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Research paper

Quality Attributes of Cured and Smoked Chicken Legs Using Different Processing Methods

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ABSTRACT

Preliminary trials for processing cured and smoked chicken legs were conducted using variables like a method of treatment (dipping, dry curing, injection, and tumbling) and brine solution at different concentrations and optimized by evaluating the product by a sensory panel and calculating the residual nitrite content. The processing methods (T1- Injection and dipping (24 hours); T2- Injection and tumbling twice for 30 min with a gap of 20 min in between, and T3- Injection, tumbling for 20 min and dipping for 12 h) were adopted for the development of cured and smoked chicken legs and evaluated the quality of developed products. No significant differences in the pH of chicken legs are observed. The shear force value is significantly lower ($P<0.05$) in T1 and T3 as compared to T2. Residual nitrite was significantly less ($P<0.05$) in T3 as compared to T1 and T2. The T3 had significantly higher nitroso pigment (%) than T1 and T2. No significant differences were observed in proximate composition amongst different processing conditions of smoked chicken legs. In sensory evaluation, the T3 was rated higher in colour and overall acceptability score. It can be concluded that tumbling had a better effect on the development of cured and smoked chicken legs with superior quality attributes. Further, we can reduce the processing time by decreasing the dipping time in the brine solution.

Keywords: *Cured and smoked chicken legs, Dipping, Injection, Tumbling, Marination, Quality characteristics*

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INTRODUCTION

Chicken meat is reported to be the highest contributor (36.68 per cent) to the total meat production in India (FAO, 2020). Broiler chicken occupies a prime position in the Indian non-vegetarian diet due to its price competitiveness, nutritional quality, universal availability, and absence of religious taboos tagged with it. Novel ways of utilizing chicken meat in the form of convenience products need to be evolved to keep the chicken meat industry vibrant. Considering the rapidly increasing demand for meat products suitable for fast food consumption, it would be beneficial to develop simple, easy to prepare, low-cost further-processed meat products having improved nutritive values thus providing health benefits for consumers (Gurikar et al. 2014). Generally, commercial marinade solutions usually contain a complex solution of water, salts, polyphosphate, flavorings, and other ingredients and are applied to the meat by soaking, blending, tumbling, or injection. It is well known that marination is a popular technique used to tenderize and improve the quality characteristics of meat products. Various new techniques have been introduced to accelerate marinade transport throughout the meat. As a kind of physical-mechanical treatment, tumbling is well recognized and accepted (Pietrasik and Shand, 2004). To accelerate the diffusion of the brine into the meat and to get a more uniform salt distribution in the meat, the processing often involved tumbling or massaging. Tumbling aimed to activate, or solubilize protein, which improved cooking yield, firmness, and texture and in addition created a layer of activated protein on the surface of the meat. The combination of marination and tumbling provides a useful means of loosening the muscle structures, disrupting muscle cells, and destroying the connection between the myofibres and the connective tissue. It consequently improved the physical characteristics and sensory qualities of prepared pork chops (Yusop et al. 2012).

Curing, smoking, and salting are the[1] earliest known methods of meat preservation. Nitrites in the curing process is mainly used to develop attractive pink colour in meat though it has a specific antibotulinal effect which is a potential pathogen in meat products. The process of curing was also later adapted as a means of preservation (Ahmad et al. 2005). Ascorbic acid reduces the possibility of the formation of nitrosamine from nitrite in cured products (Holmes, 2007). Smoking is a meat preservation system as it reduces the proliferation of microorganisms (Sikorski, 2016). Chicken meat has not been subjected to curing and smoking processes and to sustain the increasing demand for chicken products during development of cured and smoked chicken products. Keeping the above facts in view, the present study was conducted to assess the influence of injection, dipping, and tumbling methods on the quality characteristics of convenient, ready-to-eat, and highly palatable cured and smoked chicken legs.

MATERIALS AND METHODS

Broiler chicken legs were procured from retail shops in Hyderabad and packed in polyethylene bags. Packed samples were transported in ice to the ICAR-National Research Centre on Meat, Chengicherla, Hyderabad. The meat brought to the laboratory was trimmed off fascia and separable fat and processed immediately. The curing solution was prepared by using sodium chloride 65 g, sugar 25 g, sodium nitrite 0.5 g, sodium ascorbate 1.2 g, and Sodium tripolyphosphate 10 g dissolved in 1 lit potable water and one liter of the brine was used to cure 2 kg of chicken. The chicken legs were processed by following three different treatments: T1- Injection and dipping for 24 h; T2- Injection and tumbling twice for 30

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min with a gap of 20 min in between and T3- Injection, tumbling for 20 min and dipping for 12 h. After processing, the chicken legs of all the treatments were steam-cooked for 20- 25 min. The cured, cooked chicken legs were then subjected to smoking in a smoking chamber (Smoke Rite ovens). The chicken legs were kept in a smoking chamber and the oven temperature was maintained at 65^0C for 30 min without a smoking process. Then the temperature was raised to 85-100^0C for 30 min with a smoking time of 20 min, till an internal temperature of 72^0C was attained. Then the product was cooled and analyzed for various physicochemical, proximate, and sensory quality characteristics.

