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Full-Length Research Paper

Effect of citric acid and cinnamon stick on smoked chicken

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ABSTRACT: This study was conducted to evaluate the effect of citrate and cinnamon stick on smoked chicken. Four live broilers were obtained from Maiduguri Monday market. They were slaughtered and dressed. Each broiler meat weighing about 1.5 Kg were divided into four groups, namely A (Control), B (0.2% citric acid), C (3% cinnamon stick) and D (0.2% citric acid and 3% cinnamon stick). The samples were washed, soaked into various mixtures of cinnamon and citric acid separately for a period of 30 min; the samples were removed and drained for five minutes, smoked in a smoking kiln at a temperature range of 50-52 °C, for 7 hours a day for 48 hours. After processing, the smoked meat was cooled to room temperature, packed in a transparent polyethene bag, and chemically and organoleptically evaluated. The result showed an increase in pH and free fatty acid of 'smoked chicken' after processing and storage. The panelist rated the sample treated with 0.2% citric acid and 3% cinnamon stick higher in terms of colour, texture, taste, aroma, flavor, and overall acceptability.

Keywords: Broiler, smoking, citric acid, cinnamon stick

INTRODUCTION

Meat is the flesh of animals used as foods (Bjerre, 1956; Lawrie, 1998) that is highly perishable due to its high nutrients content (Kramlich *et al*., 1973). Fish meat and its products are prone to microbial action, chemical and physical changes (Okonkwo and Obannu, 1986). Smoking is one of the oldest methods to preserve meat and the process of flavouring, cooking or preserving food by exposing it to the smoked from burning or smoldering plant materials, most often wood. Meat smoking has been practiced since the beginning of recorded history Smith and Acton (2001), Barbut, (2015). Barbut (2015) further stated that smoke releases various antimicrobial compounds (phenols, ketones, aldehydes and organic compounds) which have bacteriostatic and/or bactericidal effect. Curing and smoked of meat are closely interrelated and are often practiced together (kramlich *et al*., 1973). Cinnamon stick is a spice obtained from the inner bark of several tress from the genus cinnamon which involves all species of evergreen trees which can be used in both sweet and savory foods (Wijesekara *et al*., 1975), the flavor is strong and aromatic. Spices are known not only to improve flavor but also have anti-microbial properties (Nkama *et al*., 1994). The demand for natural antimicrobial agents is increasing due to consumers' concern on health issues (Quinto *et al*., 2019). Spices such as cinnamon and clove have been used for their antimicrobial and antioxidant properties or in combination with other techniques for food preservation (Holley and Patel 2005; Gutierrez *et al*., 2008; Proestos *et al*., 2008).

It is principally employed in cooking as a condiment and flavorings materials. Cinnamon sticks are 5-10 cm (2.0-3.9 in) long. The flavor is strong and aromatic and is divided into four, cinnamon verum, cinnamon burmani, cinnamon loureiroi, cinnamon aromaticum (Wijesekara *et al*., 1975). Cinnamon contains sinnamic aldehyde and eugenol which have antimicrobial activity (Barbut, 2015). Steen (2021) also reported that addition of cinnamon to

diet will reduce inflammation, fight infections, supports heart health, stabilizes sugar levels, reduce risk of type 2 diabetes and helps brain function and protects against cognitive disorders.

Citric acid is effective at both improving texture and inhibiting lipid oxidation in beef (Ke *et al*., 2009). Citric acid has been reported to enhance flavor, storage stability, and reduced microbial counts of meat products (Jay, 1987) as well as reduces biogenic amine (BA) content in raw poultry breast and thigh meat (Fazayeli-Rad *et al*., 2014).

Citric acid is the most widely used organic acid in food industry. It is regarded as a GRAS compound by FDA for miscellaneous and general purpose used. It also inactivates darkening reaction and off-odor development (Bouchard and Merit, 1979).

