EFFECTS OF L-ARGININE ON THE SENSORY, PHYSICOCHEMICAL AND MICROBIOLOGICAL CHARACTERISTICS OF BEEF JERKY

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Abstract- The objectives of this study were to evaluate three different beef jerky preparations, which included: 1) control (0% L-arginine), 2) treatment 1 (1.7% L-arginine) and 3) treatment 2 (3.3% L-arginine). Untrained participants (N=103) evaluated the jerky for acceptability of flavor, texture, taste, saltiness, and overall liking. Samples were examined monthly at room temperature (25°C) during a 6 month period. Each sample was analyzed for amino acid profiles, pH, moisture content, color (L*, a*, and b* values), lipid stability (TBARS), aerobic plate count, *Escherichia coli, Listeria* spp. and *Salmonella* spp. Beef jerky prepared with 3.3% L-arginine was the most desirable with a texture score of 6.29. The pH values for all samples increased (P<0.05) with storage time. The initial L-arginine and moisture content of beef jerky ranged from 2.43% to 8.81% and 37.37% to 41.20%, respectively. Beef jerky prepared with 1.7% L-arginine had the highest (P<0.05) L* lightness (29.97) and a* redness (6.33). The TBARS values were lower in the control treatment at 1.14 mg MDA/kg. Aerobic plate counts decreased by 1.42 log CFU/g with beef jerky prepared with 3.3% L-arginine. No *E. coli, Listeria* spp. or *Salmonella* spp. were detected.

Key Words– Meat product, amino acid, hedonic scale

I. INTRODUCTION

Beef jerky is a popular snack item and is classified by the U.S. Department of Agriculture (USDA) as a heat-treated and shelf-stable ready-to-eat meat product. Jerky is made from a diversity of meat types and additives including table salt (sodium chloride) and spices [3]. Salt enhances the flavor of beef jerky, acts as a preservative and provides sensations termed mouthfeel [4]. However, overconsumption of table salt (sodium chloride) might increase blood pressure, which has been linked to other health concerns, such as hypertension and stroke. Faced with these health issues, many consumers are concerned with limiting their salt intake. Their concerns have likewise influenced food processing manufacturers.

The use of salt alternatives such as L-arginine may reduce sodium content in processed foods. L-arginine is reported to enhance the saltiness of foods with low to moderate levels of salt [2]. Additionally, application of L-arginine in the meat industry can improve flavor [6], color [1] and provide additional protein compared to original beef jerky. To date, no studies have addressed the sensory, physicochemical and microbiological characteristics of beef jerky prepared with L-arginine. The objective of this study is to evaluate specific attributes of beef jerky prepared in three different L-arginine solutions.

II. MATERIALS AND METHODS

Ground beef (80% lean; 20% fat) was purchased from a local market in Lake Charles, Louisiana. Samples were subjected to three treatments and cured using the following L-arginine solutions: 0%, 1.7% and 3.3%. Other ingredients were included: 5.9% Worcestershire sauce (Lea & Perrins Inc., Pittsburgh, PA), 4.2% soy sauce (Kikkoman Foods, Inc., Walworth, WI), 2.5% liquid smoke (The Colgin companies, Mint Way, Dallas, TX), 0.5% garlic powder (Bolner's Flesta Products Inc., San Antonio, Texas), 0.5% onion powder (Kroger Co Cincinnati, Ohio) and 0.2% black pepper (Kroger Co Cincinnati, Ohio). The samples were allowed to cure for 12 hours at 3°C. The cured jerky samples were then dried in a dehydrator (Model 778SS LEM^{TM}) at 70°C for 6 h. After drying, the samples were cooled to ambient

temperature. Each sample was placed into the vacuum packaging. Using a 9-point hedonic scale, one hundred and three untrained participants evaluated the jerky for acceptability of flavor, texture, taste, saltiness, and overall liking. Participants also completed an acceptability and purchase intent questionnaire. Additionally, each sample was analyzed for amino acid profile (Alltech Associates, Inc., Deerfield, IL, USA), pH, moisture content, color (L*, a*, and b* values), lipid stability (TBARS), yeast/mold, aerobic plate count, *Escherichia coli*, *Salmonella* spp. and *Listeria* spp. at room temperature (25°C) during a 6 month experimental period. Raw data was analyzed by Proc GLM procedures [5]. The PDIFF option of LSMEANS was employed to determine significance among treatments. All data are presented as means with standard deviation (SD) and a significance level of $P<0.05$ was used for statistical analysis of means from treatments.

