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Evaluation of Quality and Safety Parameters of Poultry Meat Products Sold In Hyderabad Market, Pakistan

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Abstract 30 Samples of five poultry meat products including chicken nuggets (S1), chicken fillets (S2), chicken burgers (S3), chicken meatballs (S4) and chicken kababs (S5) were collected from various retailers from Hyderabad market to evaluate quality and safety parameters. All the samples were investigated for pH, water holding capacity (WHC), moisture, ash, fat, protein content, total volatile base (TVB), total viable count (TVC) and coliform count (CC). Results revealed that chicken nuggets, fillets, burgers, meatballs and kababs varied significantly ($P \leq 0.05$) for pH, WHC, moisture, ash, fat, protein contents, TVB and CC, and non-significantly ($P > 0.05$) for TVC. Highest pH (6.05) was recorded for meatballs, while lowest pH value (4.90) was recorded for chicken fillets. Among the investigated chicken products meatballs showed highest WHC (48.18%), while lowest was recorded in chicken kababs (27.72%). Moisture content was highest (70%) in meatballs, and lowest in chicken nuggets (62.45%). Maximum ash content (3.13%) was recorded in kababs, and lowest (1.27%) was confirmed in fillets. Fat content was maximum (10.78%) in meatballs, while minimum was recorded in kababs (4.97%). Highest protein level (20.25%) was found in kababs, while meatballs displayed lowest protein level (12.53%). Highest TVB (69.50 mg/100 g) was noted for fillets, while lowest in kababs (17.14 mg/100 g). In the microbiological examination of chicken products Total viable count (TVC) was highest in (7433.33 cfu/g) fillets, while lowest was noted in meatballs ($6.43x10^3$cfu/g). The Coliform count (CC) was highest ($6.3x10^3$cfu/g) in meatballs, while lowest values were verified in burgers ($3.05x10^3$ cfu/g). Total volatile base (TVB) and Total viable count (TVC) was greater in chicken fillets as compared to other products. This clearly indicates unhygienic circumstances at certain stages during manufacturing, processing, handling and storage of chicken meat products.

Keywords: *quality, safety, poultry meat products, physicochemical parameters, microbial analysis*

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1. Introduction

It is a universal truth that, across numerous traditions Poultry meat remained a great part of human diet with high quality nutrients like, protein, vitamins and minerals. A lot of poultry meat products are highly desirable, palatable, digestible and more importantly nutritious for all times. Moreover their price is cheap as compared to other types of meat i.e., beef and mutton, and per capita consumptions of beef, mutton and poultry meat increases [1]. Poultry meat is composed of 22 to 25% protein and other products, including frankfurters, bologna and sausages may contain 17 to 20% protein, with 20% fat, and 60 to 80% water [2]. The consumption of poultry meat and its products is increasing rapidly all over the world [3]. Chicken Nuggets, chicken fillets, chicken burgers, chicken meatballs, and chicken kababs are the ready to cook and ready to eat products and these products have very uncomplicated preparation that makes them popular for consumers to use as a quick meal and the masterpiece of these products is meat, usually from chicken, fish or combination with vegetables [4].

In Pakistan poultry meat adds 26.8 percent of the total meat production in the country where broiler production during the year 2011 to 2012 was 34.82 million which increased to 37.25 million heads during 2012 to 2013. Total poultry meat production during 2011 to 2012 was 834000 tons which increased to 907000 tons during 2012 to 2013 [5]. Like other meat types, chicken meat is subject to deterioration in quality because poultry meat is highly perishable with a limited shelf life even when stored at cooling temperatures. Cooling temperature can delay growth of microorganisms and chemical reactions which lead to reduction in the loss of meat quality and improve the meat safety [6].

Poultry meat contains high concentration of myoglobin and iron which are oxidation catalyst [7]. Lipid oxidation and microbial growth are two major factors which alters meat composition and reduces its colour [8], develops off-flavour [9], changes in texture [10] and forms lipid oxidation products such as malonaldehyde (MDA) and cholesterol oxides [11]. Lipid oxidation is one of the primary causes of quality deterioration in raw and cooked meat products during refrigerated or frozen storage [12] [13]. Moreover when meat is fried during the formulation of different products, its physical, chemical and sensory features changes [14]. Processed raw poultry meat naturally anchorages bacteria, most of which are responsible for spoilage and deterioration [15]. The existence of pathogenic microorganisms or spoilage microorganisms, or both in poultry meat is detrimental but unavoidable [16]. The importance of meat and poultry as vectors of harmful pathogens is significant in public health and economic point of view. For that, the Hazard Analysis Critical Control point (HACCP) provides the basis for the food safety management system in meat chain. The seven essential steps for a HACCP plan are outlined by Codex Alimentarius Commission [17] and should cover all stages of the food chain from production, to catering and retail.

