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Age Dependent Growth Performance and Blood Profiling of Broiler Chicken Reared at High Altitude

Deachan Chuskit, Nazia Parveen, Mayarngam Khansu, Swati, O.P. Chaurasia 10.18805/ajdfr.DR-1757

ABSTRACT

Background: Leh-Ladakh is situated at an altitude of 3500 m above mean sea level which poses many climatic challenges to the dwellers and animals of this region including the chickens. Chicken rearing is a huge challenge keeping in view the fact that Leh does not have a native chicken breed of its own that is adapted to this conditions. It is necessary to have an high-altitude adapted chicken breed in order to meet the demands of fresh chicken meat and eggs for the locals and the armies deployed in Ladakh. Therefore, the present study was carried out to evaluate growth performances like body weight, feed conversion ratio (FCR), hematological and serum-biochemical parameters of broiler chicken reared at high altitude.

Methods: During the experimental period the birds were fed according to the rations scale formulated by DIHAR for broiler chicken at high altitude. Body weight was taken weekly up-to 28th week and feed conversion ratio (FCR) were calculated up to 7th week. Blood samples were collected on 7th, 14th, 21st and 28th week of the birds age. Whole blood was used to study different hematological parameters while serum sample was used to study various biochemical parameters.

Result: It was found that broiler reared at high altitude attained 701.3 g at 7th week of their age whereas lowlander broilers are known to attain the equivalent weight by 4th 5th week. Mean FCR by 7th week was found to be 2.38. Among various hematological parameters, hemoglobin (%) increased with the age of birds. Red blood cell also increased with the age. Drop in hematocrit (%) and mean corpuscular volume (fl) value was observed at 14th week and then it increased by 21st and 28th week of age. There was increase in value of mean corpuscular hemoglobin concentration at 14th and 21st week. Erythrocyte sedimentation rate value also dropped with age. Among biochemical parameters; calcium, total protein, aspartate aminotransferase and uric acid was observed to increase with age of the birds whereas triglyceride decreased from 7th week to 28th, thus indicating that the birds are adapting to the environmental condition of high altitude.

Key words: Broiler, Chicken, Growth performance, High altitude, Hemato-biochemical analysis.

INTRODUCTION

It is quite evident that the demand for fresh animal meat is increasing with people opting for better-quality meat. The poultry industry is likewise expanding with the increasing demand for meat as well as eggs across the globe. Poultry is opted not just for its meat but these poultry birds keep humans a company, provides egg, feathers and also contributes in solving issues of unemployment (Mohanty *et al*, 2020). Poultry meat and egg production becomes a necessity in regions that lack a good source of nutritional food at least for half the year like Leh-Ladakh. Various facts that hinders and makes it necessary to establish, expand and popularize poultry farming in region where non-availability of any native breed and commercial hatcheries, challenges with bringing day-old chicks and difficulties in procuring poultry feed prevails (Biswas *et al*, 2010). Ladakh is located in the high himalayas at an altitude of 3000 m-5670 m above mean sea level. It is a cold arid region and because of its geographical location and harsh climatic conditions *i.e* -30°C to +35°C temperature range, hypobaric (540 mmHg) hypoxic (45% of MSL) and dry (30% relative humidity) conditions prevails. The climatic conditions in Ladakh are such that in winter it gets extremely cold for humans as well as animals. With such prevailing climatic conditions and other harsh situations of high altitude, it becomes necessary to emphasize on ways and methods to improve the quality and nutrition of the food.

The main reason high altitude gets detrimental for livestock is that the reduced atmospheric pressure leads to deficiency in oxygen availability which as a consequence affects all parts of the animal body (Smith *et al*, 1955). The performance of poultry birds and any other animals in Ladakh varies from the lower region. Study of growth performances like growth rate, FCR, hematological and biochemical parameters are important factors in determining whether the birds are suited and can perform better at high

DRDO, Defence Institute of High Altitude Research, Leh, Union Territory-194 101, Ladakh, India.

