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Chicken Products from Chennai: Effect of Different Cooking Methods on Physicochemical and Microbial Quality from Different Retail Outlets

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ABSTRACT

Background: Methods of cooking used for chicken products play a significant role in oxidation reactions which in turn leads to loss of nutritional quality, color and further leads to spoilage.

Methods: The aim of the research was to study the effect of different cooking methods *viz*, dry (Chicken 65 and Grilled chicken) and moist cooking (Chicken briyani and Chicken gravy) on physicochemical and microbial quality of chicken products sold at different retail outlets (street outlets, small hotels and restaurants) in Chennai.

Results: Moist cooked chicken products in street outlets had significantly higher pH, when compare with dry cooked chicken products, whereas, thiobarbituric acid (TBA) and tyrosine value (TV) were higher ($P<0.05$ and $P>0.01$) in chicken 65. Chicken products from street outlets had significantly higher ($P<0.01$) pH, TBA and tyrosine value in both type of cooking methods. Significantly higher ($P<0.01$) hue, chroma and value were noticed in chicken 65, of which chicken 65 from restaurant had higher ($P<0.01$ and $P<0.05$) colour properties. Significantly lower ($P<0.01$) microbial count was noticed in dry cooked chicken products. However, chicken products sold at street outlets had poor microbial quality.

Key words: Chicken products, Cooking methods, Microbial quality, Physicochemical quality.

INTRODUCTION

In India poultry industry has come a long way from a backyard activity to a well organized, scientific and vibrant sector due to higher demand for meat and egg production. India is the world's sixth largest producer of poultry meat and the country produces 5.3 million metric tons (MT) of chicken which shares around 51.44% of total meat production (BAHS, 2022). Though a significant increase in poultry production was achieved, concomitant increase in processing and marketing of poultry products has not been attained.

Generally, the poultry is relatively cheaper source of protein as compared to beef, mutton and fish meat; and the demand of poultry meat is continuously increasing. Under these circumstances, it is imperative to consumers of poultry meat and its products to have quality meat products in the market (Barbut, 2002). Generally, meat cooking methods were categorized into dry, moist and novel heating i.e. microwave and infrared (Tiwari and O'Donnell, 2012). Changes in the physicochemical characteristics during cooking (*e.g*. weight loss, water-holding capacity modification, color and aroma development and muscle fiber shrinkage) are highly based on the muscle composition, its characteristics and different heating methods in which time-temperature combination during cooking, which eventually influence the quality parameters and palatability of meat and meat products (Lee *et al.,* 2017; Chumngoen *et al.,* 2016). However, published data on the effects of moist and dry heat cooking on the quality of poultry meat products was also very limited.

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The chicken products such as grilled chicken, chicken 65, chicken biryani and chicken gravy are most commonly available in different outlets in and around Chennai. Also, research work quality standards of chicken products, which are available or market in major metropolitan cities was meagre. So, in previous study, we evaluated the effect of

different cooking methods on the proximate composition of chicken products sold at different retail outlets in and around Chennai (Vanathi *et al.,* 2022). Hence, the study was conducted to evaluate the physicochemical and microbial quality of chicken products available at different retail outlets in and around Chennai.

MATERIALS AND METHODS

The studies were carried out in the Department of Livestock Products Technology (Meat Science), Madras Veterinary College, Chennai-600 007, TANUVAS during the year 2020 to 2021.

Source of materials

A total of 120 nos. of chicken products, based on cooking methods such as dry heat (chicken 65 and grilled chicken) and moist cooked (chicken biryani and chicken gravy) samples were collected from different retail outlets located at 12 different zones in Chennai such as Vepery, Purasaiwakkam, Chennai Central, Perambur, Erukkancheri, Egmore, Periamet, Valasaravakkam, Shozhinganallur, Perungudi, Annanagar and Koyembedu were presented in Table 1. Chicken products samples were placed in UV sterilized polythene bags and transported hygienically to Department of Livestock Products Technology (Meat Science), Madras Veterinary College, Chennai -7 in clean insulated box with ice packs. The collected samples were immediately used for analysis of quality characteristics.

