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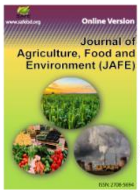

Research Article

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Unlocking the nutritional secrets of Bangladesh's three popular chicken genotypes: A comprehensive analysis of proximate composition, fatty acid profile and mineral content of meat

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ABSTRACT

Poultry provides protein and nutrients for health and food security. This research examined the proximate composition, fatty acids, and minerals in meat from Bangladeshi broiler, layer, and Sonali chickens. Birds were reared on commercial farms where conditions were carefully controlled and massacred at their usual market ages. Significant differences were observed in the biochemical properties, fatty acid, and mineral content of breast and thigh meat, regardless of chicken type. Layer and Sonali chicken breast had higher protein and lower lipids than broiler. In terms of nutritional properties, Sonali breast meat contained notably higher proportions of UFA (72.51%) and a lower amount of SFA (26.99%) than the other two breeds. Additionally, Sonali exhibited significantly higher proportions of DFA, EFA, PUFA/SFA ratios and (18:0 + 18:1)/16:0 ratios. Moreover, among all breeds, layer chickens exhibited the highest levels of potassium. The breast meat of broilers and the thigh meat of layers contained the highest amounts of calcium, at 44.12 and 53.09 mg/100 g, respectively. Sonali breast meat and layer thigh meat had lower sodium levels at 56.08 and 59.75 mg/100 g, respectively. Sonali chicken breast and broiler thigh contained high magnesium (76.04 and 73.39 mg/100 g). In summary, Sonali chicken meat has special qualities and is better than regular broilers and layers. Layers are rich in potassium and calcium, while broilers have higher magnesium. So, Sonali chicken is more nutritious and safer to eat.

INTRODUCTION

Meat has been an important part of the human diet (Klurfeld, 2015) over a million years. Meat is important for nutrition. It gives us energy, fatty acids, vitamins, proteins, and minerals. When eaten with carbohydrates, fruits, and vegetables (Wood, 2017) a proper balance was produced.

Chicken and turkey, which are types of poultry meat, are often regarded as being more nutritious (Bordoni & Danesi, 2017) than other kinds of meat. Poultry meat aligns with contemporary consumer preferences by offering high-quality protein, minimal fat, and a significant amount of UFA (Stangierski & Lesnierowski, 2015) while also being low in sodium and cholesterol. In Bangladesh, poultry products contribute to 20% of the total protein consumption. Chickens dominate the poultry sector, comprising 90% of the birds raised, while ducks account for 8%, and the remaining 2% includes other types of birds (Das *et al*., 2008).

Bangladesh hosts four unique types of chickens: broilers, layers, Sonali, and local breeds (Imam *et al*., 2020). Broiler is the most common variety found in markets throughout the country, typically sold when they are 30 to 33 days old (Rabbani & Ahmad, 2021). The Sonali chicken, a hybrid created by crossbreeding male Rhode Island Reds (RIR) with female Fayoumis, bears a physical similarity to the indigenous chickens (Uddin *et al*., 2015). The breed is becoming increasingly favorite due to its excellent production performance, better disease resistance, low mortality rates, and favorable profit margins per bird (Hasan *et al*., 2017). Layers, conversely, are older birds that can be accustomed as a source of moderate quality chicken meat. Their meat is often seen as less desirable because it is tough. This toughness occurs because their diet contains firm collagen, which is also heat-stable (Kang *et al*., 2009).

The demand for poultry meat has experienced a significant increase over the past several decades (Korver, 2023), attributable to both a growing population and an increase in per-capita consumption (FAO, 2022). The eating habits concerning poultry products in Bangladesh underscore the significant contribution of chickens to the nation's protein consumption (Islam, 2003). As the sector progresses, there could be chances to expand and encourage the use of other poultry types, like ducks, quails, and pigeons, to broaden the range of protein sources for consumers and possibly fill nutritional deficiencies in the population's diet (Batool *et al*., 2023).

In recent years, most studies on chicken meat quality have focused on carcass traits (Tang *et al*., 2009) color, and water retention (Zhao *et al*., 2011). However, there is a lack of detailed information about the nutrient profile (Rikimaru & Takahashi, 2010), particularly the fatty acid and mineral content of (Franco *et al*., 2012) different types of chicken genotypes and meat. There is not much research on the chemical makeup of meat from some types of Sonali, broiler and layer chickens. Scientific studies have not thoroughly investigated their distinct flavor and nutritional value compared to other chickens. Considering the importance of meat, particularly poultry, in human nutrition and focusing on the chicken industry in Bangladesh, this study aims to examine the biochemical and nutritional qualities of meat collected from broiler, layer, and Sonali. It also assessed the differences between breast and thigh meat in relation to these characteristics. This data can help choose chicken breeds for specific uses. This can support breeding programs to improve meat production and increase the variety of chicken meat available for consumption.

