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Effects of brine concentration and curing time on quality attributes of cooked turkey laps

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Abstract

The objective of this study was to investigate the effect of brine concentration and curing time on physicochemical, microbial and sensory characteristics of turkey laps. 48 turkey laps of weight between 1.00 – 1.5kg were divided into 4 treatment groups of brine concentration – 10, 15, 20 and 25% respectively and were cured for 0, 4 and 8 days after cooking at 72°C for 20min. The results showed that Water Holding Capacity (WHC) and pH of the cured turkey laps increased ($p<0.05$) as cooking loss decreased ($p<0.05$) thereby increasing the yield of the turkey laps after cooking. Total Viable Count (TVC) and Total Coliform Count (TCC) decreased ($p<0.05$) while Total Fungal Count (TFC) increased ($p<0.05$) as brine concentration increased, but the TVC and TCC fluctuated while TFC increased steadily as curing time increased, not above tolerable levels which made the turkey laps wholesome and safe for consumption. Colour, flavour, texture and juiciness scores increased ($p<0.05$) as the brine concentration and time of curing increased, but were higher ($p<0.05$) in turkey laps in treatment 3 that were cured for 4 days. It was observed that treatment 3 (20% brine) and curing for 4 days furnished higher quality attributes of turkey laps as pH, WHC and moisture were high considerably thereby increasing the yield while cooking loss decreased. Also the microbial counts were lower while colour, flavour, texture and juiciness were higher. In the overall assessment of turkey laps, those cured with 20% brine for 4 days were most acceptable to sensory panel members.

1. Introduction

Poultry meat plays an important part in consumer's diet as a key source of protein supply. It contains several important classes of nutrients low in calories and source of both saturate and unsaturated fatty acids (Oluyemi and Robert 2000). Apart from chicken, turkey is the largest popular poultry meat consumed in most countries. It was domesticated from wild turkey in the United States of America with the generic name

Meleagris gallopavo belonging to the genus *phasianidae* (Atteh, 2004). In order to make turkey meat available to the teeming population of the world, emphasis should be placed on value addition and preservation of the meat through the period of slaughter, distribution and consumption (Apata, 2010). One of the preservation techniques in meat industry is curing which entails the use of brine at low temperature, addition of optimal nitrite salt, polyphosphate and sucrose to enhance yield, flavour and colour as the meat is protected against microbial attack during the period of preservation (Tenin *et al.*, 2000). Brining involves the use of sodium chloride (common table salt) as the highest percentage in brine solution due to its antimicrobial potentials and safety for human consumption, while the percentage inclusion of other components of brine such as nitrite and dextrose are lower as they only serve for flavour and colour enhancers of meat (Mountney and Pankhurst 2001). It was reported (Tenin *et al.*, 2000) that curing time had significant effect on quality of goat ham however, there is dearth of information on the implications of brine concentration on the quality of processed turkey meat. This study was conducted, therefore, to investigate the effects of different brine concentrations and curing time on quality attributes of cooked turkey laps.

2. Materials and Methods

This study was carried out in Meat Science laboratory of the Department of Animal Production, Olabisi Onabanjo University, Yewa Campus, Ayetoro, Ogun State.

48 Turkey laps of weights between 1.00 – 1.5kg were used for this study. They were purchased from Obasanjo Farms Ota fresh and chilled at 4°C for 24hrs before processing.

2.1. Brine Formulation

Brine solution was prepared following the procedures of Tenin *et al.* (2000) as shown on Table 1.