Chemicals

The chemicals used for analysis of chicken products were of analytical grade was obtained from standard firms (M/S Sigma Aldrich, M/S Hi-Media and M/S Loba Chemie).

Estimation of physico-chemical qualities

pH

pH of the sample was measured by using a digital pH meter (Cyberscan pH 510, Merck). About 5 gm of sample was homogenized with 45 ml of distilled water in a warning laboratory blender for 1 min. The pH recorded by immersing the combined electrode of digital pH meter into the homogenate.

Estimation of thiobarbituric acid value (TBA)

The TBA value is the measured as the oxidative rancidity of food and is generally expressed as a value or number. Rancidity of fat in stored food is defined as the development of state off flavor as a result of oxidation of unsaturated fatty acid. The TBA value of chicken products was assessed in triplicates as per the procedure mentioned by Tarladgis *et al.* (1960).

Estimation of tyrosine value (TV)

The tyrosine value can be effectively used as an indication for proteolysis and to measure the amino acid tyrosine and tryptophan present in nonpolar extract of the meat product. The TV of chicken products was assessed in triplicates as per the procedure mentioned by Strange *et al*. (1977).

Munsell colour analysis

The Munsell color-order system is the best way of detecting specific colors as well as showing the relationships among different colors. Every color has three specific qualities or color attributes: such as hue, value and chroma. Munsell established numeric scales along with visually uniform steps for each of these attributes. The Munsell Book of Color, which had collection of colored chips and were arranged according to these scales. Each chip is identified numerically using these scales. The color of any surface can be identified by comparing it to the chips, under proper illumination and viewing conditions. The color is then identified by its H (hue), V (value) and C (chroma).

Estimation of microbial qualities

Microbial qualities such as standard plate count, coliform count and yeast and mould counts in chicken products were determined following the standard method of APHA (1984).

Statistical analysis

The data obtained from each experiments were subjected to statistical analysis (Snedecor and Cochran, 1994) for Analysis of Variance (ANOVA) and Duncan's multiple range test to compare the means by using SPSS software for window (Version 17.0, SPSS Inc., Chicago, IL, USA). The level of significant effects, least significant differences were calculated at appropriate level of significance of 0.05 was used for comparison of means.

RESULTS AND DISCUSSION

pH, thiobarbituric acid value and tyrosine value

The results for the effect of different types of cooking on the pH, thiobarbituric acid and tyrosine value of chicken products sold at different retail outlets in and around Chennai are shown in Table 2. Higher significant differences ($P<0.01$) was noticed in between chicken

Table 1: Experimental design.

Chicken meat products		Sample from different outlets		
Type of cooking		Street outlet	Small hotels	Restaurant
Dry heat cooking	Grilled chicken	10 Nos.	10 Nos.	10 Nos.
	Chicken 65	10 Nos.	10 Nos.	10 Nos.
Moist cooking	Chicken biryani	10 Nos.	10 Nos.	10 Nos.
	Chicken gravy	10 Nos.	10 Nos.	10 Nos.