MATERIALS AND METHODS

Collection and Preparation of Sample

For this study, three breeds of chickens—broilers, layers, and Sonali were utilized. A total of 315 (105 individuals from each breed) birds were reared with mixed sex, where the male: female ratio was 4:6 (Rabbi, 2019). All three breeds were raised on a commercial farm providing uniform conditions. They were provided with grower and starter feed that is commercially available (Rabbi, 2019). The starter feed comprises approximately 11.0-12.0% moisture, 3.0-6.0% crude fat, 18.0-21.5% crude protein, 3.0-5.0% crude fiber, 0.9-1.2% lysine, 0.46-0.50% methionine, 0.9-3.8% calcium, 0.42-0.48% phosphorus, and provides 2850-3100 kcal/kg of metabolic energy. Similarly, the grower feed contains about 11.0-12.0% moisture, 3.0-5.0% crude fiber, 18.0-21.5% crude protein, 3.0-6.0% crude fat, 0.9-1.2% lysine, 0.46-0.50% methionine, 0.9-3.8% calcium, 0.42-0.48% phosphorus, and delivers 3000-3250 kcal/kg of metabolic energy. Both water and feed were available for unrestricted consumption. The broilers, Sonali, and layers were killed when they reached the right age for selling, 33 days (Rabbani & Ahmad, 2021), 64 days (Afrin *et al*., 2024), and 530 days (Uddin *et al*., 2015), respectively. In the experimental process, 20 birds from each breed were chosen at random and separately slaughtered using a standard neck cut. This was followed by a two-minute bleeding, decapitation, and evisceration. Subsequently, the pectoralis major (breast portion) and biceps femoris (thigh portion) from both sides were separately separated and deboned. The muscles were cleaned of skin, extra fat, and connective tissues. Then the meat was separately chopped. After that, the corpses were cooled at 4°C for a duration of 24 hours. Each bird was processed one by one, vacuum-sealed, and kept in a freezer at -20°C until further nutritional analysis.

Analysis of proximate composition

The assessment of moisture, crude protein, lipid, ash, and carbohydrate was performed by the procedures described in (AOAC, 2000), with slight adjustments. The moisture and dry matter levels were measured by drying the sample at 105 °C for 8 hours in a hot air oven. Ash content was checked at 600 °C. using the Kjeldahl method (Kelplus Classic, DX VA, Pelican Equipment), nitrogen content was measured and Crude protein was found by multiplying the nitrogen percentage by 6.25. Crude fiber was measured by treating the sample, which had no moisture or fat, with a weak (1.25%) acid and then an alkali, using the Fiber cap (Foss Tecator, Sweden). The amount of fat was measured using a machine called the Soxtec system (SOCS Plus, SCS-6, Pelican Equipment). This machine used a chemical called diethyl ether, which boils at 40–60°C, to extract the fat. Each composition analysis was conducted in triplicate.

Analysis of fatty acid profile

The fatty acids in the oils were checked as their methyl esters, using a slightly changed method from (Akbar *et al*., 2009). Here, a small amount of fat was mixed in a test tube with petroleum ether, it was methylated using sodium methoxide (Merck, Germany) while near a flame. The mixtures were subsequently thinned with distilled water and left to stand for a few minutes until a very clear upper layer appeared. The top layer, which had methylated esters of fatty acid (FAME), was collected and analyzed using gas chromatography (GC).

Gas chromatography analysis

The study of fatty acids, including trans fats, was done using a Shimadzu GC-14B gas chromatograph from Japan. This machine had a flame ionization detector and a special column (FAMEWAX, Crossbond polyethylene glycol, 15m×0.25mm×0.25µm film thickness, Restek; Pennsylvania, USA). Nitrogen gas was used to move the sample through the system at a steady rate of 20 mL/min. The oven started at 150ºC for 5 minutes. The injector was heated to 250 ºC. Then, the temperature was increased to 190ºC at 8ºC/min, and then to 200ºC at 2 ºC/min for 10 minutes. Fatty acids were identified using standard samples (FAME mix; Sigma-Aldrich, St. Louis, Missouri, USA) and measured as a percentage with automated GC software (Class GC-10; Shimadzu; Japan).