Table 1. Percentage Composition of brine solution

Ingredient	%
Water	87.00
Nitrite Salt ¹	10.00
Dextrose ²	3.00
Total	100.00

1. Nitrite salt (sodium chloride = 99.4%; Sodium nitrite = 0.6%).

2. Dextrose (bophos – crystalline – labovida)

Source: Tenin *et al.* (2000)

2.2. Brine Concentration and Curing of Turkey Laps

Five levels of brine concentrations were prepared and each level constituted a treatment thus, T1 = 10%, T2 = 15%, T3 = 20% and T4 = 25% respectively. The Turkey laps were randomly assigned to these 4 treatments with 12 Turkey laps per treatment. Brine was injected into Turkey laps using four 10ml syringe and needles, one syringe per treatment. The Turkey laps were subsequently immersed in pickles of the

same concentrations as brine and stored in a refrigerator at 2°C for 0, 4 and 8 days.

2.3. Cooking of Turkey Laps

Turkey laps were removed from pickles at 0, 4 and 8 days, rinsed and cooked at 85°C on water bath to an internal temperature of 72°C for 20 minutes on an adjustable Pifco Japan Electric hot plate model (No ECP 202). After cooking, the Turkey laps were rapidly showered with tap water and stored in a refrigerator at 2°C until the following day when analyses were carried out.

2.4. Cooking Loss

Percent cooking loss was determined at 0, 4 and 8 days by taking the weight of Turkey laps in each treatment before and after cooking and cooling and comparing the difference in weight with original weights. (Wattanachant *et al.*, 2005). Thus:

$$\% \text{ Cooking loss} = \frac{\text{Initial wt of laps} - \text{Final wt. of laps}}{\text{Initial wt of laps}} \times 100$$

2.5. Thermal Shortening

Was determined at 0, 4 and 8 days by taking the original length of Turkey laps muscle in each treatment before and after cooking and cooling and comparing the difference in length with original lengths (Wattanachant *et al.*, 2005). Thus:

$$\% \text{ Thermal shortening} = \frac{\text{Initial length of laps muscle} - \text{Final length of laps muscle}}{\text{Initial length of laps muscle}} \times 100$$

2.6. Cooking Yield

Turkey laps, from each treatment were weighed after cooking and cooling, they were allowed to drain for 10mins prior to weighing to determine cooking yield at 0, 4 and 8 days which was obtained as the difference between 100% and cooking loss %. Thus: Cooking yield = (100% - Cooking loss %) (Awosanya and Okubanjo 1993).

2.7. Drip Loss

10g of meat samples from Turkey laps in each treatment were wrapped in polythene bag and hung in a refrigerator at 2°C prior to cooking for 48hrs, after which the surface moisture was mopped with filter paper and reweighed. (Insausti *et al.*, 2001).

$$\% \text{ Drip loss} = \frac{(W_p + j) - (W_p)}{(W_p + m) - (W_p)} \times 100$$

2.8. Cold Shortening

This was determined at 0, 4 and 8 days prior to cooking by taking the original length of turkey laps muscles. The muscles were frozen for 48hrs after which they were removed and final lengths of the laps muscles were taken and

The difference in length between the original and final length (Hedrick *et al*, 1994) compared as:

$$\% \text{ Cold shortening} = \frac{\text{Initial length} - \text{final length}}{\text{Initial length}} \times 100$$

2.9. Water Holding Capacity (WHC)

This was determined using press method as described by Suzuki *et al* (1991). 1g of meat samples from Turkey laps from each treatment were removed prior to cooking at 0, 4 and 8 days curing and placed between two 9cm Whatman No 1 filter paper (Model C, Caver Inc; Wabash, USA). The meat samples and the filter papers were pressed between two 10.2x10.2cm² plexi – glasses at about 35.2kg/cm³ absolute pressure for 1minute with a vice. Moisture content of the pressed meat samples was determined in the oven at 105^oC for 24hrs. Amount of water released from meat samples was determined indirectly by measuring the area of wetted filter paper relative to area of pressed meat samples. Thus;

$$\text{WHC} = \frac{100 - (A_w - A_m) \times 9.47}{W_m \times M_c} \times 100$$

Where:

A_w = Area of water released from meat samples (cm²)

A_m = Area of meat samples (cm²)

W_m = Weight of meat samples (g)

M_c = Moisture content of meat samples (%)

9.47 = constant factor.

