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Research Article

Evaluation of different poultry meat products available in twin cities of Rawalpindi and Islamabad

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Abstract
Meat whether poultry, beef etc. is the source of protein that is consumed throughout the world to fulfill the protein requirement of the body. Due to the modern life style and the busy schedule the trend of the diet is shifting towards the value added, processed and ready to cook food products. Analysis were performed for quality and safety evaluation. pH of the samples was determined and the range 5.77-6.5 for pH of the samples was obtain. Moisture content of the samples was ranged between 56.55-68.03%. The ash content of the samples ranged 0.86-1.13%. Crude fats content of the samples ranged as 5.30-10.21%. The Crude protein is determined for the samples ranged as 15.42-21.18%. The TVC and TCC ranges were obtained as 1.74×10^5-3.03×10^8 and 5.14×10^4-6.48×10^7 respectively. The *Campylobacter* and *Listeria spp.* isolation and detection was carried out. This paper emphasizes the impact of Manufacturing practices and the hygienic conditions needed to ensure Quality products in both nutrition and safety regards.

Keywords: AOAC; Fats; ISO; Meat; Protein

Introduction

The poultry meat is one of the most important sources of protein for the purpose of consumption by humans throughout the world **[1]**. Consumption of poultry meat has no adverse or detrimental effects on the human health, and it has a variable nutritional profile **[2]**. Poultry meat composition depends on the species of the bird, the cuts, feeding of the bird and the presence of skin is of good nutritional value along with low energy content. The poultry meat is low in fats and cholesterol when it is consumed without the skin and also contains micro-nutrients. Due to the presence of fatty acids mainly polyunsaturated fatty acids i.e. Eicosapentaenoic acid and Decosahexaenoic acid poultry meat also shows the potential to be the possible alternative to fish meat **[3]**. In Pakistan, livestock includes cattle, buffalo, goats, sheep, chickens, and camels. The commercial poultry meat products available in the markets of Pakistan are of various brands and include ready to eat products.

Consumption of meat is the inclusion of meat and meat products in the diet, influenced by culture, economic status, and religious practices. The per capita consumption of poultry meat in 2016 was

5.469 kg, in 2017 it was 5.819 kg, in 2018 it was 6.176 kg and so on moved to 6.0621 kg in 2020; [4]. Among many factors regarding meat consumption, religion is considered to be an important factor along with household income which has a positive effect on the consumption of meat [5]. This fact explains the higher consumption of meat in developed countries than in developing countries [6]. To address this growing demand, the meat sector is now focused on meeting demand by providing adequate, healthy, and quality products which are both natural and processed [7]. In addition, consumer awareness compels the meat industry and regulatory agencies to focus on meat quality, safety assurance, animal health and welfare, and direct compliancefor the purpose of health related issues of customers and welfare [8].

Market developments in this industry add to various types of meat such as beef, mutton, chicken, camel, goat, etc. However, chicken is a slice of cheap and preferred meat that offers strategic production, business start-up, and operation [9]. Pakistan's poultry industry especially the broiler meat dominates the meat markets, and Pakistan is the world's 11th largest poultry producer with 1.02 billion broiler production annually. The sector accounted for 30% of total meat production, indicating a growth rate of 8-10% hinting the natural strength of the sector [10]. The food quality is a term which incorporates intrinsic characteristics i.e. texture, color, appearance, and flavor, while the extrinsic characteristics are also studied i.e. labelling and certification [11]. From the safety point of view, it is taken into consideration that different microorganisms are responsible for causing problems and diseases in the human, when meat is consumed [12]. So, in poultry meat, safety refers to prevention or elimination of any material or hazard which could cause complications and diseases in humans i.e. *Escherichia coli* and *Streptococcus aureus* [13]. Meat quality is defined as the properties of meat on the basis of which it is preferred by the customers for various purposes i.e. eating, purchasing, and using it as a raw material for the processing of different meat products. The properties on the basis of which meat is selected are associated with the sensory perception i.e. taste, touch, smell, odors etc. along with juiciness, flavor and water holding capacity etc. [14]. So the quality of the meat products has a direct relationship with the preference of the customer [15]. Some other factors which should also be discussed in the quality and safety of meat products are “halal” and “haram” meat since we are Muslims and only Halal foods are allowed to be eaten [16]. Diseases which are food-borne are a major problem around the world regarding the food material because these diseases affect the human health and also affect the economic value of the products. So, therefore, emphasis has to be put on the safety and quality of the meat products [12, 17].

