Comparing Chick and Grower Stages of Nine Breeds of *Gallus gallus domesticus*, Linnaeus, 1758 for RBC and WBC Parameters

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Abstract

The present study estimates haematological parameters of different breeds of chicken, viz., Aseel, Black Rock, Dahlem Red, Kadaknath, Naked-neck, Red Cornish, Rhode Island Red, Vanaraja and White Leghorn. Blood samples were collected from 40 unsexed birds of each breed, comprising 20 chicks (< 2 months) and 20 growers (2-8months). Erythrocytic parameters such as Haemoglobin, Total Erythrocyte Count, Packed Cell Volume and erythrocyte indices and leukocytic parameters such as Total Leukocyte Count and Differential Leukocyte Count were taken into account. The data were subjected to ANOVA followed by post-hoc analysis and significant differences were observed at $p < 0.01$ and $p < 0.05$. As a whole, Red Blood Cell and White Blood Cell parameters (except Total Leukocyte Count and Basophil percentage which are not significantly different) record significant differences at $p < 0.01$ among and between the breeds. But some birds also differ at $p < 0.05$ among and between themselves.

Declarations

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2nd Author: Designed the study (made plan for the research), Provided facilities for estimation of different parameters and guided in writing results and discussion.

3rd Author: Analyzed data (Performed statistical analysis).

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Introduction

The investigation was conducted on nine breeds of chicken (*Gallus gallus domesticus*) maintained by local poultry farmers of Bhubaneswar as backyard poultry. These breeds are Aseel, Black Rock, Dahlem Red, Kadaknath, Naked-neck, Red Cornish, Rhode Island Red, Vanaraja and White Leghorn. **Aseel** (AS) means real or pure and native to Andhra Pradesh. The standard weight varies from 3 to 4 kg for cocks and 2 to 3 kg for hens. Sexual maturity is gained at 196 days and produces 92eggs per year. (Anonymous 2018). **Black Rock** (BR) **chicken** is a hybrid of selected strains of RIR cockerels and Barred Plymouth Rock hens. They are good foragers, densely feathered to protect from ailments and have strong immune system. They lay around 280 brown eggs in their first year. Dahlem Red (DR) is a dual-purpose chicken. The DR males and females weighed 1786g and 1285g respectively at 20 weeks of age. Sexual maturity is attained at 218 days. Mean total egg production in 52 weeks is 143 (Horst 1999). Kadaknath (KN) or Kalamasi, a fowl with black flesh has most of the internal organs intense black coloured. The blood is also darker than normal blood. These are due to deposition of melanin. Body weight is 920 g at 20 weeks and attains sexual maturity at 180 days of age and lays 105 light brown eggs per year (SA PPLPP 2009). Naked-neck (NN) or Transylvanian Naked-neck or Turken has a brilliant reddish plumage with bright red coloured featherless neck and vent. They are able to withstand very high temperature than other chicken. They are good layers and meat producers. The standard weights of cock, cockerel, hen and pullet are 3.82kg, 3.37 kg, 2.92 kg and 2.47 kg respectively and lays 180eggs per year (Grobbelaar et al. 2010). Red Cornish (RC) or Indian game bird are heavy, muscular birds and require little feed if allowed free range and produce 160-180 brown eggs per annum. However, they are highly prone to parasites and need extra shelter as their feathers tend to be thinner than other chicken (Dohner 2021). Rhode Island Red (RIR) is probably best egg-layer, laying 250 eggs per year among dual-purpose chickens and has been widely used for that function. It is advantageous over other breeds because of longevity and very strong adaptability to all sorts of conditions or feed (Dohner 2021). Vanaraja (VR) is a multi-coloured dual-purpose bird with attractive plumage, better immunity against common poultry diseases and adaptable to the free-range rearing. The males attain moderate body weight at eight weeks of age under regular feeding system. The hen lays 160-180 eggs in a laying cycle. (Anonymous 2007-2008). White Leghorn (WL), the most popular commercial strain of layer chickens' worldwide lays 280 white eggs per year. The leghorn is a light breed and weighs only 1.5 to 2.0 Kg and not a viable meat producer (Akers et al. 2002). Out of nine breeds, one egg type WL

belongs to Mediterranean class; two meat type breeds RC and BR belong to American class; two English breeds RIR and DR; two Indian breeds Aseel and Kadaknath, one hybrid of chicken and domesticated turkey Naked-neck and one synthetic breed Vanaraja. All chicken breeds have common ancestor the Red Jungle Fowl (RJF) and the variety of breeds are the result of excessive breeding and cross-breeding programs. Due to which, though all these breeds are different but they all are placed in same taxonomic position and comes under same binomial name *Gallus gallus domesticus* (**Kanginakudru et al., 2008)**.

In poultry birds, many factors influence blood parameters, like molting (Driver 1981), physical condition, parasites, overcrowding (Lokhande et al. 2009), breeds, age, sex, feed, season, temperature, environment etc. Therefore, establishing a certain value for a breed as a whole is difficult. Complete blood count (CBC) may facilitate early diagnosis and treatment of disease (Clark et al. 2009). If all parameters are normal, then it reflects healthy status of bird. Earlier authors have mentioned hematological parameters of various chicken breeds mostly considering adult stages. Even, differences in these parameters as per age, sex, breed, rearing conditions have been reported. But comparison of CBC, considering chick and grower stages of these wide range breeds of chicken, reared under same conditions are unavailable. So, authors have attempted to evaluate and analyze hematological differences between these birds.

