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EFFECT OF RIGOR STATE AND CURING TIME ON QUALITY OF GOAT HAM

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Target audience: Animal scientists, meat scientists, meat processors.

ABSTRACT

Twelve West African Dwarf goats were slaughtered in this study. They were divided into two main units of pre- and post-rigor treatments. The main units were further treated in a split plot design to study the effects of three curing times on quality and yield of goat ham. Yields of pre- and post-rigor hams were similar at each processing step except the cooking yields which were higher with pre-rigor hams. Both rigor state and curing time significantly affected the moisture and protein contents of the hams as well as their pH, water holding capacity and residual nitrite levels. However, the rigor state had no effect on the salt content. Products cured for two days were tougher than products cured for four and six days respectively. Colour score was higher for hams cured for a long time than those cured for a short time. In the overall assessment of the samples, products cured for four days were the most acceptable by sensory panel members

Key words: Chemical composition; pH; residual nitrite; sensory attributes; water holding capacity.

DESCRIPTION OF PROBLEM

The goat is adapted to wide climatic conditions and can successfully survive in hot, arid and semi-arid zones which are unsuitable for other livestock. The world goat population is estimated to be 501 million, 140 million of which inhabit Africa (1). In Nigeria, goats make a valuable contribution to the production of meat. Using a 1993 herd population of 34.5 million goats in Nigeria as baseline, Istifanus et al. (2) projected an animal protein yield of 17.76 million kg by the year 2010.

Currently, goat meat is eaten in the form of 'stews' and 'pepper soup' and in the traditional processing of intermediate moisture foods like tsire and balangu. However, little information is available on the use of goat meat in further processed meat products in the subregion. The accelerated

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processing of meat in the pre-rigor state has been widely studied but entirely in association with pork and beef. In harnessing the substantial goat meat potential for further processing in the subregion, this study evaluates the effect of rigor and curing time on the composition and palatability of goat hams.

MATERIALS AND METHODS

Twelve West African Dwarf goats with live weight ranging from 15 to 20 kg were conventionally slaughtered in four batches of three. One goat from each batch was slaughtered at a time at two days intervals. The meat from each of the two hind legs from the goat was assigned at random to either pre- or post-rigor curing treatments. Pre-rigor curing was carried out within two hours following the exsanguination of the animal. The leg from one half of each carcass was injected with curing brine containing 10 g nitrite salt, 2.5 g dextrose and 2.5 g phosphate in 100 ml solution to 115 % of its green weight using a two needle injection pump model Gudin type 2.

The injected leg was then held in a cover pickle (same concentration as the injected brine) for either 2, 4 or 6 days, as determined by the time of slaughter, in a cooler at 2 ^{o}C. After curing, the leg was held out of the pickle in the same cooler for an additional two days for salt equalization. The remaining three legs from the other halves of the carcasses in each batch were processed post-rigor after holding for 24 h in a cooler at 2 ^{o}C. The processing was for the pre-rigor samples, except that equalization period was for 24 h. The slaughtering, curing and equalization schedule allowed for simultaneous evaluation of meat from the six treatments,

The legs were cooked at 85 ^{o}C in a water bath to an internal temperature of 72 ^{o}C using an electric cooker (model Corpo 60). During cooking, the internal temperature of the ham was monitored with a glass thermometer inserted into the centre of the sample. After cooking, the hams were rapidly showered with tap water and then stored in a cooler at 2 ^{o}C until the following day when analyses were carried out. Hams were weighed at each processing step to determine respective product yields. After cooking and cooling, each ham was allowed to drain for 10 min prior to weighing. Percent cooking loss was determined by taking the weight of each ham before and after cooking and cooling and comparing the difference in weight with the original weight.

All analyses were carried out on samples taken from the quadriceps femoris and ground through a 3 mm plate (Kitchen Aid Grinder, Model K4.B.). Moisture content was determined by oven drying; protein by Kjeldahl nitrogen estimation; fat by soxhlet extraction with petroleum ether and ash by incineration at 525 ^{o}C (3). For pH measurement, 10 g of each ground meat sample taken prior to and after cooking was homogenised in 90 ml of distilled deionised water. The pH was measured with a pH meter (model Jenway 3420). Water holding capacity (WHC) was carried out using a centrifuge (model Biobloc Scientific T62-1) according to the method described by Wierbicki et al. (4). Salt accumulation was determined as the chloride (3). Residual nitrite was extracted from 5 g minced sample with hot water and was estimated following the procedure described by Walter et al. (5).