Materials and Methods

Samples were gathered from the local markets of Rawalpindi and Islamabad.Samples were tagged with A, B, C, D, E initials and the Nuggets and Kebabs were tagged as AI, B1, C1, D1, E1 and A2, B2, C2, D2, E2 respectively. Before the analysis the samples were homogenized so that no constituent of the samples was distinguishable from each other and for the purpose of making a homogeneous mixture of samples.

pH

The pH value of the meat sample was determined by using a pH meter and following [18], Method No 943.02.

Moisture content

Moisture content of the meat sample was measured by using a hot air oven and following [18], Method No 943.02.

Ash content

Ash content of the meat was determined by using muffle furnace and following [18], Method No 943.02.

Crude fat

Fat content of the meat sample was determined by using Soxhlet extractor and following [18], Method No 943.02.

Crude protein

The crude protein content was determined by using Micro-Kjeldahl apparatus and following [18], Method No 943.02.

Total viable count

Total Viable count was determined by following the method given [19], with modifications and Pour plate technique was employed. Plate count agar (PCA) was used as a growth media and sample 10 gwas taken. Microbial load appeared after solidification.

Total coliform count

Coliform count was enumerated by the method given [20], with modifications and Pour plate technique was employed. Violet crystal, Red, bile, lactose agar (VRBL) will be mixed with inoculum. Dish containing 10 or fewer than 200 colonies was selected and counted by colony counter.

***Campylobacter* spp. isolation and detection**

Detection and isolation of *Campylobacter* spp. was carried out by the method given [21], with modifications. Meat sample 10 g was homogenized and transferred to Preston enrichment broth base containing Campylobacter selective supplement IV. For identification at the genus level Gram's staining, catalase test, oxidase test was used.

***Listeria* spp. isolation and detection**

Detection and isolation of *Listeria* spp. was carried out by the method given [22], with modifications. Meat sample 10g was homogenized and transferred to Fraser broth enrichment media. For identification at the genus level Gram's staining, catalase test, oxidase test was used.

Statistical analysis

After the Proximate and Microbial analysis, one-way ANOVA was used for determination of the Statistical differences i.e. $P \leq 0.05$ between various characteristics of the samples which were analyzed by using the Statistics 8.1 software. Least Significant Difference(LSD) test was employed for the determination of significance difference between the Pairwise values for the samples by following [23].

Results

The pH value of the samples was analyzed and mean along with standard deviation(SD)were calculated whereas ANOVA showed that the value of $P < 0.01$ indicating that the values were highly significant. The range of the values was found to be 6.37, 5.86, 6.44, 5.89, 6.53, 5.77, 6.31, 5.93, 6.59, and 5.97 respectively for the samples as mentioned in the (Table 1). The values of pH for Nuggets were observed between 6.37-6.59 and for the Kebabs the values were observed between 5.86-5.97. Among these values the lowest value was observed for the Subsample C2 with the pH value of 5.77 and the highest value was observed for Subsample E1 with the pH value 6.59.

The moisture content of the samples was analyzed and mean along with standard deviation was calculated whereas ANOVA showed that the value of $P < 0.01$ indicating that the values were highly significant. The range of the values were found to be 63.21%, 66.78%, 60.98%, 67.71%, 56.55%, 68.02%, 57.08%, 64.73%, 65.15%, and 68.03% respectively for the samples as demonstrated in the (Table 2). The moisture content for Nuggets was observed between 56.55%-65.15% and for the Kebabs the values were observed between 66.78 %-68.03%. Among these values the lowest value was observed for the Subsample C1 with the moisture content of 56.55% and the

highest value was observed for Subsample E2 with the moisture content of 68.03%.

Table 1: Mean (±SD) pH values of the sample

Samples	Mean ± SD
Subsample A1	6.37 ± 0.01^{d}
Subsample A2	5.86 ± 0.01^{i}
Subsample B1	6.44 ± 0.01^{c}
Subsample B2	5.89 ± 0.02^{h}
Subsample C1	6.53 ± 0.01^{b}
Subsample C2	5.77 ± 0.01^{j}
Subsample D1	6.31 ± 0.02^{e}
Subsample D2	5.93 ± 0.02^{g}
Subsample E1	6.59 ± 0.02^{a}
Subsample E2	5.97 ± 0.01^{f}

[a, b, c, d, e, f, g, h, I, j] Repeating alphabets within the rows indicates that values are not significantly different from each other.

