Trop. J. Anim. Sci. 4 (2): 141 - 148 (2001)
ISSN: 1119 - 4308

EFFECTS OF PRE-RIGOR HOT AND COLD CURING METHODS ON THE QUALITY OF SMOKED COOKED RABBITS

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Target Audience: Rabbit farmers, meat scientists, processors, consumers and researchers

ABSTRACT

Eight rabbits were used to study the effects of pre-rigor hot curing on the quality of smoked cooked rabbits. They were each slaughtered and divided into two symmetrical halves to give sixteen half carcasses. These were randomly assigned to one of four curing treatments proir to being smoked. The treatments were: (A) Post slaughter chilling at 2°C for 24 hrs followed by cold brining for 24hrs. (B) Pre-rigor curing in brine at 24 hrs. (C) Pre-rigor curing in brine at 45°C for 18 hrs. (D) Pre-rigor curing in brine at 45°C for 6hrs. All carcasses were injected to 110% of their green weight before immersion in brine of the same concentration at the given temperature. The cured products had satisfactory processing yields (100.82 - 113.22%) but yields were relatively lower in hot cured rabbit carcasses.

The mean nitrite level for all processing treatments was 250.94 ppm. Tenderness as measured by the shearforce values and organoleptic testing did not differ significantly among treatments. Cooking loss and water holding capacity were similar in all treatments. There was also no discernible difference observed in the various organoleptic attributes. Results obtained indicate that it is possible to accelerate the curring process of rabbit through pre-rigor treatment with brine at a temperature of 45°C.

Key words: Hot curing, residual nitrite, water holding capacity, smoking.

DESCRIPTION OF THE PROBLEM

Rabbits were not common features either on farm yards or in the homes a couple of years back as they were classified as rodents. They are referred to as microlivestck, a term that is used to describe the small animals which can be reared by the small holder farmers for food production systems in developing countries (1). The domestic rabbit has the potential to become one of the worlds major livestick species. As the human population exerts increasing pressure on the world food resources, it is very likely that rabbits will assume an incresingly important role not only in rural poverty alleviation but also serve as a possible solution to the acute protein

insufficeincy problem crippling the developing countries.

Fresh meat is considered one of the most perishable foods, therefore, relatively cheap and efficient processing and preservation measures must be applied promptly after slaughter in the absence of efficient refrigeration facilities. Meat that is cured and processed can be more stable than fresh meats with respect to microbial deterioration because of activities such as salt or nitrites. It could therefore be assumed that introducing such processing to rabbit meat should introduce variety and enhance its acceptance by the populace. This study therefore evaluates the effects of pre-rigor hot and cold curing methods on the quality of smoke-cooked rabbit meat.

MATERIALS AND METHODS

The eight rabbits used in this experiment had an average weight of 2.0kg and were 20 weeks old at the time of slaughter. Following the conventional dressing process, the carcasses were split into symmetrical halves down the middle of the spine. Each carcasses from the same animal were assigned to different treatments. This arrangement afforded four replications per treatment.

The half carcasses assigned to treatment A were chilled for 24 hr at 2°C, injection pumped to 110% of the green weight (2) and further immersed completely in the curing solution for 24 hr at 2°C. Half carcasses in treatment B were injected pre-rigor with cold brine of the same strenght to 110% of the green weight followed by immersion completely in the curing solution for 24hr at 2°C. In treatment C, the curing solution of the same strength was warmed to 45°C. The pre-rigor half carcasses in this group were injected with the warm brine to 110% of the green weight, then immersed completely in the immersion cure and held for 6hr in a special thermostatically controled chamber of 45°C. Half carcasses in treatment D were subjected to a similar condition as in the third treatment except that the holding period at 45°C was for 18hr. The injection and immersion brine were of the same strength and contained 5.4kg common salt, 0.1kg sodium nitrite, 2kg sodium hexametaphosphate and 2.5kg common sugar per 10 litre of brine.

