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Research Article

Comparative Assessment of Physical and Nutritional Meat Quality Traits among Different Chicken Breeds

Arshad Ali Khaskheli[1]*, Nasir Rajput[1], Ghulam Shabir Barham[2], Gul Bahar Khaskheli[2], Uzma Khatiyan[3], and Asad Ali Khaskheli[4]

[1]Department of Poultry Husbandry, Faculty of Animal Husbandry and Veterinary Sciences, Sindh Agriculture University, Tando Jam, Pakistan

[2] Department of Animal Products Technology, Faculty of Animal Husbandry and Veterinary Sciences, Sindh Agriculture University, Tando Jam, Pakistan

[3]Department of Animal Nutrition, Faculty of Animal Husbandry and Veterinary Sciences, Sindh Agriculture University, Tando Jam, Pakistan

[4]Queensland Alliance for Agriculture and Food Innovation (QAAFI), The University of Queensland, Australia

Abstract: Exotic and indigenous chicken breeds are gaining popularity over broilers due to their specific meat taste and flavor. This study evaluated the physical and nutritional meat quality traits of four chicken breeds to identify the most suitable breed for meat consumption. A total of 60 day-old-chicks of four different breeds (Fayoumi, Black Australorp, Naked Neck and Aseel) were assigned into 4 groups (15 chicks/group) and were raised for 20 weeks post-hatch. At the end of trial, meat samples (n = 5) from each group were assessed for physical traits (pH, water holding capacity, drip loss, and cooking loss) and nutritional composition (dry matter, protein, fat, and ash content). The Fayoumi breed exhibited significantly ($P < 0.05$) higher meat pH (5.74), greater water-holding capacity (49.73%), and lower drip loss (2.81%) than Black Australorp (5.18, 49.25%, 3.21%), Naked Neck (5.39, 49.04%, 3.07%), and Aseel (5.26, 46.94%, 3.22%). Cooking loss was comparatively lower in Fayoumi (25.89%) than in Naked Neck (26.88%) and Aseel (27.79%), while Black Australorp showed the lowest cooking loss (24.44%). The Fayoumi meat also contained significantly ($P < 0.05$) higher dry matter (30.54%), protein (21.88%), fat (5.13%), and ash (1.53%) relative to Black Australorp (28.36%, 21.16%, 4.13%, 1.07%), Naked Neck (28.60%, 20.92%, 4.34%, 1.35%) and Aseel (25.99%, 19.91%, 3.03%, 10.05%). In conclusion, Fayoumi chickens demonstrated superior overall meat quality, characterized by favorable physical properties and enhanced nutritional composition, suggesting that this breed may be a more suitable choice for consumers seeking high quality poultry meat.

Keywords: Meat Quality, Poultry Breeds, Chicken, Nutritional Evaluation, Proximate Composition.

1. INTRODUCTION

Meat is one of the important food sources for people in the world. Cattle, buffalo, sheep, goats, camels, yaks, fish, wild animals, poultry, and wild birds etc., are mainly used as sources of meat [1]. Among poultry, broilers are commercially reared on large scale to meet consumers' meat demand as they can convert feed into meat with rapid growth. The changes occurred in broiler growth performance and carcass characteristics (85-90%) have largely resulted from long-term quantitative genetic selection implemented in commercial breeding programs [2]. The indigenous chickens *(Gallus*

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* Corresponding Author: Arshad Ali Khaskheli <arshadkhaskheli@gmail.com>

domesticus) are another source of chicken meat that are frequently reared under extensive production systems. Comprehensive genomic analyses have definitively shown that these domestic birds originated from the Southeast Asia [3]. These chickens hunt for feed and require low cost for maintenance and have a greatly adaptive feature to the harsh pedo-climatic and socioeconomic conditions found in rural areas [3]. The indigenous chickens are reared in tropical areas because they can tolerate feed scarcity, poor management, and typical pathogens or diseases.

