Comparative serum biochemical profile for different breeds of ducks versus White Leghorn chickens in peak laying period

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ABSTRACT

An investigation was carried out to compare the serum biochemical profile of two prominent avian species: ducks vis a vis chickens, at peak egg production phases. The genotypes consisted of 3 breeds of ducks: Khaki Campbell, White Pekins and a native duck breed: Kuzhi (reared in Odisha and adjoining regions) and besides the White Leghorn chickens, at 50 week age, numbering 30 each, with rearing done in individual cages. The result revealed significant (p<0.0001) genotype-associated differences for almost all the serum biochemical parameters, except globulin. There existed a significant (p<0.0001) difference between the species (duck verses chicken) for these parameters, with distinct inter-breed variations. Among the lipid profile HDL of ducks remained comparable to that of chickens, with the indigenous Kuzhi ducks displaying the most desirable lipid-profile of all the genotypes except LDL. The serum liver-enzymes (SGOT and SGPT) were well within normal ranges, expected or laying birds with significant difference between species, with between-breed variations among ducks. It was concluded that, ducks had significantly-distinct and variant serum biochemical profiles compared to chickens, where the indigenous ducks (of Odisha region) possessed the most-desirable estimates, as expected from table-egg laying species.

Key words: Chickens, Duck-Breeds, Kuzhi indigenous ducks, Serum-biochemical parameters.

INTRODUCTION

The knowledge of basic metabolic profile in domesticated poultry species provides a true reflection of their health status, immunity, disease condition, besides any ailment in the host’s body. The serum metabolites should therefore, be studied in detail, in every poultry species, especially in table egg layers. Among all poultry species, the waterfowls especially: ducks are mostly preferred for their table egg production next to chickens, across the globe. Citing the latest (19th) Livestock census of Govt. of India, the ducks constitute about 3% (23.539 millions) of total poultry (729.2 million), in India (GOI, 2012). However, available reports on serum biochemistry of blood across species and breeds of duck are scarce, as compared to those of chickens and other avian species. Comparative studies of serum biochemistry in chicken versus ducks are limited (Franco et al., 2012; Kabir, 2012). The existence of breed difference in laying chickens has been documented by many researchers (Dutta et al., 2013; Gyenis et al., 2006; Khawaja et al., 2013); while the literature is porous in ducks especially in the native duck breeds in their peak laying period. The egg quality attributes of Kuzhi indigenous ducks render them as dependable egg type poultry for Odisha state and adjoining region (Rath et al., 2014), however studies on biochemical profile for the same is scanty. Moreover, fluctuations and variation in the biochemical parameters with respect to change in species, breed, age, feed, sex, season, stress etc. have been evidenced in laying hens which are less published in waterfowls. So, an investigation was carried out with objectives to compare and create baseline information on serum biochemical profiles of different breeds of ducks and chickens in their peak laying period.

MATERIALS AND METHODS

Experimental design: The experimental birds comprised of 90 ducks and 30 chickens, each aging ~50 weeks age maintained at the Regional Centre, ICAR-Central Avian Research Institute, Odisha, India. The ducks were sourced from 3 different breeds, viz., Khaki Campbell, Kuzhi ducks (a native breed of Odisha) and White Pekin and chickens were white Leghorn layers i.e. (BV-300, a commercial WLH brand, from M/S Venkateswara hatcheries Ltd. Pune). The birds were kept in individual cages specially equipped with egg collection tray for daily egg collection. The birds were provided with wheat based diet in the form of wet-mash (feed moistened by water) @ 150g feed per day & ad libitum water. Clean drinking water was provided daily and necessary

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health care measures were adapted. Routine managemental practices were adapted for all the birds as per standard practices of farm.

**Blood collection and different biochemical parameters studied:** Venous blood samples were collected from each of the experimental birds, following standard procedure. The sera thus separated, were used for analysis of glucose (mg/dl), total protein (g/dl), albumin (g/dl), globulin (g/dl), globulin, calcium (mg/dl), total cholesterol (mg/dl), triglyceride (mg/dl), HDL (high-density lipoprotein cholesterol) (mg/dl), SGOT (Serum glutamate oxalate transaminase) (U/L), SGPT (Serum glutamate pyruvate transaminase) (U/L), employing customized colorimetry-based biochemical Kits (Crest Biosystems, Goa, India). VLDL (very low density lipoprotein) cholesterol was cross-estimated using the estimates of Triglycerides [one 5th of triglycerides] and low-density lipoprotein cholesterol (LDL) was estimated using the equation: [Low-density lipoprotein cholesterol=Total cholesterol – High-density lipoprotein cholesterol – Triglycerides/5] (Friedewald et al., 1972).

