ORIGINAL PAPER

Variations in meat chemical composition of some captive avian species

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Key Message This study explores the potential of avian species for the production of quality food and it reports that the highest moisture contents (78.52%), crude protein contents (82.57%) and ash contents (5.34%) were recorded in the meat of the *M. gallopavo*.

ABSTRACT Increasing population of Pakistan puts a lot of pressure for more food production. Therefore, it is the need of the day to explore potential of avian species for the production of quality food and inclusion in existing meat resources. A study was conducted to analyze meat chemical composition of domestic pigeon (*Columba livia domestica*), wild pigeon (*Columba livia*), grey francolin (*Francolinus pondicerianus*), broiler chicken (*Gallus gallus domesticus*) and turkey (*Meleagris gallopavo*). During the investigation, interspecific variations in meat chemical composition were recorded. The highest moisture contents (78.52%), crude protein contents (82.57%) and ash contents (5.34%) were recorded in the meat of the *M. gallopavo*, while the highest fat contents (16.99%) were recorded in the meat samples of *C. livia domestica*. Monthly variations in chemical composition of meat were also recorded during this study. The highest moisture contents were recorded during the month of January, 2016 followed by February, 2016 and March, 2016. Similarly, the highest protein contents were observed during the month of March, 2016 followed by February, 2016 and January, 2016 months. The highest fat contents were recorded during March, 2016 followed by the months of February, 2016 and January, 2016. Maximum ash contents were observed during January, 2016 followed by the months of March, 2016 and February, 2016. It can be concluded from the present study that meat of the turkey, grey francolin and wild and domestic pigeons may also be utilized to fulfill the protein requirements and these species should be included into the existing poultry industry.

Keywords: Broiler chicken, Chemical composition, Pigeons, Protein content, Turkeys

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INTRODUCTION

Increasing human population demands more food sources, pressurizing poultry industry to enhance meat production. Furthermore, the consumers prefer organic food with quality nutrient profile, acceptable flavor and free from contaminants (Owens et al., 2006; Anjum et al., 2016). Meat of the animals is important components of human nutrition due to their nutritive values and these values are measured in terms of availability of quality proteins, carbohydrates, minerals, fats and fatty acids (Pearson & Gillet, 1996). The tissue and dietary proteins consist of two groups of amino acids, the essential amino acids and the non-essential amino acids. From the total 20 food amino acids, 10 are essential for infants and 8 for adults. Poultry meat is a source of quality protein and preferred by the consumers due to a number of attributes including easy to cook, nutritious, possessing organoleptic properties, high protein contents, low calories and enriched with essential amino acids necessary for the human health and growth (Panda, 1995). The characteristics of meat vary with species and are also influenced by the factors such as gender, diet and age of the animals

(Colmenero et al., 2001; Rule et al., 2002; Insausti et al., 2004; Leosdottir et al., 2005; Hoffman & Wiklund, 2006; Krystallis & Arvanitoyannis, 2006).

Meat of the pigeon is highly digestible and contains low fat contents than the meat of many other species (Gontariu & Buculei, 2009). Pigeons are effectively reared and used for sports, ornamentals, experimental purposes and for the production of meat (Rahman & Khatun, 1999). Bhuyan et al. (1999) documented that meat of the pigeon contains high protein and other nutrients than that of chicken meat. Moreover, the pigeons are mostly used for ceremonial purposes rather to meet protein requirements (Parkhurst & Mountuey, 2004). Demand for turkey meat is also increasing due to low fat and high protein contents. In addition, the meat of the turkey is categorized due to high mineral profile (Ribarski et al., 2001). Chemical composition of partridge meat shows that it contains 55.9-62.4% moisture, 25.2-29.1% protein, 1.6-5.6% lipids, 1.2-1.4% ashes and 70-234 mg/100g cholesterol showing its potential for production of special meat (Moro et al., 2006).

While considering health with growing human population, this is of utmost important to have knowledge about the foods of animal origin/sources providing good quality and quantity of nutrients specifically in terms of proteins and energy. Regarding it, special attention was given towards diversified avian breeds for the production of meat. So, more species have been added in the existing poultry industry like quail, turkey and ostrich. Therefore, meat is becoming popular among locales in Pakistan. Present study was therefore planned to find out monthly variations in meat chemical composition of some avian species along with finding out its nutritional value, as this is directly related with health.

