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Summary

Beef semitendinosus steaks were used to evaluate the effects of sodium phosphate and potassium lactate on quality characteristics of enhanced beef steaks. Sodium phosphate decreased the amount of package purge and cook loss and gave the beef product a darker, redder appearance. Potassium lactate gave the product a darker, redder appearance, while increasing levels of lactate decreased total psychrotrophic (bacterial) plate counts, and decreased package purge and cook loss. Sodium phosphate and potassium lactate aid in extending shelf-life and improving quality attributes of enhanced beef steaks.

Introduction

Changes in consumer buying trends and lifestyles have required the meat industry to look for new technologies that allow meat products to be prepared quickly and easily by the consumer while improving overall product quality and consistency. The use of sodium phosphate in meat has been shown to increase moisture retention and reduce oxidative rancidity. Sodium lactate has long been used as a shelf-life extender in meat products. Research has shown that increasing sodium lactate levels decreases bacterial counts in cooked beef roasts. A recent study also indicated that sodium lactate in frankfurter formulations controlled growth of *Listeria monocytogenes*. Although extensive research has been conducted on the use of sodium lactate and sodium phosphate in meat products, limited research has been conducted to evaluate the use of potassium lactate in conjunction with particular sodium phosphate types. The desire by some consumers to lower sodium intake has led to increased use of potassium lactate in some meat products to accommodate the low sodium diet without losing the antimicrobial benefits of lactate. The objective of our study was to evaluate the effects of potassium lactate levels and sodium phosphate types on quality characteristics of enhanced beef steaks.

Procedure

Thirty-six U.S. Select beef *semitendinosus* (ST) muscles were purchased from Swift and Company, Grand Island, Nebraska, and delivered to the Loeffel Meat Laboratory at the University of Nebraska. The ST muscles were trimmed of external fat and connective tissue. Three sodium phosphate types [no phosphate, Brifisol® 85 Instant (BK85), and sodium tripolyphosphate (STP)] were used to evaluate sodium phosphate functionality. Brifisol® 85 Instant is a blended phosphate containing hexameta-, pyro-, and poly-phosphates. Blended phosphates are formulated to balance the phosphate pH for increased functionality in specific applications, however, they are slightly more expensive than STP. Three potassium lactate (KL) levels were evaluated in this study (0%, 2%, and 4% lactate). Four replications were used in this project. Following trimming and denuding, each ST muscle was injected to 112% of the green weight of the roast with enhancement solutions containing 0.35% sodium chloride, 0% or 0.35% sodium phosphate (no phosphate, BK 85, or STP), and 0%, 2%, or 4% potassium lactate. Following injection, each roast was sliced into 3/4-inch thick steaks. Each steak was individually packaged in a modified atmosphere package containing 80% food grade oxygen and 20% carbon dioxide. Steaks were placed on a table in a 38°F cooler under simulated lighted retail display conditions where they remained for 0, 3, 6, 9, 12, or 15 days. When the display time was completed, packages were aseptically opened for microbial sampling. Total psychrotrophic (bacteria) plate counts were used to evaluate microbial growth. Color traits were measured using a HunterLab colorimeter. A 1-inch port was used with Illuminant A and 10° standard observer settings. L* (lightness to darkness), a* (red to green color), and b* (yellow to blue color) were used to objectively define color in a three-dimensional color space. Package purge loss (the amount of moisture lost from the steak while in the package) and cooking loss were measured. Warner-Bratzler shear force was measured on each steak following cooking.

Results

Adding sodium phosphate and potassium lactate in enhanced beef steaks increased the pH of the steaks (Table 1). The use of alkaline phosphates in meat products to increase the pH has been well documented. By increasing the pH, the product can bind more water, resulting in decreased purge and cooking loss. The decrease in cooking loss produces a juicier, more desirable product. In our study, adding sodium phosphate increased ($P < 0.05$) steak pH. Use of STP should increase the pH of meat more than BK85 because it is more alkaline, however, there was no difference between the two phosphate types ($P > 0.05$). Increasing levels of lactate significantly increased steak pH ($P < 0.05$). The ability of potassium lactate to increase product pH also should increase moisture retention in the product. Research indicates lactate has the ability to delay microbial growth, which will have an effect on the product pH. The ability of potassium lactate to increase pH and delay microbial growth over the 15-day storage period may have allowed the product pH to remain higher than steaks containing 0% potassium lactate.

Increasing levels of potassium lactate delayed bacterial growth and held the total bacterial plate counts lower over the 15-day refrigerated storage period as compared to bacterial counts from steaks containing 0% lactate (Figure 1). Steaks containing 0% KL had higher microbial counts by day 15 as compared to steaks containing 2% and 4% KL ($P < 0.05$). Increasing the level of lactate from 2% to 4% reduced the bacterial count over the 15-day storage period ($P < 0.05$). The addition of potassium lactate in meat products has been shown to increase the shelf-life of the product by delaying bacteria growth. A decrease in bacterial load also may have an effect on other quality characteristics. As bacteria grow, they

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Table 1. Effect of phosphate type or lactate level on the pH of beef *semitendinosus* steaks.