At the end of each treatment schedule, the rabbit carcasses were rinsed with cold tap water, drained and equilibrated at 2°C until the longest treatment had gone through it's normal schedule. Thereafter each carcass half was fabricated into the leg, loin, rib, shoulder and flank primal parts following the procedure of (3) for lamb and part yield determined. The smoke chamber was a locally designed smoke cabinet consisting of a covered metal drum layered inside with a thick wire mesh 2/3rd way up from its base. Heated smoke was piped in at the bottom from a side smoke generator in which most hardwood sawdust was burnt. The cured carcasses

were smoked at 40-45°C for 2hr. Cuts were turned periodically to allow for uniform doneness.

Processing yields:
Weights were obtained at each step along the processing chain to obtain percentage yields. Smoking and cooking losses were also determined. Part yield were obtained by fabricating carcasses into wholesale cuts which were weighed and determined as percentage of the whole carcass.

Shear Force Measurement
A chop 3.5cm thick was obtained from the cooked loin starting from its caudal end. A single 13mm diameter core was taken with the shearing device from the longissimus dorsi in its fibre direction. Tenderness was measured by shearing the core sample three times across its length using a Warner - Bratzler shear apparatus.

Chemical Analyisis:
All the meat remaining on the loin and rib were recovered (including that from the sheared core) and minced. Representative samples were taken. Total moisture was measured by the difference in weight before and after drying. The dry matter percetage is the difference of moisture percentage from 100. Ash determination. salt and nitrites were also estimated according to the methods of (4) Water holding capacity (WHC) was determined by the filter paper wetness test method (5).

Sensory evaluation:
Meat cubes, $1cm^3$ were obtained from the cooked leg muscles and presented to an eight member sensory evaluation panel. Meat pieces from the four treatment were given to each member for evaluation. Scoring of samples from the four treatments was on a 9 point hedonic scale for tenderness, juiciness, flavour, saltiness, smokiness and overall acceptability.

All data were subjected to statistical analysis of variance. Means were separated where necessary by Duncan's Multiple Range Test (6).

RESULTS AND DISCUSSION

Processing Yields
Data presented in Table 1 shows the processing yields of cured whole rabbit carcasses under the different curing treatment. Rabbits cured pre and post rigor in cold brine at 2°C for 24hr had significantly higher processing yields ($P<0.05$) than those cured in hot brine at 45°C. The highest mean cured yield of 113.22% was obtained in the rabbits cured injected pre-rigor and cured for 24 hours at 2°C, while the lowest mean cured yield of 100.82% was obtained in the rabbits cured pre-rigor in hot brine at 45°C for 18hr. The cured yields were generally satisfactory considering that

carcasses were processed without the skin. Studies carried out by (7) on pheasants and on chicken by (8) follow a similar trend, they however obtained slightly lower cured yields in the pre-rigor cured chicken and pheasant. Hot curring produced lower carcass yields than cold curing probably because of lower resident time in the curing brine. It has been observed that hot cured bacon had more shrinkage than that produced by a more conventional cure and that hot cured rabbits produced a curing loss realtive to cold cured rabbits (9). The relatively low yield in the hot cured rabbits could be rectified by suitable modification of the curing brine, brine strength and possibly by slightly reducing the temperature. In this study, reducing curing time to 6hr gave slightly higher processing yield than the 18hr curing period.

Table 1: Processing yields of cured whole rabbit carcasses

	CURING TREATMENTS							
	A		B		C		D	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Fresh wt. (kg)	1.07	0.31	1.0	0.25	0.99	0.23	1.05	0.26
Cured yield (%)	112.0[b]	4.0	113.22[b]	4.11	103.99[a]	11.00	100.82	4.72
Part yield % cured Carcasses								
Leg	36.65	1.29	36.96	3.01	38.47	2.81	38.64	4.76
Loin	16.80	3.21	18.42	2.48	20.17	2.96	20.49	2.51
Rack	11.58	1.91	12.69	3.59	12.23	1.94	10.97	3.62
Shoulder	28.55	5.33	24.42	0.97	22.92	1.69	24.30	2.77
Flank	7.67	4.04	7.27	2.29	6.20	4.17	6.29	1.80
Yield % Cured part (after smoking)								
Leg	93.62	3.64	94.40	2.98	93.55	0.98	89.75	6.71
Loin	95.19	9.96	92.53	4.69	90.14	6.30	91.27	9.08
Rack	84.40	8.16	86.44	9.43	81.83	21.5	89.99	5.08
(after broiling)								
Leg	71.85	5.41	75.15	5.24	74.09	6.93	77.29	6.88
Loin	62.93	10.69	69.39	9.89	68.79	6.61	68.12	6.55
Rack	56.06	10.48	58.14	12.34	52.62	9.62	59.32	7.71