Corresponding Author: Swati, DRDO, Defence Institute of High Altitude Research, Leh, Union Territory-194 101, Ladakh, India. Email: swatikeshri29@gmail.com

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altitude. Blood parameters reflect the status of birds that are exposed to various environmental conditions. Analyzing various hematological and biochemical parameters provides crucial role in the high altitude physiological, nutritional, and pathological status of the birds. The parameters change with the changing environmental conditions which is crucial to understand the physiological status of the animal (Etim *et al*, 2014). Analysis of full blood count thus focuses on the examination of cellular components of blood whereas on the other hand biochemical analysis is mostly performed to study the level of various chemical constituents present in blood (Hrubec *et al,* 2002). Various factors including age and sex are also known to affect the hematological parameters (Brijpuria *et al*, 2017). Hematological studies not only reflects the physiological status but also play a crucial part in determining the productivity and how the birds are adapting to its environment. Various biochemical parameters like total protein, albumin, calcium, uric acid, urea, glucose and triglycerides are being studied to understand how the birds are coping with the physiological changes brought about by various factors like age, sex, housing system, environment and breed *etc.* Therefore, the present study is conducted to evaluate growth performance and various blood parameters of broiler chickens at high altitude.

MATERIALS AND METHODS

Experimental birds

A total of 100 unsexed day-old broiler chicks were procured from CPDO, Chandigarh and these chicks were inducted and reared further at an altitude of 3500 m above MSL at the poultry house of DRDO, DIHAR, Leh Ladakh. These chicks were kept in a room provided with local heating (Bukhari) for initial 3 weeks. Light was provided as 19 hrs light and 5 hrs dark. Vaccine for Ranikhet disease was given to all the experimental birds. Birds were fed on readymade ration and the amount of feed to be given was calculated according to the ration scale formulated by DIHAR poultry division. The experimental study was done with approval from IAEC.

Growth rate and FCR (feed conversion ratio)

Body weight of the experimental birds were taken in the morning before feeding till 28th week. It was followed on weekly basis and FCR was calculated based on feed taken and weight gain at the end of every week till 7th week. Feed taken per bird was also calculated weekly as: total feed given-leftover/total number of birds. FCR- weight gain/feed taken per bird.

Blood sampling

Fresh blood was collected at the age of 7th, 14th, 21st and 28th week of birds age from wing veins using a syringe (2.5 ml) and was collected in vacutainer with EDTA for hematological studies. Blood hematological parameters were studied using Vet hematology analyzer (spin cell). Blood was collected in vacutainers without anticoagulant and serum was extracted by centrifuging the blood at 3000rpm for 10 minutes. The later was used to study the biochemical profile by automated chemistry analyzer (Mindray BS-120).

Hematological and biochemical parameters

Hematological parameters included in the study were hemoglobin (Hb), red blood cells (RBC), white blood cells (WBC), hematocrit, mean corpuscular volume (MCV), mean concentration of hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC). Erythrocyte sedimentation rate (ESR) was also observed using the ESR tube and keeping it still in the ESR stand for 24 hours. Biochemical parameter included calcium (Ca), alanine transferase (ALT), aspartate aminotransferase (AST), total protein (TP), triglyceride (TG), uric acid (UA) and glucose (Glu) for which serum sample was used.

Statistical analysis

To detect any significant differences among the different age group of broiler chickens in growth pattern, hematological and biochemical profiles, a statistical package (SPSS version 16.0 for windows) was used to calculate mean, standard error (SE) and one way analysis of variance (ANOVA). The level of significance were based on 95% confidence limit (*i.e*, $P<0.05$).

RESULTS AND DISCUSSION

Growth rate and feed conversion ratio

The present study showed that the body weight of broiler birds under experimental group at first week was 71.7g and at 28th week it was 2726 g. FCR was shown to increase every week and mean FCR at 7th week was 2.38. Daily feed intake of birds also increased with age. The details of weekly body weight observed is presented in the Table 1 and growth is graphically shown in Fig 1. Daily feed intake per bird is shown in Table 2. The detail of FCR is shown in Fig 2.

It was found that birds raised at high altitudes grow slower as equated to broilers reared at lowland in accordance to Swati (2020). Hassanzadeh *et al* (2004) reported in the findings that broiler chickens reared at lowland grow much faster than broilers reared at high altitude. Weekly body weight increased with age and so does the FCR. Body weight of 540 g at 4th week for female broilers was recommended by the genetic company and Rezende *et al* (2017) observed an attainment of 538 g body weight at 4th week in their studies which was conducted in plain area. However, in the present study 287.1 g of body weight was obtained which is much lower.