III. RESULTS AND DISCUSSION

Demographic information of the 103 participants in this study are presented in Table 1. All participants were volunteers solicited through advertisements posted in the Agricultural Sciences building on the McNeese State University Campus. The two largest age groups (18-24 and 25-34 years old) accounted for 81.6% of the total. Female participants (67.0%) exceeded males (33.0%).

Table 1 Participants age groups[1]

Age group	Participants	Percentage
18-24	62	60.2
25-34	22	21.4
35-44	6	5.8
45-54	5	4.9
Over 54	8	7.7
Total	68	100.00

[1]Untrained sensory panel

To confirm that participants can distinguish relative saltiness and bitterness, discriminative tests by ranking were performed. Participants were asked to rank the three preparations in order of most to least salty. The control treatment samples received a plurality of 70.9% as the most salty (Table 2). The 3.3% L-arginine samples were rated the most bitter by 56.3% of participants (Table 3). These results suggest that the prepared samples were distinguishable for saltiness and bitterness by the participants.

Table 2 Rank responses for saltiness[1]

Jerky Treatments	Participants (N = 103) Number/Percentage		
	1st Most salty	2nd Most salty	3rd Most salty
Control	73/70.9	21/20.4	9/8.7
Treatment 1	12/11.7	43/41.7	48/46.6
Treatment 2	18/17.5	39/37.8	46/44.7

[1]Untrained sensory panel

Table 3 Rank responses for bitterness[1]

Jerky Treatments	Participants (N = 103) Number/Percentage		
	1st Most bitter	2nd Most bitter	3rd Most bitter
Control	25/24.3	37/35.9	41/39.8
Treatment 1	20/19.4	45/43.7	38/36.9
Treatment 2	58/56.3	21/20.4	24/23.3

[1]Untrained sensory panel

Using the hedonic scale, 103 untrained participants evaluated the jerky for flavor, texture, taste, saltiness, and overall liking (Table 4). With respect to texture, beef jerky prepared with 3.3% L-arginine was the most desirable with a score of 6.29.

Table 4 Mean consumer acceptance scores for sensory attributes and overall liking of three salt solutions[1]

Properties	Control	Treatment 1	Treatment 2
Flavor	6.60^{a}	5.75^{b}	5.76^{b}
Texture	6.26^{a}	5.91^{a}	6.29^{a}
Taste	6.79^{a}	5.75^{b}	5.72^{b}
Saltiness	6.08^{a}	5.32^{b}	5.47^{ab}
Overall liking	6.56^{a}	5.60^{b}	5.50^{b}

[a,b,c] Means with different superscripts within a same row is significantly different ($P<0.05$). [1]Untrained sensory panel

Using the acceptability and purchase intent questionnaire, participants evaluated the jerky for acceptability, whether or not they would purchase the product and whether or not they would purchase the product if it claimed to

contain reduced sodium, which might impact blood pressure (Table 5). The control samples received the highest scores of 80.6% for acceptability. Finally, with respect to purchase intent and whether or not the participants would purchase the product if it claimed to contain reduced sodium, the jerky samples prepared with 1.7% L-arginine scored the highest at 64.1% and 56.3%, respectively (Table 5). Once again, these results suggest that jerky prepared with L-arginine is a viable alternative to jerky treated exclusively with NaCl.

Table 5 Acceptability and purchase intent questionnaire (N= 103)[1]

	Control	Treatment 1	Treatment 2
Acceptable			
Yes	83/80.6	71/68.9	66/64.08
No	20/19.4	32/31.1	37/35.92
Purchase			
Yes	61/59.2	66/64.1	57/55.3
No	42/40.8	37/35.9	46/44.7
Purchase + health claim[2]			
Yes	N/A	58/56.3	52/50.5
No	N/A	45/43.7	51/49.5

[1]Untrained sensory panel
[2]Reduced sodium jerky

Samples were analyzed for amino acid concentration (Table 6). Amino acid concentration remained stable across treatments except L-arginine which ranged from 2.43% to 8.81% (Table 6).

Percent moisture content declined ($P<0.05$) over 6 month storage (Fig. 1). Specifically, beef jerky prepared with 3.3% L-arginine had the lowest moisture content at 34.57%.

The pH values for all samples increased ($P<0.05$) with storage time (Fig. 2). Beef jerky with 1.7% L-arginine had the highest ($P<0.05$) pH at 7.35 over a six month period.