Materials And Methods

Design, type of sample and sample size

Blood samples from 40 individual birds, comprising 20 chicks (<2 months) and 20 growers (2-8months) (unsexed) from each breed randomly were collected. Determination of age of chicken was done as per Magwisha et al. 2002. Blood sampling was done during late February to early March with temperature and relative humidity 31-32°C and 62-66% respectively. The precipitation was 19-20mm during this time. The birds selected had body weight ranging from 1 to 2.5 Kg.

Sampling technique and description of data collection tools

Samples were taken out with the help of sterile 2ml syringes [Dispo Van Single Use Syringe, Hindustan Syringes & Medical Devices Ltd., Faridabad, India] and 25-gauge needles [Dispo Van Single Use Needle, Hindustan Syringes & Medical Devices Ltd., Faridabad, India] from the wing vein known as ulnar vein of the birds aseptically (Talebi et al. 2005) and collected in anticoagulant vials containing Ethylene Diamine Tetra-acetic Acid (EDTA) [K_3 EDTA, 2ml *13×75mm, Mfg By: HXS Tech Co., Ltd. PRC. For: Peerless Biotech Pvt. Ltd., Chennai, Tamil Nadu, India] and labeled properly. This was done during afternoon hours, i.e., between 2.00pm to 4.00pm. Blood smears were prepared at site on clean grease free slides [Blue Star Pic-2, Polar Industrial Corporation, Mumbai, Maharashtra, India] and air dried and fixed in methanol [Qualigens Product No.34457, Thermo Fisher Scientific India Pvt. Ltd., Mumbai, Maharashtra, India] for two minutes for later staining. Samples collected were kept in ice box and taken to laboratory for haematological analyses on the same day.

Description of methods and tools

Estimation of CBC include parameters like haemoglobin per cent (Hb %), total erythrocyte count (TEC), total leukocyte count (TLC), packed cell volume (PCV), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) and differential leukocyte count (DLC). Estimation of Hb % was done by Sahli's acid hematin method (Sonia et al. 2012) with Sahli's hemometer [HiMedia GW 191-1NO, Plane hemometer (Square Type), HiMedia Laboratories Pvt. Ltd., Mumbai, Maharashtra, India]. TLC and TEC were counted by using hemocytometer having Neubauer's chamber following Dacie and Lewis (1991) with the help of Turk's [HiMedia RO16-500ML, W.B.C. Diluting Fluid, HiMedia Laboratories Pvt. Ltd., Mumbai, Maharashtra, India] and Hayem's fluid [HiMedia RO13-500ML, R.B.C. Diluting Fluid (Hayemis), HiMedia Laboratories Pvt. Ltd., Mumbai, Maharashtra, India] respectively. PCV were estimated by centrifuging [REMI CENTRIFUGE, Catalogue No.C852 7/94, Serial No. GCLC-1632, REMI MOTORS, Bombay, Maharashtra, India] Wintrobe hematocrit tube method containing blood at 3,500 rpm for 15 minutes. MCV, MCH and MCHC were estimated from the values of PCV, TEC and Hb% of the blood as per appropriate formula (Campbell 1988). For evaluating DLC, the method of Nowaczewski and Kontecka (2012) was followed. Blood smears made earlier were stained with Giemsa stain (Clark et al. 2009) and observed under Hunds Weltzar photomicroscope [MICROSCOPE H 600 WILOZYT PLAN, Serial No. 1024980, Helmut Hund GmbH, Wetzlar-Nauborn, Germany]. Giemsa stain was prepared from Giemsa powder [Qualigens CAS NO. 51811-82-6 Product No. 39382, Thermo Fisher Scientific India Pvt. Ltd., Mumbai, Maharashtra, India] as per the standard protocol (Lillie 1977). For DLC, 20 observations per type of cell from each type of bird were taken except basophils. The entire data obtained were analysed by the statistical software Paleontological Statistics (PAST) Version 2.17 [Natural History Museum, University of Oslo] for One-Way Analysis of Variance (ANOVA) followed by post-hoc analysis (Tukey's pair wise comparison tests). Significant differences were tabulated and studied at $p < 0.01$ and $p<0.05$.

Results

Haemoglobin (Table 1) differs among and between groups of birds as follows. AS chicks show significant difference at $p<0.01$ with RC chicks and growers of DR, KN, NN, RC, VR and WL whereas AS growers reflects significant difference at $p<0.01$ with BR chicks and DR, KN and RC growers. BR chicks are significantly different at $p<0.01$ with DR and RC chicks and BR, KN, NN, RC, RIR, VR and WL growers whereas BR growers are significantly different at $p<0.01$ with DR and KN growers. DR chicks have significant differences at $p<0.01$ with DR, KN, NN and RC growers whereas DR growers have significant differences at $p<0.01$ with KN, NN, VR chicks and with both groups of RIR and WL. KN chicks show significant differences at $p<0.01$ with growers of KN, NN and VR and RC birds whereas KN growers reflects significant differences at $p<0.01$ with AS and BR birds and chicks of DR, KN and NN. NN chicks are significantly different at $p<0.01$ with NN and VR growers and RC birds but NN growers are significantly different at $p<0.01$ with RIR, VR and WL chicks. RC birds have significant differences at $p<0.01$ with RIR, VR and WL chicks, however, RIR chicks have significant difference at $p<0.01$ with VR growers. VR chicks reflects significant differences at $p<0.01$ with VR and WL growers whereas VR growers shows significant differences at $p<0.01$ with WL chicks. Significant differences at $p<0.05$ between AS and NN growers, BR and NN growers and DR birds and RC chicks & VR growers are observed.