Analysis of mineral

Digestion of meat samples for elemental analysis

A sub-sample of each meat specimen, weighing 0.5 g (oven-dried and ground), is transferred into a dry, clean digestion flask. Subsequently, 5-8 mL of concentrated HNO_3 is added. After allowing the mixture to stand for 0.5-1 hour, the flask is heated in a digestion chamber, with the temperature gradually increased to 160-180°C for 35-40 minutes. The contents of the flask are then cooled, and 2-4 mL of H_2O_2 is added, followed by additional heating for 25-30 minutes at 160°C. The final digest becomes clear and colorless. The mixture is cooled, then mixed with distilled water until it reaches 100 mL. It is filtered using filter paper (Whatman No. 41). The solution is put in a dry plastic bottle and stored in a freezer.

Determination of Na and K

The concentrations of sodium and potassium in the samples were individually quantified using a flame emission spectrophotometer (Spectrolab Analytical UK), employing appropriate filters and standards.

Determination of phosphorus

Phosphorus (P) was measured by employing ascorbic acid as a reducing agent to develop color, and the reading was obtained using a spectrophotometer (T60UV). The absorbance was recorded 15 minutes after the color had developed. Following this, a standard curve was established by graphing the spectrophotometer's absorbance of light against the concentrations of P, which was subsequently utilized to determine the P content in the sample.

Determination of Calcium

Calcium was measured using the complexometric titration method with Na_2-EDTA serving as the complexing agent (Page, 1982). During the titration, 5 mL of the extracts was put into a conical flask (250 mL). Then, added 50 mL of warm water. To this, 2 mL of 10% KOH, and 2 mL each of hydroxylamine hydrochloride (NH_2OH. HCl), triethanolamine, and $K_4Fe(CN)_6$ were added to remove interference from various ions. Finally, 5 drops of calcon, an ion-selective indicator, were introduced, which turned the solution pink. The solution was subsequently titrated with 0.01 M Na_2-EDTA until the color altered from pink to a clear blue.

Determination of Magnesium

The quantification of magnesium was conducted utilizing the complexometric titration method, employing Na_2-EDTA as the complexing agent. This analytical technique was implemented to mitigate potential interference from non-target ions, with the presence of the Eriochrome Black-T indicator (EBT). To isolate magnesium, calcium was initially precipitated from the extracted samples. Additionally, 2 mL of potassium ferrocyanide $K_4Fe(CN)_6.3H_2O$, 2 mL of hydroxylamine hydrochloride ($NH_2OH.HCl$), and 2 mL of ammonium buffer solution were introduced to suppress the competition from various ions, including Fe, Cu, Zn, Mn, and phosphate. The estimation of magnesium was subsequently performed titrimetrically using Na_2-EDTA (Page, 1982);(Rice *et al.*, 2012).

Determination of Sulphur

Sulfur (S) was measured using the turbidimetric method outlined by (Tandon, 1995), with a spectrophotometer (T60UV) set to detect absorbance at 425 nm.

Statistical analysis

The findings of the experimental are stated as the mean ± standard deviation (SD) from three separate measurements. We used one-way analysis of variance (ANOVA) to analyze the data. Tukey's pairwise comparison tests at (p = 0.05) or independent sample T-tests (p = 0.05) were employed to identify significant differences. The MINITAB 18 (Minitab Inc., State College, PA, USA) was utilized for conducting statistical analysis.

RESULTS

Proximate composition

Table 1 displays the proximate compositions of three popular chicken breeds' breast and thigh meat, namely broiler, layer, and Sonali hens. The breed of chicken played a significant role in determining the proximate composition of the meat. The breast meat's composition included moisture levels between 72.47% and 76.47%, crude lipid from 0.78% to 1.83%, crude protein ranging from 17.07% to 20.30%, ash content between 0.69% and 1.21%, crude fiber from 0.51% to 0.62%, and carbohydrates from 2.82% to 4.23%. In contrast, the thigh meat of various chicken breeds showed moisture content from 72.47% to 77.27%, crude lipid between 2.94% and 4.11%, crude protein from 16.04% to 17.27%, ash content ranging from 0.47% to 0.77%, crude fiber between 0.54% and 0.60%, and carbohydrates from 2.65% to 2.77%. Notably, the moisture level was significantly greater (p<0.05) in thigh meat compared to breast meat across all breeds. Broiler meat contained more moisture than both Sonali and layer meat in the breast and thigh sections. Moreover, irrespective of breed, the protein content was significantly higher (p<0.05) in breast meat compared to thigh meat (Table 1). Among the three chicken types, layer and Sonali chickens had higher protein levels than broilers, irrespective of the meat portion. As indicated in Table one, the lipid level was lower in the breast meat compared to the thigh meat, which was the opposite of the protein content. Additionally, Sonali chickens' breast meat had the lowest lipid content. Broilers' breast meat had significantly higher (p<0.05) ash content than their thigh meat. No statistically significant difference (p>0.05) in ash percentage was found between the breast and thigh portions of Sonali and layer. The carbohydrate content was notably higher in the breast portion of the layer. In thigh meat, there was no significant difference in carbohydrate percentage among the three breeds. Statistically, no significant differences were observed in crude fiber percentage across the meat portions of broilers, layers, and Sonali.