Hematological parameters

The hematological profiling of broiler chicken at high altitude showed that all the parameters changed with the age of the birds and the pattern of every parameters are presented in Table 3. The results obtained for the hematological analysis

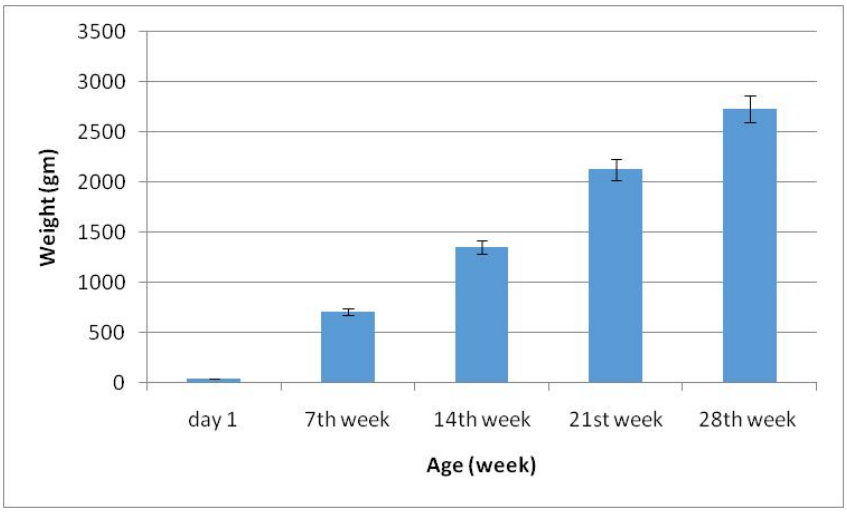

Fig 1: Body weight.

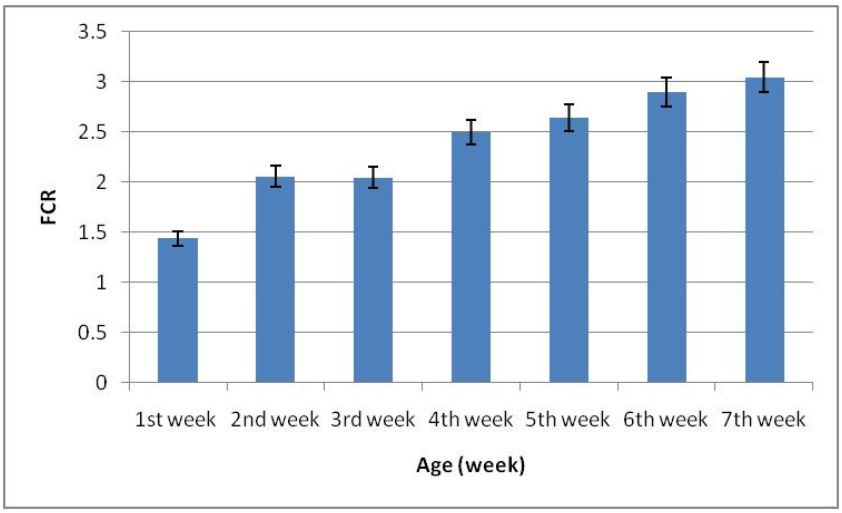

Fig 2: FCR weekwise.

in the current study showed that these parameters are affected by age and the change in altitude. Various studies reported that many factors like age, sex, feed and environmental conditions *etc* affect the physiological performance of chickens. But no suitable reference values were available for chicken (Gallus gallus) at these particular age groups at high altitude. Hb concentration followed an increasing trend in the present study and this was similar to the result obtained by Ali *et al*, (2019) where they observed an increase in the Hb concentration of Guinea fowl as the bird grows although they didn't find any effect of age on RBC value (Brijpuria *et al*, 2017). Hb (%) in the present study increased with the age of birds and a significant difference was observed between 7th and 28th week of birds age. Zhang *et al* (2007) in their study observed an elevation in the level of red blood cell (RBC) and a decrease in mean corpuscular volume (MCV) level during the growth period of birds *i.e.* from younger to older age of the birds. Mean corpuscular volume is used to calculate the average size of erythrocyte

Table 1: Body weight in gms.

Week	Weight (gm)
Day 1	35.88±1.05
7th week	701.3±15.66
14th week	1345.20±45.63
21st week	2117±13.58
28th week	2726±20.07

Table 2: Daily feed intake in gms.

Age (week)	Feed intake (gms)	FCR
1st week	7.37	1.44
2nd week	15	2.06
3rd week	19.9	2.05
4th week	34.49	2.5
5th week	50	2.64
6th week	55	2.9
7th week	65	3.05

Table 3: Hematological values of broiler of different age group.