TEC (Table 1) differs among and between groups of birds as follows. AS chicks have significant difference at p<0.01 with AS, BR, KN and RC growers and RIR chicks whereas AS growers have significant difference at p<0.01 with DR, NN and RIR chicks and WL growers. BR chicks are significantly different at p<0.01 with BR, KN and RC growers and RIR chicks but BR growers are significantly different at p<0.01 with DR, KN, NN, RC and VR chicks and with both groups of RIR and WL. DR chicks show significant differences at p<0.01 with growers of DR, KN and RC, however, DR growers reflect significant differences at p<0.01 with NN and RIR chicks and RC growers. KN chicks reflects significant differences at p<0.01 with KN and RC growers and RIR chicks, however, KN growers show significant differences at p<0.01 with NN, RC and VR chicks and NN growers and all RIR and WL birds. NN chicks are significantly different at p<0.01 with RC and VR growers whereas NN growers are significantly different at p<0.01 with RC growers and RIR chicks. RC chicks records significant differences at p<0.01 with RC growers and RIR chicks but RC growers have significant difference at p<0.01 with both groups of RIR, VR and WL. RIR chicks records significant differences at p<0.01 with RIR growers and all VR and WL birds. Significant differences at p<0.05 are observed between AS growers and RC birds, RIR growers & VR chicks, DR chicks and VR growers and DR & WL growers.

PCV (Table 1) differs among and between groups of birds as follows. AS chicks have significant differences at p<0.01 with DR, KN, NN and VR growers and both groups of RC whereas AS growers have significant differences at p<0.01 with DR, KN and RC growers. BR chicks are significantly different at p<0.01 with growers of DR, KN, NN, RIR, VR and WL growers and all RC birds whereas BR growers are significantly different at p<0.01 with DR, KN, NN, RC and VR growers. DR chicks reflects significant difference at p<0.01 with DR and KN growers whereas DR growers shows significant difference at p<0.01 with KN, NN and VR chicks and all RIR and WL birds. KN chicks records significant difference at p<0.01 with KN growers whereas KN growers have significant difference at p<0.01 with NN, VR and WL chicks and all RIR birds. NN chicks show significant difference at p<0.01 with NN and VR growers, RC chicks & growers whereas NN growers reflects significant difference at p<0.01 with RIR, VR and WL chicks. RC growers have significant differences at p<0.01 with RIR, VR and WL chicks. RIR and VR chicks have significant differences at p<0.01 with VR growers. Significant difference at p<0.05 are observed between AS and NN growers, BR chicks and DR & KN chicks and DR growers and RC chicks.

MCV (Table 1) differs among and between groups of birds as follows. Significant differences are observed at p<0.01 between RC chicks and AS chicks & NN growers, RC growers and Aseel chicks and RIR chicks and all other birds considered in this study.

MCH (Table 1) differs among and between groups of birds as follows. RIR chicks have significant difference at p<0.01 with AS, BR, DR, KN, NN, RC, VR and WL birds and RIR growers.

MCHC (Table 1) differs among and between groups of birds as follows. AS chicks and growers have significant difference at p<0.01 with BR growers & RC chicks and KN chicks respectively. BR growers reflects significant difference at p<0.01 with DR, KN and VR chicks. DR chicks and growers show significant differences at p<0.01 with NN & RC chicks and KN chicks. KN chicks are significantly different at p<0.01 with KN growers and NN, RC and WL birds. RC and NN chicks record significant difference at p<0.01 and p<0.05 respectively with VR chicks. All AS birds are significantly different at p<0.05 with NN and DR chicks.

TLC do not have any significant differences between and among the 9 breeds of chicken (Table 2).

Lymphocytes (Table 2) differs among and between groups of birds as follows. AS chicks and growers are significantly different (p<0.01) with DR & RIR chicks and chicks and growers of NN, RC and VR. BR rock chicks have significant differences (p<0.01) with DR chicks, KN growers, NN, RC, RIR & VR birds whereas BR growers have significant differences (p<0.01) with DR & RIR chicks and NN, RC & VR birds. DR chicks show significant differences (p<0.01) with KN & VR chicks and WL birds but DR growers reflect significant differences (p<0.01) with NN birds and chicks of RC, RIR & VR. KN chicks reflect significant differences (p<0.01) with NN & VR birds and RC & RIR chicks whereas KN show significant difference (p<0.01) with NN birds and VR chicks. NN birds are significantly different (p<0.01) with RIR growers and WL birds. RC chicks and growers record significant difference (p<0.01) with WL birds and VR & WL chicks respectively. RIR chicks and growers are significantly different (p<0.01) with WL birds and VR chicks respectively. VR chicks and growers have significant difference (p<0.01) with VR growers & WL birds. AS, BR & DR, NN chicks and RC growers reflect significant differences (p<0.05) with KN & RIR, DR, RC and WL growers.