The pH of cured and smoked chicken legs was determined by a conventional probe electrode (IQ Scientific instruments, 150-77 pH/mV temp system) inserted into muscle tissue at least 1 cm below the surfaces exposed to air, which was calibrated against a buffer of pH 7 and 4. The weight of chicken legs was recorded before (raw weight) and after cooking (smoking). Percent cooking yield was determined by calculating weight differences for samples before and after cooking according to Murphy et al. (1975). Shear force value was determined as per the method described by Berry and Stiffler (1981). It was measured as the force required for shearing a one cm square block on Warner-Bratzler Shear Press (Model no. 81031307, GR Elec. Mfg. Co. USA) and expressed as kg/cm^2. The nitrite content in meat was determined by the procedure as described by AOAC (1975). One gram of ground cured meat sample was placed in a 50-ml beaker, then 40 ml of hot water (80°C) was added and mixed thoroughly with stirring rods taking care to break all lumps. The suitable aliquot (20 ml) was prepared and then transferred to a 50- ml volumetric flask. The sodium nitrite content of the solution was read from the optical density standard curve. The salt (sodium chloride) in cured meat was determined by the procedure as described by the American Meat Institute, laboratory methods of the meat industry, Chicago. The total pigment of the cured and smoked chicken leg was determined by following the procedure of Hornsey (1956) with modifications. The absorbance and the amount of total pigment (ppm) were measured using the formula: Total pigment in ppm = Optical density x 680. Nitroso pigment of the cured and smoked chicken leg was determined following the procedure of Hornsey (1956) with modifications. The procedure for the estimation of nitroso pigment was almost the same as that of the total pigment analysis, except for the solvent and the wavelength used in the spectrophotometer. The moisture content was determined by hot air oven drying, protein by automatic Kjeldahl method, fat by Soxhlet extraction with petroleum ether, and total ash by muffle furnace as described by AOAC (2002). Sensory evaluation was conducted by using experienced taste panel members consisting of scientists at ICAR-National Research Centre on Meat and evaluated for colour, flavour, saltiness, juiciness, texture and overall palatability using 8-point descriptive scale (where, 8=extremely desirable, 1= extremely undesirable) as described by Keeton, (1983) with slight modifications.

The experiments were repeated six times and the data (for physicochemical and proximate composition "n" is 6 and sensory parameters "n" is 24) was analyzed using the General Linear Model procedure of statistical package for social sciences (SPSS) 16 version and compared the means by using one-way analysis of variance (ANOVA) and the level of significance was tested using least significant differences (LSD) test as per Snedecor and Cochran, (1994).

RESULTS AND DISCUSSION

The influence of the three treatments *viz.,* T1 (Injection and dipping), T2 (Injection and tumbling), and T3 (Injection, tumbling and dipping) on various physicochemical characteristics like pH, cooking yield, shear force value, residual nitrite, salt content, total pigment and nitroso pigment of cured and smoked chicken legs (CSCL) are tabulated in Table 1.

The tumbling process employed in T2 and T3 significantly ($P<0.05$) influenced the pH (Table 1). A significantly lower ($P<0.05$) pH value was observed in T1 as compared to T2 and T3, while the differences between T2 and T3 were not significant ($P>0.05$) statistically. The samples (T2 and T3) processed in tumbling had higher pH than the samples prepared by injection and dipping (T1). This might be due to the increased penetration of curing solution during the tumbling process. Further, higher pH could be due to the addition of sodium tripolyphosphate in the curing solution. Li et al. (2011) also reported the pH of cooked cured products in the range from 5.6 – 6.6. Plimpton et al. (1991) also reported higher pH in tumbled samples than in non-tumbled ones. The analysis of variance revealed that there was a significant difference ($P<0.05$) in terms of shear force values (SFV) among treatments (Table 1). The T1 had significantly higher ($P<0.05$) SFV as compared to T2 and T3. However, no significant difference ($P>0.05$) was noticed between T2 and T3. Tumbled samples (T2 and T3) had lesser shear force values than the non-tumbled samples (T1). Improved tenderness in tumbled samples might be due to cellular disruption and myofibrillar fragmentation of the muscle tissue (Theno et al. 1978). Chow *et al.* (1986) and Dzudie and Okubanjo (1997) reported improved tenderness for tumbled products.