United State Department of Agriculture confirms that bacterial species connected with chicken meat and its products mostly include: *Salmonella enterritidis, Campylobacter. jejuni, Staphylococcus. aureus, and Listeria monocytogenes* [18]. Furthermore ready to eat meat products with *Staphylococcus aureus* or *Closteridium perfringens* up to 10^6cfu/g may cause illness, while the presence of *Salmonella* is considered to be a potential hazard [19] [15] [20]. Poultry ranked first as cause in food poisoning with an incidence of 29.32%, followed by meat and cream with an incidence of 15.33 and 8.78%, respectively [20]. Most successful and worthwhile step to inhibit food-borne human diseases is monitoring the microbiological value of poultry meat and other meat products during manufacture, storage and circulation [21].

Minimalizing the probable risks of food poisoning accompanying with *Salmonellae, Campylobacter spp*. and similar pathogens in poultry products were formerly deliberated by several researchers [22,23]. In a study poultry products and mutton products were examined for their Total Viable Counts (TVC) by Murugkar *et al* [24]. They revealed higher TVC in pork products as compared to mutton and poultry products. In another study, the effects of different proportions of washed mechanically deboned chicken meat (WM) as a substitute for hand deboned chicken meat, on the physicochemical and sensory characteristics of chicken nuggets was analyzed by Perlo *et al* [25]. They deciphered increased fat content whereas significant reduction in protein content when WM was added. Al-Dughaym and Al-Tabari [26] found variation in the chemical composition of chicken meat products with high fat percentage with high thiobarbituric acid value, which causes unacceptable flavor of the product

In a study Ismed *et al* [4] showed that chicken nuggets produced by different manufacturers, were dissimilar in chemical composition, colour, textural properties and sensory attributes. Another study found significant differences in the chemical composition amongst the four features of canned chicken meat [27]. In Pakistan chicken products are important food served at almost all fast food restaurants and spots and a lot of food factories are active in Pakistan especially in Hyderabad city, which increases the production and meets the growing demands of customers. The elevated degree of struggle among different companies, venture in advanced technologies has been essential to manufacture high quality foodstuffs [4].

Food safety is one of the major challenges in the meat industry and Public concern leads to increased requirements for high quality, safety and stability during the storage period. An extended shelf life of meat products is of great economic importance for both consumers and producers and physicochemical characteristics of poultry meat products traded in markets are the maximum noteworthy factors for improved shelf life and consumer satisfactoriness [28]. Since the Quality and Safety parameters of these poultry meat products sold in Hyderabad were not previously well studied and documented. So the objective of this study was to reveal quality and safety parameters of five poultry meat products sold in Hyderabad market to unfold their hygienic status. Additionally this work will provide better insights for manufacturers to improve the quality attributes of their chicken products.

2. Material and Methods

Thirty samples of different poultry meat products including chicken nuggets (S1), chicken fillets (S2), chicken burgers (S3), chicken meatballs (S4) and chicken kababs (S5) were randomly collected from different shops of Hyderabad market during the year 2015. Samples were secured properly and immediately brought to the Laboratory of Food Sciences and Technology, Sindh Agriculture University Tandojam, to evaluate quality and safety parameters.

2.1. Analysis of Physical Parameters

2.1.1. pH Value

pH value of poultry meat product samples was examined according to the method as reported by Ockerman [29]. Briefly, A sample (10g) homogenized in distilled water (90 ml) was transferred into the beaker and electrode along with temperature probe. The constant reading appeared on pH meter base was noted and recorded as pH value for different meat products.

2.1.2. Water-holding Capacity (WHC)

The method reported by Wardlaw *et al* [30] was used to determine water holding capacity (WHC) of poultry meat products. Approximately 8g meat sample was placed in a centrifuge tube together with 0.6 M NaCl solution (12ml). The tube was centrifuged (4°C) at 10,000 RPM for 15 min, and the supernatant was decanted and measured using the formula.

$$\text{WHC}\ (\%) = \frac{\begin{pmatrix}\text{Beforecentrifuge weight} \\ -\text{After centrifuge weight}\end{pmatrix}}{\text{Before centrifuge weight}} \text{x}100$$

2.2. Analysis of Chemical Parameters

2.2.1. Moisture Content

Moisture content was observed according to the method of Association of Official Analytical Chemistry [31]. The fresh poultry meat sample (5g) was transferred in pre-weighed flat bottom aluminum dish, which was transferred to a hot air oven at 101±1°C for 3-4 hours. Dried sample was then placed in desiccators having silica gel as desiccant. After 1hour, the dish was weighed. Moisture content was calculated by applying the following formula.

$$\text{Moisture }(\%) = \text{W1} - \text{W2} \times 100 / \text{W1}$$

Where,
W1 = weight (g) of sample before drying
W2= weight (g) of sample after drying.