Age week	7th week	14th week	21st week	28th week
Hb g/dl	16.56±.56^{b}	16.72±.66^{b}	22.14±2.17^{a}	24.60±1.46^{a}
RBC (10*12/L)	3.04±.12^{b}	2.93±.12^{b}	3.6±.34^{ab}	3.9±.22^{a}
WBC (10*9/L)	35.47±.46^{b}	35.38±.72^{b}	47.63±3.13^{a}	45.02±2.24^{a}
HCT %	39.5±1.38^{b}	37.08±1.38^{b}	46.16±4.63^{ab}	53.36±3.09^{a}
MCV (1f)	130.20±1.77^{b}	126.96±1.64^{b}	127.82±.94^{b}	136.84±1.04^{a}
MCH (pg)	54.44±.90^{c}	57.08±.46^{b}	61.20±.67^{a}	62.90±.36^{a}
MCHC (g/dl)	41.82±.21^{b}	47.66±2.72^{a}	47.90±.41^{a}	46±.15^{a}

Mean±SE with subscripts (a, b, c) within row between different age group of chicken differ significantly (P<0.05).

Table 4: Erythrocyte sedimentation rate (ESR).

Age (weeks)	ESR (mm/hr)
7th week	1.63±.15^{a}
14th week	1.12±.65^{b}
21st week	.81±.62^{c}
28th week	.6±.55^{c}

Mean±SE with subscripts (a, b, c) within row between different age group of chicken differ significantly (P<0.05).

and stated that perhaps these increase in red blood cell and the decrease in mean corpuscular volume could be common hematological mechanisms to adapt to the hypoxic condition caused due to an elevation in the altitude (Zhang *et al*, 2007). There was an increase in the value of red blood cell in the present study as well although a slight decrease at 14th week was found but overall by the age of 28th week red blood cell increased. Hematocrit was shown to have affected by factors like altitude, breed and age by Zhang *et al* (2007) in the Tibetan chicken, however they observed an increasing trend of hematocrit value in the chickens from younger to older age and in our studies we observed a drop in value of hematocrit at 14th week although it further increased significantly. Magdalena *et al* (2013) also observed an increase in values of hematocrit with age. Ali *et al* (2019) reported that mean corpuscular hemoglobin (MCH) increases with age and in our study also it increased with the age of birds. Atansuyi *et al* (2019) found in their studies that different breed has a different value of hematological parameters. Time, room temperature, feeding, and breeding technology and other factors are there that also affect and alter hematological parameters (Koncicki and Depta 2005). The effect of feed on the hematological parameters was also studied by Wayas *et al* (2018). Reproductive hormones affect the chicken's red blood cell and hemoglobin concentration. In contrary to results obtained in the present study, Albokhadaim (2012) observed that hemoglobin, mean corpuscular volume, mean corpuscular hemoglobin and mean corpuscular hemoglobin concentration values did not change with age and therefore these blood parameters are age-independent.

It was found that erythrocyte sedimentation rate value dropped with the age of the birds which is shown in Table 4 and Fig 3 below. Islam *et al* (2004) reported in their study that ESR is inversely related to the age of the birds i.e with increase in the age the value of ESR drops and a similar result was observed in the present study. Miao (2001) reported that altitude majorly affects ESR value and stated that it decreases with increasing altitude.

Biochemical parameters

In the present study; calcium, total protein (TP), aspartate aminotransferase (AST) and uric acid (UA) was observed to increase with the age of the broiler chicken whereas triglyceride (TG) decreased from 7th week to 28th week. Its values are presented in Table 5.

The process of development and growth in broiler chickens is a very intensive phase with great changes in its metabolic activities and increase in its body mass and buildup of a huge amount of muscles in a short duration of time. Therefore, age and various other factors that are associated with its development process become an important factor that may possibly affect the metabolism and could also induce changes in the pattern of various serum biochemical parameters including total protein (Tothova *et al*, 2019).

Concentration of total protein (TP) in birds was reported to be half the value of its concentration in mammals and that being caused by presence of high blood concentration of glucose which may be suggested to reduce the concentration of protein to maintain the colloid osmotic pressure (Scanes, 2015). Total protein can be analyzed to understand the quality of protein obtained from the feed (Alikwe *et al*, 2010).

Glucose and triglycerides in the animal body function to fulfill the energy required to maintain the optimal physiological functions and biochemical status (Rehman *et al*, 2017).