Meat from the semimembranosus muscle from each treatment was cut into bite size samples and were subsequently evaluated by a fifteen member sensory evaluation panel. Samples were scored on a nine-point Hedonic scale ranging from 1 for dislike extremely (flavour, overall acceptability), extremely dry (juiciness), extremely tough (tenderness), extremely white (colour), extremely salty (saltiness) to 9 for like extremely for flavour and overall acceptability, extremely juicy, extremely tender, extremely pink and extremely tasteless respectively.

The data collected were subjected to analysis of variance (6) while differences between means were analysed by Duncan's Multiple Range Tests (7).

RESULTS AND DISCUSSION

As the curing time increased from two to six days, there was a corresponding increase in the percent yield of the hams at the end of the curing period and after cooking (Fig. 1). This observation was probably due to the extra uptake of salt and sugar which was retained during processing, thus increasing water retention. Maximum cured uptake was probably not attained with short time cure. Consequently the hams cured for two days suffered more cooking losses than those cured for either four or six days. In all the treatment groups, the least cooking loss was observed with pre-rigor meat. Cia and Marsh (8) reported that beef samples cooked at a higher initial pH suffered appreciably smaller losses than those cooked at a low initial pH.

Data presented in Table 1 are means for proximate analysis of the raw and cooked hams. As the moisture content of the products increased with the increase in the curing time, there was a decrease in protein content of the products with the lowest protein content corresponding to the products cured for six days. It was also found that the protein content of the pre-rigor ham was significantly ($P < 0.05$) less than that obtained for the post-rigor ones. The difference in the protein content of the products could be attributed to the difference in the moisture content of the products rather than to the denaturation of the protein by salts. The highest ash content found in the product cured for a long time was probably due to the high salt uptake during curing. Such salts are detected in the ash (9).

Means for pH, WHC, cooking loss, sodium chloride and residual nitrite are shown in Table 2. The state of rigor or the curing time significantly affected these parameters ($P < 0.05$) but salt content was unaffected by the state of rigor. Seman et al. (10) have demonstrated that salting of the pre-