MATERIALS AND METHODS

This study was conducted at Avian Conservation and Research Center, Ravi Campus, University of Veterinary and Animal Sciences, Lahore during January-March, 2016. Size of sample (n = 5) for each bird i.e. domestic pigeon (*Columba livia domestica*), wild pigeon (*Columba livia*), grey francolin (*Francolinus pondicerianus*), broiler chicken (*Gallus gallus domesticus*) and turkey (*Meleagris gallopavo*) was taken to study their chemical composition. Month wise variations in chemical composition of domestic and wild were also recorded from January, 2016 through March, 2016. The birds were cared and grown in controlled conditions closed to natural conditions for experiment purpose. The meat was taken from breast and thigh parts of birds for chemical analyses.

Determination of moisture contents and dry matter

Moisture contents and dry matter were determined through loss in meat weight on drying. The meat sample (5 g) was placed in cleaned and dried petri-dish. It was then oven dried at 103 ˚C for 24 h. After cooling in desiccator, petri-dish was weighed again and moisture (%) contents and dry matter were recorded using following formulae;

$$\text{Moisture contents (\%)} = \frac{\text{Wet weight of sample (W1)} - \text{dry weightof sample (W3)}}{\text{Weight of the sample (W2)}} \times 100$$

$$\text{Dry matter} = 100 - \text{Moisture \%}$$

Determination of crude protein

Meat sample (1 g) was taken in a Kjeldahl digestion flask (500 ml), 5 g digestion mixture (K_2SO_4 and $CuSO_4$) and 20 ml H_2SO_4 were then added into it. It was heated until the appearance of light green color. The mixture was cooled and 250 ml of sample was prepared using distilled water. After that, solution (10 ml) was taken and 10 ml NaOH solution (40% w/v) was added into it. Liberated ammonia was then collected in 10 ml of 0.01 N H_2SO_4 with 1 drop of methyl red as an indicator. The sample was titrated again with 0.01 N NaOH until light blue color appears.

Crude protein (%) was determined using the formula:

$$\text{Crude Protein (\%)} = \frac{V \times 0.00014 \times D \times 100 \times 6.25}{w \times A}$$

Where

"V" is volume of N/10 H_2SO_4 used; "0.00014" is nitrogen conversion factor; "D" is the quantity of digested and diluted sample; "100" is to get %age; "6.25" is to convert %age of nitrogen into crude protein; "6.25" is nitrogen % on dry matter basis; "w" is sample weight in grams; "A" is weight of diluted and digested sample

Determination of crude fat

Meat sample (3 g) was taken into a filter paper pouch, prepared through Whatman filter paper and the pouch was weighed. Soxhlet's apparatus was used to extract fats using petroleum benzene at temperature of 60-80 ºC. The extraction continued for 3-4 hours, the sample was then dried at 100 ºC for 30 min. It was the cooled and final weight of the pouch that was recorded. Fat contents (%) were recorded using following formula:

$$\text{Fat contents mg/100g of dried sample} = Wi - Wf$$

$$\text{Fat contents (\%)} = \frac{\text{Weight of fat (g)}}{\text{Weight of sample (g)}} \times 100$$

Where

"Wi" is initial weight of sample (Before extract) and "Wf" is final weight of sample (After extract)

Determination of ash contents

Dried meat sample (2 g) was taken into the crucible. The crucible was then transferred to the muffle furnace and heated for 4-6 h. It was then cooled through desiccator and weighed. Ash contents (%) were recorded using following formula:

$$\text{Ash contents (\%)} = \frac{\text{Ash weight}}{\text{Sample weight}} \times 100$$

Statistical analysis

Meat chemical composition of domestic pigeon, wild pigeon, grey francolin, broiler chicken and turkey was recorded and DMRT was employed at 0.05 probability level to compare their mean values using statistical software SAS 9.1.

