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Development and Consumer Acceptance of Pre-cooked Goat Roasts[1]

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Summary

The objective of this study was to develop a palatable, pre-cooked goat roast. Goat legs (n = 64) were fabricated into 220 roasts and assigned to one of four spice treatments: control (CON), Italian, Mexican, prime rib. After being injected with a 15-percent brine mixture, roasts were smoked to an internal temperature of 63°C, vacuum packaged, and frozen at -10°C. Roasts were thawed and reheated one of three ways (conventional oven, microwave oven, or boiling) and served to a trained sensory panel to determine differences in reheating method. The trained panel rated roasts boiled lower ($P < 0.05$) for initial and sustained juiciness and tenderness than roasts reheated in the microwave or conventional oven. The trained panel rated the prime rib spice juiciest, most tender, most flavorful, and the best in overall acceptability. The control treatment (CON) was rated higher ($P < 0.05$) for goat flavor, warmed-over flavor, and flavor intensity by the trained panelists. Upon completion of the trained sensory panel, a consumer panel was conducted to determine differences in treatments. Consumer panelists (n = 200) were served samples of roasts to determine preferred spice blend. Consumers rated the prime rib spice the highest ($P < 0.05$) for all palatability attributes and the Italian roasts the lowest ($P < 0.05$). This study indicated the prime rib spice treatment was preferred most often for tenderness, juiciness, flavor, and overall liking by both trained sensory panelists and consumer panelists. Therefore, roasts seasoned with the prime rib rub appear to have the most market potential.

Key words: Goat, Pre-cooked Roasts, Flavor, Reheating Method

Introduction

The demand for new, red-meat products, especially convenient, pre-cooked items, is greatly increasing (Resurreccion, 2003). The red-meat industry, especially the beef and pork industries, has taken steps to develop products that are not only low in fat, but also quick, easy, and convenient to prepare and accommodate the changing lifestyles of consumers (Nayga, 1993). However, little research has been done to develop a convenient, pre-cooked goat meat product.The meat goat industry could benefit from gaining red-meat-consumption market share by providing consumers with a high-quality, convenient product.

Meat goats have been used primarily as a control of noxious plants or as part of multi-species grazing systems without much emphasis on meat production (Glimp, 1995). However, recently the demand for goat meat has increased. In 2001, 10.9 million kg of goat meat were produced and consumed in the United States and another 5.7 million kg were imported (Shurley, 2002). Currently, live meat goats are sold directly to consumers, or to brokers who in turn sell the animal directly to consumers, or goat processors sell goat meat to retail stores that cater to various ethnic groups (Cosenza et al., 2003). With little goat meat offered at major retail stores and very few consumers who know how to prepare goat, the industry could benefit by the introduction of a convenient, pre-cooked product that could establish a continuous market share. Therefore, the objective of this study was to develop a palatable, convenient pre-cooked goat roast.

Table 1. Ingredient list of three different spice blends and the percentage of each spice for goat roasts.

Italian	Mexican	Prime Rib
Italian spice (37.5%)	Coriander (12.5%)	Prime rib rub[a]
Rosemary (6.25%)	Paprika (20%)	
Oregano (12.5%)	Garlic powder (15%)	
Savory (6.25%)	Ground pepper (20%)	
Ground pepper (37.5%)	Cumin (12.5%)	
Salt (20%)		

[a] AC Legg Blend RF-04-161-000 (Calera, AL).

Materials and Methods

Preparing the Roasts

Goat legs (n = 64) were purchased from Texas Tech University (Lubbock, Texas) and transported to the Angelo State University Food Safety and Product Development Center (San Angelo, Texas) for further processing. Legs were cut into 5.08 cm roasts (n = 220 roasts) with a bandsaw. Roasts were trimmed of any external fat, and the seam fat containing the popliteal lymph node was removed. All roasts were injected with a 15 percent injection of a brine mixture of water, 0.05 percent phosphate, and 1 percent salt using a Gunther Pickler Injector (model P1632, Koch Supplies, Inc., Kansas City, Mo.). After the roasts were injected, they were allowed to drain for 10 minutes at 2°C. Three spice blends (Table 1) were formulated (55 roasts/spice blend), and 55 roasts were used as a control group. The roasts were randomly assigned to one of four spice treatments: control (CON), Italian, Mexican, and prime rib. Immediately after all roasts were rubbed, they were cooked and smoked in a smokehouse (model 1000, Alkar Corporation, Lodi, Wis.) to an internal temperature of approximately 63°C to achieve a medium-rare degree of doneness (AMSA, 1995). The smoke cycle consisted of two stages. Stage 1 lasted for 1.5 h, with the dry bulb set at 65°C and the wet bulb set at 38°C for a relative humidity of 18.5 percent. Stage 2 was set to cook to an internal core temperature of 63°C, with the dry bulb set at 74°C and the wet bulb set at 60°C to equal a 50 percent relative humidity. After cooking, the roasts were chilled to 2°C, vacuum packaged, and frozen at -10°C for 21 to 25 d.