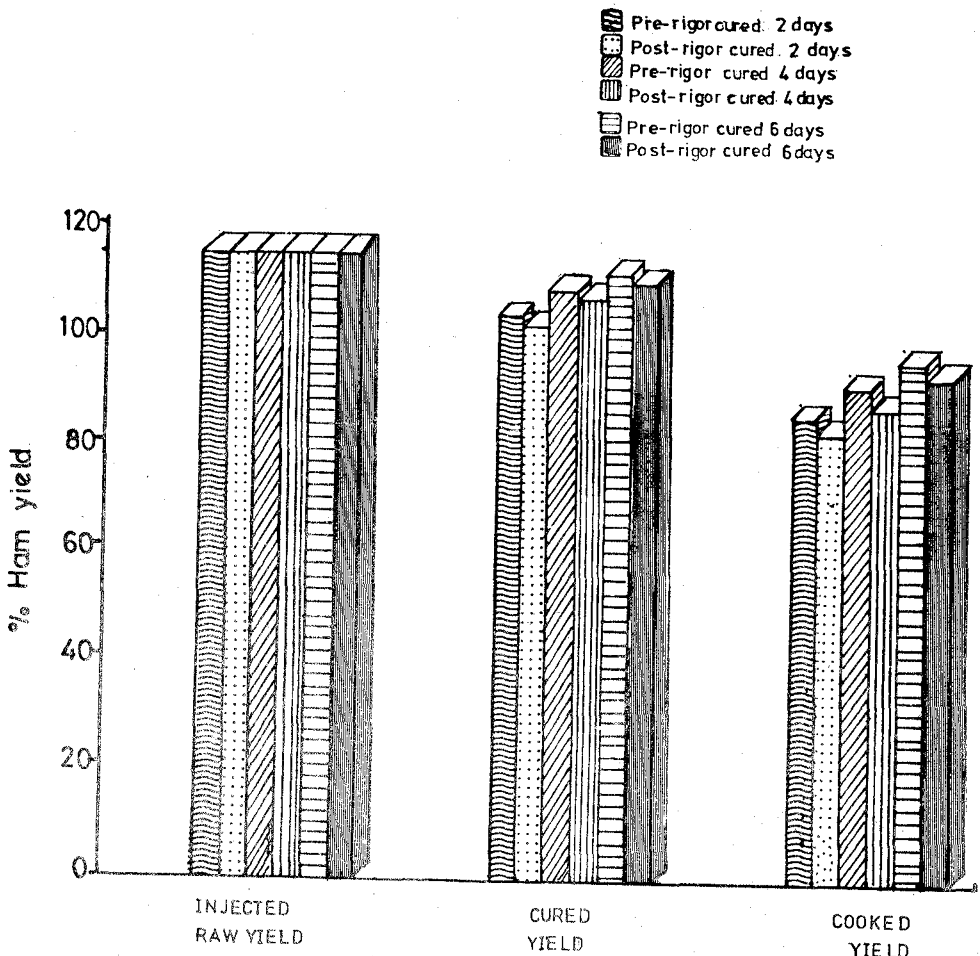

Fig.1. Yield of ham at each processing step as percentage of the green ham weight.

TABLE 1: Effect of Rigor State and curing time on composition of raw and **cooked Goat Hams**

		Curing time (days)					
		2		4		6	
		Mean	SD	Mean	SD	Mean	SD
RAW HAM							
Moisture %	Pre	74.32	0.82^{cd}	75.81	1.08^{bd}	76.93	0.76^{ad}
	Post	72.10	0.89^{ce}	73.94	1.12^{be}	75.48	0.93^{ae}
Fat %	Pre	2.36	0.36	2.30	0.38	2.83	0.93
	Post	2.20	0.54	2.13	0.24	2.70	0.45
Protein %	Pre	21.09	0.76^{ad}	19.04	1.05^{bd}	17.15	1.07^{cd}
	Post	22.83	1.08^{ae}	20.68	0.86^{be}	18.7	0.75^{ce}
Ash %	Pre	2.50	0.40^{c}	3.32	0.35^{b}	4.30	0.47^{a}
	Post	2.92	0.35^{c}	3.50	0.30^{b}	4.76	0.41^{a}
COOKED HAM							
Moisture %	Pre	68.25	0.68^{cd}	69.92	0.92^{bd}	71.04	0.91^{ad}
	Post	66.11	1.03^{ce}	67.78	1.09^{be}	69.61	0.87^{ae}
Fat %	Pre	2.95	0.69	3.06	0.77	2.56	0.78
	Post	2.65	0.48	2.91	0.65	2.98	0.92
Protein %	Pre	25.85	0.80^{ad}	23.86	0.78^{bd}	20.80	0.79^{cd}
	Post	26.04	0.58^{ae}	25.25	0.98^{be}	22.70	1.07^{ce}
Ash %	Pre	2.46	0.40^{c}	3.26	0.35^{b}	4.28	0.40^{a}
	Post	2.80	0.39^{c}	3.45	0.52^{b}	4.68	0.46^{a}

^{abc} Means on the sameline with different superscripts are significantly different ($P < 0.05$) (Comparison of the effect of curing time).

^{de} Means on the same column with tests and rigour state with different superscripts are significantly different ($P < 0.05$) (Comparison of pre vs post-rigor processing).

rigor meat causes an inhibition of glycolysis resulting in a higher pH and WHC compared to that of the salted post-rigor meat. The higher pH and possibly higher salt content of the products cured for a long time probably accounted for the greater improvement in the WHC over that of the short cured product. The influence of pH on WHC has been demonstrated by Bouton et al. (11). Trout et al. (12) showed that increasing salt concentration from 1.33 to 2.93 % increased the WHC of the corresponding products.

