GENETIC AND NON GENETIC EFFECTS ON BODY WEIGHT, CONFORMATION TRAITS AND SOME HAEMATOLOGICAL AND BIOCHEMICAL PROFILES IN VANARAJA AND ITS CROSSES WITH DESI CHICKEN OF BIHAR

THESIS

SUBMITTED TO THE

BIHAR AGRICULTURAL UNIVERSITY

(FACULTY OF VETERINARY SCIENCE AND ANIMAL HUSBANDRY)

Sabour,(Bhagalpur), BIHAR

In partial fulfillment of the requirements

FOR THE DEGREE OF

Master of Veterinary Science

IN

(ANIMAL GENETICS AND BREEDING)

BY

Kiran Kumari

Registration No – M/AGB/135/BVC/2013-14

(P.G. Deptt. of Animal Genetics and Breeding)

BIHAR VETERINARY COLLEGE

PATNA 800014

2015

GENETIC AND NON GENETIC EFFECTS ON BODY WEIGHT, CONFORMATION TRAITS AND SOME HAEMATOLOGICAL AND BIOCHEMICAL PROFILES IN VANARAJA AND ITS CROSSES WITH DESI CHICKEN OF BIHAR

THESIS

SUBMITTED TO THE

BIHAR AGRICULTURAL UNIVERSITY

(FACULTY OF VETERINARY SCIENCE AND ANIMAL HUSBANDRY)

Sabour,(Bhagalpur), BIHAR

In partial fulfillment of the requirements

FOR THE DEGREE OF

Master of Veterinary Science

IN

(ANIMAL GENETICS AND BREEDING)

BY

Kiran Kumari

Registration No – M/AGB/135/BVC/2013-14

(P.G. Deptt. of Animal Genetics and Breeding)

BIHAR VETERINARY COLLEGE

PATNA 800014

2015

DEPARTMENT OF ANIMAL GENETICS AND BREEDING

Bihar Veterinary College, Patna-800014.

(Bihar Agricultural University, Sabour, Bhagalpur, BIHAR)

1. **Dr. K. G. Mandal, Ph.D**
Assoc. Professor-cum Sr. Scientist
Deptt. of Animal Genetics and Breeding
Bihar Veterinary College Patna-14

CERTIFICATE-I

This is to certify that the thesis entitled **"GENETIC AND NON GENETIC EFFECTS ON BODY WEIGHT, CONFORMATION TRAITS AND SOME HAEMATOLOGICAL AND BIOCHEMICAL PROFILES IN VANARAJA AND ITS CROSSES WITH DESI CHICKEN OF BIHAR "** submitted in partial fulfillment of requirement for the degree of Master of Veterinary Science (Animal Genetics and Breeding) of faculty of post-Graduate Studies, Bihar Agricultural University, Sabour, Bhagalpur, Bihar is the record of bonafide research carried out by **Dr.kiran kumari** , Registration No – **M/AGB/135/BVC/2013-14** under my supervision and guidance. No part of the thesis has been submitted for any other Degree or Diploma.

It is further certified that such help or information received during the course of this Investigation and preparation of the thesis have been duly acknowledged.

Endorsed

19/6/15

(Dr.S. B. Verma)

Univ.Prof. and Chairman
Department of Animal Genetics and Breeding
Bihar Veterinary College, Patna-14

19/06/2015

(K. G. Mandal)

Major Advisor

DEPARTMENT OF ANIMAL GENETICS AND BREEDING

Bihar Veterinary College, Patna-800014.

(Bihar Agricultural University, Sabour, Bhagalpur, BIHAR)

CERTIFICATE- II

We, the undersigned members of the Advisory Committee of **Dr. kiran kumari**, Registration No – **M/AGB/135/BVC/2013-14** , a Candidate for the degree of Master of Veterinary Science with major in Animal Genetics and Breeding, have gone through the manuscript of the thesis and agree that the thesis entitled "**GENETIC AND NON GENETIC EFFECTS ON BODY WEIGHT, CONFORMATION TRAITS AND SOME HAEMATOLOGICAL AND BIOCHEMICAL PROFILES IN VANARAJA AND ITS CROSSES WITH DESI CHICKEN OF BIHAR**" may be submitted by **Dr.Kiran Kumari** in partial fulfillment of the requirement for the degree.

G Mandal 19/06/2015

Dr. K. G. Mandal

Chairman, Advisory Committee

Members of the advisory Committee:-

1. **Dr. Ramesh Kumar Singh**
   Asstt. Professor- cum Jr. Scientist
   Deptt. of Animal Genetics and Breeding
   Bihar Veterinary College Patna-14.

   19.6.15

2. **Dr. P.C. Chandran**
   Scientist,Division of Livestock Fisheries and management,
   ICAR-RCER,Patna

   19.06.15

3. **Dr. R.R.K Sinha**
   Asstt. Professor- cum Jr. Scientist
   Deptt. of Livestock Production & Management
   Bihar Veterinary College Patna-14

   19/6/15

4. **Dr. R. P. Pandey**
   Univ. Professor-cum-Chief Scientist
   Deptt. of A.R.G.O
   Bihar Veterinary College Patna-14

   19.6.15

5. **Dr. Dipyaman Sengupta**
   Asstt. Professor -cum Jr. Scientist
   Dept. of A.R.G.O, Bihar Veterinary College Patna-14
   (**Nominee of Dean, PGS)**

   19.6.15

DEPARTMENT OF ANIMAL GENETICS AND BREEDING

Bihar Veterinary College, Patna-800014.

