Comparative study of growth performance, meat quality and haematological parameters of Fayoumi, Rhode Island Red and their reciprocal crossbred chickens

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Abstract

A total of 2001 unsexed day-old-chicks of each Fayoumi, Rhode Island Red (RIR), RIR × Fayoumi (RIFI) and Fayoumi × RIR (FIRI) were obtained from hatchery of Poultry Research Institute, Rawalpindi. The birds were maintained on deep litter system for a period of 20 weeks. The results revealed that the average day old weight was highest in RIR and FIRI, intermediate in RIFI and lowest in Fayoumi chickens. The RIR breed consumed more feed and gained maximum (P<0.05) weight gain than those of Fayoumi and crossbred chickens at all ages of growing phase. The poor (P<0.05) feed conversion was observed in Fayoumi and better feed conversion was recorded in RIR and both crossbred chickens. The crossbred chickens had lowest (P<0.05) mortality than purebred chickens. The highest dressing percentage was observed in FIRI (62.60%) followed by RIFI (62.40%), RIR (57.50) and Fayoumi (54.08) chickens. The breast and thigh meat composition had non-significant (P>0.05) difference among pure and crossbred chickens. There was non-significant (P>0.05) difference in haematological values among all chickens. The total erythrocyte number, haemoglobin and packed cell volume increased with the advancement of age. However, erythrocyte sedimentation rate, mean corpuscular volume and mean corpuscular haemoglobin values decreased gradually with the advancement of age. It may be concluded that crossbred chickens gained better body weight than Fayoumi and moderate than RIR chickens with lower mortality. The crossbred chickens of FIRI showed better performance in all traits than crossbred chickens of RIFI.

Introduction

Genetic progress can be attained either by selection or crossbreeding (Adebambo et al., 2011). Crossbreeding of the indigenous stock with exotic commercial birds will take advantage of artificial selection for productivity in the exotic birds and natural selection for hardiness in the indigenous birds. A crossbreeding could lead to production of birds that will be better in growth rate, efficiency of feed conversion and reproductive traits without sacrificing adaptation to the local environment, thereby resulting in reduced cost of production (Adebambo et al., 2011). The outcome of cross-breeding is due to the phenomenon of heterosis, which is expressed in the performance of the hybrids. Since heterosis is almost exclusively the aggregate of all single locus dominance effects, and as these are usually positive or beneficial, heterosis can be expected to be usually in the favourable direction (Kitalyi, 1998). To utilize the good adaptive characteristics of the indigenous chickens and possibly exploit the phenomenon of heterosis, Olayemi et al. (1979) proposed that crossbreeding programmes including upgrading local chickens with suitable exotic stocks would be more appreciable. A study by Njenga (2005) revealed that the crossbred offspring of Rhode Island Red and Fayoumi had the best level of body weight and highest cost-benefit ratio with low mortality among four different breeds under a semi-scavenging system of production in Kenya. The genetic potential of the indigenous chickens could be improved by crossing them with selected but still robust exotic breeds (Guéye, 1998).

In a crossbreeding study in Pakistan, Yaqoob (1970) developed a rural poultry breed known as Lyallpur Silver Black (LSB). He used four breeds viz., Desi, New Hampshire, White Leghorn and White Cornish and a four-way crosses method was applied to produce this breed. The LSB was claimed to be superior to Desi fowl in all the economic traits, i.e. matured 32 days earlier and laid 77 more eggs/ hen/year. A selection of Desi chickens was undertaken by Safalah (2001) in which he crossed Austrailan males with indigenous female chickens in Malawi. The progeny of the cross gained higher body weight, fertility rate (77% vs 91%), hatchability (84 vs 92%) and early sexual maturity (158 days vs 153 days). The above cited evidence has provided some base line information which is very useful for future cross breeding work.

