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Evaluation of a dehydrated beef protein to replace sodium-based phosphates in injected beef strip loins

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ABSTRACT

A dehydrated beef protein (DBP) was evaluated as a replacement for the phosphate added to beef injection brines. U.S. Select strip loins (n = 20) were injected to 110% of their initial weight with a brine containing 3.6% salt and 4.5% sodium phosphate (CON) or 3.6% salt and 5% dehydrated beef protein (DBP). DBP loins had less fluid loss after 30 min. Steaks from both treatments lost similar amounts of fluid during storage. Total fluid loss was lower for DBP injected product. Lipid oxidation (TBARS) products were 0.23–0.60 mg/Kg higher for DBP steaks. DBP steaks were slightly less red than CON steaks according to instrumental measurements. Sensory panel evaluation, however, indicated no differences in redness. DBP steaks were less tender according to trained sensory panel. Results indicated the DBP to be effective in increasing brine retention and a viable alternative to phosphates when used in brines injected into beef strip steaks.

1. Introduction

It is common for meat products to be injected with a brine containing water, sodium chloride (NaCl; salt) and sodium phosphates (SP). Salt and SP are important ingredients in enhanced meats because they act synergistically to alter myofibrillar protein to improve the water holding capacity of the product (Offer & Knight, 1988; Offer & Trinick, 1983). This effect is important to processors because it compensates for the natural loss of fluid (purge) from meat in storage and retail display and retains fluid through cooking (Baublits, Pohlman, Brown, & Johnson, 2005). Brine injection with sodium phosphates can also provide the benefits of increased oxidative and microbial stability (Lamkey, Mandigo, & Calkins, 1986; Pohlman, Stivarius, McElyea, Johnson, & Johnson, 2002), increased tenderness (Baublits et al., 2005; Vote et al., 2000), and improved juiciness (Baublits et al., 2005; McGee, Henry, Brooks, Ray, & Morgan, 2003). However, color stability can be adversely affected by brine injection (Lawrence, Dikeman, Hunt, Kastner, & Johnson, 2004; Stetzer et al., 2007). The high sodium content of salt (39.3%) and sodium phosphates (30 ± 1%; Brifisol® 85 Instant) can negatively affect the nutritional value of meat. Sodium reduction has long been advocated by government and consumer groups because of its association with hypertension, cardiovascular disease and stroke (Desmond, 2006; Meneton, Jeunemaitre, De Wardener, & MacGregor, 2005). Approximately 21% of the sodium in the U.S. diet is supplied by processed meats (Engstrom, Tobelmann, & Albertson, 1997). In light of this, it would be advantageous to research novel ingredient technologies that can increase water binding while allowing for an overall reduction of sodium. One such ingredient, a dehydrated beef protein (DBP), is a purified beef collagen protein powder. A similar product manufactured from pork collagen has previously been successful in reducing purge and cook loss in hams and pork frankfurter-type sausages (Prabhu, Doerscher, & Hull, 2004; Schilling, Mink, Gochenour, Marriott, & Alvarado, 2003). The objective of this study was to investigate the effects of DBP, on shelf life and palatability characteristics, such as purge, color, lipid oxidation and microbial stability, cook yield, shear force and sensory attributes of beef strip steaks.

2. Materials and methods

2.1. Collection of beef strip loins

Paired USDA select beef strip loins (IMPS 180; n = 20) were collected at a processing facility at the time of carcass fabrication. Paired loins were vacuum packaged at the processing facility, transported to Oklahoma State University and stored at 4 °C overnight. All subsequent preparation of brines and raw materials

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was conducted in a processing facility with a constantly maintained temperature of 4 °C.

2.2. Brines

The control brine (CON) consisted of 3.6% salt and 4.5% sodium phosphate (SP) blend (Brifisol® 85 Instant; BK Giulini Corporation, Simi Valley, CA) and 1% Herbalox seasoning type HT-S wt/wt (Kalsec, Kalamazoo, MI), which has antioxidant capacity due to the presence of rosemary. The brine containing dehydrated beef protein (DBP) consisted of 3.6% salt, 5% dehydrated beef protein (Proliant Meat Ingredients, Inc., Ankeny, IA) and 1% Herbalox seasoning type HT-S wt/wt. The dehydrated beef protein was prepared in 9.07 Kg of 30 °C water before being mixed with a 13.61 Kg ice/water (1:1) solution containing the salt. The 30 °C water was necessary to properly disperse the DBP powder. The balance of water was then added at 4 °C. The CON and DBP brines had pH of 8.44 and 7.49, respectively. Both brines were injected at 4 °C. Individual brine batches (45.45 Kg) were prepped immediately before injection.

2.3. Injection

Strip loins were trimmed, a sample (~30 g) was collected from each loin for initial pH and proximate composition and then loins were weighed. Injection took place approximately 24 hr postmortem. Loins within pairs were assigned to CON and DBP treatments. Weights were taken immediately after injection. Loins were injected with an automatic brine injector (Fomaco Model FGM 20/20S, Fomaco Food Machinery Co., Copenhagen, Denmark) calibrated to inject at 110% of the initial weight that was used. The needles (n = 20; Model #6, Fomaco Food Machinery Co., Copenhagen, Denmark) penetrated the meat to 0.64 cm above the lower meat surface at a rate of 40 strokes/min and a pressure of 26 psi and were spaced 2.54 cm apart.