Table 1: Proximate Composition Analysis Results of Meat (Moisture Basis) Expressed as Percentage

Proximate Composition	Brest meat			Thigh meat		
	Broiler	Layer	Sonali	Broiler	Layer	Sonali
Moisture	76.47 ± 0.32^{Ba}	72.47 ± 0.30^{Bc}	74.70 ± 0.10^{Bb}	77.27 ± 0.11^{Aa}	74.48 ± 0.10^{Ac}	76.66 ± 0.11^{Ab}
Crude Lipid	1.83 ± 0.07^{Ba}	1.69 ± 0.09^{Ba}	0.78 ± 0.10^{Bb}	2.94 ± 0.14^{Ab}	4.11 ± 0.22^{Aa}	3.20 ± 0.33^{Ab}
Crude Protein	17.07 ± 0.43^{Ab}	20.30 ± 0.56^{Aa}	19.88 ± 0.24^{Aa}	16.04 ± 0.18^{Bb}	17.27 ± 0.36^{Ba}	16.12 ± 0.23^{Bb}
Ash	1.21 ± 0.03^{Aa}	0.69 ± 0.08^{Ab}	0.72 ± 0.06^{Ab}	0.47 ± 0.05^{Bb}	0.77 ± 0.09^{Aa}	0.83 ± 0.04^{Aa}
Crude Fibre	0.60 ± 0.04^{Aa}	0.62 ± 0.05^{Aa}	0.51 ± 0.09^{Aa}	0.54 ± 0.08^{Aa}	0.60 ± 0.05^{Aa}	0.62 ± 0.05^{Aa}
Carbohydrate	2.82 ± 0.04^{Ac}	4.23 ± 0.04^{Aa}	3.41 ± 0.09^{Ab}	2.74 ± 0.11^{Aa}	2.77 ± 0.13^{Ba}	2.65 ± 0.06^{Ba}

The data are shown as mean ± standard deviation (n=3).
Lowercase letters within the same row indicate significant differences (p<0.05) among broiler, layer, and sonali for either breast or thigh meat.
Uppercase letters in the same row within the same breed indicate significant differences (p<0.05) among breast and thigh meat.

Fatty acid composition

Table 2 compellingly illustrates the critical differences in fatty acid compositions between the breast and thigh meat of the three chicken varieties, offering invaluable insights that underscore the importance of choosing the right variety for optimal health benefits. The identification of oleic (C18:1), palmitic (C16:0), and linoleic acids (C18:2) as the primary fatty acids in the meat from broilers, layers, and Sonali chickens aligns with expectations. The breed of chicken undeniably exerts a profound influence (p<0.05) on the levels of all individual fatty acids in both types of meat. Specifically, for the total SFA in breast meat, Sonali chickens exhibited notably lower values (26.99±0.00) compared to broilers and layers. Compared to Sonali and layer chickens, the thigh meat of broilers had significantly less (p<0.05) SFA. It is undeniable that both meat portions boast significantly elevated levels (p<0.05) of UFA. Among the chicken breeds, Sonali had the highest level of UFA, with values of 72.51±0.00 in breast meat and 73.25±0.00 in thigh meat. Regarding MUFA, the layer breed had a higher oleic acid (C18:1) content in both meat portions than other breeds. Amidst the realm of *n-6* PUFA, Sonali emerged as a champion, boasting a richer tapestry of linoleic acid (C18:*2n-6*) woven into the very fibers of broilers' and layers' breast and thigh meat. Meanwhile, the elusive *n-3* PUFA, with eicosapentaenoic acid (EPA) as its herald—a fatty acid often found frolicking in the depths of marine fish (Chauton *et al*., 2015), —made a subtle appearance in chickens, whispering its presence in the gentlest of quantities. In the quest to unravel the nutritional tapestry and health implications of IMF for consumers, a symphony of measurements was conducted, including the total DFA, total EFA, PUFA/SFA ratio, and the 18:0+18:1/16:0 ratio. Within this study, the percentage of DFA (18:0+MUFA+PUFA) in the IMF of the breast and thigh across the three breeds ranged between 75.16% and 80.50%, and 74.12% and 81.26%, respectively, painting a vivid picture of variation and richness.