**Data analysis:** The data were subjected to analysis of variance (ANOVA) using the “General Linear Model” procedure of Statistical Analysis System (SAS, 2009) software programme, version 9.2, to test for significant differences between treatment means, wherever necessary.

**RESULTS AND DISCUSSION**

During the period of study, the layers from both species: displayed appreciable egg production and egg quality parameters, which inferred about their being in peak egg-production phases. Based on their hen day egg production, the WLH chickens were at ~ 80% on hen-day production basis, while the ducks were laying in the range of 65 to 76% varying over breeds. The mean egg weight, production (%) and serum biochemical parameters estimated in respect of the different genotypes are presented in Table 1.

To reflect and interpret on the serum biochemical profiles of various genotypes, the mean egg weight and egg-production status for the duck breeds and WLH layers, at the point of study, are summarized along their respective serum parameters.

**Glucose:** The serum glucose was significantly higher in chickens as compared to ducks. Across the duck breeds, the Khaki and Pekins were measured for higher (p<0.0001) glucose values than the Kuzhi ducks. The values obtained were as per the reference range for chickens (Kaneko et al., 2008) and ducks (Tully et al., 2009). Mondal and Sahoo (2012) have reported higher serum glucose values in Muscovy ducks (Carina moschata). Comparative studies on laying chickens showed higher serum glucose as compared to exotic chicken breeds (Dutta et al., 2013).

**Total protein:** The total serum proteins are considered important blood parameters, considering that: these estimates are indicative of immune status of the species due to the antibody fractions contained in them. In this study, the genotype associated difference was significant (p<0.0001) for the total serum protein levels. The level of total serum protein was higher (p<0.0001) in the ducks than chickens, with the Khaki and Pekins measuring highest among the genotypes. There was no statistical difference between the Kuzhi ducks and White Leghorns chickens with respect to serum protein values. The serum protein values were however, as per Tully et al. (2009). The difference in serum protein levels within the duck breeds in our study is in agreement with the findings of Swathi and Sudhamayee (2005). The laying period is accompanied by increased levels of estrogens there by inducing protein synthesis (Swathi and Sudhamayee, 2005). Okeudo et al. (2003) reported the effect of sex on the total protein values suggesting significantly higher serum total protein values in female ducks (12.07 ± 1.5 g/100 ml) as compared to males (6.87 ± 0.42 g/100 ml).

**Table 1:** Mean egg weight, production (%) and serum biochemical parameters of different genotypes.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Khaki</th>
<th>Kuzhi</th>
<th>Pekin</th>
<th>White Leghorn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean egg weight (g)</td>
<td>59.9±1.03ab</td>
<td>65.98±0.68ab</td>
<td>70.52±1.20ab</td>
<td>51.26±1.20ab</td>
</tr>
<tr>
<td>Percent production</td>
<td>76.73b</td>
<td>73.19a</td>
<td>73.19a</td>
<td>80.39a</td>
</tr>
<tr>
<td>Total protein (g/dL)</td>
<td>7.33±0.24ab</td>
<td>6.73±0.24ab</td>
<td>7.31±0.22ab</td>
<td>6.93±0.20ab</td>
</tr>
<tr>
<td>Glucose (mg/dL)</td>
<td>168.94±4.36ab</td>
<td>139.33±5.39ab</td>
<td>163.25±6.16ab</td>
<td>200.11±6.16ab</td>
</tr>
<tr>
<td>Albumin (g/dL)</td>
<td>2.64±0.13ab</td>
<td>2.58±0.13ab</td>
<td>2.1±0.21b</td>
<td>2.74±0.16ab</td>
</tr>
<tr>
<td>Globulin (g/dL)</td>
<td>4.15±0.24ab</td>
<td>4.07±0.34ab</td>
<td>4.20±0.25a</td>
<td>4.19±0.18a</td>
</tr>
<tr>
<td>Albumin: Globulin</td>
<td>0.63±0.05c</td>
<td>0.63±0.09b</td>
<td>0.50±0.10b</td>
<td>0.65±0.14a</td>
</tr>
<tr>
<td>Calcium (mg/dL)</td>
<td>13.83±0.81b</td>
<td>16.61±0.91ab</td>
<td>13.28±0.77c</td>
<td>17.29±0.72b</td>
</tr>
<tr>
<td>Serum glutamate oxalate transaminase (Units/L)</td>
<td>94.47±4.14b</td>
<td>89.57±5.67b</td>
<td>80.37±2.85b</td>
<td>145.87±13.26b</td>
</tr>
<tr>
<td>Serum glutamate pyruvate transaminase (Units/L)</td>
<td>30.70±2.45ab</td>
<td>23.10±0.75b</td>
<td>28.21±1.46ab</td>
<td>31.92±2.39ab</td>
</tr>
</tbody>
</table>