Monocytes (Table 2) differs among and between groups of birds as follows. AS chicks and growers are significantly different (p<0.01) with NN birds, RIR & VR chicks and NN chicks respectively. BR chicks and growers have significant differences (p<0.01) with DR chicks and both groups of NN, RC, RIR & VR whereas BR chicks and growers also have significant difference (p<0.01) with both groups of KN and KN growers respectively. DR chicks and growers show significant differences (p<0.01) with DR growers and KN growers & NN, RC, RIR and VR birds respectively. KN chicks reflect significant differences (p<0.01) with both groups of NN chicken. Both groups of NN, RC, RIR & VR chicks and RC growers are significantly different (p<0.01) with both groups of WL and WL chicks. AS, BR, RC & RIR growers, DR chicks & KN growers and NN chicks record significant differences (p<0.05) with BR & VR, KN chicks, WL, NN birds and VR growers respectively.

Eosinophils (Table 2) differs among and between groups of birds as follows. AS chicks are significantly different (p<0.01) with DR & KN growers and both groups of NN, RC, RIR and VR. AS growers and BR birds are significantly different (p<0.01) with DR, RC & RIR chicks, VR growers and NN birds. DR chicks and growers have significant differences (p<0.01) with KN chicks & WL birds and NN birds & VR chicks. KN chicks and growers show significant differences (p<0.01) with NN & VR birds and KN chicks also show significant differences (p<0.01) RIR chicks. RC growers and WL birds reflect significant differences (p<0.01) with VR growers and NN & RIR birds, RC chicks & VR growers respectively. BR birds, DR & KN growers, NN birds and RIR growers record significant differences (p<0.05) with RC & RIR growers and VR birds respectively.

Heterophils (Table 2) differs among and between groups of birds as follows. As a whole, all the birds are significantly different at p<0.05. But no significant difference is observed among and between them.

Basophils do not have any significant difference exists among and between groups of 9 breeds of chicken (Table 2).

H/L (Table 2) differs among and between groups of birds as follows. AS birds differs significantly at $p<0.01$ with NN and VR chicks. BR chicks and growers differ significantly at $p<0.01$ with DR, NN, RC, RIR & VR birds and KN & WL growers and VR chicks respectively. WL chicks differs significantly at $p<0.01$ with DR, NN, RC, RIR and VR chicks and KN chicks differs significantly at $p<0.01$ with NN, RC and VR chicks. AS chicks differ significantly at $p<0.05$ with DR & RIR chicks, NN growers and RC birds whereas AS growers differs significantly at $p<0.05$ with chicks of DR, RC and RIR. BR growers, DR, KN and WL chicks differ significantly at $p<0.05$ with NN, RC & RIR chicks, KN chicks, NN & RC growers & RIR chicks and NN, RC & VR growers respectively.

Discussion

All the grower chicken from the present study has some or other similarity with that of 6-12 months old indigenous chicken from Bangladesh studied by Sharmin and Myenuddin (2004) in case of Hb%, TEC, PCV, MCV, MCH, monocyte, eosinophil and basophil content of DLC. AS, NN and RC chicks and KN and WL chicks have similar MCH values with that of 44-day old broiler chicken reported by Nowaczewski and Kontecka (2012) and 42-day old control group broilers (Bedáňová et al. 2007) respectively. AS, BR, KN, NN, RC, RIR and WL chicks have similar Hb%, PCV, MCHC, lymphocyte, heterophil and basophil percentage (DLC) with that of one day old control group broiler chicks mentioned by Ayuk and Essien (2009). RC and BR chicks have similar PCV and Hb value respectively with that of 42day old control group broilers (Bolu et al. 2009). RC chick have approximately similar TLC values with that of one day old control group broiler chick studied by Okunlola et al. 2015. AS, BR, DR, NN, RC and WL growers have similar TLC, lymphocyte, eosinophil and basophil % from DLC with that of 18 weeks old indigenous and Ross-308 cocks and hens (Abdi-Hachesoo et al. 2011).

KN and RC growers have similar Hb% with that of indigenous chicken but AS, KN, NN, RIR, VR and WL chicks have similar Hb% with that of broiler chicken. Also, RC chicks and NN, VR and WL growers have similar Hb% with that of Fayomi and ISA brown chicken respectively. WL chicks and KN growers have similar TLC value with that of indigenous chicken whereas NN chicks and RIR growers have similar TLC value with that of broiler chicken. While considering DLC, VR chicks have similar lymphocyte % with that of indigenous chicken whereas NN chicks have similar lymphocyte % with that of broiler chicken and ISA brown chicken. Also, RIR growers have similar lymphocyte% with that of broiler chicken. RIR and NN chicks and VR growers have similar heterophil% with that of indigenous, Fayomi and ISA brown chicken. RIR grower have similar eosinophil% with that of indigenous chicken. NN, RIR and VR chicks have similar monocyte % with that of broiler chicken and ISA brown chicken (Kabir 2012).

KN and NN chicks have similar MCV and MCH with that of one day to 4 weeks old dominant blue and frizzled chicken; also, VR chicks have similar MCH with that of one day to 4 weeks old dominant blue chicken. All chicks of present study have some or other similar MCHC with that of one day to 4 weeks old different local and exotic chicken (Isidahomen et al. 2011) respectively. RIR grower have similar Hb and PCV with that of adult RIR; KN grower have similar MCH with that of adult KN; WL grower have similar PCV and MCHC with that of adult WL (Pandian et al. 2012). WL and NN grower have similar Hb and MCH with that of 21 weeks old Nera black strain chicken (Azeez et al. 2009). AS grower have similar Hb with that of 3 months old Assil. Similarly, RC and WL growers have similar TEC and PCV with that of 3 months old Fayomi chicken. Also, DR and RIR grower have similar MCH with that of 3 months old local chicken. While comparing chicks from both studies, KN, NN, RIR and WL chicks have similar Hb, DR chick have similar TEC and DR and NN chick have similar MCH with that of 1 month old local chicken. Moreover, BR chick and grower have similar MCV with that of 1 and 3 months old Fayoumi chicken (Islam et al. 2004). All the chicken studied by the above author are from Sylhet region of Bangladesh.