(Bihar Agricultural University, Sabour, Bhagalpur, BIHAR)

CERTIFICATE- III

This is to certify that the thesis entitled "**GENETIC AND NON GENETIC EFFECTS ON BODY WEIGHT, CONFORMATION TRAITS AND SOME HAEMATOLOGICAL AND BIOCHEMICAL PROFILES IN VANARAJA AND ITS CROSSES WITH DESI CHICKEN OF BIHAR**" submitted by **Dr. Kiran Kumari** in partial fulfillment of the requirement for the degree of Master of Veterinary Science (Animal Genetics & Breeding) of the faculty of Post-Graduate Studies, Bihar Agricultural University, Sabour, Bhagalpur, Bihar was examined and approved on 31/10/ 2015.

31/10/15

Dr. K. G. Mandal, Ph.D
Assoc. Professor-cum Sr. Scientist
Deptt. of Animal Genetics and Breeding
Bihar Veterinary College Patna-14

31/10/15

(P.K. Senapati)
Professor
Deptt. Of Animal Genetics & Breeding
&
DEAN
Faculty of Veterinary & Animal Sciences
WBUA & FS, Kolkata
&

(External examiner)

Members of the advisory Committee:-

1. **Dr. Ramesh Kumar Singh, Ph.D**
   Asstt. Professor- cum Jr. Scientist
   Deptt. of Animal Genetics and Breeding
   Bihar Veterinary College Patna-14.

31.10.15

2. **Dr. P.C. Chandran, Ph.D**
   Scientist,Division of Livestock Fisheries and management, ICAR-RCER,Patna

31.10.15

3. **Dr. R.R.K Sinha, Ph.D**
   Asstt. Professor-cum Jr. Scientist
   Deptt. of Livestock Production and Management
   Bihar Veterinary College Patna-14

31/10/15

4. **Dr. R. P. Pandey, Ph.D**
   Univ. Professor-cum-Chief Scientist
   Deptt. of A.R.G.O
   Bihar Veterinary College Patna-14

31.10.15

5. **Dr. Dipyaman Sengupta, Ph.D**
   Asstt. Professor- cum jr- Scientist
   Dept. of A.R.G.O, Bihar Veterinary College Patna-14
   (Nominee of Dean, PGS)

31.10.15

ACKNOWLEDGEMENT

I would like to express my deep sense of gratitude and indebtedness to my guide and major advisor, Dr. K. G. Mandal, Assoc. Prof. cum Sr. Scientist Department of Animal Genetics and Breeding, Bihar Veterinary College, Patna, for valuable guidance, keen interest, close supervision, constant encouragement and healthy criticisms during the course of investigation. His painstaking supervision of the manuscript warrants special mention, without which this research undertaking would not have completed.

I am highly obliged to Dr. S. B. Verma , Univ. Prof. & Chairman Deptt. of Animal Genetics and Breeding for his useful suggestions and needful facilitation of contrivance during the course of investigation.

I am grateful to the other members of my advisory committee, Dr. Ramesh Kumar Singh, Asstt. Professor- cum Jr. Scientist Deptt. of Animal Genetics and Breeding, Dr. R. R. K Sinha, Assistant Professor -cum Jr. Scientist Department of Livestock Production and Management, Dr. R. P. Pandey, Univ. Prof. cum Chief Scientist, Department of Animal Reproduction Gynecology and Obstetrics, Dr. Dipyaman Sengupta, Assistant Professor -cum Jr. Scientist Department of Animal R. fuction Gynecology and Obstetrics, Bihar Veterinary College, Patna, Dr. P.C. Chandran Scientist, Division of Livestock and Fisheries Management, ICAR-RCER, for their valuable guidance, constructive suggestions and timely help during the entire period of investigation.

My sincere thanks are also due to Dr. Ramesh Kumar Singh, Assistant Professor, Department of Animal Genetics and Breeding, Bihar Veterinary college, Patna, for his co-operative behavior and valuable suggestions during the statistical analysis. Thanks are also due to Dr. Birendra Kumar, Asstt. Professor- cum Jr. Scientist Deptt. of Animal Genetics and Breeding, for his moral support.

I, with great pleasure, acknowledge my thanks to Dr. M.K. Choudhary, Associate Dean cum-Principal, Bihar Veterinary college, Patna-14, for providing the necessary facilities during the tenure of this investigation,

A deep sense of gratitude is expressed to Bihar agricultural University, Sabour, Bhagalpur, Bihar, for providing facilities to conduct this investigation.

I very much wish to express my deep sense of gratitude to Dr. P. C. Chandran, Scientist, ICAR Research complex for Eastern Region, Patna, Bihar, Dr. Sanjay kumar, Asstt. Prof-cum-jr-Scientist, Deptt. of Animal Nutrition, Dr. Anil Gattani , Asstt. Prof-cum-jr-Scientist, Deptt. of Veterinary Biochemistry, Dr. Kaushlendra Kumar, Asstt. Prof-cum-jr-Scientist, Deptt. of Animal Nutrition for their constant help and encouragement for smooth running of present research work.

I am indeed fortunate to have many colleagues like Dr. Bhawesh Kumar, Dr. Manoj Kumar Shrivastava, Dr. Alok Kumar, Dr. Devendra Kumar, Dr. Soni Kumari, Dr. Shivranjan Kumar Gunjan, Dr. Md. Sameer Alam, Dr. Vineeta Yashveer, Dr. Pallavi Sinha, Dr. Jyoti Kumari, Dr. Jitendra Kumar , Dr. Abhishek Kumar, Dr. Promod Kumar, Dr. Pappu Kumar and all other friends for their friendly cooperation and physical help from time to time during the course of study.