products prepared by dry and moist cooking sold at street outlets. In contrast to that no significant differences (P>0.05) was noticed between different cooking methods on chicken products sold in small hotels and restaurants. When compare with three different outlets, chicken biryani and chicken gravy showed higher significant differences (P<0.01), of which highest pH value was noticed in chicken biryani sold at street outlets, lowest pH value was observed in all the four products sold at restaurants. Thiobarbituric acid value of chicken products prepared by dry and moist cooking methods sold at street outlets had no significant differences (P>0.05), but higher significant differences (P<0.01), was noticed in case of small hotels and restaurants. But between different outlets except for grilled chicken all the chicken products showed higher significant differences. Chicken products sold at street outlets had higher thiobarbituric acid value when compare with small hotels and restaurants. Similarly, tyrosine value was found significantly higher (P<0.01), in chicken 65 and lower in grilled chicken and chicken biryani in all the three outlets. But in comparison between three different retail outlets, chicken products sold at street outlets had significantly highest (P<0.05) tyrosine value for all the products except for chicken gravy. Similar reports on the pH of grilled beef tenderloin steak was higher than that of pan-fried, oven-roasted, or microwaved steak (Kim *et al,* 2001). Influence of cooking methods on the pH values of meat products might be associated with the heating rate. Also high temperature during cooking, increase the oxidation process in meat (O'Grady *et al.,* 2008). However, some cooking methods did not produce this effect was also reported by Serrano *et al.* (2007). Pinthus and Saguy (1994) reported that fried croquettes had the highest oxidation level compared with moist-cooked nuggets and dry-cooked patties which was mainly due to increased porosity and uptake of oil. Generally during the process of frying, heat is transferred to the meat through hot oils or fat which causes oxidation changes in both meat as well as oil or fat.

Colour properties

The results for the effect of different types of cooking on the colour properties of chicken products sold at different retail outlets in and around Chennai are shown in Table 3. No Significant differences was noticed in the hue value of both dry and moist cooked chicken products sold in small hotels and restaurants. However, highly significant differences (P<0.01) was noticed between dry and moist cooked chicken products in street outlets. In contrast to that the hue value was found significantly higher (P<0.01) in chicken 65 sold at restaurants. Also there was no significant differences (P>0.05) was noticed in hue value of grilled chicken and chicken biryani sold at three different outlets. Chroma value revealed that highly significant differences (P<0.01) was noticed between dry and moist cooked chicken products in all the three outlets. In which chicken gravy sold at small hotels and grilled chicken sold at

Table 2: Effect of different cooking methods on pH, TBA and TV of chicken products sold in different outlets in and around Chennai.

Parameters	Type of cooking	Chicken products	Different outlets			
			Street outlet	Small hotel	Restaurant	F value
pH	Dry cooking	Chicken 65	5.77^{A}±0.80	5.58±0.11	5.74±0.14	0.69
		Grilled chicken	5.87^{AB}±0.12	5.73±0.09	5.77±0.10	0.49
	Moist cooking	Chicken biryani	6.46^{bBC}±0.08	6.01^{a}±0.06	5.98^{a}±0.11	8.77**
		Chicken gravy	6.22^{bC}±0.11	5.82^{ab}±0.09	5.54^{a}±0.10	10.66**
		F value	9.68**	3.60	2.38	
Thiobarbituric acid value (mg of malonaldehyde/Kg)	Dry cooking	Chicken 65	0.701^{b}±0.049	0.593^{abC}±0.05	0.455^{aB}±0.04	5.75**
		Grilled chicken	0.547±0.05	0.349^{B}±0.05	0.331^{B}±0.05	4.99
	Moist cooking	Chicken biryani	0.436^{b}±0.06	0.103^{aA}±0.03	0.079^{aA}±0.02	30.48**
		Chicken gravy	0.669^{b}±0.08	0.350^{aB}±0.05	0.38^{aB}±0.05	7.26**
		F value	3.50	18.61**	13.60**	
Tyrosine value mg/100gm	Dry cooking	Chicken 65	0.996^{bB}±0.03	0.979^{bB}±0.05	0.789^{aB}±0.04	6.25*
		Grilled chicken	0.704^{A}±0.09	0.666^{A}±0.04	0.428^{A}±0.06	4.47
	Moist cooking	Chicken biryani	0.725^{bA}±0.04	0.527^{aA}±0.06	0.404^{aA}±0.03	11.33**
		Chicken gravy	0.959^{cAB} ±0.07	0.706^{bA}±0.06	0.291^{aA}±0.05	28.13**
		F value	5.28**	11.37**	18.46**	

N = 120, n=10 Mean bearing different superscripts differ significantly.

A, B, C- Mean bearing different superscripts differ significantly between cooking methods a. b, c- Mean bearing different superscripts differ significantly between outlets.

