5%

Table 1: Enhancement treatments used in the present study. Each compound listed represents the final concentration in the fresh pork loin after a 10% uptake injection before slicing into chops.

pH and Color : pH was measured using a solution containing 5mM iodoacetic acid (pH 7.0) and 150mM KCl [5]. Color was measured using a CIELAB color scale for L*, a*, and b* with a Konica Minolta CR-410 Chroma colorimeter with a 50mm after a 30 min bloom period at 4°C [6].

Cook loss and Shear Force analysis: Pork loin chops were weighed before cooking, cooked to a final internal temperature of 71°C on an electric clamshell grill according to AMSA recommendations, and weighed immediately thereafter to determine cook loss [7]. Pork loin chops were then placed in an ice water bath for 30 minutes to prevent further temperature increase and stored at 4°C overnight prior to shear force analysis. Cores of a 1.27 cm diameter were excised from the pork loin parallel to the muscle fibers and analyzed in triplicate on a TAXT-plus Texture Analyzer with a Warner-Bratzler shear force blade to determine peak force of each pork chop [8].

Data analysis: All data were analyzed with a mixed model in JMP with a repeated measures statement. The model used included the effects of treatment, time, and the two-way interaction. The least squares mean differences of the treatments were evaluated using a Student's t-test and considered significant at $P \leq 0.05$.

III. RESULTS AND DISCUSSION

The addition of K_2CO_3 increased the pH of the chops. Specifically, the 0.3% and 0.5% K_2CO_3 treatments significantly increased ($P \leq 0.0464$) pH compared to all other treatments. The addition of K_2CO_3 also affected chop color. The 0.3% and 0.5% K_2CO_3 treatments decreased ($P \leq 0.0285$) lightness compared to the NaCl and 0.1% K_2CO_3 treatments. However, no lightness differences ($P \geq 0.73$) were detected between the 0.3% K_2CO_3, 0.5% K_2CO_3, and PO_4 treatments. In all treatments, redness decreased ($P \leq 0.0001$) with time. However, the 0.3% K_2CO_3 and 0.5% K_2CO_3 treatments reduced ($P \leq 0.0066$) redness loss compared to the unenhanced and NaCl treatments at 7 days of simulated retail display. The 0.3% K_2CO_3 and 0.5% K_2CO_3 treatments all decreased ($P \leq 0.0016$) yellowness compared to the unenhanced and NaCl treatments. The presence of K_2CO_3 also affected cook loss. The 0.3% K_2CO_3 and 0.5% K_2CO_3 treatments significantly reduced ($P \leq 0.0278$) cook loss compared to the unenhanced, NaCl, and 0.1% K_2CO_3 treatments. Additionally, the 0.5% K_2CO_3 treatment reduced cook loss ($P = 0.0058$) compared to the PO_4 treatment. Finally, the 0.3% K_2CO_3 and 0.5% K_2CO_3 treatments reduced ($P \leq 0.0147$) Warner-Bratzler peak shear force compared to the unenhanced and 0.1% K_2CO_3 treatments. There was no tenderness differences ($P \geq 0.57$) between the 0.3% K_2CO_3, 0.5% K_2CO_3, and PO_4 treatments.

IV. CONCLUSION

The K_2CO_3 enhancement of fresh pork increased pH, decreased lightness, reduced redness loss, decreased yellowness, reduced cook loss, and improved tenderness in the pork loin chops. Moreover, the addition of K_2CO_3 at 0.3% and 0.5% improved or maintained pork quality attributes similar to the PO_4 enhancement treatment. Thus, these data suggest that K_2CO_3 could be a viable alternative to phosphate.

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