Two breeds of exotic chickens [Rhode Island Red (RIR) and Fayoumi] were imported to Pakistan since the 1980s (Sahota and Bhatti, 2003). The Fayoumi breed as the rural poultry flock is surviving normally with the farmers as a scavenger bird but Fayoumi is a small sized bird, lays smaller eggs, low carcass yield and hence low economic return (Rajput et al., 2005). On the contrary, Rhode Island Red, which is successfully maintained under rural as well as farming conditions in different parts of the country and have potentials of a higher economic return as layers and / or broilers (Javed et al., 2003). The high egg and meat production genes, present in RIR, can possibly be transferred to Fayoumi, which already has genes for survival under harsh scavenging conditions of countryside, so as to produce a breed having higher survival and better economic returns. Exotic breeds like RIR and Fayoumi, which are typically used for cross-breeding, were imported into Pakistan many decades ago. So the purity of such imported breeds is doubtful and continuous inbreeding may now have caused them to be less productive. Genetic improvement of important economic traits would increase the production efficiency of native fowl and profitability of these birds. The body weight at 8 weeks of age is the most important trait for improving the economic efficiency of native fowl (Kiani- manesh, 2000). The information on growth pattern in chickens of reciprocal crossing between RIR and Fayoumi breeds are lacking. Likewise, the literature on haematological val-
ues of RIR, Fayoumi and their reciprocal crossbred chickens is also limited. Therefore, the present study was designed to develop a rural breed resulting in reciprocal crossing between RIR and Fayoumi breeds with better body weight and feed conversion efficiency and also compare haematological parameters.

Materials and methods

Birds and experimental feed

A total of 2001 unsexed day-old-chicks of each Fayoumi, Rhode Island Red and their reciprocal crossbred (RIR male × Fayoumi female: RIFI; and Fayoumi male × RIR female: FIRI) were obtained from hatchery of Poultry Research Institute, Rawalpindi, Pakistan. The chickens of each breed were divided into 3 groups as replicates under the completely randomized design, so that there were 667 chickens in each replicate. The stocking density was 15 birds/m² (Thiele, 2007). All of the chicks were reared under standard temperatures that were controlled by gas heaters (33-35°C at chick level for 1 wk, followed by a reduction of 3°C/wk until the temperature reached 18-20°C at 6 wk of age). Artificial light was only provided during the first week (23 h light:1 h dark). The birds were maintained in floor pens on deep litter system for a period of 20 weeks. Chicks were fed standard chick starter diets containing 18% crude protein (CP), 2800 kcal of metabolizable energy (ME)/kg, 1% calcium (Ca) and 0.56% available phosphorus (P) up to 8 wks of age; and chick rearing diets containing 17% CP, 2800 kcal of ME/kg, 2.5% Ca and 0.51% available P up to 20 wks of age. Nutrient content of the feed (Table 1) followed recommendations of the NRC (1994). Feed and water were supplied for ad libitum consumption. All chicks were vaccinated following a program typical of the region. Care and management of the birds followed accepted guidelines (FASS, 2010).

Parameters measured

The growth performance data (initial body weight, final body weight, feed intake, and feed conversion) were recorded at 14-d intervals. Mortality was also recorded in different regimens over the brooding and rearing periods. Records of the feed intake were taken on bi-weekly basis. Birds were checked twice daily; weight of dead birds was used to adjust for feed consumption. Feed conversion was calculated as the ratio of grams of feed to grams of weight gain. At the age of 20 weeks, five birds from each replicate were slaughtered to obtain their dressing percentage. The meat samples from breast and thighs of different birds of each breed were also taken, dried, ground and then subjected to proximate analysis such as percentage moisture, dry matter, crude protein, fat and total ash. Samples were analyzed using standard methods (AOAC, 2011).

Blood samples were collected from 20 birds of each type of chickens at 4, 12 and 20 weeks of age and analyzed for the estimation of red blood cell (RBC) count, packed cell volume (PCV), haemoglobin (Hb) concentration, and white blood cell (WBC) count. Differential WBC counts were made on monolayer blood films, fixed and stained with Giemsa-Wright’s stain. Total RBC and total WBC count were measured by a standard manual technique using microhaematocrit capillary tubes centrifuged at 2500 rpm for 5 min. Haemoglobin concentration was measured by Cyanamethemoglobin method. Erythrocyte indices [mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentrations (MCHC)] were calculated from total red blood cell, PCV and Hb (Ritchie et al., 1994), respectively.