2.10. Proximate Composition of Cured Turkey Laps

This was determined following the procedures of AOAC (2000).

2.10.1. Moisture Contents

Cured Turkey laps moisture content was determined by oven drying 2g of meat samples at 105^oC for 24hrs till a constant weight was obtained.

$$\% \text{ Moisture} = \frac{\text{Initial wt of meat} - \text{Final wt of meat}}{\text{Initial wt of meat}} \times 100$$

2.10.2. Crude Protein

Meat samples crude protein from cured Turkey laps was determined with Kjedahl method which consisted of digestion of ground meat samples, distillation of the digest and titration of distillate. The actual crude protein values of meat samples were obtained by converting nitrogen (N %) content of meat with a constant (6.25). Crude protein was obtained thus (6.25 x N %).

2.10.3. Ether Extract (Fat)

Fat content of cured Turkey laps was determined using soxhlet extraction with petroleum ether and fat values calculated thus:

$$\% \text{ Fat} = \frac{\text{Weight of oil}}{\text{Weight of meat}} \times 100$$

2.10.4. Ash Content

Ash content of meat samples from Turkey laps was determined by igniting 2g of ground meat in a Muffle furnace at 550 – 600^oC for 4hrs till ashes were formed and were weighed and their values calculated thus:

$$\% \text{ Ash} = \frac{\text{Weight of Ash}}{\text{Weight of meat}} \times 100$$

2.10.5. Nitrogen Free Extract

Nitrogen Free Extract values were obtained by subtracting the sum of moisture, crude protein, fat and ash from 100%.

2.10.6. pH of Turkey Laps

10g of meat samples from each treatment cured for 0, 4 and 8 days was homogenized for 5mins with 90ml distilled water using a kitchen blender of 5mm blade, model 242 Nakai, Japan.

2.10.7. Microbiological Analysis of Cured Turkey Laps

10g of meat samples from cured Turkey laps in each treatment were removed at different days, 0, 4 and 8 of curing and blended with 90ml of 0.1% (W/V) peptone water for 60sec with a blender – plate 5mm, model 242 Nakai, Japan. 9ml of distilled water was pipette into clean test tubes covered with cotton wool and aluminum foil and autoclaved at 121^oC for 15mins. 1ml of homogenized material was then used for serial dilution of between 10⁻¹ to 10⁻⁴ and were spread on duplicate petri-plates. Bacterial numbers were determined from plates bearing colonies. Aerobic plate counts (TVC) were obtained on plate count Agar (DIFCO, USA) incubated at 32^oC for 48hrs. Enterobacteria count (ECC) on Violet Red Bile Glucose Agar (DIFCO, USA) over laid with same medium and incubated at 37^oC for 24hrs and Total fungal count (TFC) on Potato Dextrose Agar (FLUKA/LABLEMCO, UK) inverted and incubated at 28 – 30^oC for 5days. Both macroscopic and microscopic observations of the colonies were done after incubation with high power objective with immersion oil using an Olympus microscope – model 210 – 230. The number of colonies were counted in a plate and expressed as cfu/g of samples (IC MSF 1986; Olutola *et al.*, 1991; APHA 1992; AOAC, 2000).

2.11. Sensory Evaluation of Cured Turkey Laps

Meat from Turkey laps in each treatment was cut into bite size samples and these were subsequently evaluated by a 10-member semi-trained sensory evaluation panel (IAMS 1995). Samples were scored on a 9-point Hedonic scale ranging from 1=dislike extremely to 9=like extremely for colour, flavour, tenderness, juiciness, texture and overall acceptability. Samples were served to panelists in random order with a label control. Each treatment was presented to

each panelist thrice.

2.12. Experimental Design and Statistical Analysis

Completely randomized design with factorial arrangement where brine concentration was the first factor and time of curing was the second factor was used for this study. Data collected were statistically analysed with analysis of variance (ANOVA) using (SAS 2002) and in case of significant effects, the means were compared with Duncan’s Multiple range test of the same computer software.

