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Physical and Biochemical Characterization of Eggs of Chicken Crossbreed and Its Comparison with Dahlem Red for Rural Poultry Development

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ABSTRACT

Background: Crossbreeds of indigenous chicken are suitable for sustainable rural farming practices in developing countries as they are better adapted to local environment than pure breeds. Study was conducted to compare physical and biochemical parameters of egg between indigenous crossbreed of chicken (DND) locally called *Himsamridhi* and exotic chicken breed Dahlem Red (DR) under similar rearing conditions.

Methods: 45 egg samples were collected from DND and 45 from DR. Physical characteristics and biochemical parameters of eggs were determined. Further, effect of these egg characteristics on hatching and progeny health were investigated.

Result: External physical characteristics *viz*. weight, length, breadth, shell weight and total egg surface were significantly (P<0.05) higher in DR whereas shape index and shell ratio were significantly (P<0.05) higher in DND. Internal physical characteristics *viz*. yolk, albumen weights and albumen volume were significantly (P<0.05) higher in DR whereas Haugh unit was significantly (P<0.05) higher in DND. Biochemical parameters *viz*. total proteins significantly (P<0.05) higher in DND and total cholesterol significantly (P<0.05) higher in DR. Egg hatchability on fertile egg set basis (FES) and total egg set basis (TES) was higher in DND. Thus, some parameters were better in indigenous crossbreed, such as low cholesterol, higher total proteins, higher hatchability and chick survivability.

Key words: Biochemical, Chick survivability, Hatchability, *Himsamridhi.*

INTRODUCTION

Indigenous breeds of chicken and their cross with superior breeds are suitable for sustainable farming practices (Lordelo *et al.* 2020) especially in developing countries like India for achieving food security. Indigenous poultry breeds and their crossbreeds have ability to tolerate harsh environmental conditions. They play major role for rural, poor and marginalised section of people with respect to their subsidiary income and also provide them with nutritious chicken egg and meat for their own consumption (Padhi, 2016). Native breeds are known to be hardy, able to thrive under adverse climatic conditions and to be resistant to bacterial and parasitic diseases. Native breeds carried out at intensive system indicated that there is high genetic diversity (Haunshi and Rajkumar, 2020). Crossbreed birds are suitable for backyard poultry production and egg production as compared to pure exotic breeds. Present study is focused on determining quality characteristics of eggs produced by newly introduced local crossbreed named *Himsamridhi* which is crossbreed between native chicken of Northern state of Himachal Pradesh, India and well-known poultry breed, Dahlem Red (DR). DR chickens are bred for egg purpose. They were imported from Germany to India. It is red feathered breed laying tinted eggs with good egg weight and immune competence (Kundu *et al.* 1999). This breed is also used to produce improved germplasm suitable for backyard rearing in India. DND is location specific crossbreed has 25% native inheritance and 75% DR characteristics. It is suitable for backyard poultry farming as well as for cage system. DND (DRN × DR) birds lay larger eggs (50-55 gm) with annual egg production potential of 130-140 eggs/bird under farmer's flock and 160-180 eggs/bird under farm rearing conditions. Developed variety is well adapted to sub-temperate Himalayan region and is readily accepted by farmers as stock of choice for backyard/rural poultry farming (Sankhyan and Thakur, 2018). There are significant variations in production performance and mortality pattern between crosses of DR between their parent birds (Jha *et al.* 2013, Shivaprasad *et al.* 2017). Objective of this study was to characterize physical and biochemical parameters of eggs between DND crossbreed and DR under

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similar rearing conditions. Further, other parameters like egg fertility, hatchability, weight and survivability of chicks were also compared. This study may help farmers to take decision for adopting the mentioned crossbreed as well as find potential of marketability of eggs.

MATERIALS AND METHODS

Experimental birds and collection of eggs

The study was carried out during the period of February 2019 to June 2020, in Department of Veterinary Physiology and Biochemistry and Poultry Farm situated in College of Veterinary and Animal Sciences, CSKHPKV, Palampur, Himachal Pradesh. Total 48 healthy layer birds with 24 from DND and 24 from DR of 16-18 weeks of age were randomly selected and reared upto 70 weeks in different pens separately on deep litter system with nest boxes. Birds were offered standard layer feed (Table 1) and *ad libitum* drinking water. Total 90 egg samples were randomly collected with 45 from DND and 45 from DR. Freshly laid eggs were randomly collected in morning, labelled and dry-cleaned with sandpaper to remove feaces and dirt from outer egg shell for further investigations.