Main exotic chicken breeds include Black Australorp, Rhode Island Red and Fayoumi, while the indigenous breeds include Aseel, Desi and Naked Neck [4]. Among these breeds, meat of Aseel breed is famous due to its stiffness, texture, shear force value, large proportion of connective tissues, and overall palatability. Conversely, Fayoumi breed is famous due to its faster growth rate and higher egg production than the native Desi breed [5]. Fayoumi has the ability to tolerate harsh environmental conditions and has low nutritional requirements compared to other breeds [5]. Black Australorp, on the other hand, is a dual-purpose chicken breed recognized for its high egg production potential and adaptability, and has been widely used in crossbreeding programs to improve productivity and performance traits in poultry production systems [6]. The Naked Neck is also a dual-purpose breed and is kept by farmers due to its better survivability in adverse rural conditions [7]. The Naked Neck chicken is an important indigenous genetic resource that exhibits good growth performance, meat quality traits, desirable carcass, and superior adaptability to tropical environments [8]. There is increasing demand for meat that has been produced without the addition of chemical additives. Interestingly, meat of indigenous and exogenous chickens has been found to possess a distinctive taste, flavor with stiff muscles [9]. Therefore, there is an increasing demand of consumers for meat from indigenous and exogenous chicken breeds over commercial broiler chickens [10]. But literature lacking information on which breed has nutritious and healthier meat suitable for consumers. As nutritional (proteins, lipids and minerals) and physical (pH, water holding capacity, texture, drip loss) quality of meat mainly depends on genetics of the breed [11, 12]. Thus, we hypothesized that nutritional quality of meat would vary with breed type. The current study was conducted to comparatively assess the physical and nutritional meat quality traits among different chicken breeds. Our main objective of study was to identify a breed which has best quality meat for consumers.

2. MATERIALS AND METHODS

Day-old chicks of four chicken breeds (Fayoumi, Black Australorp, Naked Neck, and Aseel) were purchased from the Poultry Research Institute (PRI) Rawalpindi, Pakistan and were brought the Poultry Husbandry Department, Faculty of Animal Husbandry and Veterinary Sciences, Sindh Agriculture University Tando Jam. A total 60 (N = 60) day-old chicks of each breeds were used in the study and randomly assigned to 4 groups (n = 15 birds per group) in a completely randomized design. The selection of these breeds was based on their availablity in Pakistan and their known variation in growth performance and meat quality traits, making them suitable for comparative evaluation. Birds were reared under an intensive deep-litter housing system for 20 weeks post-hatch under standard housing conditions. Feed as provided twice a day and drinking water was given *ad libitum* throughout the experimental period. Standard brooding and rearing practices were followed, including appropriate litter management, ventilation and lighting schedule. A routine vaccination program was applied according to standard poultry health management guidelines practiced at the institution, including vaccinations against common viral poultry diseases. Birds were monitored regulary for health status and no therapeutic antibiotics were administered during the trial unless required for clinical.

2.1. Meat Sampling

At the end of the trial, 5 birds from each group were sacrificed using the Halal method in accordance with standard Islamic and ethical poultry processing procedures. The meat samples of each group were collected. Samples were stored in ice and then in the refrigerator at the Laboratory of Animal Products Technology (APT), Faculty of Animal Husbandry and Veterinary Sciences, Sindh Agriculture University, Tando Jam till further analysis.

2.2. Meat Samples Analysis

Meat samples were analysed for physical (pH, WHC, cooking loss, and drip loss) and nutritional quality (dry matter, protein content, fat, and ash content). The pH values in fresh meat samples were recorded using digital pH meter. The procedure developed by Barbut [13] was applied to measure the WHC of chicken meat. The protocol of Sen *et al*. [14] was used to assess the drip loss of chicken meat samples. The procedure as described by Pang *et al.* [15] was followed to determine the cooking loss of the chicken meat. Dry matter was determined according to the official methods of the AOAC International [16]. Nitrogen content in meat was determined using the Kjeldahl method [16], and the nitrogen percentage was converted to crude protein by applying the appropriate conversion factor. Fat content was determined using the Soxhlet extraction method [16], while ash content was determined using the gravimetric method [16].

2.3. Statistical Analysis

The data was analysed by statistical package statistics version 8.1 (copyright 2005, Analytical Software, USA). Firstly, the descriptive analysis under summary statistics was performed to compute the variation within the groups. Further, the data was analysed using a one-way analysis of variance to compute the significant variation. Further, the Least Significant Difference (LSD) test was applied to sort out significant variation among the means [17].