Trained Sensory Panel

Trained sensory panel analysis was conducted on 120 roasts (30 roasts/treatment) to determine the ideal reheating method and to detect differences between spices for differing palatability characteristics. The roasts were thawed at 2°C for 24 h and reheated to an internal temperature of approximately 63°C in one of three ways (10 roasts/treatment/reheat method): conventional oven, microwave, and boiling. A conventional oven was preheated to 163°C, four roasts were placed in an aluminum pan, and 250 mL of distilled water was placed in the bottom of the pan. Two roasts were placed on paper plates, covered with wax paper, and reheated in a microwave at 1100 watts for 4.5 min (model JES1036PWH, General Electric, Louisville, Ky.). Boiling involved placing each individual roast into unsealed bags and placing them into pots containing two liters of distilled water. After reheating, roasts were cut into 1 cm x 1 cm x 5.08 cm pieces, placed into serving pans, and kept at 60°C. Samples were served warm to an eight-member panel trained as recommended by Cross et al. (1978). Panelists evaluated the samples based on an 8-point hedonic scale involving initial and sustained juiciness, initial and sustained tenderness, flavor intensity, characteristic goat flavor, and overall acceptability (8 = extremely juicy, tender, intense, characteristic goat flavor, and like extremely; 1 = extremely dry, tough, bland, uncharacteristic goat flavor, and dislike extremely). Panelists also evaluated the samples for warmed over flavor (WOF) based on a 5-point hedonic scale (1 = no WOF; 5 = extreme WOF). Samples were served under red lights to mask color differences, and panelists were given apple juice and water to cleanse their palates between samples. Results from the trained panel were used to determine the most appropriate reheating method for the consumer panel.

Consumer Panel

The remaining 25 roasts per treatment were used for the consumer panel. Consumers (n = 200) at the Taste of San Angelo Food Festival were asked to participate in the study to determine which

spice blend was preferred. Each consumer tasted samples from each treatment. Trained panelists detected no differences between microwave and oven reheating methods for palatability traits, so a microwave was used for ease of resources to serve consumers. Roasts were thawed at 2°C for 2 d and then reheated for 4.5 min using an 1100 watt microwave (model JES1036PWH, General Electric, Louisville, Ky.). Roasts were cut into 1.5 cm x 1.5 cm x 5.08 cm pieces, placed into serving pans, and kept at 60°C. Panelists tasted each sample to determine juiciness, tenderness, flavor, and overall liking (6-point scale from 1=like extremely to 6=dislike extremely). Also, the panelists were asked their likelihood to buy the roast (5-point scale from 1=definitely would buy to 5=definitely would not buy) if it was available in a grocery store. After tasting all four samples, consumers were asked which sample they preferred the least and the most. In addition, the consumers were asked to answer demographic questions including: marital status, gender, ethnicity, age, household income level, and how many times they have consumed goat in the last month.

Statistical Analysis

Data from the trained sensory panel were analyzed using the GLM procedure of SAS (2003), as a 3 x 4 factorial design (three cooking methods and four spice blends) with individual roast as the experimental unit. Cooking method x spice blend interaction was analyzed in the original model but no significance was found. Least-square means were computed for each dependent variable, and statistically separated by pair-wise t-test (PDIFF option of SAS) with predetermined $\alpha = 0.05$.

Data from the consumer panel were analyzed using the GLM procedure of SAS as a completely randomized design with spice blend as the treatment and individual roast sample as the experimental unit. Least-square means were computed for each dependent variable, and statistically separated by pair-wise t-test with predetermined $\alpha = 0.05$. Also, comparisons of frequencies from consumer panelists' responses were tested for significance ($\alpha \leq 0.05$) using Chi-Square tests.

Table 2. Least square means and standard errors for goat roasts of sensory panel ratings for different reheating methods.