2.2.2. Ash Content

Ash percentage was determined by Gravimetric method as described by AOAC [31] using the muffle furnace. The meat sample (5g) was transferred in pre-weighed crucible and transferred to muffle furnace at (550°C) for 4-5 hours. Ashed sample was transferred to desiccators having silica gel as desiccant. After 1 hour, the dish was weighed. Ash content was calculated by using the following formula:

$$\text{Ash }(\%) = \frac{\text{Weight of ash sample}}{\text{Weight of sample taken}} \text{X}100$$

2.2.3. Fat Content

Fat content was extracted in soxhlet extraction unit as described by AOAC [31]. Briefly, the soxhlet extractor was set with reflux condenser and distillation flask which was previously dried and weighed. Dried sample (2 g) was taken in to fat free extraction thimble and placed in extraction apparatus. Then ether (150 ml) was transferred in to extraction flask and condenser was joined and placed on electric heater in order to boil the solvent gently. Extraction was carried out for 6 hours. The solution was removed and fat content was calculated by using the following formula.

$$\text{Fat\%} = \text{W1} - \text{W2} / \text{W3 x100}$$

2.2.4. Protein Content

Protein content was determined according to the method described by AOAC [31]. Sample (2 g) was digested using Micro-Kjeldhal digester in the presence of catalyst (0.35 g copper sulfate and 7 g sodium sulfate/potassium sulfate) where sulfuric acid (20-30 ml) was used as an oxidizing agent and diluted with distilled water (250 ml). The diluted sample (5 ml) was distilled with 40% NaOH solution using Micro-Kjeldhal distillation unit where steam was distilled over 2% boric acid (5 ml) containing an indicator bromocresol green for 3 min. The ammonia trapped in boric acid was determined by titrating with 0.1N HCl. Nitrogen percentage was calculated using the following formula:

$$\text{Protein }(\%) = \frac{1.4\ (V_1 - V_2) \times \text{Normality of HCl} \times 250}{\left(\begin{array}{l}\text{Weight of sample taken} \\ \times \text{Volume of dilutedsample}\end{array}\right)}$$

Where,
V_1 = titrated value
V_2 = blank sample value. The protein percentage was determined by conversion of nitrogen percentage of protein by using conversion factor (6.25) assuming that all the nitrogen in meat was presented as protein i.e.
Protein percentage = N% × CF.

2.2.5. Total Volatile Base

The method described by Kirk and Sawyer [32] for determination of TVN based on a semi-micro distillation procedure was used with little modification. Extracts or solutions were made alkaline with sodium hydroxide. The bases are steam distilled into standard acid and back titrated with standard alkali. Formaldehyde was added to the neutralized mixture and the acid released is equivalent to the volatile bases other than trimethylamine.100g ± 0.5 of prepared sample was weight into a homogenizer with 300ml of 5 percent m/v trichloracetic acid. The homogenizer was run to obtain a uniform slurry, and then centrifuge to obtain a clear extract. By using pipette 5ml of the extract was transferred to a semi-micro distillation apparatus. 5ml 2M sodium hydroxide solution was then added. Steams distilled were collected in 15ml 0.01M standard hydrochloric acid. Indicator solution (1 percent rosolic acid in 10 percent v/v ethanol) was added. Finally titrated to a pale pink and point within the titration flask. The liberated acid was titrated with 0.01M sodium hydroxide.

$$\text{Total base nitrogen } = \frac{14(300 + W) \times V_1}{500} \text{mg} / 100\text{g}$$

Where, V1 = volume, in ml, of standard acid consumed; and W = water content of sample (g/100 g)

2.3. Microbial Analysis

2.3.1. Preparation of Media

Plate count agar (17.5 g) was dissolved in distilled water (1L) and heated to boil with frequently stirring. Transparent medium was distributed into test tubes (12-15ml) and plugged with cotton. These were further sterilized in an autoclave (121°C) for 15 min and stored till use.

2.3.2. Preparation of Test Samples

Minced meat sample (10g) was reconstituted aseptically with 90 ml of 0.1% peptone water (Oxoid England) in a laboratory blender to make 10^{-1} dilution. Further a series of dilution were prepared accordingly.

2.3.3. Total Viable Count (Colony Count Method at 30°C)

Total viable counts were counted according to the method of International dairy federation [33] and Karna *et al* [34]. Pre prepared test sample (1ml of 10^3, 10^4, 10^5, 10^6 or 10^7) dilution was transferred into sterile petri dishes in duplicate through sterile graduate pipette or dispensing pipette (1000µl) with sterile plastic tips and warm (45±1°C) sterile plate count agar medium (15ml) was mixed with inoculums. The mixture was allowed to solidify and incubated (30°C) for 72±2 hours. Parallel to that, control plates were also prepared using similar medium (15ml) to check the sterility. The dishes containing more than 30 and/or fewer than 300 colonies were selected and counted using colony counter. The result was calculated using following formula:

$$N = \Sigma C / \left[(1.0 \text{ x n1}) + (0.1 \text{ x n2})\right] d$$

Where:

N = number of colonies per ml or gram of sample.
ΣC = sum of all of the colonies in all plates counted.
n1 = number of plates in the lower dilution counted.
n2 = number of plates in the next higher dilution counted.
d = dilution from which the first counts were obtained.