Results and discussion

Performance during growing phase

The growth performance and mortality of RIR, Fayoumi and crossbred chickens during growing phase is shown in Table 2. The average day old weight was highest in RIR and FIRI, intermediate in RIFI and lowest in Fayoumi. The results are in line with findings of Farooq et al. (2001), who reported higher day-old chick weight in RIR (35.32±0.86 g) and lower in Fayoumi chickens (30.74±0.72 g). Moreover, Mostageer et al. (1975) observed that live weight at hatching averaged 28.5 g for the Fayoumi and 34.5 g for the RIR, with no

Table 1. Ingredients and nutrients composition of diets fed to experimental birds.

| Ingredients, % | Week 1-8 | Week 9-20 |
|----------------|----------|----------|
| Corn           | 35.60    | 42.00    |
| Rice           | 23.00    | 12.00    |
| Rice polish    | 10.00    | 9.68     |
| Soyabean meal  | 10.00    | 16.00    |
| Canola meal    | 8.00     | 6.40     |
| Corn gluten meal (60%) | 5.00 | 5.00 |
| Fish meal      | 5.00     | 5.00     |
| Limestone      | 1.50     | 2.00     |
| DCP            | 1.25     | 1.50     |
| NaCl           | 0.33     | 0.27     |
| Premix°        | 0.25     | 0.30     |
| DL-methionine  | 0.07     | 0.05     |
| Total          | 100.00   | 100.00   |

Calculated nutrients

| Metabolizable energy, kcal/kg | 2800 | 2800 |
|-------------------------------|------|------|
| Crude protein, %              | 18.5 | 17.0 |
| Crude fat, %                  | 3.80 | 4.30 |
| Ether extract, %              | 3.31 | 3.30 |
| Calcium, %                    | 1.0  | 2.5  |
| Available phosphorus, %       | 0.56 | 0.51 |
| Lysine, %                     | 1.00 | 0.69 |
| Methionine, %                 | 0.43 | 0.31 |

DCP: dicalcium phosphate; °supplied per kg of diet: vitamin A, 12,000 UI; vitamin D₃, 2200 UI; vitamin E, 10 mg; vitamin K₂, 2 mg; vitamin B₁, 1 mg; vitamin B₂, 5 mg; vitamin B₆, 1.5 mg; vitamin B₉, 0.01 mg; nicotinic acid, 30 mg; folacin acid, 1 mg; pantothenic acid, 10 mg; biotin, 0.05 mg; choline chloride, 500 mg; copper, 10 mg; iron, 30 mg; manganese, 60 mg; zinc, 50 mg; iodine, 1 mg; selenium, 0.1 mg; cobalt, 0.1 mg.
significant sex difference for the 2 breeds, respectively. The values of day-old weight of breeds in the above studies were higher than the present findings. Similarly, Malago and Baitiwake (2009) also reported that the higher mean weight of newborn chick was recorded in RIR (30.12 g) than local Tanzanian (23.71 g) and crossbred chickens (28.54 g). In the current study, the higher weight of newborn chick of RIR could probably be due to larger egg weight and size than Fayoumi and crossbred chickens. Farooq et al. (2001) also reported positive correlation ($r=0.4962$) of egg weight with hatching chick weight in RIR and scavenger Desi and Fayoumi chickens in Pakistan. Similarly, Narkhede et al. (1981) reported a positive correlation ($r=0.93$) of egg weight with hatching chick weight in crossbred chickens (RIR × WLH).

Rhode Island Red breed consumed more feed and gained maximum (P<0.05) weight than those of Fayoumi and crossbred chickens at all ages of growing phase, which could be explained by the variation of genotype. The body weight gain and feed intake of FIRI chickens are higher than the RIFI crossbred chickens. The lowest body weight gain was recorded in Fayoumi chickens during growing phase. The poor (P<0.05) feed conversion was also observed in Fayoumi chickens and better feed utilization, its requiring 255 g more feed per kg body weight than the WLH and RIR. The difference in growth rate of chickens is due to interplay of multiple genes and this trait could be improved through intensive genetic selection (Chambers, 1990).