*= Significant (P<0.05), **= Highly significant (P<0.01) and NS= Non significant (P>0.05).

restaurants had highest chroma value. No significant differences (P>0.05) were noticed in the value of chicken products sold at street outlets and small hotels. Highly significant differences (P<0.01) were noticed between different cooking methods on chicken products sold at restaurants, of which chicken biryani showed highest score for value. Chicken 65 and chicken gravy showed highly significant differences (P<0.01) between three different outlets but no significant differences were noticed in grilled chicken and chicken biryani. Highest hue value in chicken

Table 3: Effect of different cooking methods on the colour parameters of chicken products sold in different outlets in and around Chennai.

Parameters	Type of cooking	Chicken products	Different outlets			
			Street outlet	Small hotel	Restaurant	F value
Hue	Dry cooking	Chicken 65	5.92^{A}±0.77	5.71±0.82	8.33±0.71	3.60*
		Grilled chicken	6.25^{A}±0.57	7.29±0.71	6.46±0.65	0.71
	Moist cooking	Chicken biryani	10.00^{B}±0.00	7.92±0.96	8.33±0.71	2.53
		Chicken gravy	4.58^{A}±0.96	5.21±0.89	6.15±0.95	0.70
		F value	11.62**	2.24	2.37	
Chroma	Dry cooking	Chicken 65	4.92^{aA}±0.71	9.33^{bB}±0.66	6.83^{abAB}±0.75	9.65**
		Grilled chicken	8.58^{B}±0.39	8.17^{B}±0.53	9.17B±0.38	1.27
	Moist cooking	Chicken biryani	3.25^{A}±0.41	5.17^{A}±0.89	4.83^{A}±0.29	2.98
		Chicken gravy	8.50^{B}±1.01	10.25^{B}±0.97	7.75^{B}±0.97	1.68
		F value	15.15**	7.88**	7.53**	
Value	Dry cooking	Chicken 65	6.58^{b}±0.74	4.83^{ab}±0.16	3.67^{aA}±0.25	10.01**
		Grilled chicken	5.50±0.72	6.50±0.72	5.75^{B}±0.57	0.58
	Moist cooking	Chicken biryani	8.58±0.19	6.50±0.86	8.04^{C}±0.21	4.20
		Chicken gravy	8.42^{b}±1.12	7.08^{ab}±1.01	3.83^{aA}±0.36	6.88**
		F value	3.72	1.62	28.72**	

N = 120, n=10 Mean bearing different superscripts differ significantly.

A, B, C- Mean bearing different superscripts differ significantly between cooking methods a.b, c- Mean bearing different superscripts differ significantly between outlets.

*= Significant (P<0.05), **= Highly significant (P<0.01) and NS= Non significant (P>0.05).

Table 4: Effect of different cooking methods on the microbial quality (log_{10}cfu/gm) of chicken products sold in different outlets in and around Chennai.

Parameters	Type of cooking	Chicken products	Different outlets			
			Street outlet	Small hotel	Restaurant	F value
Standard plate count	Dry cooking	Chicken 65	6.96^{A}±0.54	5.62^{B}±0.37	4.41^{B}±0.39	17.18**
		Grilled chicken	4.87^{bA}±0.73	2.83^{aA}±0.34	2.59^{aA}±0.32	6.10**
	Moist cooking	Chicken biryani	6.67^{bA}±0.59	5.53^{bB}±0.27	2.96^{aA}±0.46	16.06**
		Chicken gravy	10.82^{bB}±1.09	7.85^{abC}±0.72	5.69^{aB}±0.20	11.21**
		F value	10.40**	19.4**	15.3**	
Coliform count	Dry cooking	Chicken 65	0.95A±0.49	ND	ND	
		Grilled chicken	ND	ND	ND	
	Moist cooking	Chicken biryani	3.64^{bB}±1.08	0.51^{a}±0.36	ND	8.88**
		Chicken gravy	1.41^{bAB}±0.46	0.85^{ab}±0.35	ND	4.52*
		F value	5.82*	2.68		
Yeast and mould count	Dry cooking	Chicken 65	5.12^{bAB}±0.40	3.85^{b}±0.51	1.96^{a}±0.34	13.85**
		Grilled chicken	3.71^{aA}±0.49	2.12^{ab}±0.57	1.37^{a}±0.67	5.38*
	Moist cooking	Chicken biryani	7.10^{bB}±1.02	4.31^{ab}±0.45	2.71^{a}±0.60	9.10**
		Chicken gravy	5.36^{bAB}±0.72	2.34^{a}±0.69	2.78^{ab}±0.61	5.73*
		F value	4.4**	3.69	1.37	