External physical egg characteristics

Egg weight was measured using digital balance; egg length and breadth was measured with help of digital vernier caliper to the nearest. Egg shell thickness was measured at broad, narrow and middle portion of egg using digital vernier caliper. Egg shell weight was measured after washing egg shell under running tap water to remove sticking albumen and chalazae residue and further air dried overnight and weighed on a digital balance.

$$\text{Egg shape index as} = \frac{\text{Egg breadth}}{\text{Egg length}} \times 100$$

$$\text{Total egg surface as } S = 4.68 * P^{2/3}$$

Where
S is total egg surface and P is egg weight in grams.

$$\text{Egg shell ratio as} = \frac{\text{Egg shell weight}}{\text{Egg weight}} \times 100$$

(Sirri *et al.* 2018) were also determined.

Table 1: Standard layer feed.

Ingredient	Standard layer feed (Crum-egg 1)
Moisture (Maximum)	10%
Crude protein (Minimum)	18%
Crude fibre (Maximum)	6%
Crude fat (Minimum)	3%
Calcium (Minimum)	3.5%
Phosphorus (minimum)	0.4%
Metabolic energy (Minimum)	2800 kcal/kg

Internal physical egg characteristics

Egg was broken on flat surface and allowed to stand for five minutes. Egg yolk and albumen heights were measured with help of spherometer. Albumen height was recorded twice and average value was calculated. Yolk and albumen were carefully separated. Yolk was placed on Whatmann filter paper no. 1 and rolled to remove albumen residues and chalazae. After that outer membrane of yolk was punctured with rat tooth forceps and pure yolk was poured into pre-weighed graduated glass beaker. Thus weight and volume of yolk and albumen was determined with electronic balance and by observing graduated scale on beaker respectively. Haugh Unit (HU) was estimated by using the following formula-

$$HU = 100 * \log (h - 1.7W^{0.37} + 7.6)$$

Where,
h is height of albumen in mm and W is weight of egg in grams.

$$\text{Yolk percentage} = \frac{\text{Yolk weight}}{\text{Egg weight}} \times 100$$

$$\text{Albumen percentage} = \frac{\text{Albumen weight}}{\text{Egg weight}} \times 100$$

Biochemical parameters of egg

Total proteins estimation

Total proteins (grams/egg) were estimated by Biuret method. Standard protein solution of different concentrations *viz.* 1, 2, 3, 4, 5 mg/ml was prepared by dissolving different concentrations of serum bovine albumin in distilled water. For blank 6 ml of distilled water was taken. For protein standard 1 ml of protein standard solution, 4 ml of 0.75 Normal (N) sodium hydroxide and 1 ml of biuret reagent were added and mixed. Let it stand for 20 minutes at room temperature. Absorbance was measured at 545 nm in spectrophotometer. Calibration curve was prepared (Fig 1).

1 ml of albumen and 0.5 ml of yolk samples were diluted with 1ml of distilled water in different test tubes. For blank 5 ml of 0.75 N sodium hydroxide and 1 ml of biuret agent were added. For test 100 µl of diluted sample, 4.9 ml of 0.75 N sodium hydroxide and 1 ml of biuret reagent were added and mixed. Let it stand for 20 minutes at room temperature. Absorbance measured at 545 nm in spectrophotometer. Protein concentration was measured by using calibration curve after multiplying with dilution factor. Protein concentrations of albumen and yolk fractions were added to determine total protein in mg/ml.

Total cholesterol estimation

Total cholesterol in yolk (mg/egg yolk) was estimated by cholesterol oxidase peroxidase method (Pasin *et al.* 1998).

Total glucose estimation

Total glucose (mg/egg) was estimated by glucose oxidase and peroxidase method (Lott and Turner, 1975).

Total lipids estimation

Lipids (grams/egg) were estimated by modified Folch method (Folch *et al.* 1957, Washburn and Nix, 1974 and Washburn, 1989).

1 gram of yolk and 1 gram of albumen samples was weighed in different test tubes with screw cap. Add 15 ml of 2:1 chloroform: methanol to each sample. Test tubes were shaken vigorously with hand. Add 5 ml of distilled water and again shake with hand. Centrifuge test tubes for 10 minutes at 2500 rpm. There was formation of biphasic layer. Top water-methanol layer was discarded. Bottom layer of chloroform was filtered through Whatmann filter paper no. 1 into pre-weighed test tubes. These test tubes were placed in boiling water bath with agitation until chloroform was evaporated. Test tubes were kept in dessicator containing copper sulphate overnight. After that test tubes were weighed on electronic balance. Grams of total lipids per egg were obtained by adding lipids in yolk and albumen samples.

