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Effect of Cures and Storage Periods on the Sensory and Microbial Evaluation of Smoke-dried, Vacuum Packaged Rabbit Meat Products

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Abstract: Sensory and microbial determination of cured smoke-dried rabbit meat products were carried out under different storage conditions. Sensory attributes were determined using the 9-point Hedonic scale. Sensory evaluation of rabbit meat products in terms of overall acceptance showed there was no significant difference ($p>0.05$) between freshly processed unpackaged products and packaged products, stored under refrigeration temperature at 8±2°C. At $p<0.05$ there was significant difference between product flavour obtained from different cure types. Packaged products were also preferred to the freshly processed unpackaged products from the various cures as a result of vacuum packaging ability to prevent surface dehydration and exclude oxygen from products. Cured smoke-dried, vacuum packaged rabbit meat products could be stored under ambient temperature (26±2°C). However, products stored under refrigeration temperature (8±2°C) had stable colour than products under ambient temperature (26±2°C). The results showed that microbial population (bacterial and fungi) in rabbit meat products were significantly different ($p<0.001$) because of the type of treatments (Storage periods, storage temperatures, different cure).

Key words: Nitrite, cures, meat curing, vacuum package, rabbit

INTRODUCTION

Rabbit meat could be useful food in human dietetics. It is higher in protein, lower in fat, sodium and cholesterol than other meats (Rao *et al*., 1978). Fortunately the domestic rabbit *Oryctolagus cunniculus* can be raised on diets that are low in grains and high in roughage. It can also be raise on forage alone while production can be improved by supplementation with other food by-products that are not directly useful to man. Increase rabbit production could bridge the supply-demand protein gap. It is by far the most appropriate type of production system for subsistence meat nation where grains are in short supply (Adaku and Olukosi, 1990). Meat curing is an aspect of meat preservation in which salt, sugar, nitrite/nitrate and phosphate and other curing ingredients are used to improve meat colour and it's acceptability after slaughter. According to Kramlish *et al*. (1980) curing was originally used almost entirely as a means of preserving meat-side.

MATERIALS AND METHODS

Source of rabbit: New Zealand male white rabbit (16 wks old) with uniform genetic background were used. The rabbits were bought from a modern rabbitry in Benin City Nigeria.

Preparation of sample: Before slaughtering, the rabbits were fasted for 24 h, supplied with fresh cool water and weighed, then stunning, sticking, bleeding, removal of fur, evisceration were carried out, while cutting of each rabbit was done using the standard 5 cuts which include rib, loin, rump, arms and legs as described by Oteku and Igene (2005).

Rabbits were processed by the use of three different cures:

Cure 1 With nitrite, salt, sugar and spices.
Cure 2 Without nitrite, but with salt, sugar and spices
Cure 3 Without nitrite, salt, sugar plus spices

Cured meat was smoke-dried in an improved smoking kiln at the University of Benin for 5 h. After smoking, the meat products were allowed to cool, one piece from each treatment unpackaged was kept in the fridge for 1 h, cooled and served with some meat products that were not packaged and not kept in the fridge.

Rabbit meat products were vacuum packaged in high-density cellophane (one product per cellophane). Two storage temperatures were used:

- Room temperature (26±2°C)
- Refrigeration temperature (8±2°C)

After the meat products were packaged, the different products from the different cures were stored under room temperature. These meat products were stored for total duration of 2 months and meat samples were withdrawn every 2 weeks for sensory evaluation as follows 0 wk (control), 2 weeks, 4 weeks, 6 weeks, 8 weeks.

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Sensory evaluation: Rabbit meat products were served to 8 trained panelists, who evaluated the products based on a 9-point Hedonic scale described by Larmond (1977), samples were coded and juiciness, tenderness, flavourr, colour and overall acceptability were scored by the panelists.

Microbial analysis: Fresh meat sample of about 10 g was weighed into 5 mls of sterilized water in McCartney bottle to form meat stock. 1ml from the meat stock was taken using a syringe and added to the first test tube containing 9 ml sterilized water. 1 ml was later transfer from the 1st test tube into the 2nd test tube. This continued in this order until the 6th test tube using the 6th dilution factor. 1 ml was taken from the 6th test tube into Petri dishes that contained potato dextrose agar and nutrient agar. On cooling below 44°C sterilized reagents were poured into the Petri dishes and allowed to set. Swab sticks were dipped into minced meat, smear streak were made subsequently. Petri dishes containing set reagents were incubated for 24 h. After 24 h, organisms were isolated into bijoux bottle containing PDA and NA before identification.