My thanks are also extended to all the respected seniors like Dr. Md.Ali wafa, Dr. Beena Sinha, Dr. Subhash Kumar, Dr. Saravjeet Kumar, Dr. Pappu Kumar, Dr. Ruchi Kumar, Dr. Rachana Sinha ,Dr.Santosh Kumar and most loving junior Dr. Sushma Suman who helped me directly or indirectly during my research work with a company of whom helped me to overcome the stressful m nt of investigation.

I am also thankful to the Librarian, and the staff-members of the library of the Bihar Veterinary college, Patna-14 for rendering their cooperation.

Thanks are also due to the non-teaching staff members of the department of Animal Genetics and Breeding for their assistance.

Gratitude alone fails to convey my feelings which cannot be expressed in words for the affectionate care, thought fullness, moral support and encouragement constantly received from all members of my family specially my father, Sri.Mahatma Singh, my mother Laxmi Devi, my sisters and elder brother Renu, Sunita, Anuksha, Smita, Tanuja, Jaya, Janmejay Kumar Singh and my students like Priyanka and Mansi for their constant source of inspiration during the study.

Last but not the least, I thank God for giving me patience and strength to overcome the difficulties which crossed my way in accomplishment of this endeavour.

Place PATNA

Date 19/06/2015

Kiran Kumari

(Kiran Kumari)

DEDICATED TO

My Dear

Grandparents

CONTENTS

LIST OF TABLES

INTRODUCTION

INTRODUCTION

India is second most populous country with decadal growth rate more than 17 per cent. Hunger, malnutrition, unemployment, limited resources and poverty are some of biggest obstacle in its development. Hence, it is necessary to develop a comprehensive economic program to mitigate poverty and hunger of the growing population. Agriculture and animal husbandry particularly poultry farming which can lead us to the economic development in a short term period with low investment.

Now a day, poultry industry is one of the most profitable business of agriculture in India that provides nutritious meat and eggs for human consumption within the shortest possible time. Poultry industry shares a major portion in agriculture sector in developing countries including India. During the last two decades, India had a remarkable growth in poultry industry. Presently, our country is the 3rd largest egg-producer in the world producing over 180 million eggs being produced every day or 65.7 billion eggs for the year 2011-12.(thehansindia.info/News/Article) and world's 6th largest producer of poultry meat. Recently, broiler industry has become a rapidly developing enterprise among the other sector of poultry production.

Per capita consumption has grown up from 1.22 kilograms in 2001 to 2.26 kilograms in 2010. Broiler production grows at an annual growth rate of 8.35%. The

current strength of layers and broilers in India is estimated to be 230 million and 2300 million respectively (USDA's Agricultural Marketing Service report, 2008). Poultry sector has been growing at the rate of around 8-10 percent annually over the last decade with broiler meat volumes growing at more than 10 percent (Information and Credit Rating Agency, ICRA, May 2014).

Domestic poultry meat production in India is estimated to have remained at 3.5 million tons in calendar year 2013 with per capita consumption of 2.8 kg per annum, while table egg production is estimated to have increased from 66 billion eggs in 2012 to 70 billion eggs in 2013, with per capita egg consumption at 57 eggs per annum(ICRA, May 2014).

In India the rank of Bihar is 6th in poultry population and 9th in poultry meat production. The poultry meat production in Bihar was 37000 tonnes in 2010 and it was 1.69% of total poultry meat production in India (Deptt. of A.H., Govt. of India, 2010-11). Bihar lags behind many southern states in poultry meat production. In Bihar there is wide gap between per capita availability of animal protein and its requirement. This gap may be bridged up by genetic manipulation and improving feeding and management practices of poultry production.

Backyard poultry farming is helpful for increasing income, preventing malnutrition, empowering rural women and generating employment. Backyard poultry with improved genetic variety of birds and liking characteristics of rural people can be very helpful in increasing the poultry production in India. Local birds are reared in the forage on naturally available food, be it grains, insects, etc. They are dual purpose, used both for meat and eggs. They are more hardy birds, less susceptible to diseases. However their growth rate is slower and they are less efficient in both meat and egg production. These improved hybrids are readily accepted by the rural farmers due to their similarity with local birds and very low operational cost with significant returns under the existing methods of rearing in rural areas. For this purpose different improved varieties like Vanaraja, Gramapriya, Hitcari and Upcari have been introduced in backyard farming. These varieties resemble indigenous fowl in body conformation, plumage colour, dull shanks, pink skin etc. These improved birds have more economically viable characteristics which are of great importance for village production of eggs and meat.

Vanaraja chicken, a dual purpose backyard variety, is preferred by farmers for their coloured plumage, better growth rate and more egg production. Vanaraja has been developed by crossing random bred meat control population as the female line and Red Cornish population as the male

line by Project Directorate on Poultry, Hyderabad (Chandra *et al.*, 2004).

Poultry breeder desires improvement in body weight as well as conformation traits of meat type chicken. Body weight trait is good indicator of growth. Body conformation, which constitutes bone structure, may be considered a better measure of body capacity of laying hens. Shank and Keel lengths are indicators of skeletal growth and associated with egg production of laying hens. Blood-biochemical profiles may be a reliable health indicator. Haematological and biochemical parameters in indigenous chickens in various regions of the world differ from each other. Therefore, it is important to investigate blood profiles of indigenous birds in order to accurate interpretation of health status.