2.3.4. Coliform Count (Colony Count Method at 30°C)

Coliform counts were enumerated according to the method of British Standards Institute (BSI, 1993). Pre prepared test sample (1ml) of 10^1, 10^2, 10^3, 10^4 and / or 10^5 dilution was transferred into sterile petri dishes through dispensing pipette (100µl) with sterile plastic tips and warm (45±1°C) sterile MacConkey agar (15ml) was mixed with inoculums. The mixture was allowed to solidify and incubated (30°C) for 24±2 h. Parallel to that control plates were also prepared using similar medium (15ml) to cheek its sterility. The dishes containing more than 10 and / or fewer than 200 colonies were selected and counted using colony counter. The result was calculated using formula.

Number of bacteria / ml of original solution
= No. of colonies on plate x dilution factor

2.4. Statistical Analysis

The data was exposed to the analysis of variance (ANOVA) with XL Stat program for windows. Significance level was chosen at $P \leq 0.05$ and the results are given as mean ± SE. Duncan's multiple range tests was employed determine the significance of differences among means [35].

3. Results and Discussions

3.1. pH Value

The analysis of variance shown in (Table 1) suggested significant (P<0.05) variation in pH of different chicken meat products. The experimental results indicated chicken meatballs with highest pH value (6.05) ranging 5.98 to 6.15 while chicken nuggets with pH value (5.66) ranging between 5.26 to 6.00 and pH value of chicken kabab was (5.17) ranging between 4.76 to 5.79. Among the examined chicken meat products, chicken burgers have lower pH value (4.97) ranging 4.87 to 5.01 while the chicken fillets were found with lowest pH value (4.94) ranging 4.82 to 5.00. Previous studies reported that variations in color occurs in the production of chicken raw meat that might affect pH [36] and another studies found that scalding methods also effects meat pH expressively [37].

Table 1. pH of different poultry meat products marketed in Hyderabad

Product Name	Samples						Mean
	R1	R2	R3	R4	R5	R6	
Chicken Nuggets (S1)	5.35	5.26	6.00	5.98	5.38	5.97	5.66 b
Chicken Fillets (S2)	4.89	4.82	5.00	4.97	5.00	4.96	4.94 c
Chicken Burgers (S3)	4.98	4.87	4.97	4.97	5.01	5.01	4.97 c
Chicken Meatballs (S4)	6.02	6.05	6.13	6.15	5.99	5.98	6.05 a
Chicken Kababs (S5)	5.00	5.03	5.79	5.66	4.76	4.76	5.17 c

S.E.± 0.1317
LSD 0.05 0.2747
LSD 0.01 0.3747
Mean values followed by similar letters are not significantly different from each other at alpha level 0.05.

3.2. Water Holding Capacity (WHC)

All chicken meat products were able to withstand water when pressure was imposed by means of centrifuge. The data in (Table 2) shows water holding capacity of chicken meat products. Chicken meatballs have highest water holding capacity (48.18%) which was in the range of 47.15 – 49.00%, followed by chicken burgers and chicken fillets 37.11 (35.32-39.11%) and 35.78 (34.35-37.86%), respectively. The chicken nuggets determined to have lower water holding capacity of 32.30% ranging between 30.11-34.35%; while the chicken kababs were found to have lowest water holding capacity (27.72%), ranging between 25.14-29.77%. It was further noted that WHC in chicken meatballs, chicken nuggets, chicken kababs, chicken burger and chicken fillets varied greatly. Variation in Water holding capacity in different chicken products were also obtained in studies which might be due to the difference in composition of meat product [4]. Water holding capacity is the vital parameter that resolves stability of meat products to withstand water when pressure is imposed in a centrifuge [38]. Another study found that water holding capacity values remains proportional with premature content of products, where products with elevated fat content have little water holding capacity values [39].

Table 2. Water holding capacity (%) of different poultry meat products marketed in Hyderabad

Product Name	Samples						Mean
	R1	R2	R3	R4	R5	R6	
Chicken Nuggets (S1)	33.31	30.11	31.00	31.00	34.35	34.00	32.30 c
Chicken Fillets (S2)	36.88	37.86	35.55	35.51	34.52	34.35	35.78 b
Chicken Burgers (S3)	39.11	35.32	37.34	37.35	36.79	36.77	37.11 b
Chicken Meatballs (S4)	49.00	49.00	47.15	47.35	48.22	48.35	48.18 a
Chicken Kababs (S5)	29.77	28.76	25.14	26.00	28.33	28.34	27.72 d

S.E.± 0.7524
LSD 0.05 1.5694
LSD 0.01 2.1408
Mean values followed by similar letters are not significantly different from each other at alpha level 0.05.