3. Results

Brine concentration affected ($p < 0.05$) all the physical

properties of cured turkey laps. (Table 2). The yield and water holding capacity (WHC) of cured Turkey laps increased ($p < 0.05$) as brine concentration increased and were higher ($p < 0.05$) in treatment 4 with 25% brine concentration. Cooking loss (CL), thermal shortening (TS), drip loss (DL) and cold shortening (CS) decreased ($p < 0.05$) correspondingly as brine concentration increased. As the curing time increased from 0 to 8 days, there were corresponding increased ($p < 0.05$) in the percent yield and WHC of turkey laps after cooking, while CL, TS, DL and CS decreased ($p < 0.05$).

The same pattern of results were observed at interaction level, as the brine concentration and time of curing increased ($p < 0.05$), yield and WHC increased while other physical properties decreased ($p < 0.05$).

Table 2. Physical Properties of Cured Turkey Laps

Variables	CY	CL	TS	DL	CS	WHC
Treatments						
T1	75.90±0.07 ^d	24.10±0.10 ^a	22.62±0.01 ^a	25.30±0.01 ^a	20.90±0.05 ^a	60.26±1.00 ^a
T2	82.00±0.05 ^c	18.00±0.15 ^b	19.76±0.10 ^b	23.27±0.01 ^b	18.86±0.05 ^b	63.20±0.00 ^b
T3	83.40±0.04 ^b	16.60±0.20 ^c	17.60±0.20 ^c	20.16±0.10 ^c	16.80±0.10 ^c	65.45±0.00 ^b
T4	85.60±0.03 ^a	14.40±0.22 ^d	11.45±0.15 ^d	18.20±0.10 ^d	15.60±0.10 ^d	67.52±0.00 ^a
Time						
0	80.58±0.06 ^c	19.42±0.23 ^a	17.25±0.27 ^a	24.30±0.10 ^a	21.55±0.60 ^a	58.25±0.10 ^c
4	81.63±0.05 ^b	18.37±0.58 ^b	16.22±0.79 ^b	22.21±0.05 ^b	20.30±0.63 ^b	63.52±0.00 ^b
8	83.70±0.04 ^a	16.30±0.57 ^c	16.19±0.79 ^c	18.30±0.15 ^c	18.24±0.67 ^c	65.15±0.00 ^a

abcd: Means on the same column and for the same variables with different superscripts are statistically significant ($p < 0.05$).
 CY = Cooking yield, CL = Cooking loss, TS = Thermal Shortening, DL = Drip Loss,
 CS= Cold Shortening, WHC = Water Holding Capacity

Table 3. Proximate Composition and pH of Cured Turkey laps

Variables	MC	CP	EE	Ash	NFE	pH
Treatments						
T1	60.23±0.81 ^d	23.72±0.50 ^a	9.57±0.20	1.50±0.15 ^d	4.98±0.08 ^a	6.20±0.20
T2	62.18±0.75 ^c	22.68±0.52 ^b	9.51±0.27	2.52±0.10 ^c	3.11±0.10 ^b	6.40±0.20
T3	64.13±0.70 ^b	21.60±0.54 ^c	9.45±0.31	3.55±0.09 ^b	1.37±0.15 ^c	6.60±0.10
T4	65.20±0.63 ^a	20.53±0.67 ^d	9.40±0.34	4.57±0.08 ^a	1.91±0.73 ^c	6.80±0.10
Time						
0	60.05±1.11 ^c	24.25±0.35 ^a	9.23±0.09	1.65±0.14 ^c	4.82±0.08 ^a	6.20±0.20
4	62.20±0.46 ^b	23.10±0.38 ^b	9.41±0.08	2.73±0.09 ^b	2.56±0.10 ^b	6.40±0.20
8	64.23±0.34 ^a	22.00±0.52 ^c	9.46±0.08	3.78±0.06 ^a	0.53±0.14 ^c	6.60±0.10

abcd: Means on the same column and for the same variables with different superscripts are statistically significant ($p < 0.05$).
 MC = Moisture Content, CP = Crude Protein, EE = Ether Extract, NFE = Nitrogen Free Extract.