Table 2: Mean (±SD) Moisture content of the samples

Samples	Mean ± SD
Subsample A1	63.21 ± 1.10^{c}
Subsample A2	66.78 ± 0.55^{a}
Subsample B1	60.98 ± 0.99^{d}
Subsample B2	67.71 ± 0.87^{a}
Subsample C1	56.55 ± 1.28^{e}
Subsample C2	68.02 ± 0.19^{a}
Subsample D1	57.08 ± 0.22^{e}
Subsample D2	64.73 ± 1.25^{b}
Subsample E1	65.15 ± 0.66^{b}
Subsample E2	68.03 ± 0.16^{a}

[a, b, c, d, e] Repeating alphabets within the rows indicates that values are not significantly different from each other.

After determination of Ash content, the values were calculated for determination of mean and standard deviation whereas, ANOVA showed the value of $P < 0.01$ indicating that the values were highly significant. The range of the values were found to be 1.04%, 1.00%, 0.86%, 1.13%, 0.92%, 1.01%, 0.97%, 1.10%, 0.87%, and 1.12% respectively for the samples as described in the (Table 3). The ash content for Nuggets was observed between 0.86%-1.04% and for the Kebabs the values were observed between 1.00%-1.12% respectively. Among these values the lowest value was observed for the Subsample B1 with the ash content of 0.86% and the highest value was observed for Subsample E2 with the ash content of1.12%.

After Crude fats determination the mean and standard deviation were calculated from the values whereas, ANOVA showed the value of $P < 0.01$ indicating that the values were highly significant. The range of the values were found to be 5.30%, 8.25%, 8.16%, 8.75%, 6.21%, 8.71%, 9.73%, 8.64%, 10.21%, and 8.73% respectively for the samples as expressed in the (Table 4). The values for Nuggets were observed between 5.30%-10.21% and for the Kebabs the values were observed between 6.84%-8.74%

respectively. Among these values the lowest value was observed for the Subsample A1 with the Crude fats content of 5.30% and the highest value was observed for Subsample E1 with the crude fats content of10.21%.

Table 3: Mean (±SD) Ash content of the samples

Samples	Mean ± SD
Subsample A1	1.04 ± 0.01^{d}
Subsample A2	1.00 ± 0.01^{c}
Subsample B1	0.86 ± 0.01^{g}
Subsample B2	1.13 ± 0.01^{a}
Subsample C1	0.92 ± 0.01^{f}
Subsample C2	1.01 ± 0.01^{d}
Subsample D1	0.97 ± 0.01^{e}
Subsample D2	1.10 ± 0.01^{b}
Subsample E1	0.87 ± 0.01^{g}
Subsample E2	1.12 ± 0.01^{a}

$^{a, b, c, d, e, f, g}$ Repeating alphabets within the rows indicates that values are not significantly different from each other.

Table 4: Mean (±SD) Crude fats of the samples

Samples	Mean ± SD
Subsample A1	5.30 ± 0.02^{h}
Subsample A2	8.25 ± 0.10^{d}
Subsample B1	8.16 ± 0.04^{e}
Subsample B2	8.74 ± 0.03^{c}
Subsample C1	6.21 ± 0.02^{g}
Subsample C2	8.71 ± 0.01^{c}
Subsample D1	9.73 ± 0.02^{b}
Subsample D2	6.84 ± 0.02^{f}
Subsample E1	10.21 ± 0.03^{a}
Subsample E2	8.73 ± 0.04^{c}

$^{a, b, c, d, e, f, g, h}$ Repeating alphabets within the rows indicates that values are not significantly different from each other.

The Crude protein content of the samples were recorded and mean with standard deviation were calculated from the values whereas, ANOVA showed the value of $P < 0.01$ indicating that the values were highly significant. The range of the values were found to be 19.31%, 21.18%, 18.89%, 20.6%, 15.71%, 20.61%, 15.42%, 20.03%, 16.14%, and 19.70% respectively for the samples as expressed in the (Table 5). The crude protein for Nuggets was observed between 15.42%-19.31% and for the Kebabs the values were observed between 19.70%-21.18% respectively. Among these values the lowest value was observed for the Subsample D1 with the Crude protein content of 15.42% and the highest value was observed for Subsample A2 with the crude protein content of 21.18%.

For TVC the values were obtained as 3.03×10^{8}, 2.47×10^{4}, 2.55×10^{9}, 1.61×10^{4}, 2.20×10^{5}, 2.27×10^{5}, 1.74×10^{7}, 3.52×10^{6}, 2.36×10^{6}, and1.74×10^{5}. The values were calculated in cfu per grams of samples where cfu is the colony forming unit. The Highest value was observed for the Subsample B1 with 2.55×10^{9} cfu/g of the sample and the lowest value for TVC was observed for Subsample B2 with 1.61×10^{4} cfu/g of sample. For TCC the values which

were observed and recorded in the (Table 6) were as followed 1.49 x 10^5, 5.28 x 10^4, 1.05 x 10^7, 7.19 x 10^4, 5.14 x 10^4,2.39 x 10^5,6.48 x 10^7, 1.37 x 10^5,8.08 x 10^4, and 3.22 x 10^5. For TCC the Highest bacterial count was observed for Subsample D1 as 6.48 x 10^7 cfu/g, and the lowest bacterial count was observed for Subsample C1 as 5.14 x 10^4 cfu/g.