It is possible that a combination of cinnamon and citric acid treatment of meat before smoking would have beneficial effect on the final product (Badau *et al*., 1997). Eduzor *et al*. (2016) reported the effect of citric acid and clove on cured smoked meat (a traditional meat product) and results obtained showed that the acid is effective in extending the shelf life of the product. Negbenebor *et al*. (1999) evaluated *Clarias Anguillaris* Treated with Spice (*Piper guineense*) for Washed Mince and Kamaboko-Type Product and results showed that addition of *Piper guineense* has no effect on TMA values but significantly (P<0.05) reduced the microbial count on kamaboko. Citric acid reduced microbial load meat product thereby improves its storage stability.

However, the information available on this subject matter is little. The objective of the study was to evaluate the effects of citric acid and cinnamon stick on proximate composition, Free Fatty Acid (FFA), PH and sensory scores of smoked chicken.

MATERIAL AND METHODS

Materials

The chicken (broiler) and Cinnamon sticks were purchased from Maiduguri Monday market and transported to Food Science and Technology Laboratory, University of Maiduguri. Citric acid was obtained from Department of Food Science and Technology laboratory, University of Maiduguri.

Sample preparation

Four chickens weighing 1.5kg each were slaughtered with knife and eviscerated. The samples were divided into four groups each weighing 0.4kg.Cinnamon stick was cleaned, milled and packaged until use.

Formulation of slurries of cinnamon powder and citric acid in distilled water.

The slurries were formulated as follows: Formulation A (Group A treatment) as control had only 1000 ml distilled, whereas Formulation B (Group B treatment) had 0.2% (w/v) citric acid (2g citric acid dissolved in 1000 distilled water. Formulation C (Group C treatment) had 3% (w//v) cinnamon powder (30 g cinnamon powder in 1000 ml distilled water) and Formulation D (Group D treatment) had 0.2%(w/v) citric acid and 3%(w/v) cinnamon powder (2 g of citric acid and 30g of cinnamon powder dissolved in 1000 ml distilled water). The formulation is shown in (Table 1).

Table 1: Formulations slurries of citric acid, cinnamon powder in distilled water.

	Groups (Formulations)			
Ingredients	A	B	C	D
Citric acid (g)	0	2	0	2
Cinnamon stick powder (g)	0	0	30	30
Distilled water (ml)	1000	1000	1000	1000

Smoking

All samples were soaked (ratio of distilled water to meat is 3:2) in various slurries (A, B, C, D) for 30 minutes (Figure 1). The samples were removed from the treatment and placed on rack for 5 minutes to drain before smoking. The poultry meat from the various treatments were smoked in a smoking kiln at a temperature of 50°C for 28 hours in order to reduce the moisture content of the meat. They were smoked using sawdust for 48 hours in smoking kiln. After processing, the smoked poultry meat from the various treatments were cooled to room temperature, packed in a transparent polythene bag and stored at ambient conditions, before chemical and sensory evaluation

Proximate analysis

The proximate composition was determined using methods described by AOAC (1994).

pH determination

pH was determined with pH meter. Five grammes of triturated smoked poultry meat was mixed thoroughly in 20 ml of distilled water. It was allowed to stand for 20 min. pH was determined by placing the pH electrode into the slurry (AOAC, 1994).

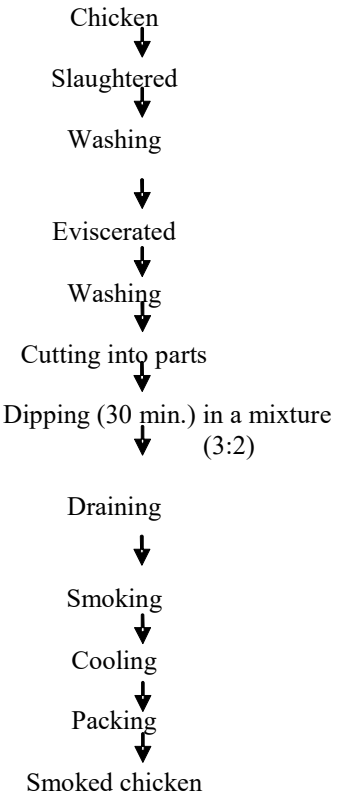

Figure1. Flow chart for the processing of smoked chicken.