In the present study, crossbred chickens were heavier at 20 wks of age than chickens of Fayoumi breed. Heterosis found in bodyweight at the age of sexual maturity reported by Kicka et al. (1978) who observed that body weight at sexual maturity of Fayoumi, RIR and Fayoumi × RIR were 1170, 1250, 1290 g, respectively. The body weight of RIR, RIR × local breed and local breed as reported by Azizul and Reza (1980) were 1320, 1216 and 1010 g, respectively. Crossbred progeny out of Fayoumi × Light Sussex and Fayoumi × RIR were superior to pure Fayoumi (Ragob et al., 1957). Bekele et al. (2010) found that Naked Neck × Fayoumi cross chicks weighed more and grew faster than local Netch × RIR chicks during the brooding period, the difference became insignificant as they grew older. However, the higher overall average body weight gain of local Netch × RIR crosses that was observed was mainly due to higher weight gain for the local cocks. The crossbreds from Bovan Brown × local chickens in Uganda were superior to local chickens in terms of daily gain to the superiority decreased gradually to zero at 6 months of age in case of Bovan crosses (Sorensen and Ssewanyana, 2003). Mondal et al. (2007) reported that among the three genetic groups Kadaknath × Brown Cornish attained maximum body weight (1025 g) at the 16th wk, followed by Aseel × Brown Cornish and minimum in Kadaknath × RIR (762 g). In all the crosses there was an average weekly body weight gain of about 100-125 g/week after the 4th week onwards. They concluded that Aseel × Brown Cornish group performed better for meat production. Chatterjee et al. (2007) reported that the body weight of reciprocal crosses of Brown Nicobar fowl with IIL-80 (White Leghorn) at

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**Table 2. Comparative growth performance of Fayoumi, Rhode Island Red and reciprocal crossbred chickens during brooding and growing periods (up to 20 weeks).**

| Parameters               | Age, weeks | RIR        | Fayoumi     | RIFI       | FIFI       | SEM      | P       |
|--------------------------|------------|------------|-------------|------------|------------|----------|---------|
| Day-old weight, g/bird   | -          | 31.30±0.38a| 20.90±0.25c| 25.24±0.28b| 30.00±0.23a| <0.010   |         |
| Body weight, g           | 0-8        | 514.60     | 385.00      | 487.96     | 521.52     | -        | -       |
|                          | 9-20       | 1125.40    | 781.66      | 692.04     | 739.00     | -        | -       |
|                          | 0-20       | 1640.00    | 1166.60     | 1213.12    | 1260.00    | -        | -       |
| Body weight gain, g/bird | 0-8        | 483.30±4.30a| 364.10±4.24c| 462.56±4.26b| 491.52±4.48c| 17.4     | <0.000  |
|                          | 9-20       | 642.10±3.08a| 417.56±3.58d| 666.80±6.31b| 708.48±2.30a| 21.5     | <0.000  |
|                          | 0-20       | 1608.00±4.36a| 1145.70±3.59c| 1188.00±4.10b| 1230.00±4.15a| 32.0     | <0.000  |
| Average feed, g/bird     | 0-8        | 3320+7.64a | 2210±10.41c | 2164.78±9.30b| 2555.90±10.57a| 60.3     | <0.000  |
|                          | 9-20       | 4440±7.63a | 2700±10.40c | 2533.84±10.67b| 2302.56±10.10c| 65.09    | <0.000  |
|                          | 0-20       | 7620±300.45a| 6720±273.66b| 5080.94±151.24c| 5596.50±161.28b| 72.0     | <0.004  |
| Feed conversion           | 0-8        | 6.45±0.17a | 5.75±0.14a | 4.88±0.11a | 5.29±0.10c | 0.55     | <0.015  |
|                          | 9-20       | 3.95±0.29a | 3.50±0.14ab | 3.80±0.12ab | 3.25±0.15b | 0.40     | <0.003  |
|                          | 0-20       | 4.64±0.36a | 5.76±0.14a | 4.40±0.20b | 4.55±0.14b | 0.43     | <0.030  |
| Mortality, %             | 0-8        | 12.00±0.25a| 9.00±0.14a | 7.30±0.21a | 7.10±0.19c | 0.70     | <0.000  |
|                          | 9-20       | 6.00±0.22a | 4.00±0.22b | 2.80±0.23a | 2.69±0.13c | 0.30     | <0.000  |
|                          | 0-20       | 20.00±0.28a| 12.00±0.28b | 10.04±0.25b| 9.80±0.22c | 0.80     | <0.000  |
| Dressing, %              | 20         | 57.5±0.28a | 54.08±0.28a | 62.40±0.28b| 62.60±0.28a| 2.75     | <0.030  |