RESULTS AND DISCUSSION

During present investigation, average moisture contents from domestic and wild pigeons were recorded 68.73 ± 0.99% and 70.70 ± 0.67%, respectively. Protein contents of domestic pigeons were analyzed 69.41 ± 0.54%, while the same were recorded 74.65 ± 0.54% for wild pigeons on dry matter basis. The fat contents for domestic and wild pigeons were recorded as 16.99 ± 0.56% and 15.04 ± 0.83%, respectively. Ash contents of domestic and wild pigeons were recorded as 4.20 ± 0.34% and 4.47 ± 0.31%, respectively (Table 1). Apata et al. (2015) reported that fresh meat of the pigeon contains 67.20% moisture, 20.40% protein, 9.31% fat and 2.05% ash contents. The genetics, type of strain and environmental factors influence chemical composition of muscle fiber and aid in determining the quality of the meat (Listrat et al., 2016). High moisture contents 69.86% were recorded from domestic pigeon meat during January, 2016 followed by the months of February, 2016 and March, 2016. Similarly, high protein contents (70%) were recorded during the month of January, 2016 followed by February, 2016 and March, 2016. High fat contents (17.53%) were recorded during March, 2016 followed by the months of February, 2016 and January, 2016. Ash contents were high (4.56%) during January, 2016 followed by February, 2016 and March, 2016 (Fig. 1). High moisture contents (71.27%) were recorded from the meat samples of wild pigeons during the month of January, 2016 followed by the months of February, 2016 and March, 2016. The highest protein contents (75.22%) were recorded during the month of February, 2016 followed by January, 2016 and March, 2016. The highest fat contents (15.72%) were recorded during the month of March, 2016 followed by February, 2016 and January, 2016. Similarly, high ash contents (4.76%) were recorded in the month of January, 2016 followed by February, 2016 and March, 2016, respectively (Fig. 2). Unified meat with better water holding capacity determines the quality of the meat

(Picard et al., 2012), which in turn is affected by many factors including species, genotypes, nutrition and slaughtering and processing conditions. These factors also influence structure and chemical composition of the meat traits and intramuscular biological properties (Gagaoua et al., 2015).

During present study, average moisture contents (72.85 ± 0.67%) and crude protein (83.68 ± 0.52%) were recorded from the meat of grey francolin on dry matter basis. Similarly, fat contents (4.75 ± 0.27%) and ash contents (4.06 ± 0.10%) were recorded on dry matter basis in the meat of grey francolin (Table 1). Similar results were reported by Calik et al. (2015) who documented moisture contents (73.06%), crude protein (24.87%), fat contents 1.48% and ash contents 1.09% on wet basis. Monthly variations in chemical composition of meat of grey francolin were also observed during present experiment (Fig. 3). The highest moisture contents (73.51%) were recorded during the month of January, 2016 followed by February, 2016 and March, 2016. Similarly, the highest protein contents (84.17%) were observed from meat of *F. pondicerianus* during the month of March, 2016 followed by February, 2016 and January, 2016. The highest fat contents (5.05%) were recorded during March, 2016 followed by the months of February, 2016 and January, 2016. Maximum ash contents (4.16%) were observed during January, 2016 followed by the months of March, 2016 and February, 2016.

Average moisture contents (75.43 ± 1.12%) of broiler chicken were recorded during present study. Protein contents of broiler chicken were 79.98 ± 0.69% on dry matter basis, while fat contents (4.50 ± 0.57%) and ash contents (5.12 ± 0.13%) were recorded on dry matter basis (Table 1). Similar results were reported by Ali et al. (2007) who documented 75.47% moisture contents, 22.04% protein contents, 1.05% fat contents and 1.07% ash contents from the meat of broiler chicken on wet basis. Month-wise variations in meat chemical composition of chicken broiler were also recorded. In January 2016, the moisture contents (76.17%) were recorded higher than that of February, 2016 and March, 2016. Similarly, crude protein contents (80.72%) were also higher in January, 2016 than that of February, 2016 and March, 2016. In March, 2016 fat contents (5.07%) were higher as compared to February, 2016 and January, 2016. Similarly, ash contents (5.26%) were also higher in March, 2016 as compared to January, 2016 and February, 2016 (Fig. 4).