Free fatty acid determination

Lipid from 10.0 g samples was extracted with hexane until the thimble showed no appearance of oil. The solvent was distilled off, and the oil was washed, weighed and kept for further analysis. The acid value and free fatty acid content was determined by AOAC method 940.28 (AOAC, 2000). The oil sample (0.2 g) was dissolved in 10ml ethanol and titrated with 0.1M NaOH solution using phenolphthalein indicator until pink color disappeared. The acid value and the percentage fatty acid were calculated from the expression below;

$$\text{Acid value} = \frac{56 \times \text{molarity of the NaOH}}{\text{Weight of oil}}$$

% free fatty acid as oleic acid = 0.503 × acid value

Sensory evaluation

The samples were rated in terms of colour, texture, taste and overall acceptability on the score sheet based on a nine point hedonic scale ranging from like extremely (9) to dislike extremely (1) by the Panelists which include the staff and students of University of Maiduguri (Amerine *et al*., 1965).

Statistical analysis

Data were subjected to analysis of variance (Snedecar, 1956), Duncan multiple comparison test were used to separate the differences among the means (Duncan, 1955).

RESULTS

Proximate composition

Table 2 shows the proximate composition of smoked chicken and as indicated there were significant variations ($P < 0.05$) between the fresh sample and the processed product in terms of moisture and protein contents. The moisture and protein content differ significantly ($P<0.05$) from the fresh sample but citric acid and cinnamon did not affect the proximate composition of the smoked poultry meat significantly ($P>0.05$).

The effect of citric acid and cinnamon stick on the pH of smoked chicken

There was a slight increase in pH during storage for all the samples in (Table 3). But samples treated with 0.2% citric acid and 3% cinnamon stick had lower pH values (5.33) on week 0. This might be due to the effect of citric acid and cinnamon stick. Other samples pH values of 6.25 to 5.33.

The effect of citric acid and cinnamon stick on free fatty acid of smoked chicken

Table 4 shows the free fatty acid values of smoked chicken after processing as 1.72 - 1.58% during the storage sample treated with 0.2% citric acid had the higher free fatty acid values when compared to other samples. After 1 week of storage sample treated with 3% cinnamon stick had lower free fatty acid values than the control sample.

The effect of citric acid and cinnamon stick on sensory evaluation of smoked chicken

Table 5 shows the result of sensory evaluation of four samples. Ten semi-trained panelist rated the colour, texture, taste and overall acceptability of smoked chicken. From the result there was significant difference ($p<0.05$) between the samples A (control) and sample C

Table 2. Proximate composition of fresh and processed smoked chicken [1,2]

Formulations	Proximate composition (%)			
	Moisture content	Protein content	Fat content	Ash content
Fresh poultry meat	67.39 ± 0.31[a]	18.22 ± 0.34[b]	14.23 ± 0.39[a]	2.22 ± 0.34[a]
A	18.30 ± 0.21[b]	62.36 ± 0.38[a]	15.23 ± 0.35[a]	3.21 ± 0.34[a]
B	18.82 ± 0.21[b]	62.69 ± 0.24[a]	15.07 ± 0.22[a]	3.42 ± 0.25[a]
C	18.52 ± 0.21[b]	63.11 ± 0.02[a]	14.89 ± 0.02[a]	3.48 ± 0.25[a]
D	18.52 ± 0.05[b]	63.11 ± 0.03[a]	14.89 ± 0.04[a]	3.48 ± 0.02[a]

[1]Mean ± Standard deviation of triplicate determinations; Formulations: A (Control); B (0.2% citric acid); C (3% cinnamon stick); D (0.2% citric acid and 3% cinnamon stick); [2]Means within each column not followed by the same superscripts are significantly (P<0.05) different.