3.3. Moisture Content (%)

Data in (Table 3) indicates that moisture content was highest (70.00%) in chicken meatballs which was in the range of 68.34-71.32%, followed by chicken fillets and chicken burgers having average moisture content of 68.59 and 67.95%, ranging between 66.47-70.11 and 66.76-69.05%, respectively. Chicken kababs contained lower moisture content (63.95%) ranging between 62.12-66.00%; while chicken nuggets were determined to have lowest moisture content (62.45%), ranging between 60.55-66.81%. Statistically, similarity (P>0.05) in moisture content was determined between chicken fillets and chicken meatballs or between chicken nuggets and chicken kababs; while significant (P<0.05) when these groups of chicken products were compared with each other. Previous studies also found significant differences in moisture content of chicken meat [27,40]. Differences in moisture content might be due to variation in meat type and the oil type used for frying [41]. The moisture content of light meat found to be greater than normal and dark chicken breast fillets and no significant relationship between pH and moisture content found in studies of Boulianne and King [42].

Table 3. Moisture content (%) of different poultry meat products marketed in Hyderabad

Product Name	Samples						Mean
	R1	R2	R3	R4	R5	R6	
Chicken Nuggets (S1)	66.81	64.11	61.34	61.34	60.55	60.55	62.45 c
Chicken Fillets (S2)	70.03	70.11	69.72	68.73	66.47	66.47	68.59 a
Chicken Burgers (S3)	68.88	66.76	67.00	67.00	69.05	69.03	67.95 b
Chicken Meatballs (S4)	71.32	70.32	70.44	71.00	68.56	68.34	70.00 a
Chicken Kababs (S5)	63.34	64.34	65.44	66.00	62.12	62.44	63.95 c

S.E.± 0.8652
LSD 0.05 1.8047
LSD 0.01 2.4617
Mean values followed by similar letters are not significantly different from each other at alpha level 0.05.

3.4. Ash Content (%)

Table 4 shows ash content of different meat products. Highest (3.13%) ash content was noted in chicken kababs that was in the range of 2.98-3.42%, followed by chicken meatballs and chicken burgers having average ash content of 3.00 and 2.28%, ranging between 2.98-3.01 and 2.13-2.37%, respectively. Chicken nuggets contained lower ash content of 2.04% ranging between 1.12-1.36%; while chicken fillets were with minimum ash content (1.27%), ranging between 1.12-1.36%. Statistically, similarity (P>0.05) in ash content has been suggested by LSD test between chicken kababs and chicken meatballs; while significant (P<0.05) when these items were compared with rest of the products. Moreover, there was marked variation in the ash content between chicken kababs and chicken fillets. Variations in ash content of chicken meat products were also reported by several researchers [43] [27] that might be due to the presence of more minerals, and higher quantities of iron present in meat [44]. In another study the mechanically deboned chicken meat contains higher ash content while traditional deboned chicken meat have lower ash content because of process of mechanical deboning, while crumpling and mixing of chicken bones into the mince may causes higher content of ash in meat products [45]. The differences of ash content may also be due to the decrease of moisture content which is associated with storage and handling proceedings with extension in storage period [43].

Table 4. Ash content (%) of different poultry meat products marketed in Hyderabad

Product Name	Samples						Mean
	R1	R2	R3	R4	R5	R6	
Chicken Nuggets (S1)	2.13	2.11	2.00	2.00	1.99	1.98	2.04 c
Chicken Fillets (S2)	1.12	1.12	1.34	1.36	1.35	1.35	1.27 d
Chicken Burgers (S3)	2.35	2.35	2.13	2.14	2.36	2.37	2.28 b
Chicken Meatballs (S4)	3.00	3.00	2.98	2.98	3.01	3.01	3.00 a
Chicken Kababs (S5)	3.41	3.42	3.00	2.99	2.98	3.00	3.13 a

S.E.± 0.0751
LSD 0.05 0.1567
LSD 0.01 0.2138
Mean values followed by similar letters are not significantly different from each other at alpha level 0.05.

3.5. Fat Content (%)

The data in (Table 5) exhibits fat content of different meat products. Fat content was maximum (10.78%) in chicken meatballs that was in the range of 10.15-11.92%, followed by chicken burgers and chicken nuggets having average fat content of 10.64 and 8.65%, ranging between 9.73-12.00 and 7.95-9.05%, respectively. The chicken fillets was holding lower fat content of 6.82% ranging between 6.35-7.24%; while the chicken kababs contained minimum fat level (4.97%), ranging between 4.36-5.97%. Statistically, the differences in fat content as demonstrated by LSD test; while significant (P<0.05) when these items were compared with rest of the chicken meat products examined in this experiment. These results showed that fat content between chicken meat products ranged 4.97 to 10.78 which reflects a wide range of difference.