Data on the yield of cured wholesale cuts indicated that the leg portions had the highest percentage followed by those of the shoulder with those of the flank the least in all the treatments. The percent weight of the leg decreased from treatment D (the pre-rigor hot cured for 18 hr) to treatment A (the post rigor cold cured for 24hr). Treatment D had the highest mean percent of 38.64±4.76 for the leg, while treatment A recorded the lowest.. The same sequence was noticed for the means of the loin portions. However, hot curing did not favour high yield of the flank and shoulder cuts as the

lowest yield of these cuts were obtained in pre-rigor rabbit carcasses hot cured for 6 or 18hr compared with cuts which were cold cured. Primal cuts for rack followed no particular sequence compared to those of the leg and loin cuts.

The percent yield after smoking and broiling of three major cuts, the leg, loin and rack are also shown in Table 1. The highest yield was obtained in the legs, followed by that of the loins. The lowest yield was observed in the racks for all the curing treatments. This might be due to the varying degree of flesh on the cuts, with the rack being the least fleshy. Treatment differences were however not significant either after smoking or after broiling of the three primal cuts.

The trend observed for salt and ash content contrast with results obtained by (10) in their studies on the effects of rigor state and curing time on goat ham. These authors reported ash and salt percentages of 4.28 and 3.11 for pre-rigor goat hams for 6 days while those cured for 2 days were 2.46% and 1.98% respectively probably because of the exceedingly longer period at curing in the former.

Table 2 shows the physical and chemical composition of rabbits processed under the different curring regimes. No significant difference was observed in the dry matter contents of the cold and hot cured rabbit carcasses, although the dry matter values of 36.88% and 37.88% obtained for the hot

Table 2: Physio-chemical and Organoleptic characteristics of cured rabbit meat.

	CURING TREATMENTS							
	A		B		C		D	
Physio-chemical	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Dry Matter	33.12a	12.48	32.0a	12.51	36.88a	10.49	37.88	9.48
Ash%	4.46	2.59	4.15	2.44	6.47	3.98	5.68	4.36
Salt %	3.42a	0.52	3.48a	0.40	4.29b	0.10	4.56b	0.60
Nitrites (ppm)	243.44	186.22	233.44	211.111	270.0	108.97	256.87	241.77
WHC	0.62	0.14	0.61	0.18	0.57	0.28	0.57	0.19
Shearforce values	1.75	0.80	1.55	0.44	1.34	0.22	0.97	0.28
Organoleptic								
Tenderness	5.72	0.41	5.69	0.37	6.41	0.59	6.13	0.44
Juiciness	6.00	0.69	6.10	8.12	6.57	0.69	5.85	0.82
Flavour	6.25	0.70	8.16	0.34	6.31	0.38	6.25	0.59
Saltiness	3.60	0.59	4.22	0.12	3.85	0.45	6.07	0.84
Smokiness	6.38	0.76	6.19	0.53	6.07	0.84	5.44	0.73
Overall Acceptability	6.35	0.60	6.19	0.52	6.81	0.24	6.25	0.62

Data are means and Standard deviation

Mean with the same superscript on the same line differ significantly ($p<0.05$)

obtained for the cold cured treatment A and B. Since total moisture and treatments and were slightly higher than those of 33.12% and 32.0% dry matter contents are inversely related, moisture contents thus varied from 63.12% to 68.00% in the four cured samples. This level of moisture is higher than the final moisture content of approximately 40% reported for traditionally smoke-dried rabbit meat (10).