3. RESULTS AND DISCUSSION

3.1. Physical Quality of Meat of Various Chicken Breeds

3.1.1. pH values

pH values of chicken meat are a critical determinant of technological meat quality, particularly water-holding capacity, tenderness, and juiciness. Current studies have confirmed that post-mortem pH decline is strongly associated with protein denaturation and changes in muscle structure, which directly influence drip loss and cooking loss [13]. In the present study, pH values of chicken meat (Table 1) were found non-significant differences ($P > 0.05$) between Black Australorp and Aseel breeds (5.18 and 5.26, respectively), while pH values of chicken meat in both of the former breeds recorded significantly lower pH values ($P < 0.05$) compared with Fayoumi (5.74) and Naked Neck (5.39). The lower pH observed in some breeds may be associated with variations in pre-slaughter stress and muscle glycogen depletion, which accelerate post-mortem glycolysis and lead to rapid acidification of muscle tissue. It is well established that rapid pH decline reduces water-holding capacity due to protein denaturation and shrinkage of myofibrillar structures, resulting in increased water loss from meat [13]. These biochemical changes ultimately affect meat quality traits such as juiciness, texture, and processing yield.

3.1.2. Water holding capacity

In the present study, water-holding capacity (WHC) of meat in Fayoumi (49.73%), Black Australorp (49.25%), and Naked Neck (49.04%) was appeared statistically similar ($P > 0.05$), whereas significantly lower WHC ($P < 0.05$) was observed in Aseel meat (46.94%) (Table 2). These current findings indicate that cooking and eating qualities of meat of above said breeds did not vary to each other, while aseel exhibited comparatively inferior water retention ability. The observed variation in WHC may be associated with differences in post-mortem muscle pH decline and protein functionality. It is well established that a rapid decline in muscle pH leads to protein denaturation and reduced water-binding sites, thereby decreasing WHC, whereas a slower or moderate pH decline helps maintain higher WHC in meat. This relationship between pH and WHC has been widely documented in poultry meat science literature [13].

3.1.3. Cooking loss

Cooking loss differed significantly among the chicken breeds ($P < 0.05$) (Table 1). The highest cooking loss was observed in Aseel (27.79%) reaching a peak followed by Naked Neck (26.88%), Fayoumi (25.89%), and Black Australorp (24.44%). The greater cooking loss recorded in Aseel meat may be attributed to its comparatively lower pH and reduced water-holding capacity, as these factors are closely associated with increased moisture loss during thermal processing. Lower muscle pH accelerates protein denaturation, reducing the ability of muscle proteins to retain water and consequently increasing cooking loss [13]. The present findings also suggest that breed-related differences in muscle characteristics contributed to the observed variation in cooking loss. Previous studies have reported that slow-growing and indigenous chicken breeds often exhibit greater cooking loss than improved or fast-growing breeds due to differences in muscle fiber characteristics and post-mortem biochemical changes [18]. These observations are consistent with the relatively higher cooking loss recorded in the Aseel breed in the present study.

3.1.4. Drip loss

The drip loss in meat of Aseel (3.22%) recorded highest followed by Black Australorp (3.21%), Naked Neck (3.07%) and Fayoumi (2.81%), nevertheless the variations between them appeared non-significant ($P > 0.05$) (Table 1). In fact, the breeds under present investigation included with indigenous breeds though categorized under slow-growing genotypes, and in several studies, it was established that slow-growing chicken demonstrated higher drip loss [19-21]. Drip loss is largely influenced by the water-holding capacity and the extent of post-mortem protein denaturation, both of which are associated with muscle pH decline. Previous studies [22] have demonstrated that breed and growth rate can influence drip loss through their effects on muscle structure and post-mortem biochemical changes, although these differences are not always statistically significant. Results of current study agree with findings of Rai *et al*. [22] who described non-significant variations in the moisture and dry matter contents of thigh meat regardless of the level of dietary fat supplementation.

3.2. Nutritional Quality of Meat of various Chicken Breeds (Fayoumi, Black Australorp, Naked Neck and Aseel)

3.2.1. Dry matter content

Dry matter content of meat showed significant variation among the chicken breeds (Table 2). The highest dry matter content was recorded in Fayoumi (30.54%), followed by Naked Neck (28.60%), Black Australorp (28.36%), and the lowest in Aseel (25.99%). Black Australorp and Naked Neck exhibited statistically similar dry matter values ($P > 0.05$). However, in former both breeds existed significantly higher dry matter content compared with Aseel, while Fayoumi showed the highest overall value among all breeds ($P < 0.05$).

The observed higher dry matter content in Fayoumi meat may be due to associated with breed-related differences in carcass composition and nutrient deposition. Similar variations in meat composition due to genetic differences among chicken breeds have been reported in poultry studies, where genotype significantly influenced proximate composition and carcass traits [18, 23].