Previous studies reported that appropriate manipulation with broiler chicken diet could modify fatty acid profile in meat and increase its nutritional value [46]. It has been assumed that the quality of meat and mainly fatty acid profile both in breast and leg muscles mostly depends on components contained in mixtures [47]. Another study found that the organic chickens had carcasses with a higher breast and drumstick percentages and lower abdominal fat levels [48]. Appropriateness of a product and rise in toughness of meat product is affect by the decrease in fat content [49]. Nutritionally, fat is a rich cause of energy in the diet providing 9 Kcal/g. Nevertheless, consumption of fat may increases risk of obesity, certain cancer types, and increased blood cholesterol and heart infections. With effect to these negative reasons many organizations such as American Heart Association, American Cancer Society and World Health Organization have suggested limiting total fat consumption which is not more than 30% of overall calories [50]. On the other hand, the differences in fat content may be due to the differences in genetic and non-genetic aspects [51].

Table 5. Fat content (%) of different poultry meat products marketed in Hyderabad

Product Name	Samples						Mean
	R1	R2	R3	R4	R5	R6	
Chicken Nuggets (S1)	9.05	9.00	8.95	8.98	7.95	7.95	8.65 b
Chicken Fillets (S2)	6.64	6.65	7.23	7.24	6.35	6.83	6.82 c
Chicken Burgers (S3)	11.98	12.00	10.01	10.33	9.73	9.78	10.64 a
Chicken Meatballs (S4)	11.92	11.92	10.22	10.34	10.15	10.15	10.78 a
Chicken Kababs (S5)	5.97	4.98	5.00	5.12	4.39	4.36	4.97 d

S.E.± 0.3021
LSD 0.05 0.6301
LSD 0.01 0.8594
Mean values followed by similar letters are not significantly different from each other at alpha level 0.05.

3.6. Protein Content (%)

The results in Table 6 shows protein content of different meat products in which highest (20.25%) protein content was confirmed in chicken kababs that was in the range of 19.17-21.35%, followed by chicken fillets and chicken nuggets having average protein content of 17.03 and 16.92%, ranging 15.80-18.02 and 15.95-18.00%, respectively. Chicken burgers were holding lower protein content(14.97%) ranging between 13.32-16.36%; while the chicken meatballs were having lowest protein content (12.53%), ranging between 11.15-14.30%. Statistically, the variation in protein content as suggested by LSD test between chicken nuggets and chicken fillets were non-significant (P>0.05); while significant (P<0.05) when compared with rest of the products examined. It was further indicated that the protein level between chicken meat products ranged between 12.53 to 20.25 percent showing great difference. In a study broiler chicken was fed with mixtures of higher protein content which showed higher body mass and protein percentage in muscle tissue as compared to broilers fed with diet protein content [52]. The difference in the protein content of various chicken products may be due to feeding of the diets formulated with different levels of protein content [40]. Romans and Ziegler [53] found 20% percentage of protein in fresh meat and 22% in canned meat. Thomas and Corden [54] stated the chemical composition of different types of meat, and the percentage of protein in the canned meat found was 20.9%.

Table 6. Protein content (%) of different poultry meat products marketed in Hyderabad

Product Name	Samples						Mean
	R1	R2	R3	R4	R5	R6	
Chicken Nuggets (S1)	16.10	15.95	18.00	17.13	17.35	16.98	16.92 b
Chicken Fillets (S2)	17.35	17.14	18.01	18.02	15.88	15.80	17.03 b
Chicken Burgers (S3)	13.32	14.00	15.00	15.00	16.12	16.36	14.97 c
Chicken Meatballs (S4)	11.15	11.88	14.00	14.30	11.92	11.93	12.53 d
Chicken Kababs (S5)	19.35	19.17	20.32	20.32	21.35	21.00	20.25 a

S.E.± 0.5125
LSD 0.05 1.0690
LSD 0.01 1.4581
Mean values followed by similar letters are not significantly different from each other at alpha level 0.05.