N = 120, n=10 Mean bearing different superscripts differ significantly.

A, B, C- Mean bearing different superscripts differ significantly between cooking methods. a, b, c- Mean bearing different superscripts differ significantly between outlets

*= Significant (P<0.05), **= Highly significant (P<0.01) and NS= Non significant (P>0.05).

65 sold (8-Red) in restaurants implies that more natural or artificial colouring agents were included in the coating ingredients for attractiveness when compare with street outlets and small hotels (5-yellowish red). Choi *et al. (*2013) reported that redness and yellowness values of the chicken steaks were higher for the grilling when compare with other cooking methods and the lowest values were observed with superheated steam. Oh *et al.* (2014), found that the lightness value of chicken fillets cooked with superheated steam was higher than those cooked with convection oven. According to Jeon *et al.* (2013) and Kim *et al.* (2001), color of meat products after cooking varies according to cooking method.

Microbial quality

The results for the effect of different types of cooking on the microbial quality of chicken products sold at different retail outlets in and around Chennai are shown in Table 4. Among different types of cooking methods, moist cooked chicken products had significantly higher ($P<0.01$) standard plate count, of which chicken gravy had highest count in all three outlets such as street outlets, small hotels and restaurants. When compared with three different outlets, chicken product sold at street outlets had significantly higher ($P<0.01$) standard plate count in both dry and moist cooked chicken products. In case of coliform count, highly significant differences ($P<0.01$) were noticed among chicken products prepared by different cooking methods. Also coliform count was detected higher ($P<0.05$) in chicken biryani and gravy, lesser in chicken 65 and was not detected in grilled chicken in street outlets. But in small hotels coliform count was not found in dry cooked products such as chicken 65 and grilled chicken, no significant count ($P>0.05$) was noticed in moist cooked products such as chicken biryani and chicken gravy. Coliform count was not detected in both dry and moist cooked chicken products sold in restaurants of Chennai. Similarly, for yeast and mould count highly significant differences ($P<0.01$) were noticed between dry and moist cooked chicken products, of which chicken biryani had significantly highest yeast and mould count in street outlets and non significantly ($P>0.05$) in small hotels and restaurants. When compare with three different outlets, street outlets had significantly highest ($P<0.01$) yeast and mould count in both of the dry and moist cooked chicken products. Meat products is considered as spoiled when the microbial load was more than 6 log cycles (Frazier and Westhoff, 1978). Similarly, Shapton and Shapton (1991) and Dang *et al.* (2021) reported that SPC counts were within the limits of 6 log cfu/g is generally considered as safe cooked meat products.

CONCLUSION

Thus it is concluded that dry type of cooking had reduced microbial load and TBA value was also as per the prescribed limitations. But microbial quality of moist cooked chicken products had higher standard plate count, coliform count and yeast and mould count were noticed among different types of cooking methods. But when compare with different type of retail outlets, chicken products sold in street outlets had higher microbial count and lipid oxidation properties, when compare with chicken products sold in small hotels and restaurants. In general, from the above study it was observed that chicken products prepared in restaurants had better physicochemical and microbial standards as per the specification when compare with street outlets and small hotels in and around Chennai.

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Conflict of Interest

The authors declares that they have no conflict of interest.

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