3.2.2. Protein content

The protein content of meat differed significantly among the chicken breeds ($P < 0.05$) (Table 2). The Fayoumi meat exhibited the highest protein content (21.88%) followed by Black Australorp (21.16%), Naked Neck (20.92%), and Aseel (19.91%). The superior protein content observed in Fayoumi may be attributed to breed-related genetic differences in muscle development and nutrient deposition.

Table 1. Physical attributes in meat of various chicken breeds.

Variables	Breed				LSD (0.05)	SE
	Fayoumi	Black Australorp	Naked Neck	Aseel		
pH value	5.74 ± 0.1^{A}	5.18 ± 0.21^{C}	5.39 ± 0.1^{B}	5.26 ± 0.24^{C}	0.0971	0.0474
Water Holding Capacity (%)	49.73 ± 0.64^{A}	49.25 ± 1.19^{A}	49.04 ± 5.19^{A}	46.94 ± 1.93^{B}	1.4952	0.7299
Cooking Loss (%)	25.89 ± 0.73^{C}	24.44 ± 1.20^{D}	26.88 ± 3.67^{B}	27.79 ± 1.91^{A}	0.6211	0.3032
Drip loss (%)	2.81 ± 0.56^{A}	3.21 ± 0.55^{A}	3.07 ± 0.41^{A}	3.22 ± 0.57^{A}	0.4094	0.1999

Note: Different Alphatical mentioned as supersript on each value represent the different grouping.

In fact, the variation in proximate composition of meat of various chicken breeds probably regarded with many factors like species, breed, muscle type, sex, age, and method of processing of carcasses [24]. Among these, breed is considered one of the major determinants of meat composition, as genetic differences affect muscle growth and protein accretion. Similar breed-dependent differences in meat protein content have been reported in previous studies, confirming the significant influence of genotype on the nutritional quality of poultry meat [18, 25].

3.2.3. Fat content

The fat content of meat differed significantly among the chicken breeds ($P < 0.05$) (Table 2). Moreover, percent of fat content in meat of Fayoumi meat contained the highest fat content (5.13%), followed by Black Australorp (4.13%) and Naked Neck (4.34%), which did not differ significantly ($P > 0.05$). The lowest fat content was observed in Aseel (3.03%). These findings indicate that breed-related genetic differences influence lipid deposition in muscle tissue, resulting in variations in intramuscular fat content. These findings indicate that breed-related genetic differences influence lipid deposition in muscle tissue, resulting in variations in intramuscular fat content. Similar breed-dependent differences in meat fat content have been widely reported and are primarily attributed to genetic background, age, nutrition, muscle type, and rearing system [18]. Likewise, Jaturasitha *et al*. [25] demonstrated that genotype significantly affects the nutritional quality and proximate composition of chicken meat. The present findings are consistent with earlier studies reporting significant variation in fat content among different chicken breeds [26]. In one of the studies, significant ($P < 0.05$) variation were reported in the fat percent of commercial chicken broiler meat against local chickens [26]. While another study indicated that fat content in native broilers varied over commercial broilers, and the inconsistency in this context probably be attributed with the unique compositional characteristics of chicken meat [27]. Therefore, the higher fat content observed in Fayoumi meat in the present study may reflect its inherent breed characteristics and nutrient deposition pattern.

3.2.4. Ash content

In Ash content differed significantly among the chicken breeds ($P < 0.05$) (Table 2). In the current study ash content in meat of Fayoumi breed exhibited the highest ash content (1.53%), followed by Naked Neck (1.35%), whereas Black Australorp (1.07%) and Aseel (1.05%) showed statistically similar values ($P > 0.05$). The higher ash content observed in Fayoumi and Naked Neck meat may indicate a relatively greater mineral content, reflecting breed-related differences in nutrient deposition. These results are in line with studies of different authors wherein similar trend of variation was reported for ash content of chicken meat [28]. Another study supported the present investigation wherein comparable variation was reported in ash content of Cobb-400 against all indigenous chicken except for Vanaraja meat [27].

4. CONCLUSIONS

The current study demonstrated that chicken breed significantly influences both the physical and nutritional quality of meat. Among the four breeds,

Table 2. Nutritional profile of meat of various chicken breeds.