DR grower have similar PCV with that of 14-18 months old Nigerian indigenous normal feathered and HARCO breed chicken whereas Hb value has resemblance only with 14-18 months old HARCO chicken. BR and RC have similar MCH with that of 14-18 months old Nigerian indigenous and exotic chicken. NN, KN and RIR growers have similar lymphocyte percentage (DLC) with that of 14-18 months old Nigerian indigenous normal feathered and ISA brown chicken (Ajayi et al. 2014). DR, BR, KN, RIR, VR and WL growers have similar haemoglobin content, TEC, MCH, TLC and lymphocyte percentage with that of adult Malaysian jungle fowl studied by Adnan and Babjee (1985). DR growers have similar Hb with that of frizzled, naked-neck and normal feathered genotypes of Nigerian indigenous chicken whereas they have similar PCV with that of frizzled genotype only. Moreover, RC grower have approximately similar RBC count and KN, NN, RC, RIR and WL have likeliness in MCHC value with different genotypes of Nigerian indigenous chicken (Peters et al. 2011).

DR grower have similar Hb value with that of normally feathered Nigerian indigenous cocks whereas BR chick, KN, NN and RC growers, RIR, VR and WL chick and grower have similar MCHC value with both naked-neck and normally feathered Nigerian indigenous chicken (Ladokun et al. 2008). DR growers have similar Hb%, KN and RC growers have similar RBC count, DR, KN and VR chicks and growers, NN chicks, RIR growers have similar MCH value, AS chicks and NN growers have similar WBC count, AS and WL chicks and BR growers have similar heterophil count, DR chicks and VR growers have similar lymphocyte%, DR and RIR chicks, KN and VR growers have similar monocyte%, DR and RC chicks and VR growers have similar eosinophil %, AS, RC and VR growers, KN chicks, NN chicks and growers have similar basophil % (DLC) with that of adult native chicken of Kashmir as per Pampori and Iqbal (2007). AS growers and BR chicks has similar PCV with that of black Nicobari fowls (Kundu et al. 2013).

AS and WL chicks has similar TEC value with that of 21-42 days old selected Hubbard, Ross and Cobb strain broilers respectively but RC chick have same PCV and MCH with that of 21-42 days old selected Hubbard and Ross strain broilers. Also, NN and RC chick have same MCHC with that 21-42 days old non-selected FC strain broilers. However, WL chicks have same WBC count with that of 21-42 days old selected Cobb and non-selected FC strain broilers (Furlan et al. 1993). NN and RIR growers have resemblance in Hb; VR growers in RBC count; DR, RC and VR growers in PCV; DR growers in heterophil % and NN, RC and VR in basophil % with 6-8 months old Thai indigenous chicken (Simaraks et al. 2004).

AS, KN, NN, RIR, VR and WL, DR and RC chicks have similar Hb with that of 1-day old Arian broilers, 7-and 14 days old Arian broilers respectively. KN and WL chicks and RC growers have RBC count close to that of 1- and 7-days old Cobb broilers and 56 days old Arbor-acres and Cobb broilers. RC chicks have PCV close to 1-day old Arbor-acres, Ross, 7 days old Arbor-acres and 14 days old Cobb broilers; BR, AS, DR and RC chicks and WL growers have near MCH value

with that of 1-day old Arian broilers, 21 days old Cobb broilers, 28 days old Arian broilers, 28 days old Arbor-acres, 49 days old Arian broilers and 56 days old Arbor-acres broilers respectively. NN and RC chicks have similar MCHC value with that of 28 days old Arian broilers (Talebi et al. 2005).

NN and DR chicks have nearer Hb value with that of one-week local and Muscovy duck respectively; AS chicks and RIR and VR chicks have alike lymphocyte % and monocyte % respectively with that of one-week local duck; DR chicks and BR and KN chicks have similar monocyte % and heterophil % with that of one-week muscovy duck; AS, BR and KN chicks have similar H/L ratio with that of one-week muscovy duck (Ismoyowati et al. 2012). VR and RIR growers have similar lymphocyte % and H/L ratio with that of 8-10 weeks old Nigerian ducks (Olayemi et al. 2003) and DR and RC growers have similar PCV and MCV values with that of 8-10 weeks old Nigerian local ducks (Oyewale et al. 1998).

