Production performance, egg quality and biochemical parameters of three way crossbred chickens with reciprocal F1; crossbred chickens in sub-tropical environment

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Abstract

A total of 225 hens (18 weeks of age) of each Rhode Island Red male x Fayoumi female (RIFI), Fayoumi male x Rhode Island Red female (FIRI) and White Leghorn male x FIRI female (RLH) were maintained on deep litter system for a period of 72 weeks of age. In floor pens, each crossbred chicken was randomly distributed between pens, with 21 to 24 birds of the same breed per pen (2.00 to 2.50 ft²/bird). The results revealed that the age of sexual maturity was lowest in RIFI followed by FIRI and RLH chickens. The highest egg production was obtained by three-way crossbred chickens (RILI) as compared with two-way crossbred chickens (RIFI and FIRI). The highest egg weight was observed in RLH than those of FIRI and RIFI crossbred chickens. The internal egg quality parameters included yolk weight, albumen weight, yolk + albumen weight and albumen height were same in all crossbred chickens. There was non-significant (P>0.05) difference in blood glucose, triglyceride, cholesterol, calcium, protein, uric acid and ALP values among all crossbred chickens. It may be concluded that three-way crossbred chickens (RLH) showed better egg traits than two-way crossbred chickens (RIFI and FIRI) with lower mortality. The FIRI crossbred chickens achieved sexual maturity earlier than both FIRI and RLH crossbred chickens with lower egg traits.

Introduction

Crossbreeding has been a major tool for the development of present day commercial breeds of chickens (Sheridan, 1981) and could likewise be used to improve the rural chicken. Cross breeding can be carried out as two-way, three-way or four-way crosses, back crosses or rotational crosses. The cross-breeding approach normally involves a two-way cross between an improved exotic and a local breed, with the aim of combining the better production capacity of the former with the later adaptability to harsh environment. This system also maximizes the expression of heterosis, or hybrid vigour, in the cross, normally reflected in improved fitness characteristics (Hoffmann, 2005). In poultry, reciprocal effects in crosses have been detected for sexual maturity, egg production, egg quality and viability traits (Fairfull et al., 1983). This phenomenon in poultry is thought to originate from sex-linked genes (Fairfull, 1990). This depicts that the dam line is very important in practical poultry breeding. Comparatively little research and development work has been carried out on rural poultry, despite the fact that they are usually more numerous than the commercial chickens in most developing countries (Cumming, 1992). A few attempts that have been made to increase productivity include upgrading and crossbreeding with exotic ones, and then leaving the hybrid offspring to natural selection (Kitayli, 1998). In a crossbreeding study in Pakistan, Yaqoob (1970) was able to develop 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 LSB 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. An upgradation program of Desi chicken was undertaken by Safalah (2001) in which the crossed Australorp males with indigenous female chicken in Malawi. The progeny of the cross gained sensationally 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.

Egg production is still the primary trait for the genetic-economic improvement of laying hens. Egg production is a complex metric trait showing many variations during the period of production of the pullet. The study of egg production and its related traits such as age at sexual maturity, rate of laying and egg characteristics attracted the attention of several investigators who found that there were wide variation in these traits between different breeds and/or strains of chickens (EL-Labban et al., 1991; Iraqi et al., 2007). Genetic improvement of important economic traits would increase the production efficiency of native fowl and profitability of these birds. The age at sexual maturity, number of eggs, egg weight and body weight at 8 weeks of age are the most important traits for improving the economic efficiency of native fowl (Kianimanesh, 2000). Our previous work on egg production performance in chickens of reciprocal crossing between Rhode Island Red and Fayoumi breeds is under publish. The results showed that crossbred chickens of FRI (Fayoumi male x FIRI female) showed better performance in all traits than crossbred chickens of RFI (RIR male x Fayoumi female). Two-way crossbred females of FRI were retained from crossing of Fayoumi males with RIR females and mated to the third breed for further improvement in production performance. Consequently, a three-way crossbred chicken, a Rural Leghorn (RLH) breed was developed by crossing between White Leghorn males with females of FIRI chickens. Therefore, RLH chickens contain White Leghorn (50%), RIR (25%) and Fayoumi (25%). The hybrid vigour is significantly lower in rotation than in three way crossing (Desi et al., 2005). However, there is still a scarcity of information about the role of maternal effects or the value of specific crosses. The present study was designed to compare the egg production performance, egg characteristics and blood constituents of three-way crossbred chicken with two-way reciprocal crosses of RIR and Fayoumi chickens.
**Materials and methods**