Variables	Breeds				LSD (0.05)	SE
	Fayoumi	Black Australorp	Naked Neck	Aseel		
Dry matter (%)	30.54 ± 1.72^{A}	28.36 ± 1.57^{B}	28.60 ± 2.19^{B}	25.99 ± 1.00^{C}	0.4370	0.2133
Protein content (%)	21.88 ± 2.37^{A}	21.16 ± 1.85^{B}	20.92 ± 2.38^{B}	19.91 ± 1.43^{C}	0.3756	0.1833
Fat content (%)	5.13 ± 1.07^{A}	4.13 ± 0.53^{B}	4.34 ± 0.40^{B}	3.03 ± 0.37^{C}	0.2472	0.1207
Ash content (%)	1.53 ± 0.35^{A}	1.07 ± 0.18^{C}	1.35 ± 0.07^{B}	1.05 ± 0.21^{C}	0.0754	0.0368

Note: Different Alphatical mentioned as supersripts on each value represent the different groupings.

meat obtained from the Fayoumi breed showed a significantly higher ultimate pH (5.74) compared to the other breeds, which is indicative of a slower post-slaughter acidification process. This moderate pH decline was associated with improved water holding capacity (49.73%) and reduced cooking loss (25.89%) and drip loss (2.81%). These parameters are critical determinants of meat tenderness, juiciness, and overall consumer acceptance, suggesting that Fayoumi meat is less disposed to moisture loss during processing, storing, and cooking, thereby retaining greater succulence and yield. From a nutritional point of view, Fayoumi meat was notably higher, containing the highest levels of protein (21.88%), fat (5.13%), ash/mineral content (1.53%), and dry matter (30.54%) when compared with Black Australorp, Naked Neck, and Aseel breeds. The elevated protein and mineral content improves its dietary value for human nutrition, while the moderate fat level contributes to palatability and energy density without being excessive. In contrast, meat from the Aseel breed, despite being traditionally valued for its flavour and texture showed the lowest physical and nutritional quality in this study. It recorded the lowest water holding capacity (46.94%), highest cooking loss (27.79%), and minimal protein (19.91%), fat (3.03%), ash (1.05%), and dry matter (25.99%) contents. These characteristics may result in drier, less juicy meat with reduced nutritional density, making it less suitable for consumers seeking high quality, nutrient rich poultry meat. The Black Australorp presenting relatively better cooking loss (24.44%) and protein content (21.16%), while Naked Neck demonstrated moderate performance across all traits. In conclusion, among the four chicken breeds assessed, the Fayoumi breed stands out as the most promising contender for producing nutritious, healthy, and technologically superior meat. Its favourable combination of high water holding capacity, low cooking and drip losses, and rich content of protein, fat, minerals, and dry matter makes it a breed of choice for consumers, nutritionists, and poultry producers aiming to meet the growing demand for premium quality chicken meat. Future research may explore the underlying genetic and metabolic mechanisms contributing to these breed-specific meat quality traits, as well as the performance of Fayoumi meat under different rearing systems and processing conditions.

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6. ETHICAL STATEMENT

The research protocol and all experimental procedures were reviewed and approved by the Directorate of Advanced Studies and Research (DASR), Sindh Agriculute University Tando Jam. All birds handling, management practices, and experimental procedures were carried out in strict accordance with institutional ethical guidelines for the care and welfare of experimental animals.

7. FUNDING

No funding was received to conduct this research.

8. CONFLICT OF INTEREST

The authors declare no conflict of interest regarding the publication of this manuscript.

9. AUTHORSHIP CONTRIBUTION STATEMENT

Arshad Ali Khaskheli: Conceptualization, Methodology, Investigation (conducted the research experiment), Data Curation, and Original Draft Preparation and Writing. Nasir Rajput: Supervision, Review & Editing. Ghulam Shabir Barham: Investigation (assisted in conducting the research experiment) and Methodology. Gul Bahar Khaskheli: Formal Analysis, Validation, and Writing, Review & Editing. Uzma Khatiyan: Resources, Literature Review, and Validation. Asad Ali Khaskheli: Visualization, Data formatting, and final proofreading.

10. DECLARATION

All authors declare that the results of the present study are original and these are neither published and are nor under consideration for publication elsewhere. Approval of all authors has been obtained and incase the article is accepted for publication, its copyright will be assigned to the Pakistan Academy of Sciences. Further, no any copyrighted material from other sources has been used in this article.

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