		Reheating Method		
Trait	Boil	Microwave	Oven	SEM
Initial juiciness[c]	5.64[b]	6.09[a]	6.10[a]	0.09
Sustained juiciness[c]	6.16[b]	6.55[a]	6.64[a]	0.08
Initial tenderness[d]	6.10[b]	6.48[a]	6.61[a]	0.09
Sustained tenderness[d]	6.59[b]	6.92[a]	7.03[a]	0.08
Flavor intensity[e]	6.08	6.21	6.07	0.05
Goat flavor[f]	3.59	3.55	3.54	0.07
Overall acceptability[g]	6.00[b]	6.28[a]	6.39[a]	0.09
Warmed-over flavor(WOF)[h]	1.05	1.03	1.01	0.01

[ab] Means in a row with different superscripts differ ($P < 0.05$).
[c] 1 = extremely dry; 8 = extremely juicy.
[d] 1 = extremely tough; 8 = extremely tender.
[e] 1 = extremely bland; 8 = extremely intense.
[f] 1 = extremely uncharacteristic; 8 = extremely characteristic.
[g] 1 = dislike extremely; 8 = like extremely.
[h] 1 = no WOF; 5 = extreme WOF.

Results and Discussion

Trained Sensory Panel

When compared to the other two reheating methods, sensory panel scores were lower ($P < 0.05$) for initial juiciness, sustained juiciness, initial tenderness, sustained tenderness, and overall acceptability when goat meat was reheated by boiling (Table 2). These results differ from results reported by Kellermeier et al. (2006), who found no differences ($P > 0.05$) in reheating methods for pre-cooked lamb roasts. No differences ($P > 0.05$) were found among reheating methods for characteristic goat flavor, flavor intensity and WOF. In

Table 3. Least square means and standard errors for goat roasts of sensory panel ratings for different spice blends.

			Treatment		
Trait	CON[k]	Italian[l]	Mexican[m]	Prime Rib[n]	SEM
Initial juiciness[e]	5.30[c]	5.56[c]	6.24[b]	6.69[a]	0.11
Sustained juiciness[e]	5.82[c]	6.01[c]	6.73[b]	7.16[a]	0.10
Initial tenderness[f]	5.85[c]	6.21[b]	6.67[a]	6.85[a]	0.11
Sustained tenderness[f]	6.35[c]	6.71[b]	7.07[a]	7.26[a]	0.11
Flavor intensity[g]	5.42[d]	6.03[c]	6.30[b]	6.73[a]	0.06
Goat flavor[h]	5.45[a]	2.85[b]	3.05[b]	2.89[b]	0.08
Overall acceptability[i]	5.51[d]	5.82[c]	6.55[b]	7.00[a]	0.10
Warmed-over flavor(WOF)[j]	1.11[a]	1.01[b]	1.00[b]	1.01[b]	0.02

[abcd] Means in a row with different superscripts differ ($P < 0.05$).
[e] 1 = extremely dry; 8 = extremely juicy.
[f] 1 = extremely tough; 8 = extremely tender.
[g] 1 = extremely bland; 8 = extremely intense.
[h] 1 = extremely uncharacteristic; 8 = extremely characteristic.
[i] 1 = dislike extremely; 8 = like extremely.
[j] 1 = no WOF; 5 = extreme WOF.
[k] CON = Control.
[l] Italian = Italian spice, rosemary, oregano, savory, ground pepper.
[m] Mexican = Coriander, paprika, garlic powder, ground pepper, cumin, salt.
[n] Prime rib = AC Legg Blend RF-04-161-000 (Calera, AL).

contrast, Lyon and Ang (1990) reported that pre-cooked chicken patties varied in their WOF development when heated in either a microwave or a convection oven. Goat may have less WOF development because it is relatively low in fat, and unsaturated fats have been shown to be a major cause of WOF.

A significant difference was found between spice blends for initial juiciness, sustained juiciness, initial tenderness, sustained tenderness, flavor intensity, characteristic goat flavor, overall acceptability, and WOF (Table 3). For both initial and sustained juiciness, prime rib was the juiciest ($P < 0.05$) followed by Mexican. No significant differences were found between the CON or Italian treatments for initial or sustained juiciness. No differences ($P > 0.05$) were found between the prime rib and Mexican treatments for initial or sustained tenderness. Roasts from the CON treatment were the least tender ($P < 0.05$), as indicated by both initial tenderness and sustained tenderness, when compared to the other treatments. Roasts from the CON treatment had the lowest flavor intensity score, most characteristic goat flavor, and highest WOF score ($P < 0.05$). Higher WOF scores may be attributed to the absence of spices. Many of the spices used in this study have antioxidative properties that retard WOF. Common spices with antioxidative properties include rosemary (Brewer and Decker, 1998), cumin, pepper, and garlic products (Rhee and Myers, 2003). Rhee and Myers (2003) also showed trained sensory panelists detected increasing "cardboard" aromatic intensity in a plain goat meat loaf as compared to a chili seasoned goat meat. Prime rib was rated the most acceptable overall, followed by Mexican, Italian, and CON ($P < 0.05$).

Table 4. Demographic characteristics of consumers attending the Taste of San Angelo who sampled goat roasts.