**Birds and experimental feed**

A total of 225 hens (18 weeks of age) of each RIR (RIR male x Fayoumi female), FIRI (Fayoumi male x RIR female) and RLH (White Leghorn male x FIRI female) were obtained from hatchery of Poultry Research Institute, Rawalpindi, Pakistan. The birds were maintained in floor pens on deep litter system for a period of 72 weeks. In floor pens, each breed was randomly distributed between pens, with 21 to 24 birds of the same breed per pen (2.00 to 2.50 ft²/bird). Each pen included a 2-tier (50 and 100 cm from the floor) perch assembly and a nest-box. Perches were 3 × 4 cm, were made of soft wood with rounded edges, and provided a space of 18 to 21 cm/bird. Four-nest, 2-tiered nest-boxes provided 1 nest for each 5 to 6 birds. Each nest-box was hung on the rear wall of the pen with the nest-box rails at 70 and 100 cm from the floor. The birds were exposed to both perches and nest-boxes from the second week of age. Birds were fed manually and fresh water was made available round the clock. Nutrient content of the feed (Table 1) followed recommendations of the NRC (1994). All birds were kept with 16 h of light per day with an intensity of 5 lux throughout. Temperature and relative humidity were between 21 to 23°C and 70%, respectively. All birds were vaccinated following a program typical of the region. Care and management of the birds followed accepted guidelines (FASS, 2010).

**Parameter measured**

The production data (age at first egg, average number of eggs, egg production percentage, feed intake, feed conversion, egg weight and egg mass) were recorded during 72 weeks trial. Egg production was recorded daily at the same time and was calculated on a hen-day basis as follows. Total number of eggs collected during 72 weeks from hatchery of Poultry Research Institute, Rawalpindi. The biochemical characteristics of blood were determined colorimetrically on UV visible spectrophotometer using commercial kits and diagnostic examinations. Total protein was quantitatively measured based on colorimetric determination as described by Henry et al. (1974). Glucose concentration was quantitatively measured based on enzymatic colorimetric method (Trinder, 1969). Total cholesterol concentration was quantitatively determined based on enzymatic colorimetric method of Alain et al. (1974). The uric acid was determined by the method of Bergman and Shabtay (1954) through the absorbency of the supernatant at 290 μμ. The activity of ALP was determined by method described by Bergmeyer and Wanlefeld (1980).

**Statistical analysis**

All data were determined by using the SPSS version 16 (SPSS, Cary, NC, USA) statistical under gently flowing tap water to release albumen residues, and were then air-dried and weighed. Shell thickness was determined bi-weekly on above same eggs from each treatment group (without the shell membranes): the measure was carried out with a digital caliper with a sensitivity of 0.001 mm at three points of the egg shell (air cell, equator, and sharp end). The eggs were broken one by one on a flat surface, with a waiting period of 5 min. The heights of the albumen, the thickness of the yolk were measured using the caliper. The yolks separated from the albumen were weighed and the weights were recorded. Correlations were analyzed for the following variables: Age of first egg, egg production, egg weight, yolk weight, albumen weight, albumen height, shell thickness and yolk thickness.

Blood samples were collected from 20 birds of each type of chickens at the age of 32 weeks and analyzed for the estimation of biochemical parameters viz., glucose, triglyceride, cholesterol, calcium, protein, uric acid and alkaline phosphatase (ALP). For this purpose, 5 mL of blood was drawn from the brachial vein into dry clean centrifuge tubes containing heparin and immediately centrifuged at 3000 rpm for 15 min. for separating blood plasma. These samples were taken in the morning before feeding (between 8:00 to 10:00 h). Blood plasma samples were stored at -20°C till time of chemical analysis. Samples were analyzed at Feed Testing laboratory, Poultry Research Institute, Rawalpindi. The biochemical characteristics of blood were determined colorimetrically on UV visible spectrophotometer using commercial kits and diagnostic examinations. Total protein was quantitatively measured based on colorimetric determination as described by Henry et al. (1974). Glucose concentration was quantitatively measured based on enzymatic colorimetric method (Trinder, 1969). Total cholesterol concentration was quantitatively determined based on enzymatic colorimetric method of Alain et al. (1974). The uric acid was determined by the method of Bergman and Shabtay (1954) through the absorbency of the supernatant at 290 μμ. The activity of ALP was determined by method described by Bergmeyer and Wanlefeld (1980).