Table 1: Physicochemical attributes of cured and smoked chicken legs as influenced by different processing variables (Mean ± S.E, n=6)

Physico-chemical attributes	T1	T2	T3
pH	6.28 ± 0.03^a	6.43 ± 0.01^b	6.36 ± 0.03^b
Shear force value (N)	13.07 ± 0.48^b	11.12 ± 0.79^a	11.13 ± 0.87^a
Cooking yield (%)	62.03 ± 0.43^a	63.66 ± 0.31^b	63.41 ± 0.38^b
Residual nitrite (ppm)	82.36 ± 0.57^a	96.90 ± 0.84^b	84.63 ± 1.74^a
Salt (%)	2.23±0.07	2.12±0.03	2.23±0.03
Total pigment (ppm)	107.40 ± 4.51^a	139.60 ± 1.50^b	135.83 ± 3.99^b
Nitroso pigment (ppm)	31.50 ± 1.63^a	42.70 ± 1.64^b	40.24 ± 1.47^b

Means with different superscripts in a row-wise differ significantly (P<0.05). T1- Injection and dipping for 24 h, T2- Injection and tumbling twice for 30 min with a gap of 20 min in between, T3- Injection, tumbling for 20 min and dipping for 12 h

The mean cooking yield following T1, T2, and T3 were 62.03, 63.66, and 63.41 per cent, respectively (Table 1). In the treatments, T2 and T3, where the samples underwent a tumbling process, the cooking yield values were significantly (P<0.05) higher than in T1, whereas, no significant difference (P>0.05) was noticed between the treatments T2 and T3. Tumbling improved cooking yield by 1.63 per cent and 1.38 per cent for T2 and T3, respectively than T1. Literature suggested that tumbling provided better migration of curing solution into the meat matrix which resulted in increase in ionic strength and pH improved water holding capacity, which offered effective penetration of curing solution during tumbling (Lautenschlaeger, 1995). Maximum residual nitrite levels were recorded in samples treated with injection and tumbling (T2), which was significantly (P<0.05) higher than T1 and T3 (Table 1). However, no significant difference (P>0.05) was noticed between T1 and T3 and the residual nitrite contents were well below the level specified by USDA (1995), ISI (1967), and PFA (1954). Residual nitrite levels were reported maximum in samples treated by injection and tumbling (T2) which might be due to effective penetration of curing solution during tumbling (Lautenschlaeger, 1995). No significant difference (P>0.05) was observed with regard to salt content between T1, T2, and T3 samples (Table 1). These salt content values were lower than those obtained by Thomas et al. (2008) who fixed the salt content at 3.5 per cent for cured and smoked buffalo meat chunks. There was a significant difference (P<0.05) in the levels of total pigments (ppm) between tumbled and non-tumbled CSCL (Table 1). The T1 had significantly (P<0.05) lower total pigment content than T2 and T3, whereas no significant difference (P>0.05) was observed between T2 and T3. The difference with respect to total pigment could be due to the variation in the type of meat used. However, these values found were much lower than those obtained by Thomas et al. (2008) who recommended a total pigment of 524.3 ppm for cured and smoked buffalo meat chunks. Maximum nitroso pigment levels (ppm) were recorded in the samples treated with injection and tumbling (T2) (Table 1). The mean values of total pigments for T1, T2, and T3 were 31.50, 42.70, and 40.24 ppm, respectively. The T1 had significantly (P<0.05) lower total pigment content than T2 and T3, whereas no significant difference (P>0.05) was observed between T2 and T3. This difference could mainly be due to the tumbling process, and thereby increased the nitrite content, which in turn increased cured pigment.

The effect of three different treatments on proximate composition *viz.,* moisture, protein, fat, and ash of cured and smoked chicken legs were tabulated (Table 2). There was a significant difference (P<0.05) observed in the case of the moisture content between T1 and T2, whereas the moisture content of T3 was not significantly different (P>0.05) with either T1or T2. There was a significant increase in the moisture content of intermittent tumbled samples (30 minutes with a gap of 20 minutes in between). This increase in moisture content of samples might be due to higher levels of salt soluble proteins that were extracted and formed a sealer upon heating.