**Lipid profile**

| Total cholesterol (mg/dL) | 138.18±2.96a | 129.37±2.23ab | 148.47±3.07a | 147.88±3.21b |
| Triglyceride (mg/dL) | 379.78±2.78ab | 315.24±3.65c | 374.93±2.87ab | 399.93±1.87ab |
| Very low density lipoprotein (mg/dL) | 75.96±9.36ab | 63.05±2.73ab | 74.99±3.17ab | 79.98±5.62ab |
| High density lipoprotein (mg/dL) | 27.56±0.01a | 28.05±0.02a | 29.45±0.01a | 28.09±0.01a |
| Low density lipoprotein (mg/dL) | 34.66±2.64ab | 38.27±1.53b | 44.03±1.99a | 39.80±2.44a |

Means bearing different superscripts in the same row differ significantly (p<0.0001).
at 28 weeks of age. Kabir (2012) documented the existence of significant difference of serum total protein in chickens as compared to other poultry birds (goose, duck, pigeon, and quail). Comparative studies between the Nigerian duck and the Nigerian laughing dove revealed significantly higher levels of total plasma proteins (Olayemi et al., 2006). Mulley (1979) did not find any difference in protein values between male and female black ducks. The species-difference in serum protein estimates, revealed in our study agrees with that of Kabir (2012).

**Albumin**: The genotypes differ significantly (p<0.0001) for serum albumin. The species difference was clearly evident with chickens showing higher serum albumin level than the ducks. The results are also in accordance with Mondal and Sahoo (2012) who obtained similar values for serum albumin in Muscovy Ducks. Studies on “between breed” comparison by Swathi and Sudhamayee (2005) suggested lower serum albumin levels in indigenous ducks than crossbred. Gyenis et al. (2006) reported genotype differences in the laying chickens for the above metabolite. They suggested significant increase in the albumin level in the laying period, and differences do occur as per genotypes.

**Globulin**: There was no significance (p>0.0001) difference in the serum globulin levels among the genotypes. On the contrary, Kabir (2012) documented existence of significant difference of serum globulin levels in chickens as compared to other poultry birds. Swathi and Sudhamayee (2005) reported lower serum globulin values in indigenous ducks than the crossbreds. Globulin fractions are increased due to increased protein synthesis in liver during the peak laying period (Swathi and Sudhamayee, 2005). Olayemi et al. (2006) observed significantly higher levels of plasma globulin in the Nigerian ducks as compared to Nigerian laughing doves.

**Albumin:Globulin ratio**: Albumin: Globulin ratio in serum did not differ significantly (p>0.0001) among the genotypes except in Pekins, indicating a constant proportion maintained between these two parameters in both the egg laying species alike. As the literature is hollow in this aspect, not much interpretation was feasible for assigning any biological meaning to this trend.

**Calcium**: The White Leghorns showed significantly higher serum calcium level followed by the Kuzhi indigenous ducks followed by Khaki ducks with no significant difference between Kuzhi and Khaki ducks, could be indicative of their calcium mobilization needs in blood, due to their high egg production status and consequent need for higher calcium need for egg shell formation in the WLH chickens. However, the literature being silent on this inter-species blood/serum calcium comparison, not much could be interpreted beyond this speculation.

**SGOT (Serum glutamate oxaloacetate transaminase)**: The WLH chickens showed significantly higher (p<0.0001) SGOT values among the genetic groups. Within the ducks, Pekins had lower values than Khakis and Kuzhitis. However no significant difference was observed between Khaki and Kuzhi ducks for serum SGOT levels. The values obtained for ducks in our study is in accordance with Tully et al. (2009). Mulley (1979) reported no difference in the values of serum SGOT in male and female black ducks. Similar results were reported by Khan et al. (2013) in Jinding ducks. Mondal and Sahoo (2012) documented higher values for this serum parameter in Muscovy ducks. The difference in species evidenced in the study could not be reasoned much, due to scarcity of literature in this aspect.

**SGPT (Serum glutamate pyruvate transaminase)**: The Leghorn chickens showed higher (p<0.0001) SGPT values than the ducks. Among the ducks, the Khakis were significantly higher than Kuzhi ducks. The result obtained in our study is in accordance with previous reports by Khan et al. (2013) in Jinding ducks and Mondal and Sahoo (2012) in Muscovy ducks. Mulley (1979) observed no significant difference between the sexes for serum SGPT levels in black ducks.