**Table 1. Ingredients and nutrients composition of diets fed to experimental birds during different phases of growth.**

| Ingredients, %  | Wk 18-30 | Wk 31-45 | Wk 46-72 |
|----------------|----------|----------|----------|
| Corn           | 49.65    | 52.00    | 54.00    |
| Rice           | 9.00     | 10.00    | 10.90    |
| Rice polish    | 6.00     | 6.34     | 6.00     |
| Soybean meal   | 15.00    | 13.00    | 12.00    |
| Canola meal    | 5.00     | 4.00     | 4.00     |
| Corn gluten meal, 60% | 5.00 | 5.00 | 4.00 |
| Fish meal      | 5.00     | 4.00     | 3.00     |
| Lime stone     | 2.50     | 3.00     | 3.00     |
| DCP            | 2.00     | 2.00     | 2.50     |
| NaCl           | 0.25     | 0.30     | 0.25     |
| Premix°        | 0.30     | 0.30     | 0.30     |
| DL- Methionine | 0.05     | 0.06     | 0.05     |
| Total          | 100.00   | 100.00   | 100.00   |

Calculated composition:

| ME, kcal/kg  | 2800     | 2800     | 2800     |
| CP, %         | 17.5     | 16.5     | 16       |
| CF, %         | 4.55     | 4.90     | 5.00     |
| EE, %         | 3.44     | 3.50     | 3.35     |
| Ca, %         | 4.10     | 4.20     | 4.30     |
| Available phosphate, % | 0.52 | 0.55 | 0.54 |
| Lysine, %     | 0.75     | 0.85     | 0.90     |
| Methionine, % | 0.35     | 0.40     | 0.42     |

*Supplied per Kg of diet: vit. A, 12,000 U; vit. D3, 2200 U; vit. E, 10 mg; vit. K3, 2mg; vit. B1, 1 mg; vit. B2, 5 mg; vit. B6, 1.5 mg; vit. B12, 0.01 mg; nicotinic acid, 30 mg; folie acid, 1 mg; pantothenic acid, 10 mg; biotin, 0.05 mg; choline chloride, 500 mg; copper, 10 mg; iron, 30 mg; manganese, 50 mg; zinc, 50 mg; iodine, 1 mg; selenium, 0.1 mg, cobalt, 0.1 mg, ME, metabolizable energy; CP , crude protein, CF , crude fibre; EE, ether extracts.

[Ital J Anim Sci vol.12:e21, 2013]
Results and discussion

Performance during production phase

The productive performance, mortality and egg quality parameters of FIRI, RIFI and RLH crossbred chickens during production phase are shown in Table 2. A non-significant (P>0.05) difference was found in age at sexual maturity amongst crossbred chickens. Numerically, an early age of sexual maturity was observed in RIFI (146 d) followed by FIRI (149 d) and RLH (150 d) chickens. Age at sexual maturity is generally determined by the age at first egg laid, which is considered as one of the important factors determining the overall profitability of the flocks. Egg production traits such as egg number, egg weight, egg mass and body weight at sexual maturity are affected by age at sexual maturity in chickens and quails (El-Bodgady et al., 1993; Camci et al., 2002).

In the present study, RIFI chickens have lower egg production, egg weight and egg mass and however, attained sexual maturity earlier than those of FIRI and RLH chickens. The FIRI and RLH chickens had the highest body weight than RIFI chickens in this study (not mentioned in data) which had delayed age at sexual maturity (149 d and 150 d, respectively). This observation is consistent with findings of Yeasmin et al. (2003), who reported that within the same level of management; genetically heavier birds attain sexual maturity later than light body weight birds. The sexual maturity age in crossbred chickens attained in the current study are in line as reported by Rahman et al. (2004), who found that there was non-significant difference in sexual maturity of RIFI and FIRI occurred at 147d and 151d, respectively.