Very few information of body weight, conformation traits, haematological and biochemical profiles of Vanaraja and their crosses are available. These traits are influenced by breed, strain, system of rearing and climatic conditions. Therefore, the proposed study was aimed at evaluating body weight and conformation traits as well as haemato-biochemical parameters in Vanaraja birds and their crosses with indigenous desi fowls in the agro-climatic region of patna, with the following objectives:

- To estimate the mean, standard error and coefficient of variation percentage of various body weight,

conformation traits, haematological and biochemical profiles in different genetic groups of chicken.

- To study the effect of sex on various body weight, conformation traits and some haematological and biochemical profiles in different genetic groups of chicken.
- To study the effect of different genetic groups on various body weight, conformation traits and haematological and biochemical profiles of chicken.
- To estimate the coefficient of phenotypic correlation among various body weight and conformation traits.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

AVERAGE BODY WEIGHT AT DIFFERENT WEEKS OF AGE

Body weight is an important indicator of general health of birds. A bird must have optimum body weight during growing periods. Various genetic and non-genetic factors affect growth of birds. A breeder increases the body weight of birds to its maximum level by exploiting genetic and non-genetic factors. Reddy *et al.* (2001) reported that the birds having higher body weight at 4 weeks have early commencement of egg production and better livability during the laying period.

The average body weight at different ages in various breeds of poultry as reported by various research workers are summarized and tabulated below:-

Table-1: Average body weight(g) at various ages in different breeds of poultry

Age	Breed of poultry	Average body weight(g)	Authors
1	2	3	4
Day old	RIR NH RIR(F) X NH(M) NH(F) X RIR(M)	32.22±1.22 39.94±0.67 33.82±0.34 38.48±1.16	Hussaini (1963)
Day old	WR RIR RIR(F) X WR(M)	36.18 33.37 33.37	Husain(1972)
Day old	WR X WR WR X WC WC X WR WC X WC	35.10 33.66 34.78 32.71	Sapra *et al* (1972)

Day old	Naked Neck	30.38±0.41	Chhabra and Sapra(1973)
	Aseel	36.15±0.46	
	Overall	32.09	
	Indigenous	35.58±0.49	
	RIR	31.26±0.90	
	WL	35.73±0.28	
	WC	33.57	
	Overall exotic	34.34	
	Overall crossbred		
Day old	WR	47.00±2.00	Ramappa and Gowda(1973)
	M	45.00±2.00	
	F	43.00±1.00	
	WC	42.00±1.00	
	M	44.00±2.00	
	F	43.00±2.00	
	WR(F) X WC(M)	43.00±1.00	
	M	43.00±2.00	
	F		
Day old	Strains of WLH		Gupta *et al.* (1999)
	MM	27.99	
	NN	27.26	
	PP	28.94	
	MN	29.75	
	MP	29.07	
	NP	29.65	
	NM	27.17	
	PM	28.23	
	PN	27.94	
Day old	Aseel M	32.50±0.30	Singh *et al.* (1999b)
	F	33.49±0.47	
	Naked Neck M	34.21±0.36	
	F	33.47±0.39	
	Dahlem Red M	38.61±0.53	
	F	35.67±0.44	
	D × A M	34.90±0.41	
	F	36.06±0.47	
	AXD M	45.65±0.38	Singh *et al.*
	F		

F	46.44±0.40	(1999b)
DXN M	36.52±0.57	
F	39.00±0.57	
NXD M	45.72±0.77	
F	44.41±0.65	
Synthetic Broiler	43.98±0.82	Padhi *et al.* (1999b)
Naked neck cross		
Synthetic broiler	37.15±1.70	
Naked Neck	32.91±0.81	
Synthetic broiler(SB)		Padhi *et al.* (1999a)
M	36.6±0.36	
F	38.3±0.31	
Black Nicobari (BN)		
M	33.1±0.53	
F	32.6±0.29	
White Nicobari (WN)		
M	36.8±0.43	
F	35.9±0.33	
SB X BN		
M	36.3±0.63	
F	36.1±0.69	
SB X WN		
M	37.3±0.85	
F	38.0±0.81	
Red Cornish	40.27±0.08	Sati *et al.* (1999)
Naked neck desi	35.7	Haque and Howlider (2000)
Rhode Island Red	39.5	
White Leghorn	41.2	
Fayoumi(Fy)	34.4	
NaDRIR	39.9	
NaDWL	36.2	
NaDFy	35.3	

Day old	Red Cornish (control line) overall	M F	41.30 40.20 40.75	*Singh et al.* (2000)
	White Leghorn		34.9±0.12	Chaudhary *et al.* (2009)
	Vanaraja	M F P	38.13±0.33 36.98±0.42 37.63±0.26	Padhi *et al.* (2012a)
	Vanaraja	M F P	38.89±0.002 38.53±0.003 38.74±0.001	Padhi *et al.* (2012b)
	Vanaraja Gramapriya Aseel		35.91±0.26 33.24±0.31 29.32±0.20	Jha and Prasad (2013)
	Hazra Aseel Kadaknath		31.48±0.28 29.72±0.21 28.54±0.33	Jha *et al.* (2013)
	Vanaraja x Vanaraja	M F P	33.83±1.14 36.00±1.14 34.91±0.58	Kumar(2014)
	Vanaraja x Vanaraja	M F P	39.96±0.29 34.93±0.18 37.45±0.17	Ali(2014)
4th week	WR(M)XRC(F)	M F C	222.50 202.67 209.56	Sharma(1984)
	Overall mean (OBNP,IC-3, SML-2,IR-3)	M F	738.96 661.76	Padhi *et al.* (1997)
	IC-3 IR-3		472.00 514.57	Reddy *et al.* (1998)