		Steak pH	
		Mean	S.E.
Phosphate Type	No Phosphate	5.70^{b}	0.018
	BK85	5.97^{a}	
	ST	5.93^{a}	
Lactate Level	0% KL	5.75^{z}	0.018
	2% KL	5.90^{y}	
	4% KL	5.99^{x}	

[ab]Means within a column with different superscripts are significantly different ($P < 0.05$).
[xyz]Means within a lactate level with different superscripts are significantly different ($P < 0.05$).
BK85 = Brifisol® 85 Instant (BK Giulini Corporation, Simi Valley, CA); pH of ~ 8.5.
STP = Sodium tripolyphosphate (BK Giulini Corporation, Simi Valley, CA); pH of ~ 9.5.
KL = Potassium lactate (Ultra-Pure PL-85®,Trumark Inc., Linden, NJ); 60% solution, pH of 7.65.

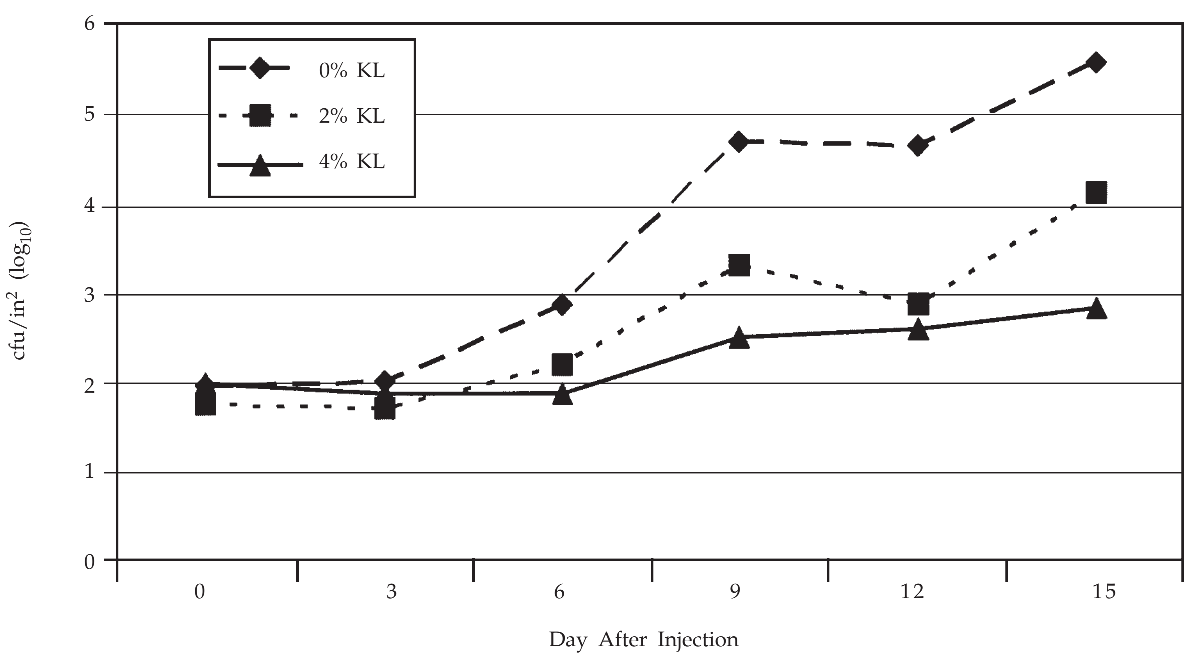

Figure 1. Effect of potassium lactate on psychrotrophic plate counts ($\log_{10}$ cfu/in^2) of enhanced beef *semitendinosus* steaks.

Table 2. Effect of phosphate type or lactate level on color values of beef *semitendinosus* steaks.

		L* Value		a* Value		b* Value	
		Mean	S.E.	Mean	S.E.	Mean	S.E.
Phosphate Type	No Phosphate	45.37[a]	0.644	26.06[b]	0.542	20.31[a]	0.297
	BK85	42.17[b]		28.73[a]		20.89[a]	
	STP	43.14[b]		28.05[a]		20.88[a]	
Lactate Level	0% KL	45.84[x]	0.644	26.12[y]	0.542	20.22[y]	0.297
	2% KL	42.51[y]		28.49[x]		21.06[x]	
	4% KL	42.33[y]		28.22[x]		20.80[xy]	

[ab]Means within phosphate types with different superscripts are significantly different ($P < 0.05$).
[xy]Means within lactate levels with different superscripts are significantly different ($P < 0.05$).
BK85 = Brifisol® 85 Instant (BK Giulini Corporation, Simi Valley, CA); pH of ~ 8.5.
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Table 3. Effect of phosphate type or lactate level on percent package purge of beef *semitendinosus* steaks.