Incubation, candling and hatching

200 eggs were taken with 100 from DND and 100 from DR at 30-32 weeks of age. Immediately after collection eggs were weighed. Fumigation of eggs was done for 20 minutes in fumigation chamber by adding 1 part of potassium permagnate and 2 parts of formalin. Egg setter trays were stored at 65°F in cold storage room with 75% relative humidity (R.H.). Egg setter trays were loaded in setter on batch basis for first 18 days at 99.5°F to 99.75°F temperature and 55-60% R.H. Autorotation of eggs was done after every one hour at 45° angle. Candling of eggs was done on 18th day using mass candler. Entire tray of hatching eggs was placed over mass candler in dark room and eggs through which light passed were infertile and were discarded. Eggs were transferred to hatcher. Eggs were kept in horizontal position in hatcher for last 4 days at 98.5°F temperature and 65-70% R.H.

Upon hatching vaccination of day-old chicks was done against Marek's disease in nape of neck by subcutaneous route. Weight of day old chicks was also recorded. The chicks were reared in brooder with 2" heighted litter material, 1.5' heighted brooder guard for one week at 95°F temperature, 60% R.H. and proper ventilation to determine chick survivability. Chicks were fed crumbled feed which was further broken into fine particles and *ad libitum* drinking water.

Percentage of fertility and hatchability of eggs were determined by following formulas-

$$\text{Fertility (\%)} = \frac{\text{Total number of fertile eggs}}{\text{Total number of eggs set}} \times 100$$

Hatchability (%) was determined on fertile egg set (FES) basis and on total egg set (TES) basis:

$$\text{Hatchability on FES (\%)} = \frac{\text{Number of chicks hatched}}{\text{Total number of fertile eggs set}} \times 100$$

$$\text{Hatchability on TES (\%)} = \frac{\text{Number of chicks hatched}}{\text{Total number of eggs set}} \times 100$$

Health of progeny of each breed was determined by estimating chick survivability (%)-

$$\text{Chick survivability (\%)} = \frac{\text{Total number of chicks alive}}{\text{Total number of chicks housed}} \times 100$$

Statistical analysis

All the experimental data were analyzed using Graph Pad INSTAT by using unpaired-'t' test at 5% level of significance.

RESULTS AND DISCUSSION

Physical and biochemical parameters

DR eggs had significantly (P<0.0001) higher egg weight, length, breadth and total egg surface values than DND eggs. Egg weight, Haugh unit and shell thickness were found higher in DR and lower in (PB-2×Indigenous) crossbreed (Kalita *et al.* 2017). No significant (P>0.05) difference was observed for egg shell thickness in DND and DR eggs. DR eggs had significantly (P=0.001) higher egg shell weight

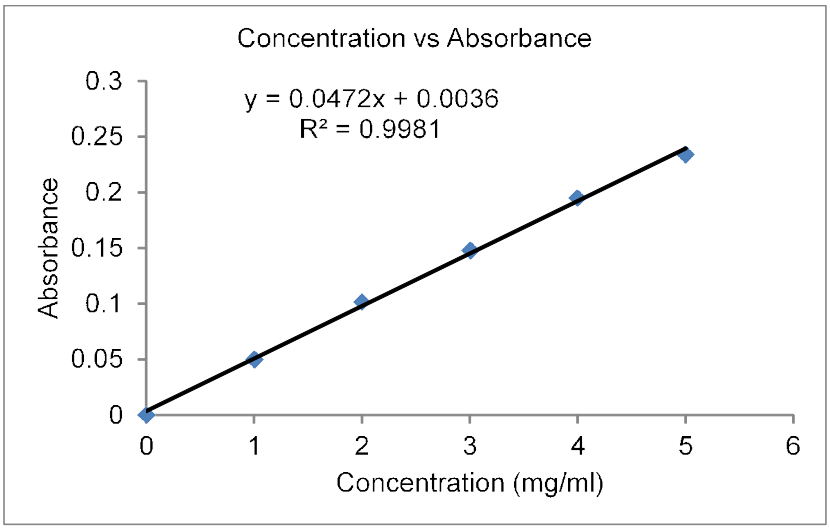

Fig 1: Calibration curve- Biuret method.

value than DND eggs. DND eggs had significantly (P<0.05) higher shape index and egg shell ratio values than DR eggs. No significant (P>0.05) difference was observed for yolk and albumen height, yolk volume, albumen and yolk percentage values in DND and DR eggs. DR eggs had significantly (P=0.0003) higher yolk weight, (P<0.0001) higher albumen weight and albumen volume values than DND eggs (Table 2). DND eggs had significantly (P<0.05) higher Haugh Unit value, (P<0.05) higher total protein value than DR eggs. DR eggs had significantly (P<0.05) higher total cholesterol than DND eggs. No significant (P>0.05) difference was observed for total egg glucose and total egg lipids among DND and DR eggs (Table 3). These parameters are important for marketability as well as consumers' choice.