Table 2: The composition of fatty acids (g/100 g of total fatty acids) in the breast and thigh meat of broiler, layer, and sonali chickens

Fatty Acids	Brest Meat			Thigh meat		
	Broiler	Layer	Sonali	Broiler	Layer	Sonali
C14:0, Myristic acid	0.45 ± 0.00^{Ab}	0.95 ± 0.00^{Aa}	0.34 ± 0.00^{Ac}	0.43 ± 0.00^{Bb}	0.72 ± 0.00^{Ba}	0.33 ± 0.00^{Bc}
C16:0, Palmitic Acid	21.57 ± 0.00^{Ab}	23.61 ± 0.00^{Ba}	18.13 ± 0.00^{Ac}	20.00 ± 0.00^{Bb}	23.68 ± 0.00^{Aa}	17.90 ± 0.00^{Bc}
C18:0, Stearic Acid	5.35 ± 0.00^{Bc}	7.84 ± 0.00^{Ab}	7.99 ± 0.00^{Ba}	5.65 ± 0.00^{Ac}	7.45 ± 0.00^{Bb}	8.00 ± 0.00^{Aa}
C20:0, Arachidic Acid	0.39 ± 0.00^{Bb}	0.28 ± 0.0^{Bc}	0.45 ± 0.00^{Ba}	0.47 ± 0.00^{Aa}	0.29 ± 0.00^{Ac}	0.46 ± 0.00^{Ab}
C16:1, Palmitoleic acid	3.37 ± 0.00^{Ba}	3.35 ± 0.00^{Ab}	2.80 ± 0.00^{Bc}	4.16 ± 0.00^{Aa}	3.03 ± 0.00^{Bc}	3.04 ± 0.00^{Ab}
C18:1, Oleic acid	39.95 ± 0.00^{Bb}	43.19 ± 0.00^{Aa}	39.12 ± 0.00^{Bc}	40.42 ± 0.00^{Ab}	43.03 ± 0.00^{Ba}	39.31 ± 0.00^{Ac}
C18:2, Linoleic Acid	25.52 ± 0.00^{Bb}	18.94 ± 0.00^{Ac}	28.11 ± 0.00^{Ba}	25.77 ± 0.00^{Ab}	18.93 ± 0.00^{Bc}	28.35 ± 0.00^{Aa}
C18:3, Linolenic Acid	1.19 ± 0.06^{Aa}	0.42 ± 0.00^{Ac}	1.09 ± 0.00^{Bb}	1.13 ± 0.01^{Aa}	0.31 ± 0.00^{Bb}	1.12 ± 0.00^{Aa}
C20:5, Eicosapentaenoic acid	1.05 ± 0.00^{Ac}	1.43 ± 0.00^{Aa}	1.39 ± 0.00^{Bb}	0.93 ± 0.00^{Bc}	1.38 ± 0.00^{Bb}	1.43 ± 0.00^{Aa}
UnFA	1.15 ± 0.00^{Aa}	ND	0.50 ± 0.00^{Ab}	1.05 ± 0.00^{Bb}	1.19 ± 0.00^{a}	0.04 ± 0.00^{Bc}
∑SFA	27.77 ± 0.00^{Ab}	32.67 ± 0.00^{Aa}	26.99 ± 0.00^{Ac}	26.54 ± 0.00^{Bc}	32.14 ± 0.00^{Ba}	26.69 ± 0.00^{Bb}
∑UFA	71.08 ± 0.00^{Bb}	67.33 ± 0.00^{Ac}	72.51 ± 0.00^{Ba}	72.41 ± 0.00^{Ab}	66.67 ± 0.00^{Bc}	73.25 ± 0.00^{Aa}
∑MUFA	43.32 ± 0.0^{Bb}	46.54 ± 0.00^{Aa}	41.92 ± 0.00^{Bc}	44.58 ± 0.00^{Ab}	46.06 ± 0.00^{Ba}	42.35 ± 0.00^{Ac}
∑n-3 PUFA	2.24 ± 0.06^{Ab}	1.85 ± 0.00^{Ac}	2.47 ± 0.00^{Ba}	2.06 ± 0.00^{Bb}	1.69 ± 0.00^{Bc}	2.56 ± 0.00^{Aa}
∑n-6 PUFA	25.52 ± 0.00^{Bb}	18.94 ± 0.00^{Ac}	28.11 ± 0.00^{Ba}	25.77 ± 0.00^{Ab}	18.93 ± 0.00^{Bc}	28.35 ± 0.00^{Aa}
∑PUFA	27.76 ± 0.00^{Bb}	20.79 ± 0.00^{Ac}	30.59 ± 0.00^{Ba}	27.83 ± 0.00^{Ab}	20.62 ± 0.00^{Bc}	30.90 ± 0.00^{Aa}
∑DFA	76.43 ± 0.00^{Bb}	75.16 ± 0.00^{Ac}	80.50 ± 0.00^{Ba}	78.06 ± 0.00^{Ab}	74.12 ± 0.00^{Bc}	81.26 ± 0.00^{Aa}
∑EFA	26.71 ± 0.06^{Bb}	19.35 ± 0.00^{Ac}	29.20 ± 0.00^{Ba}	26.90 ± 0.01^{Ab}	19.24 ± 0.00^{Bc}	29.47 ± 0.00^{Aa}
PUFA/SFA	1.00 ± 0.00^{Bb}	0.63 ± 0.00^{Bc}	1.13 ± 0.00^{Ba}	1.05 ± 0.00^{Ab}	0.64 ± 0.00^{Ac}	1.16 ± 0.00^{Aa}
18:0+18:1/16:0	2.10 ± 0.00^{Bc}	2.16 ± 0.00^{Ab}	2.60 ± 0.00^{Ba}	2.30 ± 0.00^{Ab}	2.13 ± 0.00^{Bc}	2.64 ± 0.00^{Aa}