A better level of juiciness and physical integrity is thus associated with such cured products.

The ash content of meat from some free living animals range between 0.9-1.4g per 100g fresh weight. A range of 0.8-1%; 0.7-0.9%; 0.7-1.0% for beef, pork, lamb respectively have been given (11). However, the addition of salts for curing and water retention purposes would correspondingly increase the ash levels than in fresh meat. In the present study, significantly higher ($P<0.05$) ash and salt contents were observed in the cured treatments C and D which were pre-rigor injected and hot cured for 6 or 18hrs respectively than were observed for treatments A and B which were injected post or pre-rigor then cold cured of 2°C for 24 hr. However, no significant difference was observed between the two treatments which were hot cured irrespective of the curing time or between the two treatments which were hot cured irrespective of the curing time or between the two treatments which were cold cured irrespective of the rigor state. The temperature of the curing regime was therfore a primary enhance of ash and salt accumulation rather than the rigor state of rabbit meat at time of injection. Indeed (12) observed that percent chloride in dry cured pork hams was not affected by boning time. Other workers (8) have reported 5.09% ash content for pre-rigor 18hr hot cured chicken similar to the results obtained in this study for rabbits. However, (10) in their studies on the effect of rigor state and curing time on goat ham reported an ash and salt percentages of 4.28 and 3.11 for pre-rigor goat hams cured 6 days while those cured for 3 days were 2.46 and 1.98% respectively probably because of the exceedingly longer period of curing in the former.

There was no significant difference ($P>0.05$) observed in the residual nitrite level among the four treatments. The observed nitrite levels varied from 233.44pm in pre-rigor cold cured rabbit meat to 270.00pm in pre-rigor rabbit meat hot cured for 6 hrs. These nitrite level were lower than the 364.89pm nitrite value obtained by (8) in his study with chicken cured pre-rigor at 50°C for 18 hr.

The mean values for the water holding capacity showed a downward trend from treatment A to D. The post rigor cold cure has the highest value of 0.62cm^2, this infers that the myofribils are able to hold on to the water

particles around them and such fluid is not easily lost to the extracellular spaces and on to the meat surface. The lowest value obtained in the hot cured treatment shows that with increased temperature and higher degree of ionization of salt in the medium, the myofibrils tend to loose more water to the surrounding medium to attain equilibrium.

No significant differences were found between the four curing treatments with regards to their shear force values although the hot cured samples tended to be more tender. This trend was also reflected in the subjective evaluation in which the pre-rogor 18hr hot curd products were ranked the most tender by taste panel members (13) observed a decrease in share force values of chicken within 5hr post mortem due to structural weakening of myofibrillar component of the muscle with connective tissue endomysium and perimusium. The elevated temperature of curing of rabbit meat in this experiment may have accelerated these changes, albeit very slightly such that tenderness and other sensory attributes achieved in these products were similar to those subjected to curing at 2°C with or without 24 hre pre-ageing at 2°C. While no significant difference was observed in panel scores for saltiness among the four treatment, panel rating were low on the sensory scale for all the treatments indicating too much salt content of the finished products. Other sensory attributes were however judged desirable for all treatments as shown by the scores which were all above average.

CONCLUSIONS AND APPLICATIONS

1. Yield of cured rabbit carcasses were lower in pre-rigor hot cured process because of the low resident time in the brine.
2. Pre-rigor rabbit carcasses processed at elevated temperature were higher in salt and ash content than cold cured rabbits and may therefore require some desalting in fresh hot water prior to use.
3. The overall sensory assessment indicate that both pre-rigor rabbit hot cured for 6 hr or cold cured at 2°C were more acceptable than those cured by other regimes.
4. The salt stabilized high moisture content of the cured product ensured better juiciness and physical integrity of the finished product which is often lacking in the traditionally smoke-dried bush meat with which a dry crumbly attribute is often associated.
5. Curing prior to smoking the rabbit meat and by extension other bush meats would also introduce some variety into the traditional consumption pattern of these products.

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