3.7. Total Volatile Base (TVB)

The TVB results were shown in Table-7 which indicates highest TVB (69.50 mg/100 g) in chicken fillets ranging between 68-71 mg/100 g, followed by chicken meatballs and chicken burgers with TVB of 60.17 and 29.45 mg/100 g, ranging between 56-64 and 28.93-30.35 mg/100 g, respectively. Relatively lower TVB index was observed for chicken nuggets 20.83 mg/100 g ranging between 20.00-22.34 mg/100 g; while the TVB was lowest in case of chicken kababs (17.14 mg/100 g), ranging between 16.00-18.36 mg/100 g. Statistically, the variation in TVB as demonstrated by LSD test among all the poultry meat products were linear and significant (P<0.05). The comparison of meat products suggested that the TVB ranged between 17.14 to 69.50 mg/100 g, which showed a great variation in TVB for the food items made from the same chicken meat. These results regarding Total volatile base are in complete agreement with Tománková *et al* [28] and Kenavi *et al* [55] that showed variation in TVB of chicken breast meat during storage. Volatile basic nitrogen (VBN) content is important factor that can be used for the evaluation of poultry meat freshness [56] and also be used as a quality indicator for fish products [57] and it is associated with the amino acid decarboxylase activity of microorganisms during storage. The VBN content of meat upsurges as putrefaction progresses because as a result of the deamination of amino acids, ammonia is produced during storage. Consequently, the total amount of VBN is one of the best indices of the decomposition of fresh meat and poultry [58].

Table 7. Total volatile base (mg/100 g) of different poultry meat products marketed in Hyderabad

Product Name	Samples						Mean
	R1	R2	R3	R4	R5	R6	
Chicken Nuggets (S1)	19.98	20.00	21.34	22.34	20.98	20.35	20.83 d
Chicken Fillets (S2)	71.00	69.00	70.00	70.00	69.00	68.00	69.50 a
Chicken Burgers (S3)	28.98	28.93	29.00	29.33	30.08	30.35	29.45 c
Chicken Meatballs (S4)	64.00	64.00	60.00	59.00	58.00	56.00	60.17 b
Chicken Kababs (S5)	18.32	18.36	17.14	17.00	16.00	16.00	17.14 e

S.E.± 0.9347
LSD 0.05 1.9497
LSD 0.01 2.6595
Mean values followed by similar letters are not significantly different from each other at alpha level 0.05.

3.8. Total Viable and Coliform Count (cfu/g)

The data in (Table 8) shows TVCof different chicken meat products. TVC was relatively higher ($7.4x10^3$cfu/g) for chicken fillets ranging between $5.6x10^3$-$9.1x10^3$cfu/g, followed by chicken burgers and chicken nuggets with TVC of $7.4x10^3$ and $7.06x10^3$ cfu/g, ranging between $6.5x10^3$-$8.5x10^3$ and $5.4x10^3$-$8.8x10^3$ cfu/g, respectively. Relatively lower TVC was observed in chicken kababs ($6.43x10^3$ cfu/g) ranging between $5.9x10^3$-$7.6x10^3$cfu/g; while lowest in chicken meatballs ($6.43x10^3$ cfu/g), ranging between $6.1x10^3$-$6.8x10^3$cfu/g. Although the differences in TVC were apparently higher between chicken meat products, due to higher variation within the products. Hence, the results were considered as non-significant on the basis of probability level (P>0.05). The coliform bacteria results were shown in Table 9 which indicates that the mean coliform count was highest ($6.3x10^3$cfu/g) in chicken meatballs ranging between $5.7x10^3$-$7.7x10^3$cfu/g, followed by chicken fillets and chicken kababs with coliform count of $4.9x10^3$ and $4.13x10^3$ cfu/g, ranging between $4.3x10^3$-$5.5x10^3$ and $3.8x10^3$-4.5 $x10^3$ cfu/g, respectively. Coliform count was decreased in chicken nuggets samples (3.71 $x10^3$ cfu/g) ranging between 3.1 $x10^3$-5 $x10^3$cfu/g; while the coliform count was lowest in chicken burgers (3.05 $x10^3$ cfu/g), ranging between 2.3 $x10^3$-3.7 $x10^3$cfu/g. The coliform count amongst the chicken meat products was in the range of 3.05 $x10^3$ to 6.3 $x10^3$ cfu/g, showing considerable product to product difference.

Table 8. Total viable count (cfu/g) of different poultry meat products marketed in Hyderabad

Product Name	Samples						Mean
	R1	R2	R3	R4	R5	R6	
Chicken Nuggets (S1)	$7.8x10^3$	$8.8x10^3$	$7.6x10^3$	$6.9x10^3$	$5.4x10^3$	$5.9x10^3$	$7.06 x10^3$ a
Chicken Fillets (S2)	$5.6 x10^3$	$6.6x10^3$	$7.2x10^3$	$9.1x10^3$	$8.3x10^3$	$7.8x10^3$	$7.43 x10^3$ a
Chicken Burgers (S3)	$8.5 x10^3$	$8.3x10^3$	$6.6x10^3$	$6.5x10^3$	$7.1x10^3$	$7.4x10^3$	$7.40 x10^3$ a
Chicken Meatballs (S4)	$6.1 x10^3$	$6.3x10^3$	$6.8x10^3$	$6.8x10^3$	$6.4x10^3$	$6.2x10^3$	$6.43 x10^3$ a
Chicken Kababs (S5)	$7.6 x10^3$	$7.4x10^3$	$7.0x10^3$	$6.9x10^3$	$6.7x10^3$	$5.9x10^3$	$6.91 x10^3$ a

S.E.± 566.18
LSD 0.05 1181.0
LSD 0.01 1611.0
Mean values followed by similar letters are not significantly different from each other at alpha level 0.05.