Statistical analysis: Data generated from sensory evaluation and micro-organism colony counts were analyzed using Genstat statistical package and were subjected to analysis of variance. The separation of means was done using Duncan's multiple range test.

RESULTS AND DISCUSSION

There were significant differences ($p<0.01$) among the various treatments (different cures, storage periods and storage temperatures) in terms of colour, flavour, juiciness, tenderness and overall acceptance of products.

In terms product colour Table 1, there was no significant difference ($p>0.05$) Between freshly processed unpackaged product at zero week storage and the packaged products from the different cures under refrigeration (8±2°C) storage condition. However, there was significant difference ($p<0.05$) between freshly processed products at zero week storage and packaged products from cure without nitrite, salt and sugar at 6-8 wks storage. Packaged products from cure without nitrite, salt and sugar at (8±2°C) for 6-8 wks were not significantly different ($p>0.05$) from packaged products from cure without nitrite, salt and sugar stored for 2 wks and 4 wks respectively. This was attributed to the packaging method used. Kramlish *et al.* (1980) reported that vacuum packaging extend the shelf life of cured meat products due to the low level of oxygen in vacuum packages which protect the meat from colour fading. For products stored under refrigeration condition (8±2°C) their colour was more stable under ambient temperature (26±2°C). This agrees with the report of Ikeme (1990) that refrigeration prevents colour deterioration during storage of meat products. Products from cure with nitrite were significantly different ($p<0.05$) and were most colour stable. This may be attributed to the presence of nitrite in the cure, nitrite stabilizes the pink colour of lean tissues (Cassens, 1995; Cassens *et al.*, 1996).

Flavour of freshly processed unpackaged products (0 wk) was not significantly different ($p>0.05$) from package products stored at 26±2°C for 2 weeks. Products under refrigeration temperature were more flavour stable than

Table 1: Sensory values for colour attribute of rabbit meat product

			Storage periods (weeks)					
			Unpackaged products	Packaged products				
Sensory attribute	Cure	Storage temp. (°C)	0 wk	2 wk	4 wk	6 wk	8 wk	SEM
Colour	1	26±2	8.875^{a}	8.250^{abc}	7.375^{cde}	6.375^{g}	5.625^{h}	
		8±2	8.875^{a}	8.375^{ab}	8.250^{abc}	8.250^{abc}	8.750^{a}	
	2	26±2	8.000^{abcd}	7.250^{def}	7.000^{efg}	4.875^{i}	4.750^{i}	0.2688
		8±2	8.000^{abcd}	7.625^{bcde}	7.250^{def}	7.375^{cde}	7.750^{bcde}	
	3	26±2	7.625^{bcde}	6.875^{efg}	7.000^{efg}	2.750^{j}	2.750^{j}	
		8±2	7.625^{bcde}	7.000^{efg}	8.250^{abc}	6.500^{fg}	8.750^{a}	

Mean with same superscript on the row and column are not significantly different ($p>0.05$)

Table 2: Sensory values for flavour attribute of rabbit meat products

			Storage periods (weeks)					
			Unpackaged products	Packaged products				
Sensory attribute	Cure	Storage temp. (°C)	0 wk	2 wk	4 wk	6 wk	8 wk	SEM
Flavour	1	26±2	7.625^{abcd}	$7.125^{abcdefghi}$	6.500^{efghi}	$6.750^{cdefghi}$	6.250^{i}	
		8±2	7.625^{abcd}	$7.500^{abcdefg}$	$7.375^{abcdefh}$	8.125^{a}	8.000^{ab}	
	2	26±2	7.625^{abcd}	6.625^{defghi}	6.375^{ghi}	5.000^{j}	4500^{j}	0.3285
		8±2	7.625^{abcd}	$6.750^{cdefghi}$	$6.875^{cdefghi}$	7.750^{abc}	7.625^{abc}	
	3	26±2	6.375^{ghi}	6.375^{ghi}	$7.500^{abcdefg}$	2.875^{k}	2.750^{j}	
		8±2	6.375^{ghi}	$6.875^{cdefghi}$	6.375^{ghi}	6.500^{efgh}	$7.000^{bcdefghi}$	