*a-Means with different letters differ significantly (P<0.05); RIR, Rhode Island Red; RIFI, RIR male × Fayoumi female; FIFI, Fayoumi male × RIR female. Data are expressed as mean ± standard error.*
different ages were much higher than pure Nicobar fowl under both backyard and intensive management systems. Moreover, the average live weight of the male progeny of the cross of the Brown Nicobar (M) × ILI-80 (F) was significantly (P<0.05) higher than the male progeny of the cross of ILI-80 (M) × Brown Nicobar (F) at 24 weeks of age. Body weight gain of crossbred chickens in this study is higher (491.52 g for FIRI and 462.56 g for RIFI) at the 8th wk than the findings shown by El-Maghraby et al. (1975), who found body weight of birds at same age was 316 g for FIRI and 299 g for RIFI. In the present study, the difference for body weight between Fayoumi and crossbred FIRI was 7.4% at 20 wks of age, which is higher than Kicha et al. (1978) who got 6.8% difference in body weight of FIRI at the age of sexual maturity. These differences in body weight could also be attributed to the environmental conditions such as seasons, temperature, humidity and management.

During the period of the 9-20 weeks feed conversion of birds seems to be better than the period of the 0-8 weeks. A probable explanation is that with the increase of the age of the birds, their activity (movement) and making voice loudly also increase, which require more maintenance energy. Due to that birds may utilize the feed more efficiently. Haque et al. (1999) found that feed conversion ratio 5.7 and 4.9 for Fayoumi and RIR respectively in a group of 3 male and 20 females during the week 6 to 17 wks which is similar in the present study. They also reported that the indigenous naked neck (D. Nana) X RIR showed the better growth than pure breed Fayoumi.

The results showed that crossbred chickens had lowest (P<0.05) mortality than pure bred chickens. The highest mortality was recorded in RIR followed by Fayoumi chickens. In this study, the mortality during the rearing period was higher than growing period in all types of chickens; thus further managerial practice improvement is necessary to reduce the mortality among the chicks regarding the fact that no particular infectious disease was reported during the experimental period. Livability is a composite character which concerns the question of the adaptive value for the organism. Furthermore, it relates to all physiological steps

| Parameters                      | RIR     | Fayoumi | RIFI   | FIRI   |
|---------------------------------|---------|---------|--------|--------|
| Total erythrocyte count, 10⁶/mm³| 1.76±0.27 | 2.05±0.06 | 2.00±0.15 | 1.90±0.05 |
| Haemoglobin concentration, g/dL  | 8.00±0.10 | 7.80±0.12 | 7.80±0.10 | 7.80±0.08 |
| Packed cell volume, %            | 28.12±0.64 | 28.05±0.60 | 28.00±0.60 | 28.00±0.60 |
| Erythrocyte sedimentation rate, mm in 1st hour | 35.00±0.12 | 35.00±0.12 | 35.00±0.12 | 35.00±0.12 |
| Mean corpuscular volume, μm³     | 145.55±9.95 | 150.78±8.64 | 152.34±7.53 | 152.34±7.53 |
| Mean corpuscular haemoglobin, pg/mL | 103.99±2.74 | 106.18±3.64 | 107.45±4.94 | 107.45±4.94 |
| Mean corpuscular haemoglobin concentration, % | 135.15±8.36 | 139.50±5.54 | 99.25±6.00 | 99.25±6.00 |

Table 3. Comparative meat composition (%) of Fayoumi, Rhode Island Red and reciprocal crossbred chickens (at 20 weeks of age).

Table 4. Haematological parameters in breeds of Fayoumi, Rhode Island Red and their reciprocal crosses at different ages.
leading from genotype to the resultant phenotype. Livability shows less overall genetic variation weighted against other economic traits (Khalil et al., 1999). The results of the present experiment are in line with findings of many investigators (El-Turkey, 1981; Nawar and Abdou, 1999; Nawar et al., 2004; Besbes, 2009), who found that crossbreeding improved chick viability. Bairagi et al. (1992) found better survivability in the crossbred of RIR or WLH male with indigenous Nana female compared to RIR or WLH chickens. In another study, crossbred of RIR or WLH male with D. Nana female showed lower mortality (Shivaprasad et al., 1994).