Table 3. The effect of Citric Acid and Cinnamon Stick on pH of Smoked Chicken[1,2]

Weeks of Storage	Formulations (pH)			
	A	B	C	D
0	6.25 ± 0.38	5.46 ± 0.10	5.52 ± 0.17	5.33 ± 0.14
1	6.45 ± 0.36	5.61 ± 0.18	5.74 ± 0.22	5.45 ± 0.13
2	6.61 ± 0.40	5.76 ± 0.21	5.98 ± 0.24	5.60 ± 0.10

[1]Each value is a mean of 2 determinations; Formulations: A (Control); B (0.2% citric acid); C (3% cinnamon stick); D (0.2% citric acid and 3% cinnamon stick); [2]Means within each column not followed by the same superscripts are significantly (P<0.05) different.

Table 4. The effect of citric acid and cinnamon stick on free fatty acid of smoked chicken.

Weeks of Storage	Formulations (FFA %)[1]			
	A	B	C	D
0	1.72 ± 0.03	1.66 ± 0.01	1.58 ± 0.05	1.62 ± 0.03
1	1.78 ± 0.03	1.98 ± 0.02	1.60 ± 0.03	1.77 ± 0.06
2	1.85 ± 0.04	1.97 ± 0.04	1.75 ± 0.05	1.98 ± 0.05

[1]Each value is a mean of 2 determinations. Formulations: A (Control); B (0.2% citric acid); C (3% cinnamon stick); D (0.2% citric acid and 3% cinnamon stick); [2]Means within each column not followed by the same superscripts are significantly (P<0.05) different.

Table 5. The effect of citric acid and cinnamon stick on sensory evaluation of smoked chicken [1,2]

Formulations	Sensory Scores[3]					
	Colour	Taste	Aroma	Texture	Flavour	Overall acceptability
A	6.90[b]	6.90[a]	7.10[a]	6.90[a]	6.80[b]	6.70[b]
B	7.00[b]	7.40[a]	7.40[a]	7.10[a]	6.90[a]	7.30[a]
C	7.90[a]	7.40[a]	7.30[a]	7.30[a]	7.60[ab]	7.90[a]
D	7.80[a]	7.40[a]	7.50[a]	7.60[a]	7.80[a]	7.60[ab]

[1]Each value is a mean of 2 determinations. Formulations: A (Control); B (0.2% citric acid); C (3% cinnamon stick); D (0.2% citric acid and 3% cinnamon stick); [2]Means within each column not followed by the same superscripts are significantly (P<0.05) different
[3]Based on a nine-point hedonic scale with 9 representing like extremely and I representing dislike extremely

(3% cinnamon stick). Sample C was rated better (p<0.05) than sample A, in overall acceptability but there was no significant difference between sample C (3% cinnamon stick) and sample D (combination of the two samples 0.2% citric acid and 3% cinnamon stick).

DISCUSSION

Proximate composition

The mean increase in fat protein and ash content in the

final products may also have been contributed due to the addition of spices and other ingredient. The moisture content was high in fresh sample compared to the processed ones due to heat applied during processing as reported by Negbenebor *et al*. (1999) in a similar study.

The effect of citric acid and cinnamon stick on the pH of smoked chicken

It was observed that Formulation A /Group A Treatment (Control) had higher pH values than the other sample. The lower pH of the treated sample suggested higher activity in these samples compared to the control. Lower pH is effective in controlling microbial growth (Jay, 1987).

The effect of citric acid and cinnamon stick on free fatty acid of smoked chicken

Results suggestion that sample C is more effective in inhibiting free fatty acid production during storage and in therefore regarded as the best sample (Negbenebor *et al*, 1999).

The effect of citric acid and cinnamon stick on sensory evaluation of smoked chicken

The ability of the cinnamon sticks to mask of flavor and enhance the overall acceptability (Farrel, 1985). The result suggested that Formulation C/Group C treatment and Formulation D/Group D treatment were rated significantly ($P<0.05$) higher for colour compared with the control. The control sample had the lowest rating. The combination of citric acid and cinnamon stick did not have any additive effects.

Conclusion

Addition of 0.2% citric acid and 3% cinnamon stick affected ($P<0.05$) moisture, protein and fat contents but did not affect ($P>0.05$) ash content. Treatment of samples with 0.2% citric acid and 3% cinnamon stick did not affect the pH and Free Fatty Acid (FFA) significantly ($P>0.5$).

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