Mean with same superscript on the row and column are not significantly different ($p>0.05$)

Table 3: Sensory values for juiciness attribute of rabbit meat products

Sensory attribute	Cure	Storage temp. (°C)	Storage periods (weeks): Unpackaged products 0 wk	Packaged products 2 wk	4 wk	6 wk	8 wk	SEM
Juiciness	1	26±2	3.500^{n}	5.125^{m}	6.375^{jlk}	7.375^{bcdefgh}	6.625^{ghijk}	
		8±2	4.000^{n}	7.125^{fghij}	7.000^{fghij}	8.000^{abcdef}	7.025^{cdefgh}	
	2	26±2	3.625^{n}	5.250^{lm}	5.625^{klm}	7.250^{defghij}	6.250^{ijk}	0.3376
		8±2	4.125^{n}	6.875^{fghij}	7.250^{defghij}	7.250^{defghij}	7.500^{cdefgh}	
	3	26±2	5.625^{klm}	6.500^{hij}	7.625^{cdefgh}	8.375^{abce}	8.375^{abce}	
		8±2	5.625^{klm}	7.875^{cdefgh}	7.625^{cdefgh}	8.750^{ab}	9.000^{a}	

Mean with same superscript on the row and column are not significantly different (p>0.05)

Table 4: Sensory values tenderness attribute of rabbit meat products

Sensory attribute	Cure	Storage temp. (°C)	Storage periods (weeks): Unpackaged products 0 wk	Packaged products 2 wk	4 wk	6 wk	8 wk	SEM
Tenderness	1	26±2	3.750^{i}	5.375^{h}	7.000^{cde}	7.625^{cd}	7.000^{cde}	
		8±2	4.375^{i}	6.500^{efg}	7.000^{cde}	8.250^{ab}	7.000^{abc}	
	2	26±2	3.750^{i}	5.250^{h}	6.875^{def}	7.125^{cde}	7.125^{cde}	0.2530
		8±2	3.875^{i}	6.875^{def}	7.750^{abc}	8.125^{ab}	8.000^{ab}	
	3	26±2	6.125^{fg}	6.625^{efg}	6.625^{efg}	8.250^{ab}	8.375^{ab}	
		8±2	5.875^{gh}	7.750^{abc}	7.125^{cde}	8.500^{a}	8.000^{ab}	

Mean with same superscript on the row and column are not significantly different (p>0.05)

Table 5: Sensory values acceptance attribute of rabbit meat products

Sensory attribute	Cure	Storage temp. (°C)	Storage periods (weeks): Unpackaged products 0 wk	Packaged products 2 wk	4 wk	6 wk	8 wk	SEM
Acceptance	1	26±2	8.625^{a}	7.875^{abc}	7.125^{cdef}	6.500^{fgh}	5.500^{i}	
		8±2	8.625^{a}	7.750^{abcde}	7.625^{abcde}	8.625^{a}	8.625^{a}	
	2	26±2	8.375^{ab}	7.375^{bcdef}	6.750^{defgh}	5.375^{i}	4.250^{i}	0.3276
		8±2	8.375^{ab}	7.375^{bcdef}	7.000^{cdefg}	8.000^{abc}	8.000^{abc}	
	3	26±2	7.500^{abcde}	6.000^{ghi}	5.750^{hi}	2.750^{k}	2.750^{k}	
		8±2	7.500^{abcde}	7.000^{cdefg}	6.625^{efgh}	6.750^{defgh}	7.125^{cdef}	

Mean with same superscript on the row and column are not significantly different (p>0.05)

products under room temperature. This according to Ikeme (1990) reported that refrigeration prevents flavour deterioration and extends general shelf life of meat products.

Juiciness and tenderness of packaged products from cure type at 26±2°C and 8±2°C were significantly different (p>0.05). Packaged products were also preferred to the freshly processed unpackaged products from the various cures and this may be due to the fact that vacuum packaging prevents surface dehydration and excludes oxygen from meat products (Urbin and Wilson, 1958).

Overall acceptance showed that there were no significant difference (p>0.05) between freshly processed unpackaged products and packaged products at 8±2°C. Products from cure with nitrite were most preferred this is due to the fact that nitrite inclusion improves flavour and colour of meat products (Ikeme, 1990).