	IC-3XIR-3	516.67	
	Strains of WLH MM	150.78	
	NN	128.83	
	PP	163.53	
	MN	148.33	
	MP	187.43	Gupta *et al.* (1999a)
	NP	188.93	
	NM	135.93	
	PM	146.68	
	PN	157.48	
	Synthetic broiler x Naked neck cross	284.00±15.27	Padhi *et al.* (1999)
	Synthetic broiler	129.66±9.53	
	Naked neck	94.03±5.03	
4th week	Synthetic broiler (SB) M	228.0±6.98	
	F	215.3±5.45	
	Black Nicobari (BN) M	96.65±3.02	Padhi *et al.* (1999b)
	F	87.8±1.66	
	White Nicobari (WN) M	111.6±3.38	
	F	94.3±2.03	
	SB X BN M	178.3±7.21	
	F	168.7±6.06	
	SB X WN M	147.8±8.4	
	F	144.9±12.4	
	White Leghorn	181.9±1.10	Chaudhary *et al.*(2009)
	CARI Shyama	235.88±9.47	Malik *et al.* (2009)
	White Leghorn	141.73±1.54	Jaya Laxmi *et al.* (2010)
	White Leghorn	138.55±1.51	Jaya Laxmi *et al.* (2011)

	Coloured broiler dam line	668.57±7.08	Malik(2011)
	Black Rock Red Cornish Vanaraja	455.87±8.87 456.61±6.56 448.46±7.32	Debata *et al.* (2012)
	Vanaraja M F P	364.86±5.11 343.95±5.16 355.80±3.73	Padhi *et al.* (2012a)
	Vanaraja M F P	327.37±0.03 302.81±0.04 316.72±0.02	Padhi *et al.* (2012b)
	Vanaraja Gramapriya Aseel	316.47±2.47 168.85±1.53 127.83±1.18	Jha and Prasad(2013)
	Hazra Aseel Kadaknath	162.45±2.48 127.43±1.28 114.86±1.63	Jha *et al.* (2013)
	VR XVR M F P	323.47±2.09 278.37±2.04 300.93±1.46	Md.Ali wafa (2014)
6th week	Synthetic M Broiler F	1057.92 956.97	Malik *et al.* (1997)
	Overall M (OBNP,IC-3, F SML-2,IR-3) C	1368.80 1171.98 1268.7	Padhi *et al.* (1997)
	Broiler	631.75±3.52	Bhushan and Singh(1998)
6th week	Strains of WLH MM NN PP MN MP NP	 259.40 225.14 247.39 255.09 267.24 269.59	Gupta *et al.* (1999)

	NM PM PN	237.09 252.89 244.89	
	Synthetic Broiler x Naked Neck cross Synthetic Broiler Naked neck	553.60±41.01 227.28±22.90 161.45±11.10	Padhi *et al.* (1999a)
	Synthetic Broiler (SB) M F Black Nicobari (BN) M F White Nicobari (WN) M F SB X BN M F SB X WN M F	520.4±13.6 456.4±11.3 143.5±6.4 134.7±2.8 170.3±4.9 141.5±3.4 259.5±14.4 291.7±13.9 250.2±11.8 241.2±20.6	Padhi *et al.* (1999b)
	CARI Shyama M F C	387.63±1.64 302.26±6.08 324.97±15.06	Malik *et al.* (2009)
6th week	White Leghorn	234.61±2.55	Jaylaxmi *et al.* (2010)
	DO8 chicken Variety M F C	455.88±10.91 411.06±5.63 422.59±5.21	Malik *et al.* (2011)
	Coloured broiler dam	1360±0.008	Malik(2011)

	line		
	White Leghorn	238.04±2.36	Jaylaxmi *et al.* (2011)
	Vanaraja M F P	538.45±9.92 496.42±11.01 520.24±7.51	Padhi *et al.* (2012a)
	Vanaraja M F P	589.43±0.06 533.77±0.07 565.67±0.03	Padhi *et al.* (2012b)
	Vanaraja	568±0.20	Padhi and Chatterjee (2012)
	Vanaraja Gramapriya Aseel	629.23±3.02 357.48±2.97 186.71±2.54	Jha and Prasad (2013)
	Hazra Aseel Kadaknath	276.73±3.12 186.78±2.55 152.42±2.87	Jha *et al.* (2013)
	VRXVR M F P	533.39±6.11 401.26±5.74 467.33±4.19	Md.Ali wafa (2014)
8th week	Synthetic Broiler M (SB) F Black Nicobari M (BN) F White Nicobari M (WN) F SB X BN	725.9+28.5 698.3+19.9 236.5+9.1 206.2+3.8 252.0+0.76 212.1+4.6 463.4+30.6 449.0+24.6 444.1+22.6 370.6+28.8	Padhi *et al.* (1999b)