KN, NN, RC and VR growers and NN growers have similar Hb and lymphocyte & heterophil count with that of guinea fowl growers (Alli et al. 2011); RC chicks have similar Hb value with that of 1 week old cage-raised Japanese quail mentioned by Aina and Ajibade (2014); RIR and WL chicks have similar MCHC with that of 4 weeks old control group Japanese quail (Akade et al. 2012) and AS, BR, DR, KN and VR growers have similar TEC value with that of 5-7 weeks old Japanese quails (Ali et al. 2012). BR, DR and KN growers, DR, KN, NN, RC and VR growers, RC and WL growers and NN growers have similar TEC, Hb, heterophil and eosinophil value with that of 119 days old B.U.T 6 hybrid turkeys (Lazăr et al. 2012) from Romania; KN and RC growers and AS and BR growers have similar Hb and lymphocyte value with that of 1-10 months old juvenile ostriches from Bostwana (Mushi et al. 1999) and RC and NN chicks have similar MCV and monocyte value with that of 1-day old ostrich chick (Jelena et al. 2007).

RC, VR, KN and NN growers have similar RBC, MCV, MCH and eosinophil values respectively with that of young captive hill mynah (Archawaranon 2005) and NN and RC growers have similarity in eosinophil and lymphocyte percentage with that of young common cranes (Puerta et al. 1990). VR and DR growers have similar TEC and PCV values with that of 5 weeks old juvenile ring-necked pheasants (Schmidt et al. 2007). BR, RC and VR chicks and DR growers have similar TEC with that of 1- and 5-months old pheasants respectively; WL growers have same Hb value with that of 5 months old pheasants; RC chick and DR growers and VR chicks have same PCV, MCH, heterophil and basophil counts with that of 1 month old pheasants reported by Keçeci* and Col (2011). DR and AS chicks have same Hb and MCH with that of nestling bearded vultures mentioned by Hernández and Margalida (2010).

NN, AS and RIR and WL and RC chicks have similar Hb, MCH and MCHC values respectively with that of <4 weeks old houbara bustard chicks and white-bellied bustard chicks. Similarly, RIR and WL chicks have same MCHC with that of 4-8 weeks old white-bellied bustard chicks. Moreover, AS chicks and AS, DR and KN chicks have same MCH and MCHC values with that of 8-12 weeks old rufous-crested bustard chicks and white-bellied bustard chicks. DR growers have similar Hb value with that of 12-16weeks old juvenile houbara bustard and white-bellied bustard. KN, NN, RC and WL growers have same MCHC with that of 16-20 weeks old juvenile white-bellied bustard. WL, RIR and VR growers have same MCH and MCHC values with that of 20-24 weeks old juvenile rufous-crested bustard and white-bellied bustard (Howlett et al. 2002).

Maximum birds from the present study show monocytosis which may be due to some infections or inflammations. Present study reflects eosinophilia in all birds which may be due to inflammatory and allergic reactions in body caused by food, water or environment (Clark et al. 2009). H/L ratio, an indicator of stress level, is also enhanced except, NN and VR chicks. Normally, H/L ratio should be 0.4-0.5 but under stress it goes up. Also, the heterophil count is more than lymphocyte count (Bedáňová et al. 2007), except the above-mentioned birds. These conditions occur when the birds are under some kind of stress or suffering from any physiological or pathological conditions.

The current study reports that erythrocytic and leukocytic parameters change with respect to age and sex among and between nine breeds of chicken though all of them belong to same taxa and comes under same binomial name, *Gallus gallus domesticus*. The likeliness observed while comparing this work with previous publications might have resulted mostly due to closeness in age, breed, taxonomic position, climate, environment, onset of maturity in case of growers, time of collection of blood or similar farm conditions. Apart from these factors, similarity in erythrocyte indices such as MCH, MCV and MCHC and H/L ratio might have been observed because of following same formula as previous authors while calculating. The matching of observations with many control group birds from previous researches might have occurred because the birds considered in the present study are not subjected to any type of dietary or accommodative experiments. This study may focus on the effect of above parameters on the quality of chicken poultry products and may help future investigators to consider these factors during analysis and interpretation of data. Moreover, genetic studies can reveal where these birds differ from each other and their common ancestor red jungle fowl (RJF) due to which also, the differences in their blood parameters might have occurred.

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Tables

Table 1. Hb, TEC, PCV and erythrocyte indices of nine breeds of chicken as per age