Table 6 Amino acid profiles in three different preparations of beef jerky

Amino acid profile (%)	Control	Treatment 1	Treatment 2
Crude protein	35.43	48.67	53.63
L-arginine	2.43	5.47	8.81
Glutamine	4.52	5.73	5.21
Asparagine	2.95	3.32	3.02
Lysine	2.65	2.93	2.67
Leucine	2.64	2.89	2.68
Glycine	2.27	2.67	2.64
Alanine	2.05	2.23	2.16
Valine	1.90	2.04	1.92
Isoleucine	1.64	1.81	1.65
Threonine	1.43	1.66	1.48
Phenylalanine	1.37	1.53	1.41
Serine	1.27	1.51	1.36
Tyrosine	1.09	1.23	1.12
Histidine	1.00	1.14	1.07
Methionine	0.52	0.72	0.65
Cysteine	0.25	0.32	0.30
Tryptophan	0.22	0.33	0.30

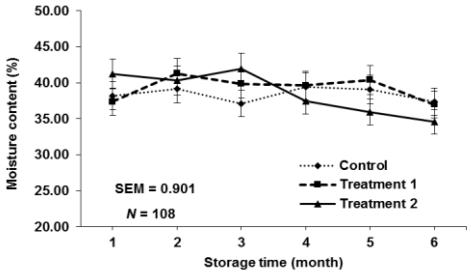

Figure 1. Moisture content (%) of beef jerky at room temperature (25°C) for 6 months.

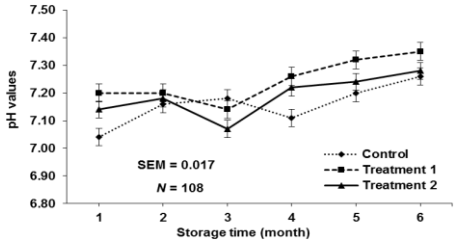

Figure 2. pH value of beef jerky at room temperature (25°C) for 6 months.

Beef jerky with 1.7% L-arginine had highest the lightness L* values at 29.97 over experimental period (Fig. 3). Redness (a*) values are good indicators of color acceptability. Samples with 1.7% L-arginine had highest a* values at 6.33 (Fig. 4).

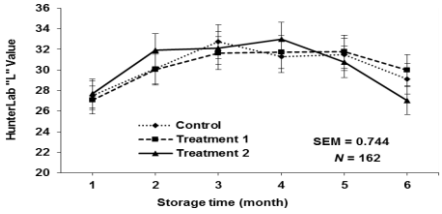

Figure 3. L* value of beef jerky at room temperature (25°C) for 6 months.

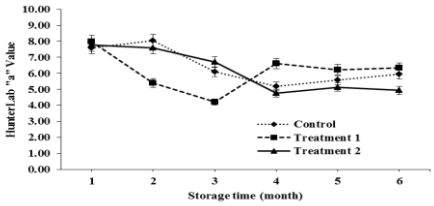

Figure 4. a* value of beef jerky at room temperature (25°C) for 6 months.

The TBARS values were statistically significant ($P<0.05$) for each of the three treatments (Fig. 5). The TBARS values were lower in the control treatment at 1.14 mg MDA/kg.

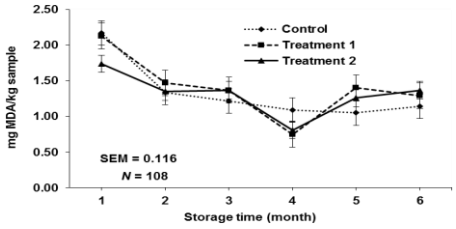

Figure 5. TBARS value of beef jerky at room temperature (25°C) for 6 months.

Aerobic plate counts ranged from 1.0 to 3.42 log CFU/g over 6 month storage. Aerobic plate counts decreased by 1.40-1.42 log CFU/g with beef jerky prepared with L-arginine (Fig. 6). No *E. coli*, *Listeria* spp. or *Salmonella* spp. were detected throughout the storage time. This study provides valuable insight into the quality, safety, shelf-life and consumer acceptance of beef jerky with L-arginine.

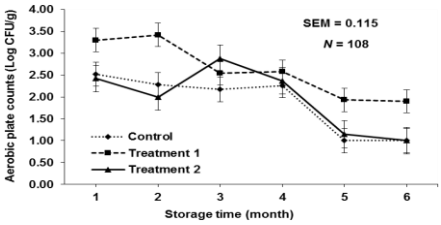

Figure 6. Aerobic plate count of beef jerky at room temperature (25°C) for 6 months.

IV. CONCLUSION

The results of this study suggest that beef jerky prepared with L-arginine is a viable alternative to jerky prepared exclusively with NaCl. Beef jerky prepared with L-arginine improved meat color and reduced populations of aerobic bacteria when stored in vacuum packaging for 6 months at room temperature (25°C).

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