During present experiment, moisture contents of turkey meat were recorded as 78.52 ± 0.67%, protein contents 82.57 ± 0.57%, fat contents 2.75 ± 0.27% and ash contents 5.34 ± 0.22% on dry matter basis (Table 1). These findings are in line with Karakok et al. (2010) who reported that turkey meat contains moisture contents 73.12%, protein contents 24.38%, fat contents 1.19% and ash contents 1.43% on wet basis. Chemical variations in turkey meat from January, 2016 through March, 2016 were also observed during present experiment. The highest moisture contents (79%) were observed during January, 2016 followed by the month of March, 2016 and February, 2016. Protein contents were recorded maximum as 83.19% during January, 2016 followed by the months of February, 2016 and January, 2016. The maximum fat contents (3.03%) were recorded during March, 2016 followed by the months of February, 2016 and March, 2016, respectively. The maximum ash contents (5.57%) were recorded during the month of January, 2016 followed by February, 2016 and March, 2016 (Fig. 5).

Species-wise variations in chemical composition of meat were observed during present study. Moisture content varied significantly ($p<0.05$) between meat of domestic pigeon, wild pigeon, grey francolin, chicken broiler and turkeys. Significantly ($p<0.05$) higher moisture contents were recorded in turkey meat (Table 1). Omojola and Adesehinwa (2006) documented that low moisture ($p<0.05$) contents could be due to singeing operation. Apata et al. (2012) documented significantly higher ($p<0.05$) moisture and protein contents from stewed meat followed by roasted and fried meat.

Significant differences in protein contents of meat were recorded for meat of domestic pigeon, wild pigeon, grey francolin, chicken broiler and turkey (Table 1). Ali et al. (2007) reported significant ($p<0.05$) differences in crude protein, fat and total ash contents between the breast meat samples from the chicken. Crude protein and ash contents were significantly higher in chicken breast. Herkel (2016) reported significant ($p<0.05$) differences in crude protein and fat contents in pectoral muscles of turkey.

Fat contents of meat also varied significantly between domestic pigeon, wild pigeon and turkeys, while non-significant variations in fat contents were recorded between grey francolin and chicken broilers. Significantly higher ($p<0.05$) fat contents were recorded from meat of domestic pigeon, while the same were the lowest in meat of turkeys (Table 1). Omojola and Adesehinwa (2006) reported that significantly lower

($p<0.05$) fat contents from skinned carcass and it might be attributed to the removal of the skin with some of the under laying fat.

Non-significant variations in ash contents were observed between chicken and turkey meat however; turkey meat possessed slightly higher ash contents. Similarly, non-significant variations in ash contents were recorded for meat sample of domestic pigeon, wild pigeon and grey francolin (Table 1). Ali et al. (2007) recorded significantly higher ash contents from chicken breast as compared to the leg meat.

Table 1 Variations in chemical composition of meat of some captive avian species

Animal species	Moisture contents (%)	Crude protein contents (%)	Fat contents (%)	Ash contents (%)
Domestic pigeon	68.73 ± 0.99^{e}	69.41 ± 0.54^{e}	16.99 ± 0.56^{a}	4.20 ± 0.34^{b}
Wild pigeon	70.70 ± 0.67^{d}	74.65 ± 0.54^{d}	15.04 ± 0.83^{b}	4.47 ± 0.31^{b}
Grey francolin	72.85 ± 0.67^{c}	83.68 ± 0.52^{c}	4.75 ± 0.27^{d}	4.06 ± 0.10^{b}
Chicken broiler	75.43 ± 1.12^{b}	79.98 ± 0.69^{b}	4.50 ± 0.57^{d}	5.12 ± 0.13^{a}
Turkey	78.52 ± 0.67^{a}	82.57 ± 0.57^{a}	2.75 ± 0.27^{e}	5.34 ± 0.22^{a}

Means with different letters in a column are statistically significant $p<0.05$. DMRT was employed at 0.05 probability level. The values after ± demonstrate standard deviation.