The data are shown as mean ± standard deviation (n=3).
Lowercase letters within the same row indicate significant differences (p<0.05) among broiler, layer, and sonali for either breast or thigh meat.
Uppercase letters in the same row within the same breed indicate significant differences (p<0.05) among breast and thigh meat.
UFA, unsaturated Fatty Acids; MUFA, monounsaturated Fatty Acids; SFA, saturated fatty acids; UnFA, unknown Fatty Acids; DFA, desirable fatty acids (sum of MUFA+PUFA+C18:0); PUFA, polyunsaturated Fatty Acids; EFA, essential fatty acids (linoleic acid and linolenic acid).

Moreover, the meat from Sonali chickens boasted a remarkable abundance of DFA, significantly surpassing (p<0.05) the levels found in other chicken groups across both meat sections. Essential Fatty Acids (EFAs) are vital for humans, as our bodies cannot conjure them up on their own; they must be gathered through our die (Jayasena *et al*., 2013), Thus, the elevated EFA content in Sonali and broilers (Table 2) may entice health-conscious consumers, offering a nutritional allure. In this study, the PUFA/SFA ratio was also assessed. The PUFA/SFA ratio proved more favorable in Sonali chickens than in broilers and layers across both meat sections, painting a picture of nutritional superiority.

Mineral composition

Table 3 displays the mineral content found in the breast and thigh meat of broiler, layer, and Sonali chickens. In all breeds, the thigh meat contained notably greater ($p<0.05$) calcium compared to breast meat. The highest calcium (53.09 ± 0.46 mg) was exhibited in the thigh meat of Layers, whereas Sonali had the lowest (48.33 ± 0.62 mg). Broilers had the highest calcium content (44.12 ± 0.41 mg) in breast meat, whereas layers and Sonali showed similar levels. Across all breeds, breast meat boasts a significantly higher ($p<0.05$) magnesium content than thigh meat. Nonetheless, in the thigh meat of layers and Sonalia notable decrease in magnesium levels was observed. In broilers and Sonali, thigh meat had a higher level of sodium than breast meat, while the opposite pattern was seen in layers. In the present study, potassium and phosphorus were found at the highest concentrations, followed by sulfur. In all breeds, the potassium level was notably higher in the thigh meat, with layers exhibiting the greatest potassium concentration at 485 ± 3.00 mg. Broilers and Layers exhibited higher phosphorus levels in their breast meat (465 ± 9.64 mg and 457 ± 27.06 mg, respectively) compared to Sonali, which had 366 ± 5.57 mg. Although the phosphorus content in thigh meat was generally lower, it displayed a similar pattern. The sulfur levels in the breast and thigh meat of broilers and layers were statistically similar. However, Sonali's breast meat contained significantly less sulfur (137 ± 2.00 mg) than its thigh meat (178 ± 9.85 mg).

