OCIMUM GRATISSIMUM AND COMMON SALT AS CURE INGREDIENTS IN BACON: A PRELIMINARY STUDY

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ABSTRACT

Pork bellies harvested from 12 large which hogs slaughtered at the Kumasi Abattoir Company Limited were transported on ice to the Meat Processing Laboratory of the Department of Animal Science KNUST. The left bellies were cured with nitrite salt while the right halves were cured using common salt plus *Ocimum gratissimum* leaf extract to produce bacons labeled as NB and OB respectively. Acidity (pH) of cure solution before and after curing, color and smoking yields of bacon were determined. Sensory evaluation was performed by thirty consumer panelists in order to evaluate consumer acceptance of the products using a 9-point Hedonic scale (9 = like extremely; 1 = dislike extremely) for juiciness, flavor, taste, appearance, aftertaste, texture, mouth feel and acceptability of bacon. There were no significant differences ($p>0.05$) between NB and OB in terms of smoking yield. The pH of cure solutions for NB before and after curing (5.77 and 5.91) were significantly lower ($p<0.05$) than for OB (5.53 and 5.85). No significant differences ($p>0.05$) existed between NB and OB for L (lightness of meat) but there were significant differences ($p<0.05$) between NB (4.99) and OB (4.55) in terms of a* (red or magenta), as well as b* in NB (3.97) and OB (2.90). All the sensory parameters evaluated did not show significant differences at 5% level of significance. The initial and final total viable counts for NB and OB were both below 9.0cfu/g. It was concluded that *Ocimum gratissimum* with common salt as cure ingredients could potentially be useful in meat curing without any adverse effects on product yield and sensory profiles. More so, bacon with *Ocimum gratissimum* and common salt could be refrigerated at 2°C for three weeks without any adverse effects on microbiological quality.

Keywords: *Ocimum gratissimum*, streaky bacon, curing salt, common salt, smoking yield.

INTRODUCTION

Meat is defined by Codex Alimentarius (2005) as all parts of an animal that are intended for, or have been adjudged as safe and suitable for human consumption. It is one of the most consumed foods in the world since creation. Meat is a valuable animal product, due to its composition of protein (amino acids), minerals, fats and fatty acids, vitamins and other bioactive components for human nutrition. The importance of meat results also from its' high quality protein since it contains all essential amino acids required for metabolism. Research shows that meat consumption has been relatively static in developed countries and has increased in developing countries since 1980 due to increase in population, and incomes along with changes in preferences (Linnemann *et al*., 2006) due to processing methods for a particular type of meat product. Curing is one of the most used food preservation methods used in the meat processing industry. It may be defined as the addition of a combination of salts, sugar and either nitrate or nitrite to meat and meat products. Salting of meat is an

ancient practice and salt has been used at high concentrations to preserve meat since ages till now. It serves as a preservative by dehydrating meat through osmotic pressure to inhibit the growth of food spoilage microbes, while adding flavor and taste.

On the other hand, using nitrites and nitrates change color of meat product to a desirable one through reactions with myoglobin. Nitrites or nitrates also have desirable effects on taste and flavor; and they act as antioxidants to prevent the development of oxidative rancidity in meat products such as bacon. Sodium nitrite also prevents growth of food poisoning microorganisms (Sebranek, 2009). Research has shown that, nitrites and nitrates when used in large quantities may be harmful to human health since they can be carcinogenic. This has called for more research work to be done to find replacement of nitrite used as curing agents (Sebranek & Bacus, 2007; Sindelar & Houser, 2009).

Ocimum gratissimum is a herbaceous plant which belongs to the family *Lamiaceae* and commonly known as Alfavaca. This plant is indigenous to tropical areas especially India and West Africa. It is believed to have originated from Central Africa and South East Asia. It is a scented shrub with lime-green fuzzy leaves. *Ocimum gratissimum* is called "Effirin" in Yoruba, "Nchonwu" in Igbo and "Daidoya" in Hausa (Effraim *et al.,* 2003). The Akan in Ghana call it "nunum", Ewe "dzo*f*otsi" and Ga "shoon". It has been revealed by Ijeh *et al.* (2005) that *Ocimum gratissimum* has active ingredients such as flavonoids, triterpenes, alkaloids, citral, saponins, eugenol, linaol, methyl cinnamate, camphor and thymol and has several medicinal purposes. Mbata and Saikia (2005) reported that the use of *Ocimum gratissimum* serves as flavour in foods and as an antimicrobial agent. This study sort to investigate the effects of using *Ocimum gratissimum* with common salt as curing agents in bacon production.

METHODOLOGY

Location of Study and Source of Ingredients

The study was carried out at the Meat Science and Processing Unit of the Department of Animal Science, Kwame Nkrumah University of Science and Technology, Kumasi. *Ocimum gratissium* was obtained from the Forestry Research Institute of Ghana (FORIG), Kumasi and curing salt was obtained from the Meat Processing Unit of the Department of Animal Science, KNUST. Pork belly was obtained from the Kumasi Abattoir Company Ltd. in Kumasi and common salt was purchased from Kumasi Central Market. Two treatments were formulated as: NB = Bacon cured with nitrite salt (control) and OB = Bacon cured with *Ocimum gratissimum* extract and common salt.