Trait	No.[a] of consumers	Percent
Gender		
Male	103	52.28
Female	94	47.72
Marital Status		
Married	88	44.90
Single	108	55.10
Ethnicity		
Caucasian	142	72.08
Hispanic	44	22.34
African-American	6	3.05
American-Indian	2	1.02
Other	3	1.52
Age, yr		
18 to 25	71	36.04
26 to 35	32	16.24
36 to 45	36	18.27
46 to 55	33	16.75
56 to 65	19	9.64
Over 65	6	3.05
Household Income Level		
<$10,000	43	22.99
$10,000 to 14,999	4	2.14
$15,000 to 24,999	1	0.53
$25,000 to 34,999	36	19.25
$35,000 to 49,999	31	16.58
$50,000 to 74,999	28	14.97
$75,000 to 99,999	25	13.37
>$99,999	19	10.16
Goat Consumption[b]		
0	146	74.49
1 to 3	40	20.40
4 to 6	8	4.08
Over 7	2	1.02

[a] Not all consumers who participated in the study provided complete data.
[b] Number of times consumers have consumed goat in previous month.

Consumer Panel

Table 4 shows the demographic characteristics of the 200 consumers that participated in the study. The percentages and numbers are based on consumer responses; however, not all consumers completed all the questions. Fifty-two percent of those surveyed were male while 48 percent were female. Forty-five percent of participants were married, and 55 percent were single. Caucasian (72 percent) and Hispanic (22 percent) were the most common ethnic groups represented. The majority of the participants reported a household income level of $25,000 or more. Seventy-five percent of the participants had not consumed goat in the previous month, 20 percent had consumed goat one to three times in the past month, and 5 percent had eaten goat four or more times in the past month.

Results from the consumer survey show roasts with prime rib and Mexican spice were not different ($P > 0.05$) in tenderness (Table 5). Roasts from the CON and Italian treatments were less tender ($P < 0.05$) than prime rib and Mexican roasts, but not statistically different when compared to each other. Consumers rated prime rib the most tender, juiciest, most flavorful, and the highest for overall liking ($P < 0.05$). Kellermeier et al. (2006) determined that consumers also prefer lamb seasoned with prime rib spice over other spice blends. Roasts with Italian spices were rated lowest ($P < 0.05$) for tenderness, juiciness, flavor, and overall liking. However, Kellermeier et al. (2006) found consumers preferred lamb seasoned with Italian spice over lamb seasoned with Mexican spice or not seasoned. Consumers rated roasts with prime rib spices the most likely to buy, followed by Mexican then CON ($P < 0.05$). Italian roasts were rated least

Table 5. Least square means and standard errors for goat roasts of consumer panel ratings for different spice blends.

	Treatment				
Trait	**CON[f]**	**Italian[g]**	**Mexican[h]**	**Prime Rib[i]**	**SEM**
Tenderness[d]	2.30[b]	2.43[b]	1.82[a]	1.68[a]	0.08
Juiciness[d]	2.38[c]	2.72[d]	2.08[b]	1.81[a]	0.08
Flavor[d]	2.82[c]	3.26[d]	2.17[b]	1.83[a]	0.08
Overall liking[d]	2.79[c]	3.24[d]	2.16[b]	1.90[a]	0.08
Likelihood to buy[e]	2.79[c]	3.23[d]	2.24[b]	1.82[a]	0.08

[abc] Means in a row with different superscripts differ ($P < 0.05$).
[d] 1 = Like extremely; 6 = Dislike extremely.
[e] 1 = Definitely would buy; 5 = Definitely would not buy.
[f] CON = Control.
[g] Italian = Italian spice, rosemary, oregano, savory, ground pepper.
[h] Mexican = Coriander, paprika, garlic powder, ground pepper, cumin, salt.
[i] Prime rib = AC Legg Blend RF-04-161-000 (Calera, AL).

likely to buy. Fifty-seven percent of the participants liked prime rib the most followed by Mexican (26 percent), CON (12 percent), and Italian (7 percent). When asked which they liked the least, 49 percent of consumers reported Italian followed by CON (33 percent), Mexican (11 percent), and prime rib (7 percent).

Implications

The results of this study revealed roasts from goat legs can be processed and sold at retail as a pre-cooked product, which would increase the value of these primal cuts. Certain spices have the ability to enhance overall flavor and improve palatability characteristics held in high regard by consumers. Hopefully, goat market-share could improve by marketing a pre-cooked goat product, especially one with prime rib spice that is palatable and convenient. Results from the current study are in agreement with previous research showing tenderness and flavor to be the two most important factors for determining overall eating satisfaction in red meat. These products should improve the overall eating quality of goat and appeal to a large number of new consumers because of palatability and convenience of preparation.

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