**Meat composition**

The carcass dressing percentage of Fayoumi was significantly (P<0.05) lower than crossbred chickens (Table 3). However, non-significant difference (P>0.05) was found among RIR and crossbred chickens. The highest dressing percentage was found in FIRI (62.60%) followed by RIF (62.40%), RIR (57.50%) and Fayoumi (54.08%) chickens. Research work on meat yield traits is scanty in literature. Azharul et al. (2005) found the higher dressing percentage in crossbred of RIR × Fayoumi compared with Fayoumi breed. Some studies showed that crossbreds from D. Nana with RIR, WLH or Fayoumi resulted in improved dressed and total meat yield in comparison with exotic or D. Nana chickens at 84 and 112 days of age (Haque et al., 1999; Haque and Howlider, 2000). In the present study, RIR with Fayoumi may be the worthy combinations for yielding improved meat. The breast and thigh meat composition had no significant (P>0.05) difference among pure and crossbred chickens (Table 3). Poultry meat quality attributes may be affected by several factors such as genotype, rearing condition and feeding that impact on muscle metabolism as well as on chemical composition. Overall comparison of dry matter between breast and thigh revealed that there was higher percentage of dry matter in thigh muscle than breast in all breeds while another study by Fujimura et al. (1996) suggested that water contents differed significantly with breed, whereas according to Zollithish et al. (1997) there was no significant difference of dry matter between thigh and organoleptic traits of breast meat. In case of protein, it was observed that there was high content of crude protein in breast meat than that of thigh meat, while breed differentiation showed no significant (P>0.05) difference. The crude fat analysis showed that thigh contained more fat contents than breast while Zollithish et al. (1997) demonstrated no difference of fat between both types. A total ash content of meat was almost same irrespective of location and breed. This similarity might be explained due to same composition of feed being offered to the birds during trial. Some observations were recorded by Fujimura et al. (1996) in case of different broiler strains.

**Haematological values**

The haematological values in purebred and crossbred chickens are shown in Table 4. There were no distinctive differentiations found amongst the tested chickens. In general, blood examination is performed for several reasons as a screening procedure to assess general health (Jain, 1993). Haematological values could be used for clinical pathological diagnosis and other studies. It is revealed from the present findings that erythrocyte number, Hb and PCV increased with the advancement of age, being lowest in 4 wks and highest in 48 wks of age. These results agreed with findings of Islam et al. (2004). However, ESR, MCV and MCH values decreased gradually with the advancement of age. Values of ESR in RIR, Fayoumi and crossbred chickens are inversely related with age. Higher ESR at early age in this study was in accordance with those of Kundra et al. (1993). The MCV values in this study for Fayoumi are lower than RIR and other crossbred chickens. Similar results were reported by Sturkie (1965). The results of MCH are slightly lower in case of Fayoumi chickens than those reported by Sturkie (1965). Orawan and Aengwanich (2007) reported that there were no statistical differences found on MCH values with respect to breeds and they observed the values ranged from 34.76 to 37.39 pg for broiler and thai indigenous chickens. Similarly, the MCHC values in this study that are nearly coincided with those quoted by Sturkie (1965). In general, it was observed that the haematological values recorded in this study were close to values reported by Schalm’s et al. (2000) for the American reference values in ducks and geese. Haematological parameters in birds have been shown to be influenced by various factors such as age, sex, season and nutrition. In general haematological parameters are affected diurnal fluctuations or changes in daily physical and metabolic activities (Piccione et al., 2005).

**Conclusions**

In conclusion, crossbred chickens gained better body weight than Fayoumi and moderate than RIR chickens with lower mortality. The breast and thigh meat composition had non-significant difference among pure and crossbred chickens. The crossbred chickens of Fayoumi male and RIR female showed better performance in all traits than crossbred chickens of RIR male and Fayoumi female. However, more studies are needed to explore other factors like disease resistance and adaptability to harsh environment of the crossbred chickens compared to RIR and local chickens through intensive selection. Findings from such studies and the ones presented here could be a significant prelude to the improvement of the local chickens.

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