Table 5: Mean (±SD) Crude protein of the samples

Samples	Mean ± SD
Subsample A1	19.31 ± 0.02^{e}
Subsample A2	21.18 ± 0.04^{a}
Subsample B1	18.89 ± 0.02^{f}
Subsample B2	20.6 ± 0.01^{b}
Subsample C1	15.71 ± 0.04^{h}
Subsample C2	20.61 ± 0.02^{b}
Subsample D1	15.42 ± 0.01^{i}
Subsample D2	20.03 ± 0.08^{c}
Subsample E1	16.14 ± 0.06^{g}
Subsample E2	19.70 ± 0.02^{d}

[a, b, c, d, e, f, g, h, i]Repeating alphabets within the rows indicates that values are not significantly different from each other.

Table 6: Mean (±SD) Tvc and Tcc in cfu/g of Samples

Samples	TVC cfu/g (Mean ± SD)	TCC cfu/g (Mean ± SD)
Subsample A1	$3.03 \times 10^8 \pm 0.11^{b}$	$1.49 \times 10^5 \pm 0.04^{g}$
Subsample A2	$2.47 \times 10^4 \pm 0.15^{cd}$	$5.28 \times 10^4 \pm 0.14^{d}$
Subsample B1	$2.55 \times 10^9 \pm 0.05^{c}$	$1.05 \times 10^7 \pm 0.07^{h}$
Subsample B2	$1.61 \times 10^4 \pm 0.11^{f}$	$7.19 \times 10^4 \pm 0.16^{b}$
Subsample C1	$2.20 \times 10^5 \pm 0.21^{e}$	$5.14 \times 10^4 \pm 0.15^{d}$
Subsample C2	$2.27 \times 10^5 \pm 0.11^{de}$	$2.39 \times 10^5 \pm 0.03^{f}$
Subsample D1	$1.74 \times 10^7 \pm 0.06^{f}$	$6.48 \times 10^7 \pm 0.15^{c}$
Subsample D2	$3.52 \times 10^6 \pm 0.09^{a}$	$1.37 \times 10^5 \pm 0.06^{g}$
Subsample E1	$2.36 \times 10^6 \pm 0.21^{cde}$	$8.08 \times 10^4 \pm 0.11^{a}$
Subsample E2	$1.74 \times 10^5 \pm 0.06^{f}$	$3.22 \times 10^5 \pm 0.05^{e}$

[a, b, c, d, e, f, g, h] Repeating alphabets within the rows indicates that values are not significantly different from each other.

Samples analyzed for the detection and isolation of *Campylobacter spp.* and *Listeria spp.* indicated thatonly 2 samples were detected positive for the presence of *Campylobacter spp.* (20%) Subsample A1 and C2 and only a single sample was detected positive for the presence of *Listeria spp.* (10%) Subsample D2, however none of the samples were detected to be positive for both the bacteria as mentioned in (Table 7).

Discussion

The range observed for pH in these Subsamples indicated that the cooking practices, ingredients, and the spices used for the preparation were completely different resulting in the values as observed, these finding were also supported by **[24]**, expressing that the meat products have variation in the pH values due to the preparation practices. These findings were similar to the findings **[25]**, for the pH of the chicken products.

The range observed for Moisture content in these Subsamples indicated that the ingredients used, and the amount of the chicken used in the preparation of these products vary considerably and since the high moisture content damages the coating of nuggets and also the color of the coating was affected by the moisture content, whereas it was not the case for kebabs, therefore variations observed in the values of moisture content of these samples were completely different resulting in the values as observed. These finding were similar to the finding **[26, 27]**, for the moisture content for Nuggets and Kebabs.

The range observed for Ash content in these Subsamples indicated that the preservatives, spices, salts, and various ingredients used in the preparation had led to the variation in the values of ash content as preservatives and salts were inorganic and burning destroyed all the organic material leaving behind inorganic and minerals content present in the samples. These finding were similar to the finding **[28, 29]**, for the ash content for Nuggets and Kebabs.