eds/Age		Hb (%) (20)	TEC ($\times 10^6/mm^3$) (20)	PCV (%) (20)	MCV (μ^3) (20)	MCH (pg) (20)	MCHC (%) (20)
	CHICK	7.2 ± 0.43^{a}	1.89 ± 0.17^{a}	22.6 ± 1.38^{a}	168.70 ± 48.67^{a}	54.62 ± 16.32^{a}	$31.98\pm0.47^{a,1}$
	GROWER	8.39 ± 0.31^{b1}	$2.54\pm0.16^{a,1}$	$24.55\pm0.97^{b,1}$	100.45 ± 3.92^{b}	34.41 ± 1.37^{b}	$34.24\pm0.14^{b,2}$
	CHICK	$6.51\pm0.36^{b,c}$	$1.97\pm0.13^{b,c}$	$20.15\pm1.36^{c,2}$	106.04 ± 4.19^{c}	34.40 ± 1.40^{c}	32.54 ± 0.59
	GROWER	$8.41\pm0.18^{c,d,2}$	$2.80\pm0.14^{a,c,d}$	24.25 ± 0.57^{d}	89.72 ± 3.66^{d}	31.14 ± 1.23^{d}	$34.74\pm0.18^{a,c}$
	CHICK	$8.18\pm0.25^{c,e,3}$	$1.77\pm0.09^{b,d,e,2}$	$25.8\pm0.48^{e,2}$	152.06 ± 8.33^{e}	46.99 ± 1.22^{e}	$31.88\pm1.08^{c,d,2}$
	GROWER	$11.39\pm0.17^{a,b,c,d,e,f,4}$	$2.45\pm0.10^{d,e,f,3}$	$33.43\pm0.56^{a,b,c,d,e,f,3}$	139.63 ± 5.25^{f}	47.68 ± 1.88^{f}	34.11 ± 0.21^{e}
	CHICK	$7.96\pm0.21^{f,g}$	$2.05\pm0.10^{d,g}$	$25.75\pm0.60^{f,g,2}$	131.08 ± 6.60^{g}	39.88 ± 1.27^{g}	$31.01\pm0.70^{b,c,e,f}$
	GROWER	$10.69\pm0.20^{a,b,c,d,e,g,h}$	$2.86\pm0.07^{a,c,e,g,h}$	$32.05\pm0.80^{a,b,c,d,e,g,h}$	112.89 ± 3.56^{h}	37.56 ± 0.76^{h}	33.63 ± 0.75^{f}
	CHICK	$7.79\pm0.28^{f,h,i}$	$1.59\pm0.07^{b,d,f,h,i}$	$22.73\pm0.97^{f,h,i}$	145.29 ± 5.89^{i}	49.92 ± 1.89^{i}	$34.49\pm0.45^{d,f,1,3}$
	GROWER	$9.97\pm0.21^{a,c,e,\ g,j,i,1,2}$	$1.96\pm0.07^{d,h,j}$	$29.76\pm0.72^{a,c,d,i,j,1}$	153.60 ± 3.25^{j}	51.48 ± 1.01^{j}	33.55 ± 0.22^{f}
	CHICK	$9.81\pm0.51^{a,c,g,i,k,\ 3,\ 4}$	$1.91\pm0.08^{d,h,k,1}$	$28.35\pm1.60^{a,c,i,3}$	$151.79\pm7.77^{a,j,k}$	52.55 ± 2.49^{k}	$34.78\pm0.40^{a,d,f,g}$
	GROWER	$10.11\pm0.38^{a,b,c,e,g,i,l,2}$	$3.15\pm0.17^{a,b,c,e,f,g,i,j,k,l,1}$	$30.4\pm1.41^{a,b,c,d,i,k}$	$97.37\pm1.82^{a,l}$	32.64 ± 0.65^{l}	33.55 ± 0.42^{f}
	CHICK	$7.95\pm0.29^{f,h,j,k,l,m}$	$1.21\pm0.11^{a,b,c,d,f,g,h,j,k,l,m}$	$23.7\pm0.85^{f,h,j,k.l}$	$282.00\pm51.16^{a,b,c,d,e,f,g,h,i,j,k,l,m}$	$93.90\pm16.78^{a,b,c,d,e,f,g,h,i,j,k,l,m}$	33.51 ± 0.10
	GROWER	$8.66\pm0.14^{c,f,h}$	$1.94\pm0.08^{d,h,l,m,1}$	$26.35\pm0.57^{c,f,h}$	139.30 ± 5.47^{m}	46.00 ± 1.95^{m}	32.98 ± 0.35
	CHICK	$7.35\pm0.35^{f,h,j,k,l,n}$	$1.94\pm0.15^{d,h,l,m,1}$	$22.9\pm1.10^{f,h,j,k,m}$	129.06 ± 9.61^{m}	41.49 ± 3.16^{m}	$32.11\pm0.23^{c,g,3}$
	GROWER	$9.76\pm0.35^{a,c,g,i,\ m,n,o,3,4}$	$2.39\pm0.12^{i,l,m,2}$	$30.00\pm1.04^{a,c,d,i,j,l,m}$	130.64 ± 7.08^{m}	42.46 ± 2.31^{m}	32.56 ± 0.41
	CHICK	$7.92\pm0.24^{f,h,j,k,l,o}$	$2.09\pm0.11^{d,h,l,m}$	$23.65\pm0.84^{f,h,j,k}$	117.87 ± 5.67^{m}	39.56 ± 1.87^{m}	33.63 ± 0.45^{f}
	GROWER	$9.19\pm0.51^{a,c,f,m,n}$	$1.86\pm0.11^{b,d,h,l,m,3}$	$27.25\pm1.60^{c,f}$	150.90 ± 8.41^{m}	50.96 ± 2.73^{m}	33.84 ± 0.25^{f}
		16.6**	15.83**	12.4**	9.651**	5.865**	5.072**
		2.75E-35	8.40E-34	8.07E-27	1.70E-11	7.97E-12	6.96E-10

** means significant difference at p<0.01, similar alphabets in superscripts mean significant difference (p<0.01) within breeds, similar numbers in superscripts means significant difference (p<0.05) within breeds, number in parentheses shows number of samples.