The lack of difference in age at first egg contrasts with the data of Abou-el-Kassem et al. (1987) who reported earlier egg laying in the FIRI compared with RIFI. The attainment of sexual maturity varied from breed to breed or strains, which occurred at a certain age and body weight. Adenowo et al. (1995) reported that sire influence as well as additive gene effects were important in the inheritance of age of first egg in crossbred chickens. A sex linked gene and an autosomal one was ascertained by Greenwood and Blyth (1951) to be involved in the inheritance of sexual maturity. This character is also influenced by many environmental factors such as temperature, nutrition, lighting intensity, etc. Moreover the modern poultry industry has succeeded to reduce age at first egg in layers at up to 20 weeks (Moreng and Avens, 1984), which has been economically important. However, this must be considered with certain precision, because it may lead to the incidence of vaginal prolapse, and hence would increase mortality within the flock.

The egg production of the all crossbred chickens differed significantly (P<0.05). The highest egg production was obtained by RLH with 72.20% followed by FIRI (60%) and RIFI chickens (54%). Similarly, relating to rate of lay (no. of eggs per hen) RLH scored higher (210) than those of FIRI (198) and RIFI (178) chickens. These results are in line with findings of El-Ghar et al. (2010), who reported that the results of 3-way crosses (Silver Montazazz x Mandrah x Lohman Brown) obtained for egg number at 13 wks, 34 wks and 52 wks of laying and egg mass at 52 wks of production showed superiority of 3-way crosses than both single crosses (Mandarah x Lohman Brown) and Lohman Brown. They suggested that the 3-way crosses would be effective in improving annual egg production yield. A significantly better feed efficiency (g feed:g egg mass) was observed in RLH crossbred chickens (2.56) than those of FIRI and RIFI crossbred chickens (4.03 and 4.41, respectively). Different studies showed that the crosses of FIRI, FIRI, Fayoumi x WLH and RIR x WLH resulted in higher egg production (Ambar et al., 1999; Rahman et al., 2004). The higher egg production observed in FIRI than in RIFI in the present study is in accordance with the findings of Abou-el-Kassem et al. (1987). They found 3% higher egg production in FIRI than in RIFI up to the age of 39 weeks. Nawar and Abdou (1999) reported higher rate of lay in cross-bred than in pure-breeds in commercial production systems and the highest was for RIFI.

Furthermore, Rahman et al. (2004) found that hen-day egg production of FIRI and RIFI were 52.3% and 48.2%, respectively. Similarly, Miah et al. (2002) reported that hen-day egg production of FIRI was 51%. In contrast, the egg production of same crossbred chickens in the current experiment is higher than the above studies due to intensive study. That is why; Ambar et al. (1999) suggested using the crossbred of RIFI called Sonali for its superior egg production under semi-intensive system. The RLH seems to have a better genetic combination than the other crossbred chickens used in this study.

The results showed that RLH and FIRI crossbred chickens had lowest (P>0.05) mortality than RIFI crossbred chickens. The highest mortality recorded in RIFI followed by FIRI crossbred chickens. In this study, no particular infectious disease was reported during the experimental period. Liveability is a composite character concerns the question of the adaptive value for the organism. Furthermore, it relates to all physiological steps leading from genotype to the resultant phenotype. Liveability shows less overall genetic variation weighted against other economic traits (Khalil

Table 2. Comparative performance of crossbred chickens during production phase (18-72 weeks).

| Breeds  | RIFI | FIRI | RLH | P value |
|--------|------|------|-----|---------|
| Age at first egg, d | 146±2.51 | 149±1.51 | 150±1.50 | 0.800 |
| Egg production, % | 54±1.51a | 60±1.50b | 72.20±1.54c | 0.004 |
| Average no. of eggs/ hen | 178±2.01 | 198±1.98 | 210±1.90 | - |
| Feed intake, g/hen/day | 112±2.50 | 115±2.35 | 119.56±2.33 | 0.005 |
| Feed efficiency, g feed/g egg mass | 4.41±0.20 | 4.03±0.15c | 2.56±0.20a | 0.100 |
| Mortality | 5.0±0.18 | 4.1±0.17 | 4.0±0.13 | 0.500 |
| Egg weight, g | 47±0.60 | 47.5±0.56 | 57.00±0.55 | 0.090 |
| Egg mass, g/ 1000 birds | 25.38±0.41 | 28.50±0.35 | 43.32±0.48 | 0.130 |
| Yolk weight, g | 15.82±0.51 | 16.00±0.277 | 16.20±0.51 | 0.150 |
| Albumen weight, g | 23.65±0.170 | 24.20±0.190 | 25.80±1.10 | 0.100 |
| Yolk + albumen weight, g | 39.50±0.550 | 40.50±0.540 | 42.60±0.510 | 0.090 |
| Albumen height, cm | 0.70±0.05 | 0.80±0.04 | 0.84±0.03 | 0.081 |
| Shell thickness, mm | 0.27±0.129 | 0.28±0.130 | 0.34±0.126 | 0.810 |
| Yolk thickness, cm | 1.45±0.075 | 1.50±0.171 | 1.52±0.165 | 0.600 |