Table 3: Mineral content (mg/100 g dry weight) in the breast and thigh meat of broiler, layer, and sonali chickens

Mineral Composition	Brest Meat			Thigh meat		
	Broiler	Layer	Sonali	Broiler	Layer	Sonali
Calcium	44.12±0.41^{Ba}	39.81±0.25^{Bb}	39.72±0.39^{Bb}	51.37±0.63^{Ab}	53.09±0.46^{Aa}	48.33±0.62^{Ac}
Magnesium	75.02±0.75^{Aa}	74.46±0.39^{Aa}	76.04±0.96^{Aa}	73.39±0.52^{Ba}	56.11±1.54^{Bb}	58.13±1.18^{Bb}
Sodium	58±0.45^{Bb}	60.82±0.58^{Aa}	56.08±0.80^{Bc}	62.36±0.44^{Aa}	59.75±0.98^{Ab}	62.06±0.44^{Aa}
Potassium	410±5.57^{Bc}	472±6.24^{Ba}	443±6.93^{Bb}	467±5.57^{Aa}	485±3.00^{Aa}	476±11.27^{Aa}
Phosphorus	465±9.64^{Aa}	457±27.06^{Aa}	366±5.57^{Bb}	449±6.24^{Aa}	434±10.44^{Aa}	409±11.36^{Ab}
Sulphur	159±10.82^{Aa}	176±7.00^{Aa}	137±2.00^{Bb}	154±17.78^{Aa}	182±4.58^{Aa}	178±9.85^{Aa}

The data are shown as mean ± standard deviation (n=3).
Lowercase letters within the same row indicate significant differences ($p<0.05$) among broiler, layer, and sonali for either breast or thigh meat.
Uppercase letters in the same row within the same breed indicate significant differences ($p<0.05$) among breast and thigh meat.

DISCUSSION

The proximate composition revealed notable differences in breast and thigh muscles among broiler, layer, and Sonali chickens. In all breeds, thigh meat contained more moisture than breast meat, with broilers showing the highest moisture levels in both muscle types. The variations in muscle composition might be attributed to differences in environmental conditions and habitats (Chakma *et al.*, 2022). This research, recognized breast meat had notably higher protein content and lower lipid content, in contrast to thigh meat, which is marked by a significantly lower protein content and higher lipid content. (Lee *et al.*, 2023) have reported similar findings. This pattern is also explained by the increased storage of triglycerides in the thigh, leading to a higher crude lipid and a lower crude protein (Gong *et al.*, 2010) compared to the breast. The research also indicated that the layer exhibited a higher protein percentage than both broiler and sonali chickens. According to (Jaturasitha *et al.*, 2008) the crude protein content in Thai indigenous chickens ranged from 22.6% to 24.8%, which was notably higher. Meanwhile, (Sirri *et al.*, 2010) observed that the protein content in slow-growing chicken genotypes was 24.6%, slightly surpassing the earlier findings. Various factors such as species, gender, age, specific meat cut, and the method of carcass processing (Xiong *et al.*, 1993) can affect the chemical makeup of chicken meat.

In broiler, layer, and Sonali chicken meat, the main fatty acids identified were palmitic (C16:0), oleic (C18:1), and linoleic (C18:2: *n*-6) (Franco *et al.*, 2012), which together made up about 80% of the total fatty acids (Jayasena *et al.*, 2013), aligning with earlier research. This research found that layer meat has more saturated fat than broiler or Sonali meat in the breast and thigh areas. Bird's slaughter age might be a factor (Chen *et al.*, 2016). Sonali and broiler chickens are younger than layer chickens when slaughtered. This is why older birds have more fat than younger ones (Tůmová & Teimouri, 2010). Differences in fat and fatty acid levels might be due to genetics. According to (Tang *et al.*, 2009) genetics can affect fat more than slaughter age. In this study, monounsaturated fatty acids, which in chickens are linked to either internal synthesis or dietary intake (Dal Bosco *et al.*, 2022), were predominantly found in layers, with oleic and palmitoleic acid being the main MUFAs identified. The reduced levels of MUFA in Sonali chicken meat are likely due to the birds' increased feed consumption and unique intramuscular fat composition (Sirri *et al.*, 2011). This study discovered that the levels of polyunsaturated fatty acids (PUFA) in the breast and thigh meat of Sonali chickens were nearly identical. Similar PUFA concentrations in breast and thigh muscles were also noted in recent research on native Italian chicken breeds (Bongiorno *et al.*, 2022). Interestingly, *n-3* PUFA, particularly eicosapentaenoic acid (EPA), was found in chickens, though in minimal amounts. EPA is recognized for its role in preventing coronary heart disease and other worsening conditions associated with aging, as well as being essential for brain health. The health advantages of these fatty acids encompass immunomodulation (lowering of inflammatory markers), hypolipidemic effects (decreasing triglyceridemia), anti-inflammatory properties (improving endothelial function), and antithrombotic benefits (reducing platelet aggregation) (FAO, 2001). The research revealed that Sonali chicken breast and thigh meat contained higher levels of linoleic acid