Table 2. TLC and DLC of nine breeds of chicken as per age

Breeds/Age		TLC ($\times 10^3/mm^3$) (20)	L (%) (20)	M (%) (20)	E (%) (20)	H (%) (20)	B (%)	H/L (20)
AS	CHICK	16049.50±3720.82	$27.30\pm2.01^{a,1}$	14.60 ± 0.96^{a}	25.40 ± 1.07^{a}	32.00±2.15	1.60±0.16(10)	$1.37\pm0.15^{a,\ 1}$
	GROWER	9862.40±88.77	29.95 ± 2.29^{b}	$13.70\pm1.50^{b,1}$	19.45 ± 2.25^{b}	35.30±2.92	3.50±2.06(10)	$1.35\pm0.15^{b,\ 2}$
BR	CHICK	7551.70±685.85	$21.65\pm2.26^{c,2}$	$21.50\pm1.45^{c,1}$	$22.70\pm2.04^{c,\ 1}$	33.20±2.43	1.50±0.19(12)	1.87 ± 0.24^{c}
	GROWER	3979.60±246.89	29.35 ± 2.96^{d}	$20.95\pm1.49^{d,\ 2}$	$21.85\pm2.37^{d,\ 2}$	26.65±2.42	1.83±0.24(12)	$1.31\pm0.27^{d,\ 3}$
DR	CHICK	49491.35±1765.99	$49.30\pm2.69^{abcde,3}$	$10.50\pm1.84^{cde,\ 3}$	8.05 ± 2.16^{abcde}	29.10±1.92	1.65±0.13(20)	$0.61\pm0.04^{ce,\ 1,2,4}$
	GROWER	26966.25±307.27	$35.75\pm2.86^{f,2,3,4}$	20.40 ± 2.59^{ef}	$15.90\pm2.61^{af,\ 3}$	25.65±2.43	1.45±0.13(20)	0.78 ± 0.10^{c}
KN	CHICK	10860.10±696.25	31.65 ± 3.90^{eg}	$13.45\pm1.40^{cg,\ 2}$	19.90 ± 2.10^{eg}	33.10±1.82	3.21±1.45(14)	$1.39\pm0.17^{f,\ 4,5}$
	GROWER	11754.95±1177.75	$41.55\pm4.27^{ch,1}$	$10.80\pm1.48^{cdf,\ 4}$	$15.10\pm2.43^{ah,\ 4}$	29.70±1.75	1.71±0.16(14)	0.98 ± 0.15^{c}
NN	CHICK	14597.95±315.80	$61.70\pm2.04^{abcdfghi,5}$	$3.05\pm0.52^{abcdfgh,3,4,5}$	$2.95\pm0.36^{abcdfghi,5}$	31.15±1.72	2.00±0.35(13)	$0.52\pm0.03^{\ abcfg,\ 3}$
	GROWER	16822.65±1030.39	56.50 ± 1.57^{abcdfghj}	$2.95\pm0.53^{acdfgi,3,4}$	$3.25\pm0.43^{abcdfghj,6}$	35.85±1.39	2.23±0.37(13)	$0.65\pm0.03^{c,\ 1,5,6}$
RC	CHICK	15295.60±2269.57	53.70 ± 3.01^{abcdfgk}	7.95 ± 0.97^{cdfj}	8.50 ± 2.29^{abcdk}	28.70±1.84	1.53±0.19(15)	$0.58\pm0.05^{\ cfh,\ 1,2,3}$
	GROWER	10779.00±1260.78	$47.60\pm3.13^{abcdgl,5,6}$	$9.05\pm1.00^{cdfk,6}$	$13.15\pm2.81^{al,\ 1,5,6}$	28.30±1.77	2.53±0.29(15)	$0.64\pm0.05^{c,\ 1,5,7}$
RIR	CHICK	10582.35±85.27	54.70 ± 2.60^{abcdfgm}	6.60 ± 1.17^{acdfl}	7.00 ± 1.47^{abcdgm}	30.65±1.71	1.40±0.21(15)	$0.59\pm0.05^{ci,\ 1,2,3,5}$
	GROWER	14888.20±1071.74	$41.35\pm2.92^{cijn,1}$	$10.05\pm1.88^{cdf,7}$	$12.30\pm2.10^{ac,\ 2,5,7}$	35.05±4.19	1.86±0.29(15)	1.04 ± 0.21^{c}
VR	CHICK	20057.80±629.01	$65.25\pm2.07^{abcdefghlno}$	$6.25\pm0.84^{acdfm,1}$	$2.40\pm0.53^{abcdfghln,7}$	25.55±1.46	1.91±0.49(12)	$0.41\pm0.03^{\ abcdfj}$
	GROWER	12375.15±1510.86	$49.80\pm3.30^{abcdgop,4}$	$10.60\pm1.91^{cdfi,5}$	$5.75\pm1.70^{abcdgo,\ 3,4}$	31.85±1.96	2.41±0.49(12)	$0.72\pm0.07^{c,\ 8}$
WL	CHICK	11415.45±656.21	28.85 ± 2.74^{eijklmop}	$17.65\pm1.89^{hijklm,7}$	19.65 ± 1.88^{eijkmno}	32.85±3.22	1.71±0.22(14)	$1.43\pm0.22^{\ egh\ ij,\ 6,7,8}$
	GROWER	8318.70±976.60	$33.75\pm2.11^{eijkmop,6}$	$16.85\pm1.76^{hijlm,6}$	20.30 ± 1.38^{eijkmno}	28.25±1.67	1.57±0.13(14)	0.94 ± 0.09^{c}
A		0.9845^{NS}	21.91^{**}	14.84^{**}	15.31^{**}	1.996^{*}	0.6979^{NS}	8.134^{**}
JE		0.4752	7.18E-45	7.72E-32	8.72E-33	0.01107	0.8051	2.85E-17

** means significant difference at p<0.01, similar alphabets in superscripts mean significant difference (p<0.01) within breeds, similar numbers in superscripts means significant difference (p<0.05) within breeds, number in parentheses shows number of samples.