	M F SB X WN M F		
	Red Cornish	1353.44+0.48	Sati *et al.* (1999)
	Red Cornish M (Control line) F Overall	1680.40 1602.52 1641.46	Singh *et al.* (2000)
	White Leghorn	473.1+2.40	Chaudhary *et al.*(2009)
	CARI Shyama M F C	545.50+17.97 414.54+9.03 460.29+7.66	Malik *et al.* (2009)
	DO8 chicken M F C	707.14+19.66 626.94+7.89 646.91+7.97	Malik *et al.* (2011)
	Coloured broiler dam line	1760+0.001	Malik(2011)
	Black Rock Red Cornish Vanaraja	974.19+21.43 1039.17+21.29 1003.08+20.28	Debata *et al.* (2012)
	Hazra Aseel Kadaknath	384.54+4.23 273.72+3.52 238.86+3.76	Jha *et al.* (2013)
	Vanaraja Gramapriya Aseel	832.51+4.53 498.76+3.86 273.78+3.57	Jha and Prasad(2013)
	Rajasree chicks M	629.6 531.8	Daida *et al.* (2012)

	F		
	VRXVR M F P	723.97±6.53 555.76±6.28 639.86±4.53	Md.Ali wafa (2014)
12th week	CARI Shyama M F C	873.34+22.70 725.59+27.09 793.39+19.00	Malik *et al.* (2009)
	DO8 chicken M F C	1096+30 1013+16 969.5+19	Malik *et al.* (2011)
	Rajasree chicks M F	765.7 697.8	Daida *et al.* (2012)
	Black Rock Red Cornish Vanaraja	1376.31+26.17 1438.16+29.56 1399.83+27.8	Debata *et al.* (2012)
	Hazra Aseel Kadaknath	614.83+5.39 416.25+4.78 372.98+4.85	Jha *et al.* (2013)
	Vanaraja Gramapriya Aseel	1072.63+5.59 824.68+4.75 416.25+4.72	Jha and Prasad(2013)
	VRXVR M F P	1425.9±8.85 1200.5±8.70 1313.27±6.20	Md.Ali wafa (2014)
16th week	White Leghorn	1000+4.02	Chaudhary *et al.* (2009)
	CARI Shyama M F C	1225+27 999+24 1108+20	Malik *et al.* (2009)
16th week	White Leghorn	909.57+5.56	Jaya Laxmi *et al.* (2010)

	DO8 chicken	M F C	1611+29 1460+19 1519+16	Malik *et al.* (2011)
	White Leghorn		907.46+4.92	Jaya Laxmi *et al.* (2011)
	Rajasree chicks M F		920.9 851.0	Daida *et al.*(2012)
	Black Rock Red Cornish Vanaraja		1681.32+31.64 1827.54+38.26 1725.75+32.48	Debata *et al.* (2012)
	Vanaraja Gramapriya Aseel		1567.85+6.38 1263.46+5.90 628.36+5.35	Jha and Prasad(2013)
	Hazra Aseel Kadaknath		1056.82+6.31 678.37+5.36 624.56+5.80	Jha *et al.* (2013)
	VR X VR	M F P	1962.6±16.45 1652.6±15.38 1807.58±11.2	Md.Ali wafa (2014)
20th Week	Red Cornish Vanaraja		2202.3±44.32 2040.5±41.27	Debata *et al*(2012)
20th Week	Vanaraja X Indigenous		1693.5±11.13 1783.14±5.03	Islam *et al*(2014)
20th week	VR X VR	M	2882.7±21.79	Md.Ali wafa

		F P	1992.2±21.35 2437.46±15.2	(2014)
20th week	VR X VR	M F P	2838.53±66.33 2176.16±66.25 2607.35±84.93	Kumar (2014)

M=Male, F=Female, C=Combined Sex, WL=White Leghorn, WC=White Cornish, RC=Red Cornish, WPR=White Plymouth Rock, NH=New Hampshire, RIR=Rhode Island Red, PB=Pure Bred, WR=White Rock, VR = Vanaraja.

Sharma (2014) Developed location specific chicken varieties for rural and tribal sector of Bihar and reported the average body weight of DESI(GAYA) X VR genetic group at day old, 6th week, 12th week, 20th week of age at 50% level of genetic inheritance to be 29.36±0.24, 420±13.00, 928.19±16.22 and 1549.43±25.37g respectively. The corresponding values for VR in crosses with DESI(MZF) fowl native to Bihar pooled over sexes at 50% level of genetic inheritance to be 30.51±0.15, 373.41±7.47, 894.66±18.66 and 1581.77±28.13g respectively.

Effect of sex on body weight at different weeks of age

Literature reveals sexual dimorphism for body weight in chicken. Males, in general, have heavier body weight than their female counterparts at different weeks of age. The reports given by various authors are reviewed as below :

Verma *et al.* (1981) found that the mean body weights of males of WL X RIR cross was higher than females by 0.7 g, 8.26 g and 36.2 g at day old, 4 and 8 weeks of age respectively.

Gupta (1983) observed that the average body weights of White Rock male chicks were heavier than their female counterparts by 23.36 g and 41.80 g at 4^{th} and 6^{th} week of age respectively.

Padhi *et al.*(1999b) studied the sexual dimorphism for body weights in different genetic groups of poultry and reported that the males of Black Nicobari(BN) were heavier by 8.85 g, 8.80 g and 30.3 g than females at 4^{th}, 6^{th} and 8^{th} week of age respectively. The corresponding increment in males of White Nicobari(WN) breed was observed to be17.3 g, 28.8 g and 39.9 g, whereas in Synthetic Broiler strain(SB) it was observed to be 12.7 g, 64.3 g and 27.6 g.

Singh *et al.* (2000) reported that the average body weights of Red Cornish male chicks were heavier than females by 1.10 g, 49.45 g and 77.88 gm at day old, 5^{th} and 8^{th} week of age respectively.

Padhi *et al.* (2012) reported that Vanaraja males were significantly ($P<0.05$) heavier than females by 0.36g, 7.58g, 24.56g and 55.66g at day old, 2^{nd}week, 4^{th}week and 6^{th}week of age respectively.