2.4. Equilibration, slicing, packaging and storage

Injected loins were allowed to equilibrate 30 min before slicing into 2.54 cm steaks using a standard 33.02 cm manual slicer (Model 3600P, Globe Food Equipment Co., OH). Twelve steaks from each loin were weighed individually and packaged on trays (Cryovac 3 Processor Trays, Sealed Air, Duncan, SC) with absorbent pads (Pad-Loc Super Absorbent Pads (PLS), Sealed Air, Duncan, SC) overwrapped with oxygen permeable film (Oxygen transmission rate = 23250 cc/m^2(24 h), OmniFilm, Pliant Corp., Schaumburg, IL). Overwrapped steaks were placed in 63.5 × 76.5 cm bags ("mother-bags"; Oxygen transmission rate = <0.1 cc per 645 cm^2/24 h @ 23 °C and 0% RH), each containing 4 randomly selected steaks. The air was evacuated and replaced with 35% CO_2, 0.4% CO and 64.6% N_2 gas using a MultiVac C500 (MultiVac, In., Wolfertschwenden, Germany). Motherbags containing the steaks were stored for 4 d at 4 °C in the dark to simulate transportation. After storage, steaks were removed from their bags and either taken for analyses (d 0) or placed in retail display until needed (d 2, 4, 6). Steaks were randomly assigned to their respective analyses and day before the initial dark storage period. Retail display was conducted in a cooler at 4 °C under 40 watt Rapid Start T12 Flourescent Platinum lights (Promolux, B.C., Canada; 1600 – 1900 lux). Lights were arranged to deliver 807 to 1614 lux (75–150 ft-candles) of continuous intensity on the meat surface (AMSA, 1991). A GE Triple Range Light Meter (Model 217, GE Lighting, Cleveland, OH) was utilized to verify light intensity. Steaks were randomly placed in the display and were rotated each day to negate any inconsistencies in light intensity among different display areas. Three steaks from each loin were randomly collected from retail display on d 0, 2, 4 and 6 for further analyses. The first and second steaks were used for purge and pH. The first steak was also used for cook yield and Warner-Bratzler shear force. The second steak was also used for cook yield and sensory. The second steak designated for d 6 was also used for color panel and instrumental color. The third steak was used for thiobarbituric acid reactive substances (TBARS), aerobic (APC) and anaerobic plate counts (AnPC) and proximate compositional analyses. All analyses were conducted on d 0, 2, 4 and 6 except for Warner Bratzler shear force, which was not measured on d 6.

2.5. Headspace analysis, proximate composition and pH

Headspace composition of each motherbag was determined after the 4 d storage period using a headspace analyzer (CheckMate 9900 O_2/CO_2, PBI Dansensor, Denmark). After sampling for lipid oxidation, each steak was cut into cubes (~1 cm) and frozen using liquid nitrogen. Frozen cubes were blended into a fine powder using a Waring blender. The powder was placed in a Whirl-Pak® bag and stored at −20 °C until used for proximate analyses. Moisture (AOAC, 2003; method 950.46), crude fat (AOAC, 2003; method 960.39), ash (AOAC, 2003; method 920.153) and protein (AOAC, 2003; method 928.08) were determined. The DBP powder was also analyzed for moisture and protein using the previously mentioned methods. Crude fat (AOAC, 2003; method 991.36) was also determined on the DBP powder.

2.6. Purge

Measurements taken:

A	initial weight of loin
B	weight of loin after injection
C	weight of loin 30 min after injection
D	initial weight of steak
E	weight of steak on day 5
B – A	brine added to the loin
B – C	fluid loss 30 min after injection
D – E	fluid loss from time steak was cut until day 5.
$\frac{D}{C}$	proportion of steak from loin

Brine loss$_{30\ min}$ (%) represents the fluid lost during the 30 min equilibration period as a percentage of the total fluid injected. It was measured by taking the difference between the weights of the loin immediately after and 30 minutes after injection. This difference is the fluid loss during the 30 min equilibration and it was then divided by the difference between the weight of the loin prior to and immediately after injection and multiplied by 100.

$$Brine\ loss_{30min} = \frac{B-C}{B-A} \times 100$$

Purge$_{30\ min}$ (%) represents the fluid lost during the 30 min equilibration period as a percentage of the total loin weight. It was calculated by subtracting the weight of the loin 30 min after injection from the weight of the loin immediately after injection and dividing it by the immediate pumped weight. It represents the weight of fluid lost during equilibration as a percentage of the total weight of the loin.

$$Purge_{30min} = \frac{B-C}{B} \times 100$$

Purge (%) reflects the amount of fluid that collects in the trays as the steak sits in retail display. *Purge* was measured by taking the weight of the steak after storage and subtracting that weight from the