Liver enzyme aspartate aminotransferase (AST) was studied in order to understand the health status of a bird and its liver function. The normal range of aspartate aminotransferase (AST) is 70-220U/L (Meluzzi *et al*, 1992) and in the current study the values are above normal range and that perhaps could be because of an effect of high altitude on liver function. Activity of AST was observed to have been most sensitive to liver damage and this is followed by alanine aminotransferase (Lumeij, 1997) and high alkaline phosphatase activity indicates weak bones of the

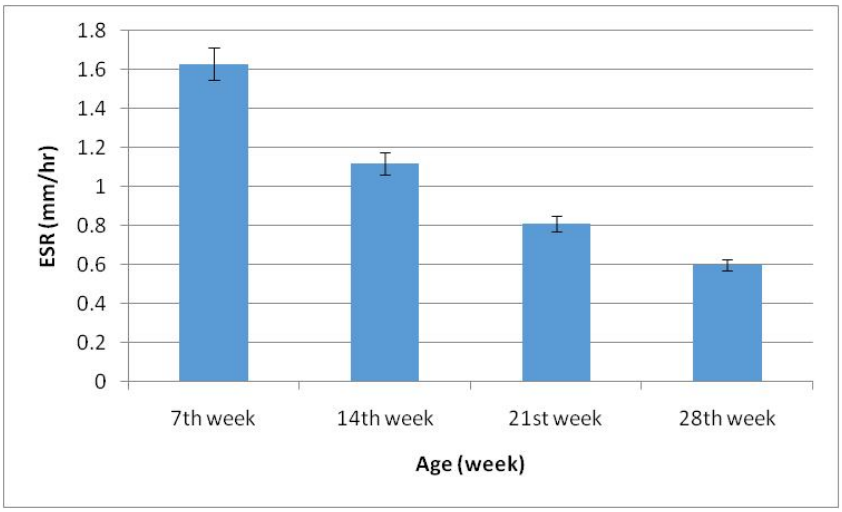

Fig 3: ESR with age.

Table 5: Biochemical parameters of broiler of different age group.

Age	7th week	14th week	21st week	28th week
Ca (mg/dl)	8.95±.77^{b}	9.74±.33^{ab}	10.7±.43	10.87±.37^{a}
ALT (U/L)	12.75±.59^{a}	12.65±.61^{a}	7.24±.6^{b}	9.01±.90^{b}
TP (g/l)	32.79±4.99^{c}	39.67±1.76^{bc}	45.42±1.07^{ab}	48.60±1.51^{a}
TG (mg/dl)	42.49±6.98^{a}	27.41±2.05^{b}	26.83±1.32^{b}	26.74±1.77^{b}
AST (U/L)	240.04±30.37	275.66±13.26	258.03±14.88	296.36±29.21
UA (mg/dl)	2.95±.15^{b}	3.62±.2^{b}	5.93±.92^{a}	6.69±.91^{a}
Glu (mg/dl)	209.04±11.30	232.89±10	191.15±10.51	185.65±20.96

Mean±SE with subscripts (a, b, c) within row between different age group of chicken differ significantly (P<0.05).

chicken (Onbasilar *et al*, 2016). Silva *et al* (2007) reported in their study that AST value increased with the age of the bird and similar result was obtained in the present study as well. Increase in level of AST could be due to increased liver activity and muscle development which Szabo *et al* (2005) reported to be maximum at this older age as compare to younger age of turkey. High liver enzyme concentrations at high altitudes as compare to lowland chickens could be because of high metabolic demands which ultimately causes damage in liver.

Uric acid in birds is the major product of nitrogen catabolism. Age of birds is suggested to influence the concentration of uric acid in birds (Simaraks *et al,* 2004). Normal range of UA in the lowlands are 1.9-12.5 mg/dl (Meluzzi *et al*, 1992) and in the present study it falls in the given range of values.

CONCLUSION

High altitude poultry rearing is a huge challenge. The high altitude with low oxygen, low pressure and low humidity with prevailing harsh environmental condition hampers rearing of poultry birds. The present study was done to analyze broiler chickens growth performance, FCR and hematobiochemical parameters in high altitude. It was found that chickens grow at slower rate at high altitudes as compare to the lowland chickens. Changes were also observed in various hematological and biochemical parameters during the growth phase in the broiler chicken. However, further detailed study is required to understand the physiology and genetic aspect of these birds and their adaptability at high altitude region.

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Conflict of interest

The authors declare no conflict of interest.

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