Singh *et al.* (2012) reported that PB-2 males were significantly (P<0.05) heavier than PB-2 females by 60.83 g and 216.94g at 3rdand 5thweek of age respectively, but in control line sex differences were found to be non

AVERAGE CONFORMATION TRAITS AT DIFFERENT WEEKS OF AGE IN VARIOUS GENETIC GROUPS OF POULTRY

Body Conformation, which constitutes bone structure is considered a better measure of performance of birds. Conformation traits like Shank length, Keel length etc. are indicator of skeletal growth. In addition to this, incorporation of some of the conformation traits in a selection index along with body weight would give better result than selection based on body weight alone.

Shank Length

Chhabra *et al.* (1972) studied the shank length, growth in different broiler breeds of poultry and their crosses. They reported the mean shank length to be 6.98cm, 7.16cm, 7.07cm and 7.20cm in WR X WR, WR X WC, WC X WC and WC X WR crosses respectively at 10th week of age.

Aggarwal *et al.* (1979) evaluated the shank length in a 4 X 4 complete diallel cross involving 4 broiler strains of chicken belonging to Rock and Cornish breeds. They reported that mean shank lengths at 10th week of age among different genetic groups ranged from 69.0±0.5 mm to 81.0±0.5 mm in males, 67.0±0.4 mm to 76.0±0.6 mm in

females and 68.0±0.4 mm to 78.01±0.4 mm in combined sexes.

Verma *et al.* (1979) used shank length at early ages as a predictor of 12 week body weight and reported the mean shank lengths in White Leghorn X Rhode Island Red birds to be 2.40 cm, 3.30 cm, 4.40 cm and 4.95 cm at dayold, 4th, 6th and 8th week of age respectively in males. The corresponding values in females were noted as 2.39 cm, 3.16 cm, 3.85 cm and 4.61 cm.

Mahapatra *et al.* (1983) studied the shank length at 10th, 11th, and 12th week of age in Aseel Peela, Aseel kagar and their crossbred. They found the average shank lengths pooled over sexes to be 6.24 cm, 6.88 cm and 6.79 cm in Aseel Peela, Aseel Kagar and their crossbred birds respectively.

Sharma (1984) studied the shank length in White Plymouth Rock (WPR) and Red Cornish (RC) breeds of poultry and their reciprocal crosses at 8th week of age. He reported the mean shank lengths in WR (M) X WR (F), RC (M) X RC (F), RC (M) X WR (F) and WR (M) X RC (F) genetic groups to be 6.71 cm, 6.85 cm, 7.13 cm, 6.90 cm respectively. The corresponding values in females were reported to be 6.04 cm, 6.17 cm, 6.56 cm and 6.25 cm, whereas the corresponding values of shank length in

combined sex were noted as 6.25 cm, 6.34 cm, 6.82 cm and 6.48 cm.

Venkatesh (1985) studied the effect of sex on shank length of White Plymouth Rock and Red Cornish crosses in poultry. He reported the mean shank length at 8th week of age to be 6.67 cm, 6.46 cm and 6.64 cm in males of RC (M) X WR (F), WR (M) X RC (F) and pooled over crosses respectively. The corresponding values in females were reported to be 6.25 cm, 6.11 cm and 6.20 cm.

Malik *et al.* (1997) studied the inheritance of shank length in a synthetic strain of broiler chicken and reported the mean shank lengths at 6th week of age to be 7.08 cm and 6.89 cm in males and females respectively.

Reddy *et al.* (1998) studied the broiler traits in Red Cornish and shank lengths in IC-3 strain of Red Cornish, IR-3 strain of White Rock and their crosses pooled over sexes to be 5.60 cm, 5.85 cm, and 5.75 cm respectively at 6th week of age.

Padhi *et al.* (1999a) reported the average shank lengths at 8th week of age in normal, homozygous and heterozygous birds for Naked Neck gene to be 4.3 cm, 4.65 cm and 4.89 cm respectively.

Padhi *et al.* (1999b) compared the performance of Nicobari fowls, Synthetic broiler and their crosses and

observed the average shank lengths of male Black Nicobari (BN), White Nicobari (WN), Synthetic Broiler (SB), SB X BN and SB X WN to be 4.09 cm, 4.09 cm, 5.75 cm, 5.27 cm and 4.27 cm respectively at 8th week of age. The corresponding values in females were reported to be 3.70 cm, 3.83 cm, 5.46 cm, 5.06 cm and 3.88 cm.

Singh *et al.* (1999a) studied the genetic effect on conformation traits in pure and crossbred chicken. They reported the average shank lengths in Aseel (A), Naked Neck (N) and Dahlem Red (D) males at 5th week of age to be 4.65 cm, 4.66 cm and 5.01 cm respectively. The corresponding values in females were obtained as 4.51 cm, 4.39 cm and 4.79 cm. The average shank lengths at 5th week of age in D X A, A X D, D X N, N X D males were obtained to be 4.93 cm, 4.95 cm, 4.84 cm and 4.93 cm respectively, whereas the corresponding values in females were reported to be 4.83 cm, 4.76 cm, 4.65 cm and 4.45 cm.

Singh *et al.* (2000) reported the average 8th week shank lengths in control line of Red Cornish breed of poultry to be 6.37 cm, 6.01 cm and 6.24 cm in male, female and combined sexes respectively.