Table 9. Coliform count (cfu/g) of different poultry meat products marketed in Hyderabad

Product Name	Samples						Mean
	R1	R2	R3	R4	R5	R6	
Chicken Nuggets (S1)	$3.3x10^3$	$3.1x10^3$	$5.0x10^3$	$3.8x10^3$	$3.4x10^3$	$3.7x10^3$	$3.71 x10^3$ c
Chicken Fillets (S2)	$4.4x10^3$	$4.3x10^3$	$5.5x10^3$	$5.2x10^3$	$5.1x10^3$	$4.9x10^3$	$4.90 x10^3$ b
Chicken Burgers (S3)	$2.3x10^3$	$2.8x10^3$	$3.0x10^3$	$3.1x10^3$	$3.4x10^3$	$3.7x10^3$	$3.05 x10^3$ d
Chicken Meatballs (S4)	$7.7x10^3$	$6.8x10^3$	$6.1x10^3$	$5.9x10^3$	$5.8x10^3$	$5.7x10^3$	$6.33 x10^3$ a
Chicken Kababs (S5)	$4.5x10^3$	$4.3x10^3$	$3.9x10^3$	$4.2x10^3$	$4.1x10^3$	$3.8x10^3$	$4.13 x10^3$ c

S.E.± 350.51
LSD 0.05 731.15
LSD 0.01 997.31
Mean values followed by similar letters are not significantly different from each other at alpha level 0.05.

Studies of AL-Dughaym and Altabari, [26] exposed total bacterial count ranging from 2.7 $x10^4$ cfu/g for nuggets to 3.3 x 10^7 cfu/g for burger and the other products in the range of 10^5–10^6 cfu/g. While Staphylococcus aureus ranges from less than 10^2 cfu/g for all samples, accept 10^4 and 10^6 cfu/g for mince. They suggests that most diseases associated with food occur due to the contamination from those who handle food but little defensive actions like sanitary food handling, appropriate cooking and chilling can circumvent illnesses associated with food products. Prior to ship the chickens to market they pass through out a variety of stages of processing. These stages may be very critical to the microbial quality of chicken, such stages includes scalding, immersion and irradiation. Altabari [59] stated that *S. aureus* enterotoxin causes food poisoning which could occurs when minced meat, containing large amount of the bacteria during processing, is stored at temperatures elevated than 14^0C. To avoid this problem it is necessary to give attention to the initial bacterial contamination. In this regard keeping meat at temperatures lower than 9°C is suitable. Keeping minced meat at room temperature for hours is a common practice and this disposes the poisoning caused by *S. aureus*.

El-Khateib *et al* [60] in their study recorded a total bacterial count of 106 to 107cfu/g for chicken burger. Ismail *et al* [61] reported mean TVC populations of 3.32–5.77 log cfu/g for various raw and processed chicken products, while in other studies Coliform count of poultry meat ranged from 4-70 X 10^2 and 1-17 X 10^2 CFU/g of chicken meat and *Staphylococcus* count from markets ranged from 12-82 x 102 CFU/g and 9-32 x 102 CFU/g for chicken meat [62]. The greater prevalence of microorganisms in chicken products are considered as a symbolic of undesirable level of contamination during handling [63] and significant risk of meat spoilage and an escalated level of number and species of bacteria mainly depends on the specific part of scrutinized chicken meat, packaging approaches and storage after circulation to the market [21].

4. Conclusion

On the basis of analysis of quality and safety parameters, differences in compositional quality of various poultry meat products were evident. These may be due to differences in the type of ingredients used, different formulations and different processing techniques (such as immersing, mixing, and frying). It was observed that chicken kababs were rich in protein whereas, chicken meatballs were high in WHC, fat content and moisture content. It was further observed that TVB was higher in chicken fillets as compared to the other investigated chicken meat products. Total volatile base (TVB) and Total viable count (TVC) was greater in chicken fillets as compared to other products. Results of the study is a symbolic for contamination, poor and insufficient of hygienic conditions in production and processing of chicken meat products. In order to improve the hygienic quality of chicken meat products to safer level for consumption, contamination must be mitigated. This could be ensured by implementing good and satisfactory manufacturing practices. Secondly, proper guidance and trainings for workers about hygiene, safety and quality assurance during handling, and manufacturing of the products are crucial practices to minimalize contamination.

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Competing Interests

The Authors have no competing interest.

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