Fertility, hatchability and chick survivability

Irrespective of egg weight, 8 eggs were found unfertile in both DND and DR. Egg weight is an important parameter that influences hatchability (Alabi *et al.* 2012). Low, medium or high weights of eggs did not affect hatching of eggs in DND and DR in this study. Heavier eggs hatched heavier chicks in indigenous Venda chicken which was observed in DR in present study (Ngami *et al.* 2013). Egg weight positively affected chick weights in broiler (Iqbal *et al.* 2017) which was observed in DR in present study.

Eight and ten percent eggs did not hatch in DND and DR, respectively. Egg fertility was 92% in both DND and DR. Egg hatchability on FES and TES for DND was 91.30 and 84.00% respectively, whereas for that of DR was 89.13 and 82.00% respectively. Average fertility and hatchability on TES for Vanaraja was 86.82±2.26 and 74.58±1.16% respectively (Sankhyan and Thakur, 2016). DR had significantly (p<0.0001) higher (35.78±0.43 g) chick weight at hatching than DND (31.45±0.33 g). Chick survivability in DND was 95.23% and in DR as 87.80% during same time in entire brooder under similar rearing conditions. Crossbreed is more successful and has better suitability to local conditions. Chick survivability was 94.32±0.10% for Vanaraja (Sankhyan and Thakur, 2016). Egg weight significantly affected chick weight which was highest in medium sized egg (Singh *et al.* 2018). Highest mean fertility and hatchability was found in Native × Dahlem Red followed by Native × Rhode Island Red (Sankhyan *et al.* 2015).

For a long time, local chicken breeds are being crossed with exotic breeds to enhance their productivity while

Table 2: External and internal physical egg characteristics

Egg characteristics	DND	DR	P-value
External			
Egg weight (g)	51.28±0.64[a]	57.67±0.91[b]	P<0.0001
Egg length (mm)	53.88±0.35[a]	56.42±0.44[b]	P<0.0001
Egg breadth (mm)	41.22±0.18[a]	42.37±0.21[b]	P<0.0001
Egg shell thickness (mm)	0.45±0.005	0.44±0.005	P>0.05
Egg shell weight (g)	4.97±0.06[a]	5.39±0.10[b]	P=0.001
Egg shape index (%)	76.59±0.39[a]	75.23±0.53[b]	P<0.05
Total egg surface (cm^2)	65.40±0.55[a]	70.73±0.74[b]	P<0.0001
Egg shell ratio (%)	9.72±0.11[a]	9.36±0.13[b]	P<0.05
Internal			
Yolk height (mm)	16.20±0.13	16.58±0.14	P>0.05
Albumen height (mm)	6.81±0.23	6.45±0.17	P>0.05
Yolk weight (g)	13.91±0.32[a]	15.53±0.54[b]	P=0.0003
Albumen weight (g)	28.33±0.42[a]	32.24±0.71[b]	P<0.0001
Yolk volume (ml)	15.47±0.18	15.54±0.21	P>0.05
Albumen volume (ml)	30.63±0.43[a]	34.13±0.68[b]	P<0.0001
Haugh unit (%)	84.08±1.53[a]	80.18±1.21[b]	P<0.05
Yolk percentage (%)	27.18±0.63	27.08±0.49	P>0.05
Albumen percentage (%)	55.25±0.37	55.71±0.45	P>0.05

(Mean±S.E.M.) Different superscripts within a row differs significantly.

Table 3: Biochemical parameters of egg.

Biochemical parameters	DND	DR	P-value
Total proteins (g/egg)	7.05±0.19[a]	6.52±0.17[b]	P<0.05
Total cholesterol (mg/egg yolk)	187.45±3.01[a]	195.66±2.81[b]	P<0.05
Total glucose (g/egg)	163.49±7.49	158.82±6.55	P>0.05
Total lipids (g/egg)	8.95±0.42	9.18±0.36	P>0.05

(Mean±S.E.M.) Different superscripts within a row differs significantly.

retaining their adaptability to local environment. Results from study suggested that DND, local crossbreed has higher survivability which is an important adaptability feature.

CONCLUSION

Present study showed that DR had significantly higher egg weight, length and breadth, egg shell weight, total egg surface, yolk weight, albumen weight and albumen volume with lower hatchability, higher hatchling weight and lower chick survivability. DND had significantly higher egg shape index, egg shell ratio and Haugh unit with higher hatchability, lower hatchling weight and higher chick survivability. However, DND had some superior parameters such as significantly ($P<0.05$) higher total proteins, significantly ($P<0.05$) lower total cholesterol but higher hatchability and chick survivability than DR. Such parameters affect marketability of eggs and chicks. As the chick survivability of DND is higher and its eggs are also comparable to exotic breed DR. Thus, this study provides information to rural poultry farmers for making informed decision about choosing suitable breed according to their requirement.

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