**Lipid Profile**

**Total cholesterol**: The cholesterol content in poultry blood has traditionally been studied, very elaborately, owing to its implications on their meat quality and associated consumer consciousness. However, many chicken studies have demonstrated that fluctuation in total serum cholesterol is usually precipitated more due to dietary differences, than genetic differences.

In the current study, the serum total cholesterol was significantly lower (p<0.0001) in the Kuzhi ducks followed by Khaki, among the genetic groups. However the values did not differ significantly between Pekins and WLH chickens. The differences evidenced between the genotypes were well expected due to the genotype associated differences. The values obtained in chickens are in agreement with Peebles et al. (2004). Simaraks et al. (2004) did not find any difference in serum total cholesterol values between male and female Thai chickens. Comparative studies between two laying strains of chicken (Leghorn verses Hy-Line Brown), depicted no difference for the above trait in the peak laying period (Gyenis et al., 2006). Lien et al. (2001) documented existence of wide difference in the lipid metabolism in WLH chickens in growing and laying period. According to Lien et al. (2005) the differences in body composition results from differences in metabolism of macronutrients including lipids, which clearly explains the higher serum total cholesterol levels in the Pekin ducks in the present study.
Triglyceride: Within the genetic groups, WLH chickens depicted significantly higher (p<0.0001) level of serum triglyceride followed by Khaki, Pekins and Kuzhi ducks. A clear species difference observed for the above trait in the study could be due to the inherent metabolic and biochemical functions in the body of these two species. The value for serum triglyceride for chickens in the present study is lower than the earlier reports (Lien et al., 2001; Peebles et al., 2004) in laying chickens. Gyenis et al. (2006) observed marked increased in serum triglyceride level with a clear genotype difference in laying chickens. The efficiency of lipid metabolism in the birds is also influenced by type of breed (Hermier et al., 2003; Lien et al., 2005). This clearly explains the variation in duck breeds obtained in our study.

Very-low-density lipoprotein cholesterol (VLDL): Across the genetic groups, WLH chickens depicted significantly higher (p<0.0001) level of serum very-low-density lipoprotein cholesterol (VLDL) followed by Khaki, Pekins and Kuzhi ducks. However there was no significant difference between Khaki and Pekins. The plasma lipoprotein profile of birds does not resemble that of mammals (Lien et al., 2005). During the laying period of the birds VLDL is relatively high which carries the triglyceride to the blood stream (Lien et al., 2005). According to previous published reports laying birds follicles can secrete estrogens that stimulate lipogenesis, and resulting in the relatively higher level of plasma and liver triglyceride in the laying period (Jensen, 1977; Poli and Woldord, 1977). This explains the higher level of triglyceride and VLDL obtained in our study. Reports are scanty for discussion regarding the breed differences for the above serum biochemical parameters evidenced in this study.

High-density lipoprotein cholesterol (HDL): The effect of genotype was not significant (p>0.0001) for serum high-density lipoprotein cholesterol (HDL) values. However the Pekins were displayed numerically higher values than other genotypes. Hens have higher serum VLDL and lower HDL values. However the genetic groups, WLH chickens depicted significantly higher (p<0.0001) level of serum very-low-density lipoprotein cholesterol (VLDL) followed by Khaki, Pekins and Kuzhi ducks. A clear species difference observed for the above trait in the study could be due to the inherent metabolic and biochemical functions in the body of these two species. The value for serum triglyceride for chickens in the present study is lower than the earlier reports (Lien et al., 2001; Peebles et al., 2004) in laying chickens. Gyenis et al. (2006) observed marked increased in serum triglyceride level with a clear genotype difference in laying chickens. The efficiency of lipid metabolism in the birds is also influenced by type of breed (Hermier et al., 2003; Lien et al., 2005). This clearly explains the variation in duck breeds obtained in our study.

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CONCLUSION
The impact of different genotypes on the biochemical parameters and enzymatic levels in serum of birds remained little inconclusive through their observed trends, though the ducks were better than chickens with respect to some serum parameters. However, an inherent species difference between the ducks and the chickens was evidenced, as these two species are much apart in their metabolic and biochemical functions in the body. The study provides baseline information of duck verses chickens for various references and therapeutic standard, including pathological conditions. Considering the importance of ducks as the 2nd most potential layer poultry besides chickens, worldwide, further studies are warranted in this area to interpret the variation and fluctuations in serum biochemistry, to conclude on the desirability of different duck breeds including the indigenous Kuzhi breed from Odisha, as ideal table egg producers from consumer’s point of view.

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