Table 3 shows the means for proximate composition and pH analysis. The moisture content of Turkey laps increased ($p < 0.05$) while the protein content decreased with increasing brine concentration and curing time. The highest ($p < 0.05$) ash content observed in Turkey laps cured with 25% brine for 8 days indicates a higher salt uptake during curing process which also increased the pH of the turkey laps numerically.

The results of cured Turkey laps in (Table 4) showed that brine concentration and time of curing affected ($p < 0.05$) the microbial loads of the product. The values of all the microbes analysed for decreased ($p < 0.05$) as the level of brine concentration and time of curing increased. Total viable count (TVC) loads were the same ($p > 0.05$) in treatments 1

and 2 and decreased ($p < 0.05$) at 20 and 25% brine concentrations, Total coliform count (TCC) loads were higher ($p < 0.05$) in treatment 1, 2 and 3 and decreased ($p > 0.05$) in treatment 4 (25%) brine concentration, while Total fungal count (TFC) were higher ($p < 0.05$) in treatments 1 and 2 and decreased ($p < 0.05$) in treatments 3 and 4 respectively. In contrast the values of both TVC and TCC were higher ($p < 0.05$) in Turkey laps cured for 0 day decreased significantly ($p < 0.05$) on 4th day and increased ($p < 0.05$) on 8th day of curing, whereas the TFC values increased ($p < 0.05$) steadily as the period of curing increased. This pattern of microbial load values was observed between treatments and time of curing.

Table 4. Microbial loads of cured Turkey laps

Variables	TVC	TCC	TFC
Treatments			
T1	5.64x10 ^{5a}	5.76x10 ^{3a}	5.56x10 ^{3b}
T2	5.54x10 ^{5a}	5.67x10 ^{3a}	5.62x10 ^{3b}
T3	4.38x10 ^{5b}	4.47x10 ^{3b}	6.75x10 ^{3a}
Time			
0	5.89x10 ^{5a}	6.47x10 ^{3a}	3.21x10 ^{3c}
4	3.84x10 ^{5c}	4.60x10 ^{3c}	5.68x10 ^{3b}
8	4.87x10 ^{5b}	5.77x10 ^{3b}	7.09x10 ^{3a}

abc: Means on the same column and for the same variables with different superscripts are statistically significant ($p < 0.05$).

TVC = Total viable count, TCC = Total Coliform Count, TFC = Total Fungal Count.

Table 5. Organoleptic properties of cured Turkey laps

Variables	Col.	Flv.	Tends	Jens	Tex	OA
Treatments						
T1	3.27±2.40 ^d	4.20±1.24 ^d	4.62±0.63 ^c	4.44±0.76 ^c	4.33±0.76 ^c	4.37±0.60
T2	4.45±1.97 ^c	5.37±1.04 ^c	5.77±0.60 ^b	5.47±0.50 ^b	5.37±0.51 ^b	5.42±0.36
T3	6.63±0.25 ^a	7.53±0.36 ^a	5.80±0.58 ^b	6.65±0.29 ^a	6.42±0.26 ^a	6.70±0.16 ^a
T4	5.57±1.68 ^b	6.45±0.96 ^b	6.83±0.29 ^a	5.57±0.40 ^b	5.28±0.32 ^b	5.35±0.40
Time						
0	4.30±1.97 ^c	4.40±1.38 ^c	4.25±0.65 ^c	5.20±0.57 ^b	4.35±0.76 ^c	4.78±0.41
4	6.65±0.21 ^a	6.55±0.32 ^a	5.70±0.51 ^b	6.33±0.47 ^a	6.62±0.21 ^a	6.98±0.24
8	5.52±0.24 ^b	5.50±1.28 ^b	6.75±0.43 ^a	5.28±0.34 ^b	5.57±0.25 ^b	5.80±0.33

abcd: Means on the same column and for the same variables with different superscripts are statistically significant ($p < 0.05$).