Table 7: Detection and percentage of *Campylobacter spp.* and*Listeria spp.*

Sample number and types N=10	*Campylobacter spp.* Presence and Percentage	*Listeria spp.* Presence and Percentage	Presence of within the same sample
Nuggets (5)	Nuggets (5)	Nuggets (5)	Nuggets (5)
Subsample A1	Present (10%)	Absent (0%)	Absent
Subsample B1	Absent (0%)	Absent (0%)	Absent
Subsample C1	Absent (0%)	Absent (0%)	Absent
Subsample D1	Absent (0%)	Absent (0%)	Absent
Subsample E1	Absent (0%)	Absent (0%)	Absent
Kebabs (5)	Kebabs (5)	Kebabs (5)	Kebabs (5)
Subsample A2	Absent (0%)	Absent (0%)	Absent
Subsample B2	Absent (0%)	Absent (0%)	Absent
Subsample C2	Present (10%)	Absent (0%)	Absent
Subsample D2	Absent (0%)	Present (10%)	Absent
Subsample E2	Absent (0%)	Absent (0%)	Absent

The range observed in these Subsamples for rude fat indicated that the preparatory practices, ingredients used, and the way products were prepared by frying or baking resulting in the findings which were observed during the analysis and also reported **[30]**, expressing that the fat content of the products was dependent on the chemical and the physical processes which occurred during the frying and baking of the products. These finding were quite similar to the finding **[31-33]**, for the Crude fats content of Nuggets and Kebabs.

The range observed in these Subsamples for Crude protein indicated that the ingredients used, and the preparation practices were responsible for the findings which were observed during the analysis which were further supported by **[31]**, expressing that the protein contest depends on the preparation of the products and the ingredients used for preparation. These finding were quite similar to the finding **[27, 29, 34]**, for the Crude protein content for Nuggets and Kebabs.

The Total Viable Count is the measure of how hygiene, safe and healthy the product is estimated to be. Higher bacterial counts indicated that the shelf life of the products reduces drastically and should be consumed

relatively faster as compared to products with low bacterial counts. Similar results were reported by [35-37]. Similarly, the TVC provides an estimating about the hygienic conditions of the products and safety guidelines followed during the product preparation. Total Coliform Count is the measure for determining the hygienic practices and quality of the products available for the customers and bacterial load indicates the quality and hygiene practices adopted for the products. These findings were quite similar to the findings [38, 39].

The main reason for the detection of *Campylobacter spp.* and *Listeria spp.* bacteria in the ready to eat meat samples could be speculated that due to the composition and the ingredients used in the Subsamples they were not cooked up to the standard and as a result of storage the bacteria even without the enrichment would become active and contaminated the food product, therefore the main cause for the detection of these bacteria can be attributed to the cooking practices.The results obtained in this research study were similar to the Findings [40], obtained for ready to eat meat products for *Campylobacter spp.* and similarly the results for *Listeria spp.* were in accordance with [41], findings for *Listeria spp.* detection in ready to cook meat products.

Conclusion

Meat is the source of protein that is consumed throughout the world to fulfill the protein requirement of the body. The poultry meat contains micro-nutrients, and it is also low in fats and cholesterol when it is consumed without the skin. It has also been observed that poultry meat is rich in polyunsaturated fatty acids i.e. EPA and DHA, which indicates that it can be a possible alternative to fish meat. Due to the modern life style and the busy schedule the trend of the diet is shifting towards the value added, processed and ready to cook food products due to the flavor, taste, aroma, and the ease of cooking in a relatively short time. However, with the shifting trend towards the value added, processed and ready to cook products the standards of quality and food safety has become a major concern for the food industry as the customer preference is majorly affected by the quality, safety, and preparatory practices of the food products. The poultry sector of livestock not only contributes to economy in the form of meat, but all provide work opportunities to a larger number of rural and urban communities. Therefore, poultry sector has a massive potential to eradicate the malnutrition and also reduce the poverty by provide job opportunities to the people. The consumption of the meat products and especially poultry meat products is gaining a rapid popularity throughout the world and in Pakistan throughout the last Decade the production of poultry meat is increasing without decreasing even for a single time. The reason for this is the balanced diet which the poultry meat offers along with essential minerals, vitamins, and fatty acids. However, with the shifting trend towards the value added, processed and ready to cook products the standards of quality and food safety has become a major concern for the food industry as the customer preference is majorly affected by the quality, safety, and preparatory practices of the food products. Therefore, special emphasis is given to the quality and safety of the products during all preparatory and packaging practices to provide products of Optimum quality for the customer satisfaction.

Author contributions

Planned the experiments: UA Rehman & A Latif, Performed the experiments: UA Rehman & AA Rehman, Interpreted the results: UA Rehman & A Latif, Write the paper: UA Rehman & AA Rehman, Provided the tools, materials and statistically analyzed the data: AA Rehman & A Latif.

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