(C18:2 *n-6*) compared to broiler and layer chicken meat. (Chen *et al*., 2016) found that Hy-Line laying hens have more linoleic acid in their breast and thigh muscles than Arbor Acres broilers. Earlier studies have emphasized the crucial roles of EFA and DFA in biological functions. Sonali chickens exhibited a greater percentage of DFA in breast (80.50±0.00) and thigh (81.26±0.00) compared to the other two breeds. According to (Rikimaru & Takahashi, 2010) DFA levels fall within this range. Essential fatty acids (EFAs) are important for humans because the body cannot make them (Jayasena *et al*., 2013). We must get them from the food we eat. Thus, the significantly elevated EFA content in Sonali and broilers emerges as a tantalizing nutritional gem for the discerning health enthusiast. In both meat sections, Sonali chickens outperformed broilers and layers regarding the ratio of PUFA/SFA. To significantly reduce the risk of cardiovascular disease, it is imperative to consume foods with a PUFA/SFA ratio of 0.45 or higher. (Banskalieva *et al*., 2000) noted that the 18:0+18:1/16:0 ratio can help understand the health effects of different fats. In this study, Sonali's results unequivocally highlight superior ratios in meat portions, specifically in the (18:0 +18:1/16:0) category, underscoring a significant advantage. Overall, these results suggest that the DFA composition of Sonali chickens is superior to that of broiler and layer chickens.

The mineral composition of muscle foods is profoundly shaped by a multitude of factors, each playing a crucial role in determining their nutritional value and quality. These factors include diet, species, breed, gender, age at slaughter, muscle types, health condition, and the production system. Additionally, post-mortem factors like analyzing methods and techniques for assessing the mineral content in meat samples also play a role (Domaradzki *et al*., 2016); (Tomović *et al*., 2016). According to (Falowo, 2021) chicken muscle contains between 17.8 and 31.5 mg/kg of calcium. In this research, the calcium content in the meat from broilers, layers, and Sonali was found to be slightly above the suggested range. (Beto, 2015) notes that the recommended daily intake of calcium is between 700 and 1300 mg. This increased level of calcium can supply about 3-5% of the daily calcium intake. In this study, potassium was found in the largest amount, followed by phosphorus. This observation matches with (Majewska *et al*., 2009), they found that chicken and ostrich meat mainly contain potassium and phosphorus. It is imperative to acknowledge that vegetables, fruits, and milk are not just dietary options; they are the cornerstone of potassium intake. As per the World Health Organization (WHO, 2012), adults are advised to consume between 3500 and 3510 mg of potassium daily to fulfill their nutritional needs. Nonetheless, the current findings reveal that 100 g of layer chicken thigh meat contributes almost 14% of the recommended daily potassium intake. Phosphorus is a vital mineral necessary for numerous biological functions, including the mineralization of bones, the production of energy in the form of adenosine triphosphate (ATP) and adenosine diphosphate (ADP), (Chen *et al*., 2016) metabolism, kidney operations, cell growth, cell signaling via phosphorylation reactions, and the maintenance of acid-base balance (Martínez-Ballesta *et al*., 2010) or adults, the recommended daily intake of phosphorus ranges from 800 to 1300 mg (Falowo, 2021). This study indicates that consuming 100 g of broiler chicken breast meat can supply approximately 35% of the daily potassium requirement.

CONCLUSIONS

Among the three types of chickens, the Layer has more protein and less fat in its breast than the broilers. Sonali breast meat exhibited higher protein and lower lipid levels, and a more auspicious fatty acid profile, characterized by increased amounts of unsaturated fatty acids (UFA), desirable fatty acids (DFA) and essential fatty acids (EFA), along with improved PUFA/SFA and (18:0 + 18:1)/16:0 ratios. Layer chickens had the highest potassium levels, while broiler breast and layer thigh meat contained the highest calcium. Sonali breast and layer thigh meat had lower sodium, and Sonali breast and broiler thigh had high magnesium content. The findings suggest that Sonali chicken meat is more nutritious and safer to consume compared to regular broilers and layers.

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CRediT authorship contribution statement

Conception and Design: S Debnath; **Analysis and Interpretation of Result:** S Debnath, M Mahmud, M Debnath; **Writing-original draft preparation:** S Debnath, M Mahmud, M Debnath; **Writing review and editing:** S Debnath. All authors have reviewed and given their approval to the final manuscript.

Data Availability

This article comprehensively presents all the necessary data

Conflict of interest

The authors confidently assert their impartiality, declaring that they have no conflicts of interest, which underscores the integrity and reliability of their research.

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