		% Package Purge	
		Mean	S.E.
Phosphate Type	No Phosphate	5.91[a]	0.283
	BK 85	2.92[b]	
	STP	2.95[b]	
Lactate Level	0% KL	6.19[x]	0.283
	2% KL	3.85[y]	
	4% KL	2.23[z]	

[ab]Means in a column with different superscripts are significantly different ($P < 0.05$).
[xyz] Means within lactate levels with different superscripts are significantly different ($P < 0.05$).
BK85 = Brifisol® 85 Instant (BK Giulini Corporation, Simi Valley, CA); pH of ~ 8.5.
STP = Sodium tripolyphosphate (BK Giulini Corporation, Simi Valley, CA); pH of ~ 9.5.
KL = Potassium lactate (Ultra-Pure PL-85®,Trumark Inc., Linden, NJ); 60% solution, pH of 7.65.

Table 4. Effect of phosphate type or lactate level on percent cooking loss of beef *semitendinosus* steaks.

		% Cooking Loss	
		Mean	S.E.
Phosphate Type	No Phosphate	31.62[a]	0.429
	BK85	29.93[b]	
	STP	30.04[b]	
Lactate Level	0% KL	33.71[x]	0.429
	2% KL	29.77[y]	
	4% KL	28.10[z]	

[ab]Means within phosphate type with different superscripts are significantly different ($P < 0.05$).
[xyz]Means within a lactate level with different superscripts are significantly different ($P < 0.05$).
BK85 = Brifisol® 85 Instant (BK Giulini Corporation, Simi Valley, CA); pH of ~ 8.5.
STP = Sodium tripolyphosphate (BK Giulini Corporation, Simi Valley, CA); pH of ~ 9.5.
KL = Potassium lactate (Ultra-Pure PL-85®,Trumark Inc., Linden, NJ); 60% solution, pH of 7.65.

produce acidic, metabolic by-products that will lower product pH. Lower product pH reduces moisture retention and the stability of myoglobin resulting in decreased shelf-life due to the development of a brown surface appearance. Sodium phosphate did not significantly reduce ($P > 0.05$) microbial growth (data not shown).

Steak color utilizing HunterLab L*, a*, and b* was monitored over the 15-day refrigerated storage period. Adding sodium phosphate or potassium lactate resulted in a darker, redder steak appearance (Table 2). Steaks enhanced with sodium phosphate had significantly lower L* values (darker appearance) and higher a* values (redder appearance) as compared to steaks containing no phosphate ($P < 0.05$). No differences in b* values (yellowness to blueness) were seen between the steaks ($P > 0.05$). Adding potassium lactate significantly decreased the lightness of the product (lower L* values) while giving the product a redder appearance (higher a* values). The ability of sodium phosphate and potassium lactate to increase the product pH may be aiding color stability. Research has shown that myoglobin is more stable at higher pH values. The results in this study indicate that adding phosphate and lactate can help increase product shelf-life because the product maintains a more desirable appearance for a longer time.

Both sodium phosphate and potassium lactate decreased the amount of package purge loss (Table 3). Adding sodium phosphate decreased the amount of package purge ($P < 0.05$), however, no differences were seen between the two phosphate types. Increasing levels of potassium lactate decreased the amount of package purge loss ($P < 0.05$).

Adding phosphate and lactate also decreased the amount of cooking loss (Table 4). Adding sodium phosphate decreased the amount of cooking loss ($P < 0.05$), however, no differences were seen between the two phosphate types. Increasing levels of potassium lactate decreased the amount of cooking loss ($P < 0.05$). The ability of sodium phosphate and potassium lactate to decrease package purge and cooking loss may be due to their ability to increase product pH, allowing muscle proteins to bind and hold more water. The decrease in moisture loss should result in a juicier product.

Adding BK85 decreased ($P < 0.05$) the Warner-Bratzler shear force values (increased the tenderness) of the enhanced beef steaks (Table 5). Research indicates the use of phosphate in meat products will increase product tenderness. It was expected that STP would also increase product tenderness, however, this was not the case in our study. Potassium lactate did not aid in increasing product tenderness.

Results of this study indicate that the use of sodium phosphate and potassium lactate can enhance product quality. Sodium phosphate decreased the amount of package purge and cook loss and gave the beef product a darker, redder appearance. Potassium lactate gave the product a darker, redder appearance, while increasing levels of lactate decreased total psychrotrophic (bacteria) plate counts and decreased package purge and cook loss. Sodium phosphate and potassium lactate aid in extending product shelf-life from a bacterial and color standpoint while improving moisture retention of enhanced beef steaks.

Table 5. Effect of phosphate type or lactate level on Warner-Bratzler shear force values of beef *semitendinosus* steaks.

		Warner-Bratzler shear force (pounds of force)	
		Mean	S.E.
Phosphate Type	No Phosphate	9.72^a	0.117
	BK85	8.71^b	
	STP	9.77^a	
Lactate Level	0% KL	9.74^x	0.117
	2% KL	9.19^x	
	4% KL	9.26^x	

[ab]Means within phosphate type with different superscripts are significantly different ($P < 0.05$).
[x]Means within a lactate level with different superscripts are significantly different ($P < 0.05$).
BK85 = Brifisol® 85 Instant (BK Giulini Corporation, Simi Valley, CA); pH of ~ 8.5.
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