Col = Colour, Flv = Flavour, Tends = Tenderness, Jens = Juiciness, OA = Overall Acceptability

4. Discussion

These results were probably due to the extra uptake of salt and sugar which were retained during processing, thus increasing water retention. The maximum cured uptake was probably not attained with 10% brine concentration and at 0 day, consequently, the turkey laps cured with 10% at 0 day suffered more cooking loss, thermal shortening, drip loss and cold shortening than those cured with 15, 20 or 25% brine concentration at 4 and 8 days. It was reported (Seman *et al.*, 1986) that salting of meat causes an inhibition of glycolysis that results in a higher pH and WHC. The higher pH due to higher salt content of the turkey laps cured with 25% for 8 days probably accounts for the increase in the WHC compared to the lower brine concentration and shorter curing times. Trout and Schmidt (1986) also reported that when salt concentration was increased from 1.33% to 2.93% it increased the WHC and yield of the products. The differences in salt content of Turkey laps cured with different brine concentrations and periods reflected the differences in ash values observed between treatments, time and interaction between the two parameters. As in this study, (Tenin *et al.*, 2000) have reported that increasing curing time affected proximate composition of cured ham. The results obtained from this study were due to the fact that salt has considerable deleterious effect on the survival of microorganisms (Ikeme 1990) as it destroys the biomass of these microbes. The decrease in microbial load observed in TVC and TCC on 4th

The results presented in (Table 5) are means for sensory properties of cured Turkey laps. Brine concentration and time of curing significantly ($p < 0.05$) affected all the sensory attributes of cured Turkey laps tested in this study. Colour, flavour, juiciness and texture were higher ($p < 0.05$) in Turkey laps in treatment 3 cured for 4 days, while those in treatment 4 cured for 8 days were more ($p < 0.05$) tender. Turkey laps cured with 20% brine concentration for 4 days were preferred ($p < 0.05$) more than those cured with 10, 15 and 25% brine for 0 and 8 days.

day of curing could be due to higher uptake of salt which might have broken down on 8th day thereby encouraging the regrowth of the microbes, while the reverse could be the case of TFC whose value increased despite increase in the brine concentration and time of curing as fungi could be more halophilic than aerobic and coliform bacteria. (Mountney and Pankhurst 2001). These results were also obtained in interaction between treatment and time effects for cured Turkey laps in this study. Turkey laps in treatment 3 cured for 4 days were preferred more probably due to their high colour, flavour, texture and juiciness of the turkey laps in this group and for the fact that they might not have been seriously attacked by microbes, as a result of lower count recorded for this treatment. The lower microbial count and nitrite in the brine could have aided higher colour and flavour values of the Turkey laps. The lower texture and overall acceptability of Turkey laps in treatment 4 could be due to high salt accumulation as a result of high uptake.

5. Conclusion

The use of brine in meat processing technology is beneficial in poultry products. This is evident in the high yield and water holding capacity as a result of corresponding lower cooking loss and high pH of Turkey laps cured for 8 days in this study. The microbial counts were lower considerably in the Turkey laps, while most of the proximate and organoleptic characteristics were better. In all, Turkey laps in treatment 3 (20% brine concentration) cured for 4 days were mostly

preferred. This could be due to the fact that, this treatment and time supported considerably high protein pH cooking yield, WHC, colour, flavour, texture and juiciness, and lower moisture, ash (major salt) and microbial counts of Turkey laps in this study. It is recommended that 20% brine concentration and 4 days curing be employed by meat processor in curing Turkey meat (laps).

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