*Egg mass, (egg production × egg weight)/100. **Means with different letters differ significantly (P<0.05). RIFI, Rhode Island Red male × Fayoumi female; FIRI, Fayoumi male × Rhode Island Red female; RLH, White Leghorn male × FIRI female.
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), 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 chicken. In another study, crossbred of RIR or WLH male with D. Nana female showed lower mortality (Shivaprasad et al., 1994).

The egg weight is one of the important phenotypic traits which influence egg quality and reproductive fitness of the chicken parents. The highest (P<0.05) egg weight and egg mass was recorded in RLH than those of RIFI and FIRI crossbred chickens. This observation corroborated the heavier body weights recorded for RLH and therefore supports the reports of Duplessis and Erasmus (1972), which showed that bigger birds normally laid larger eggs than those of smaller body weights. This instance agrees with the view that a high positive correlation exists between body weight and egg weight in chicken as reported by Rahman et al. (2002). They also reported significant (P<0.05) differences were found in egg weight between RIFI and FIRI crossbred chickens. Similar results were obtained by Rahman et al. (2004), who reported that there was nonsignificant difference between the two crossbreeds in egg weight (48.7 and 49.4g for FIRI and RIFI, respectively).

Among the internal egg quality parameters, yolk weight and albumen weight are very important from nutritional (Bain 2005) and cholesterol content (Sparks 2006) viewpoints. The internal egg quality parameters included yolk weight, albumen weight, yolk + albumen weight and albumen height were similar in all crossbred chickens. Numerically, RLH crossbred chickens recorded the highest values of above parameters compared with those for RIFI and FIRI crossbred chickens. From results, it could be noticed that eggs of RLH had numerical thicker shell and yolk followed by FIRI and RIFI crossbred chickens. This is coincided with the former egg weight since the egg components are proportionately correlated with egg weight. As for egg components of the crossbred chickens, the results showed positive correlations between the egg weight and albumen and yolk weights. Albumen weight represented the highest portion of egg component (59.92, 60.20 and 61.43% for RIFI, FIRI and RLH chickens, respectively) followed by yolk weight (40.00, 39.80 and 38.58% for RIFI, FIRI and RLH chickens, respectively). This shows that selection for increased egg weight in the chickens will ultimately result in increased weight of the various egg components. The present results are also in agreement with finding of Mekki et al. (2005). The albumen weight and albumen height are presenting an idea about the albumen quality. The eggs with higher albumen height tend to have better internal egg quality (i.e. egg protein quality). Albumen height is an important trait and it is feasible to improve egg quality through selection for it. Egg quality is also influenced by genetic and non-genetic factors such as season, environment and feed (Salahuddin and Howlinder, 1991).

Biochemical values

The biochemical values in crossbred chickens are shown in Table 3. There was non-significant (P>0.05) difference in biochemical values amongst all crossbred chickens. The higher triglyceride concentrations in improved high laying RLH and FIRI crossbred chickens and relatively lower concentration in RIFI crossbred chicken is attributable to an increased lipogenic activity of liver stimulated by the endogenous estrogens resulting from selective breeding (North and Bell, 1990). Hassan et al. (2008) reported that the concentration of triglycerides was different between the native Egyptian breeds (139.15 and 143.16 mg/dL for Dandarawi and Dokki, respectively) at 36 wks of age. These values were lower than those reported in the present study that might be due to difference in chicken strains.

It was noticed that there was no difference in plasma cholesterol level among the all types of crossbred chickens at laying stage, as was also reported by Bhatti et al. (2002). They explained that serum cholesterol level in different strains (Desi, Fayoumi, Crossbred (RIFI) and Naked Neck) during pre- and post-laying period was same which implies that laying condition did not exert any extra demand on cholesterol bio-synthesis and its release in the blood circulation. The cholesterol values of these chickens was found within range of reference (Clinical Diagnostic Division, 1990). However, these values were lower than the values reported in pheasant (236.46 mg/dL) by Homswat et al. (1999) and in broilers (140 mg/dL) by Meluzzi et al. (1992).