Experimental Procedure

The pork bellies were trimmed to desired shapes and sizes with equal weight of 500g for each of 5 replicates per treatment. The pickle was prepared with the objective of obtaining typical salt level of 1.5- 1.8% in finished product, hence the pre-cooked level of curing salt and common salt used respectively in NB and OB did not exceed 12.0g. A temperature of 2ºC was maintained and the trimmed bellies were immersed in each pickle for 72 hrs. The cured bacon was subjected to cold smoking in a traditional smoker using moist saw dust as fuel. Each smoked bacon was labeled appropriately and packaged in zip lock bags and kept at 2ºC for further studies.

Parameters Measured

Yield and pH

Each bacon was weighed before and after smoking and yield was calculated as: %Smoking Yield = [final weight of bacon after smoking/initial weight before smoking] × 100%. The pH of the curing solution for the two treatments was determined before and after curing and refrigeration using Syntax pH meter (Schott Instruments Lab 860, USA) in triplicates for each treatment.

Sensory Profile

A total of 30 consumer panelists, comprising of 24 males and 6 females were selected randomly to evaluate the two treatments. The panelists were recruited from the Department of Animal Science, KNUST. Three packages from each treatment were taken randomly from the refrigerator and sliced to equal bite length of 4cm. The treatments were labeled appropriately and microwaved for 2 minute. The microwaved bacon samples were placed on plates coded with three-digit randomized numbers in order to ensure uniformity and independent sampling, and to avoid bias in the assessment of the products. The panelists were asked to evaluate samples for flavour, tenderness, juiciness, color/appearance, aftertaste, and overall acceptability using a 9-point Hedonic scale with 9 as like extremely and 1 dislike extremely. Water was provided for the panelists to rinse their mouth before starting and between sample evaluations in order to avoid influence of the sensory attribute of one sample on the other.

Objective Color (Hunter L a* b*)

Color profile was evaluated at the Department of Food Science and Technology, KNUST using Hunter L a* b* color coordinates. The measurements were performed with a Minolta Chroma meter (Minolta CR-300, Konica Minolta Inc., Tokyo) where L indicates a diffuse white, a* (negative values indicate green, positive values indicate red/magenta); b* (negative values indicate blue and positive values indicate yellow). Calibration of equipment was done against a standard white tile provided by the manufacturer. The L a* b* values recorded were averages of three readings carried out at different points of each sample.

Total Viable Count (TVC)

The total viable counts were conducted at the Microbiology Laboratory of the Department of Animal Science, KNUST, to ascertain microbial quality of both treatments during refrigerated storage at 2 ºC.

Statistical Analysis

The data collected for yield acidity and color were analyzed using Student's test. GenStat Statistical Package version 11.1 was used for sensory profile and TVC as Repeated Measure. Significance level was determined at 5% between treatments means.

RESULTS AND DISCUSION

Yield, Acidity (pH) and Color of Bacon with and without *Ocimum gratissimum* and Common Salt

The results for cooking yield, acidity (pH) of the curing solutions of the various treatments and color of raw bacon with and without *O. gratissimum* are showed in Table 1. The cooking yield of both treatments showed no significant difference ($p>0.05\%$). The pH of the pickle used in curing decreased significantly ($p<0.05$) from 5.77 (NB) to 5.53 (OB) before curing. After curing, the pH of the various treatments decreased again from 5.91 (T0) to 5.85(OB). The pH of the curing solution before and after curing from OB could be more effective in reducing bacterial spoilage in raw bacon compared to NB (control). Wilkins *et al.* (2000),

reported that meat color is objectively defined often in terms of Hunter Colorimetric coordinates as L, a* b*. There was no significant difference ($p>0.05$) between the NB (control) and OB in terms of L and a* but significant differences ($p<0.05$) were observed for b* between NB (control) which had 3.97 and OB which was 2.90. According to Young *et al*. (1999), b* also spans from -60 (blue) to +60 (yellow). Thus using OG-common salt seem to limit the discoloration in OB-bacon compared to NB-bacon, and these finding is in consonance with AMSA (1978) which indicated that discoloration (fading) decreases a* values and increases b*-values (with or without a change in L).

Table 1. Cooking yield, acidity and color of bacon with and without *O. gratissimum* and common salt.

Parameters	Treatment		F.pr.	SEM
	NB	OB		
Yield (%)	85.28	84.82	0.517	0.465
pH (initial)	5.77[b]	5.53[a]	0.001	0.021
pH (final)	5.91[b]	5.85[a]	0.030	0.013
L	38.18	38.44	0.087	0.081
a*	4.49	4.51	0.061	0.013
b*	3.97[b]	2.90[a]	<001	0.055

[ab]Means in the same row with different superscripts are significantly different ($p<0.05$); Control (T0) = bacon cured with curing salt and (T1) = bacon cured with the extract of *Ocimum gratissimum* and common salt.