The results for microbial analysis showed that microbial population (bacterial and fungi) in rabbit meat products were significantly different (p<0.001) because of the type of treatments (Storage periods, storage temperatures, different cure). Table 6 showed that there was no significant difference (p>0.05) in bacterial count found in freshly processed but unpackaged products from different cures stores at stored 26±2°C and 8±2°C conditions. This might be because the products were freshly smoked.

Freshly processed unpackaged products from different cures at 26±2°C and 8±2°C storage conditions, were significantly different (p<0.05) from packaged products after 2-8 weeks storage, this may be due to contamination which may occur during storage of meat products. Packaged products from cure with nitrite stored at 8±2°C had the least bacterial population (6.7000 $\log_{10}$ cfu/g), this was because the cure mixture contained nitrite (Table 6) and salt which inhibited the

Table 6: Mean values for bacterial population (log_{10} cfu/g) of rabbit meat products with storage time and temperature

		Storage periods (weeks)					
		Unpackaged products	Packaged products				
Cure	Storage temp. (°C)	0 wk	2 wk	4 wk	6 wk	8 wk	SEM
1	26±2	0.0000^{r}	7.3000^{i}	7.3900^{g}	7.4400^{e}	7.4000^{g}	
	8±2	0.0000^{r}	6.7000^{q}	6.7400^{p}	6.7800^{o}	6.7500^{p}	
2	26±2	0.0000^{r}	7.3300^{h}	7.4200^{f}	7.5600^{c}	7.4300^{ef}	0.00600
	8±2	0.0000^{r}	6.8500^{m}	6.7800^{o}	6.8100^{n}	6.8000^{n}	
3	26±2	0.0000^{r}	7.4600^{d}	7.6500^{b}	7.7000^{a}	7.6600^{b}	
	8±2	0.0000^{r}	7.0800^{j}	7.1800^{k}	7.2300^{k}	7.1900^{k}	

Mean with same superscript on the row and column are not significantly different (p>0.05). Cure 1 With nitrite and other ingredients. Cure 2 Without nitrite but with salt and other ingredients. Cure 3 Without nitrite, salt, sugar but with other ingredients. Wk = Weeks, Scale 1 means dislike extremely, 9 means like extremely

growth of a number of food poisoning and food spoilage. Packaged products from cure without nitrite but plus salt stored at 8±2°C followed with a means of 6.7800 log_{10} cfu/g, this may be because the cure mixture contained salt which acts by dehydration and alteration of osmotic pressure to inhibit microbial growth. The least shelf stable products stored at 8±2°C were from cure without nitrite, salt and sugar with a mean bacteria population of 7.0800 log_{10} cfu/g, because the cure mixture did not contain salt, sugar and nitrite which inhibit bacteria growth. Bacterial population increased in all the products stored for 2-6 weeks, at 8 weeks there was decline in bacterial population for products from the different cures at 26±2°C and 8±2°C this could be due to loss of moisture during storage with its resultant reduction in water activity thereby inhibiting further growth and multiplication of bacteria within the products. Ukhun *et al*. (1988) reported that dried foods in storage could lose more moisture, if the environment of storage is dryer than the food thereby resulting in more shelf stability. Packaged products from cure with nitrite show that there was no significant difference (p>0.05) in packaged products for 4 and 8 weeks, at 26±2°C and 8±2°C, packaged products from cure without nitrite but plus salt did not show significant difference (p>0.05) for 4 and 8 weeks at 26±2°C, 6 and 8 weeks at 8±2°C, this could be due to the packaging method used. There were significant differences (p<0.05) in the bacterial population in the products obtained from different cure types. Products from cure 1 had the least bacterial count (5.6500) followed by products from cure 2 (5.6980) while the highest microorganism count was from products obtained from cure 3 (5.9150), this could be as a result of no nitrite, salt and sugar in the cure mixture.

The bacteria identified in rabbit meat products in this study were *Bacillus subtilus* and *Staphylococcus aureus*.

Conclusion: The result of this work revealed that the shelf life of processed rabbit meat could be extended through pickle curing, smoke-drying and vacuum packaging without appreciable adverse effect on the quality and overall acceptance of rabbit meat products.

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