Table 2: Proximate composition of cured and smoked chicken legs as influenced by different processing variables (Mean ± S.E, n=6)

Proximate composition (%)	T1	T2	T3
Moisture	$63.11±0.48^{a}$	$64.93±0.82^{b}$	$63.58±0.35^{ab}$
Protein	$27.75±0.41^{b}$	$25.84±0.80^{a}$	$27.10±0.25^{ab}$
Fat	3.06±0.04	3.06±0.02	3.04±0.02
Ash	3.07±0.06	3.09±0.07	3.13±0.05

Means with different superscripts in a row-wise differ significantly (P<0.05) T1- Injection and dipping for 24 h, T2- Injection and tumbling twice for 30 min with a gap of 20 min in between, T3- Injection, tumbling for 20 min and dipping for 12 h

T1 had significantly (P<0.05) higher protein content than T2 but there was no significant difference (P>0.05) observed with respect to the protein content of CSCL of T3 either with T1 or T2. Non-tumbled samples exhibited more protein than tumbled CSCL. Retention of the higher amount of moisture in the tumbled samples might have been reflected in the form of decreased protein content. There was no significant difference with regards to the fat and ash contents among treatments T1, T2, and T3. Similarly, Harmon et al. (1992) also reported a statistically nonsignificant difference in fat and ash per cent between tumbled and non-tumbled products.

The effect of three different processing methods on sensory scores *viz.,* colour, flavor, saltiness, juiciness, texture, and overall acceptability of cured and smoked chicken legs are presented in Table 3. The colour was significantly improved (P<0.05) by intermittent tumbling under vacuum (T3) also significantly different between T1and T2 and between T2 and T3. This could be because the rest period provided in the intermittent tumbling, allowed the curing solution to migrate and diffuse more uniformly throughout the tissue. Further, the increase in colour scores might be due to vacuum, which improved the development of the cured colour. Kamchorn et al. (1983) also observed rapid and more complete cured colour development during the formation of meat emulsions under a vacuum. Flavour scores revealed no significant difference between tumbled and non-tumbled CSCL. This was in agreement with the reports of Keerthi (1998) who did not observe any significant difference in flavor between tumbled and non-tumbled restructured buffalo meat blocks.

Table 3: Sensory attributes of cured and smoked chicken legs as influenced by different processing variables (Mean ± S.E n=6)

Sensory attributes	T_1	T_2	T_3
Colour	6.77±0.12 [c]	6.83±0.12 [b]	7.13±0.11 [a]
Flavor	7.00±0.04	6.77±0.12	6.97±0.12
Saltiness	7.00±0.01 [a]	6.75±0.11 [ab]	6.94±0.12 [b]
Juiciness	6.82±0.09 [b]	7.05±0.16 [a]	7.05±0.11 [a]
Texture	6.97±0.02 [a]	6.77±0.1 [b]	6.97±0.08 [a]
Overall acceptability	6.89±0.07 [b]	6.86±0.11 [b]	7.16±0.11 [a]

Means with different superscripts in a row-wise differ significantly (P<0.05). T1- Injection and dipping for 24 h, T2- Injection and tumbling twice for 30 min with a gap of 20 min in between, T3- Injection, tumbling for 20 min and dipping for 12 h

The mean scores of CSCL for saltiness were significantly (P<0.05) lower in tumbled samples than in non-tumbled ones, however, saltiness scores did not vary significantly between T1 and T2 and between T2 and T3. The results were in contrast with Yusop et al. (2011) who reported higher saltiness scores in tumbled samples, which could be due to the duration of tumbling and holding time in the brine solution. The tumbling process significantly improved (P<0.05) juiciness of CSCL under vacuum (T2 and T3). The mean scores for juiciness were in the order of 6.82, 7.05, and 7.05 for T1, T2, and T3, respectively. The juiciness scores for tumbled samples were better than those of the non-tumbled samples. The increase in juiciness scores could be due to vacuum tumbling. Tumbling under vacuum (T2 and T3) improved the texture of CSCL significantly (P<0.05). The scores were significantly different between T1and T2 and between T1 and T3. This increase in texture scores could be attributed to vacuum tumbling as it increased tenderness following physical manipulation. The mean scores of CSCL for overall acceptability were significantly improved (P<0.05) by intermittent tumbling under vacuum (T2). The mean scores for overall acceptability were in the order 6.89 < 6.86 < 7.16 for T1, T2, and T3, respectively. The scores were significantly different between T1and T3 and between T2 and T3. The same could be because of the added effect of the other sensory scores.

CONCLUSION

Based on these results, it can be concluded that cured smoked chicken legs processed by T3 variable i.e. injection, tumbling for 20 min, and dipping for 12 h had no significant differences in the pH, lower shear force values, and residual nitrite and significantly higher nitroso pigment (%) than T1 (injection and dipping) and T2 (injection and tumbling). No significant differences were observed in proximate composition amongst different processing conditions of smoked chicken legs. In sensory evaluation, the T3 was rated higher in colour and overall acceptability score. Application of injection, tumbling and dipping had a better effect on the development of cured and smoked chicken leg with superior quality attributes. Further, we can reduce the processing time by decreasing the dipping time in a brine solution.

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