There was no difference in calcium (Ca) level among these chickens at laying stage in the current experiment. The birds were found to be equally affected by the stage of egg laying during which there was mobilization of Ca for shell formation. Similar results were reported by Bhatti et al. (2002). Serum Ca of these chickens was lower than in domestic turkey (11.7-38.7 mg/dL), domestic fowl (13.2-23.7 mg/dL) and bobwhite quail (14.1-15.4 mg/dL) (Ritchie et al., 1994).

Total protein level in crossbred chickens was higher than the reference range (Clinical Diagnostic Division, 1990). In female birds, a considerable increase in total protein concentration occurs just prior to egg laying, which could be attributed to an estrogen-induced increase in globulins. The proteins were the yolk precursors (vitellogenin and lipoproteins), which were synthesized in the liver and transported via the plasma to the ovary where they were incorporated in the oocytes (Ritchie et al., 1994). Like current study, the concentration of total protein was different between the native Egyptian breeds (5.16 g/dL and 5.59 g/dL for Dandarawi and Dokki, respectively) at 36 wks old (Hassan et al., 2008). Moreover, total proteins of hens in experimental chickens were lower than the normal range of the domestic turkey (5.29-7.6 mg/dL) and pheasant (male=5.65 mg/dL; female=6.06 mg/dL), but higher than the normal range of the guinea fowl (3.5-4.4 mg/dL) and quail (3.4-3.6 mg/dL) (Ritchie et al., 1994). In birds, uric acid is a major product of the catabolism of nitrogen, being the end product of protein/amine acid metabolism, indicates similar rate of pro-

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**Table 3. Mean values of plasma glucose, triglyceride, cholesterol, uric acid, calcium, protein and alkaline phosphatase in crossbred chickens at 32 weeks of age.**

| Breeds | RIFI | FIRI | RLH | Reference | P value |
|--------|------|------|-----|-----------|---------|
| Glucose, g/dL | 215.00±13.00 | 240.00±11.00 | 257.00±8.00 | 197-299 | 0.610 |
| Triglycerides, mg/dL | 560.50±70.10 | 590.50±65.00 | 595.5±78.50 | - | 0.650 |
| Cholesterol, mg/dL | 138.00±10.00 | 130.7±9.00 | 134.3±20.20 | 129-297 | 0.850 |
| Calcium, mg/dL | 10.57±0.67 | 10.89±0.80 | 10.75±0.45 | 8.1-12 | 0.560 |
| Protein, mg/dL | 05.20±0.30 | 5.10±0.24 | 5.17±0.22 | 3-4.9 | 0.510 |
| Uric acid, mg/dL | 4.20±0.43 | 4.70±0.41 | 5.20±0.34 | 1.9-12.5 | 0.650 |
| Alkaline phosphatase, U/L | 1100±80.30 | 1090±79.90 | 108±70.19 | 10-106 | 0.880 |

*Reference values of Clinical Diagnostic Division (1990). RIFI, Rhode Island Red male x Fayoumi female; FIRI, Fayoumi male x Rhode Island Red female; RLH, White Leghorn male x FIRI female.*

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tein/amino acid metabolism in different bird groups though genetically different (Sykes, 1971). Age and diet may influence the concentration of blood uric acid in birds. The uric acid values (4.20-5.20 mg/dL) of these crossbred chickens in the present study are close to the values (4.16-4.63 mg/dL) determined by Bhatti et al. (2001) in Desi and Naked Neck hens.

During the egg shell formation there is an increase in activity of ALP in the blood of laying hens (North and Bell, 1990) due to calcification process. The ALP value quantitatively was higher in RIFI chickens (1100 U/L) than FIRI and RLH crossbred chickens (1090 U/L and 1083 U/L, respectively). Bhatti et al. (2002), who found higher ALP values in RIFI crossbred chickens (1656.5 U/L) than the present study. It may be concluded that any type of crossbred chickens possess identical genetic mechanism for regulation of glucose, triglyceride, cholesterol, calcium, protein and uric acid concentrations in blood like identical mechanism in different commercial broiler strains (Furlan et al., 1999).

Conclusions

It may be concluded that three-way crossbred chickens (RLH) showed better egg traits than two-way crossbred chickens (RIFI and FIRI) with lower mortality. The RIFI crossbred chickens achieved sexual maturity earlier than both FIRI and RLH crossbred chickens with lower egg traits.

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