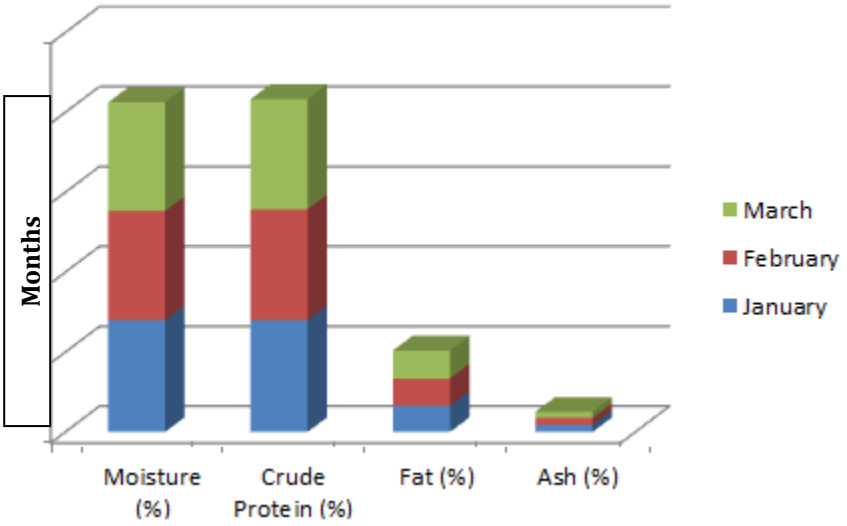

Fig. 1 Monthly variations in chemical composition of domestic pigeon meat

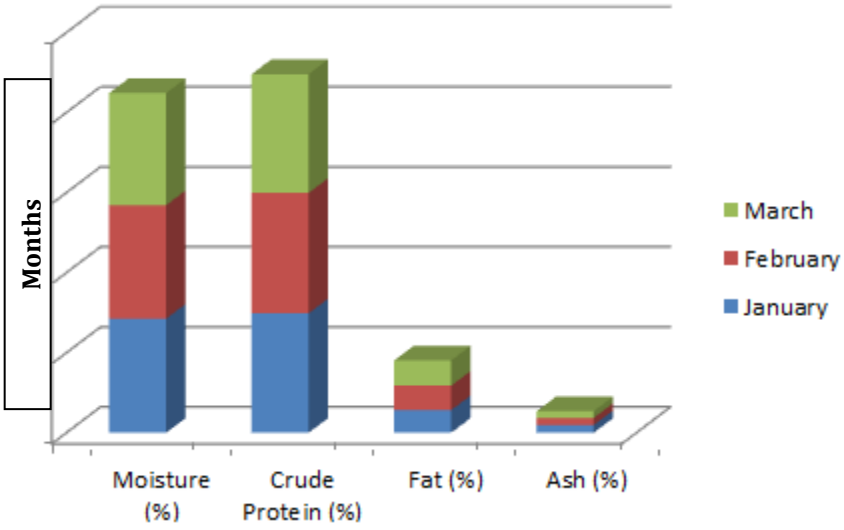

Fig. 2 Monthly variations in chemical composition of wild pigeon meat

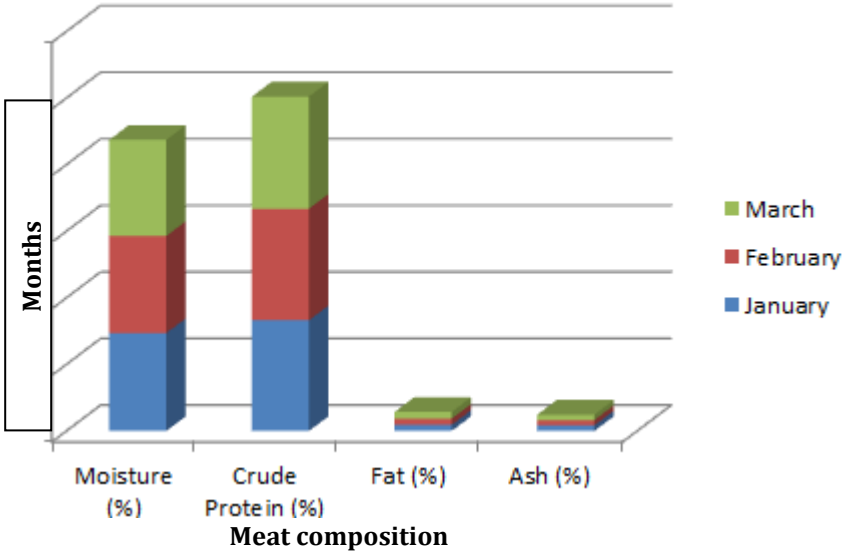

Fig. 3 Monthly variations in chemical composition of grey francolin meat

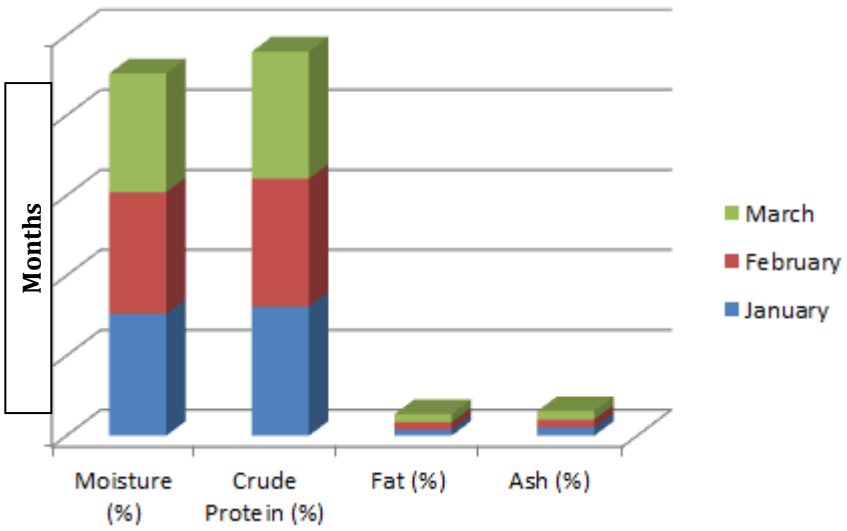

Fig. 4 Monthly variations in chemical composition of chicken broiler meat

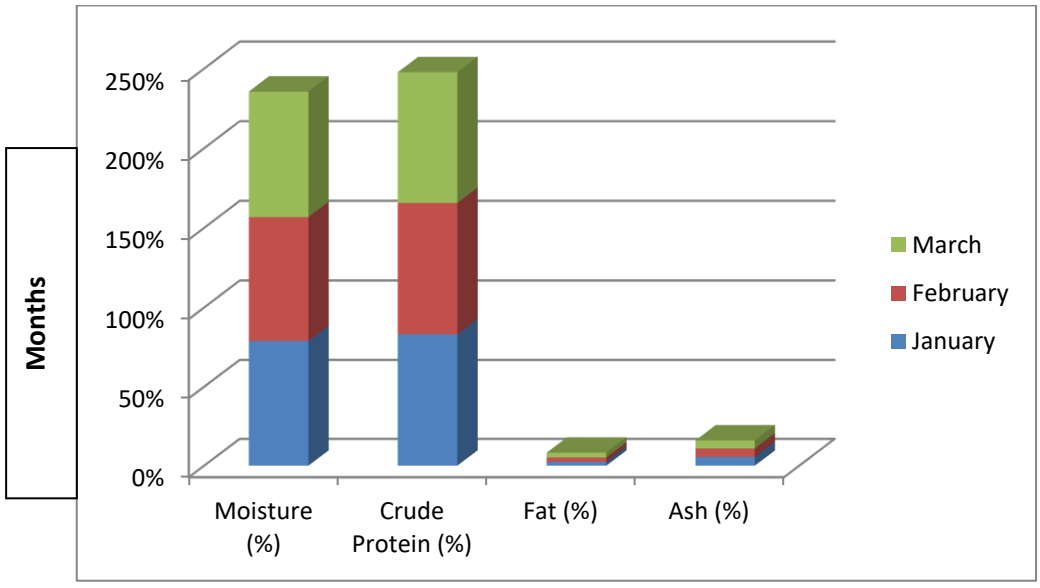

Fig. 5 Monthly variations in chemical composition of Turkey meat

CONCLUSION

It can be concluded from the present study that turkey meat contains higher moisture, protein and ash contents and lower fat contents than that of domestic pigeon, wild pigeon, grey francolin and chicken.

Authors Contribution Statement Shahid Javaid planned the experiment and refined the manuscript. Arshad Javid helped in statistical analysis of collected data. Umar Farooq collected data and executed the experiment. Ujala Kiran assisted in analysis and lab work. Tabinda Akmal helped in collection of data and rearing the birds.

Conflict of Interest The authors have mentioned no conflict of interest.

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