The differences in salt content of the products cured for different curing time reflected the differences in ash values found between treatments. As in this study, other workers (13) have reported that percent chloride in dry-cured hams was not affected by boning time. The same authors also indicated that residual nitrite levels were higher in hot boned dry-cured hams than in cold boned counterparts. In contrast to our results, Owen (14) did not find any significant difference between residual nitrite levels of smoked cooked chickens cured for 12 to 18 h. The difference in residual nitrite obtained for the various products in this study could be due primarily to the difference in myoglobin and metmyoglobin pigment of the products.

Table 2: Effect of Rigor State and curing time on Physical, Chemical, and Sensory Properties of Goat Ham.

PHYSICAL AND CHEMICAL		Curing time(days) 2		4		6	
		Mean	SD	Mean	SD	Mean	SD
pH Raw	Pre	6.40	0.13[bd]	6.53	0.23[abd]	6.76	0.17[ad]
	Post	6.09	0.11[be]	6.21	0.13[abe]	6.41	0.13[ae]
pH cooked	Pre	6.54	0.15[bd]	6.68	0.16[abd]	6.86	0.14[ad]
	Post	6.21	0.20[be]	6.37	0.14[abe]	6.54	0.21[ae]
WHC %	Pre	54.73	2.07[cd]	58.18	1.87[bd]	64.18	2.03[ad]
	Post	51.75	1.68[ce]	54.01	1.63[be]	60.35	2.6[ae]
Cooking loss %	Pre	17.14	0.09[ad]	15.60	0.89[bd]	14.53	0.90[cd]
	Post	20.23	1.09[ae]	18.31	0.75[be]	16.12	0.87[ce]
NaCl %	Pre	1.98	0.44[c]	2.56	0.41[b]	3.11	0.46[a]
	Post	2.09	0.35[c]	2.77	0.13[b]	3.26	0.20[a]
$NaNO_2$ ppm	Pre	110.50	2.20[cd]	125.23	2.88[bd]	147.35	2.87[ad]
	Post	104.81	3.28[ce]	118.55	2.90[be]	137.85	2.60[ae]
SENSORY							
Flavour	Pre	5.28	0.60[a]	5.65	0.40[a]	4.95	0.50[b]
	Post	5.32	0.50[a]	5.68	0.65[a]	4.80	0.47[b]
Juiciness	Pre	5.12	0.35	5.40	0.55	5.55	0.60
	Post	5.15	0.45	5.30	0.40	5.50	0.65
Tenderness	Pre	4.35	0.47b	5.25	0.60[a]	5.50	0.40[a]
	Post	4.28	5.50[b]	5.40	0.70[a]	5.45	0.50[a]
Colour	Pre	5.04	0.40[c]	5.95	0.55[b]	6.94	0.45[a]
	Post	5.20	0.35[c]	5.92	0.40[b]	6.89	0.65[a]
Saltiness	Pre	4.60	0.50[a]	4.45	0.55[a]	3.17	0.38[b]
	Post	4.65	0.37[a]	4.58	0.47[a]	3.24	0.45[b]
Overall acceptability	Pre	4.95	0.60[b]	5.85	0.50[a]	4.50	0.45[b]
	Post	4.93	0.40[b]	6.04	0.65[a]	4.62	0.55[b]

[abc] Means on the same line with different superscrips are significantly different ($P < 0.05$).

de As in Table 4

Data for sensory evaluation are presented in Table 2 Sensory characteristics of the hams were not affected by the state of rigor during processing. These findings are at variance with the work of Chow et al. (15) who reported that the pre-rigor processed shoulders differed from those of the post-rigor processed ones. Except for juiciness, the other sensory characteristics of the hams were affected by the time of curing the hams. In contrast, organoleptic quality of smoked chickens was not affected by curing time (14). As judged by the overall acceptability scores, the products cured for four days were the most accepted by the panelists. Chemical analysis showed these products to contain an average of 2.66 % salt.

CONCLUSIONS AND APPLICATIONS

The use of pre-rigor meat should bring about considerable benefits in goat products technology in the region.

Regardless of processing methods, pH and WHC were higher in the pre-rigor ham than in the post-rigor ones.

Cooking losses were correspondingly lower in the pre-rigor processed ham thus increasing the yield relative to the post-rigor processed ham.

Optimal organoleptic qualities were obtained when the hams were cured for for days irrespective of rigor state at curing of the goat hams.

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