Sensory Profile of Bacon with and without Common Salt and *O. gratissimum* during storage

The results obtained from the sensory evaluation of bacon with and without *Ocimum gratissimum* for two weeks of storage at 2ºC are reported in Table 2. No significant differences ($p>0.05$) were found between NB (control) and OB in all the parameters measured for the two treatments. Also there were no significant differences ($p>0.05$) between treatments with respect to storage duration. According to Gorraiz *et al*. (2000), texture, aroma and flavor characteristics are the main criteria used by consumers to evaluate the sensory quality of meat hence consumers consume meat frequently as part of their diet and enjoy the product quality because of its sensory attributes. It could thus be deduced from the above that the panelist liked both NB and OB equally, since there were no statistical differences among all the sensory parameters determined.

Table 2. Sensory profile of bacon with and without common salt and *O. gratissimum* during storage

Factor	Sensory Attributes							
	Appear	Flavour	After	Taste	Juice	Mouth	Text	Accept
Treatment								
NB	6.40	6.50	6.27	6.63	6.60	6.33	6.43	6.83
OB	6.87	6.23	6.43	6.67	6.47	6.23	6.47	6.57
SEM[1]	0.376	0.306	0.319	0.291	0.277	0.323	0.266	0.310
F.pr.[2]	0.39	0.54	0.72	0.94	0.74	0.83	0.93	0.55
Duration of stored								
WK1	6.60	6.27	6.30	6.57	6.40	6.37	6.60	6.73
WK2	6.67	6.47	6.40	6.63	6.67	6.20	6.30	6.67
SEM	0.287	0.295	0.279	0.270	0.282	0.284	0.271	0.294
F.pr.	0.87	0.61	0.80	0.67	0.51	0.68	0.44	0.87

Treatment × Duration of stored								
NB × WK1	6.47	6.33	6.47	6.67	6.47	6.47	6.67	6.93
NB × WK2	6.33	6.67	6.07	6.60	6.73	6.20	6.20	6.73
OB × WK1	6.73	6.20	6.13	6.47	6.33	6.27	6.53	6.53
OB × WK2	7.00	6.27	6.73	6.87	6.60	6.20	6.40	6.60
SEM	0.473	0.425	0.424	0.397	0.396	0.430	0.380	0.427
F.pr.	0.63	0.75	0.22	0.55	1.00	0.81	0.67	0.75

*Appear: Appearance, After: Aftertaste, Juice: Juiciness, Mouth: Mouth feel, Text: Texture, Accept: Acceptance. [1] SEM: Standard error of means, [2] F.pr: Probability, Treatment; NB: bacon with curing salt, OB: bacon cured with O. gratissimum and common salt, WK: duration of storage in weeks.

Total Viable Count During Storage

No significant differences ($p>0.05$) existed between the two treatments for total viable counts as well as the storage duration for 2 weeks (Table 3). However, there were significant differences between NB and OB for treatment × storage duration interaction during week 1, but no significant differences existed between NB and OB at the end of the 3 weeks. According to Jay *et al.* (2005), when bacon is packaged in an aerobic film, spoilage is caused by a variety of molds and yeasts after 2-3 weeks at refrigeration temperature. This research has shown lower microbial counts in bacon cured with and without *Ocimum gratissimum* and common salt (OB) during week 1 and similar results with NB during the 3rd week of storage. This research agrees with Nicholson (1998) who stated that basil (*O. gratissimum*) which is a natural antimicrobial agent has become increasingly more important in the processing industry due to its antimicrobial effects.

Table 3. Total Viable Count

Factor	TVC(cfu/g)
Treatment	
NB	$8.2x10^2$
OB	$8.0x10^2$
SEM	0.186
F.pr.	0.50
Duration of storage	
WK 1	$8.0x10^2$
WK 2	$8.3x10^2$
WK 3	$8.1x10^2$
SEM	0.081
F.pr.	0.22
Treatment × Duration of storage	
T0 WK1	$8.5x10^{2a}$
T0 WK2	$8.0x10^{2ab}$
T0 WK3	$8.1x10^{2ab}$
T1 WK1	$7.4x10^{2b}$
T1 WK2	$8.5x10^{2a}$
T1 WK3	$8.1x10^{2ab}$
SEM	0.209
F.pr.	0.03

[ab]Means in same column with different superscripts are significantly different ($p<0.05$); Treatment: NB = bacon cured with curing salt; OB = bacon cured with O. gratissimum and common salt; WK = duration of storage in weeks

CONCLUSIONS AND RECOMMENDATION

The results of the study show that the use of *Ocimum gratissimum* and common salt as cure ingredients did not affect the cooking yield and sensory profile of streaky bacon. Microbial safety of bacon cured with salt containing nitrite was not different from common salt and *Ocimum gratissimum*-cured bacon during refrigerated storage. Therefore, *Ocimum gratissimum* and common salt could be used as cure ingredients in streaky bacon. Further study is recommended using *Ocimum gratissimum* plus common salt in other cured meat products.

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