Khurana *et al.* (2006) studied the shank length, shank diameter, keel length, Abdominal span and pubic span in White Leghorn. They reported the mean shank length to be 2.77±0.02 cm, 3.82±0.02 cm, 5.40±0.02 cm, 7.18±0.03 cm,

7.31±0.03 cm, 7.59±0.03 cm, 7.50±0.03 cm, 7.53±0.04 cm, 7.51±0.04 cm respectively at 2nd, 4th, 8th, 16th, 24th, 32th, 40th, 46th, 52nd week of age.

Kalita *et al.* (2011) studied the different traits of Vanaraja reared under intensive system of management. Mean shank length at 40th week of age were recorded as 52.59±4.32 mm during the study.

Padhi *et al.* (2012a) reported the average 6th week shank lengths in males of PD-1, Vanaraja and control broiler to be 70.70±0.40 mm, 73.30±0.62 mm and 81.62±0.73 mm respectively and 68.04±0.33 mm, 70.20±0.52 mm and 78.49±0.63 mm in females respectively.

Padhi *et al.* (2012b) studied the juvenile traits in Vanaraja male line. They reported the mean shank length to be 72.29±0.003 mm in male and 68.93±0.004 mm in female at 6th week of age.

Padhi and Chatterjee (2012) studied the inheritance of shank length in PD1(Vanaraja male line). They reported the mean shank lengths to be 71.93±0.01 mm, 106.57±0.01 mm, 106.58±0.01 mm, 106.66±0.01 mm and 108.01±0.24 mm respectively at 6th, 20th, 22nd, 40th and 72nd week of age.

Jha and Prasad (2013) studied the production performance of Vanaraja, Grampriya and Aseel birds in

Jharkhand. They reported the mean shank length to be 87.43±0.67 mm, 79.86±0.73 and 71.95±0.85 mm respectively in Vanaraja, Grampriya and Aseel birds at 40th week of age.

Ali(2014) studied the genetic analysis of body weight and conformation traits in Vanaraja and Gramapriya birds and their crosses.He reported the mean shank length in VR X VR pooled over sexes to be 7.11±0.016, 8.72±0.196, 9.11±0.03, 9.58±0.06 and 10.14±0.09 at 4th , 8th, 12th, 16th and 20th week respectively.

Keel length

Mahapatra *et al.* (1983) reported the average keel lengths pooled over 10th, 11th and 12th weeks of age in Aseel Peela, Aseel Kagar and their crossbreds to be 7.04 cm, 7.72 cm and 7.61 cm respectively.

Sharma (1984) observed the average 8th week keel lengths in WR (M) X WR (F), RC (M) X RC (F), RC (M) X WR (F) and WR (M) X RC(F) genetic groups to be 8.02 cm, 8.20 cm, 8.67 cm and 8.30 cm respectively in males. The corresponding average values in females were noted as 7.05 cm, 7.20 cm, 7.79 cm and 7.37 cm, whereas the corresponding values of keel length in combined sexes were found to be 7.35 cm, 7.45 cm, 8.18 cm and 7.67 cm.

Venkatesh (1985) examined the effect of age, sex and breed on carcass characteristics of White Rock and Red Cornish crosses in poultry and observed the mean keel lengths at 8th week of age to be 7.68 cm, 7.56 cm and 7.62 cm in males of RC (M) X WR (F), WR (M) X RC (F) and pooled over crosses respectively. The corresponding values in females were reported to be 7.29 cm, 7.04 cm and 7.14 cm.

Malik *et al.* (1997) studied the genetic and phenotypic parameters of keel length in a synthetic broiler strain of chicken and reported the average 6th week keel lengths to be 8.09 cm and 7.89 cm in males and females respectively.

Singh *et al.* (1999a) studied the effect of different genetic groups on conformation traits in poultry and observed the mean keel lengths in Aseel (A), Naked Neck (N) and Dahlem Red (D) males at 5th week of age to be 5.60 cm, 5.67 cm and 5.87 cm respectively. The corresponding values in females were found to be 5.44 cm, 5.36 cm and 5.53 cm. They further observed the average keel lengths at 5th week of age in D X A, A X D, D X N and N X D males to be 5.94 cm, 6.06 cm, 5.87 cm and 6.04 cm respectively, whereas the corresponding values in females were found to be 5.84 cm, 5.85 cm, 5.79 cm and 5.60 cm.

Singh *et al.* (2000) studied the genetic and phenotypic parameters of broiler traits in different lines of Red Cornish and observed the average keel lengths at 8th week of age to

be 8.23 cm, 7.81 cm and 8.02 cm in control line of male, female and combined sexes respectively.

Khurana *et al.* (2006) studied the conformation traits in White Leghorn. They reported the mean keel length to be 7.22±0.03 cm, 10.25±0.05 cm, 10.43±0.10, 10.23±0.12 cm, 10.49±0.12 cm, 10.40±0.12 cm and 10.52±0.12 cm respectively at 8th, 16th, 24th, 32nd, 40th, 46th, and 52nd week of age.

Kalita *et al.* (2011) studied the different traits of Vanaraja reared under intensive system of management. They recorded the mean keel length at 40th week of age to be 72.58±9.56 mm.

Effect of Sex on Conformation traits

Shank length

Sharma (1984) observed significantly ($P<0.05$) lengthier shank in males than those of females in pure White Plymouth Rock(WR) and Red Cornish(RC) breeds of poultry as well as in WR(F) X RC(M) and RC(F) X WR(M) genetic groups.

Malik *et al.*(1997) reported the mean shank length of males to be lengthier by 0.19 cm than their female counterparts at 6th week of age in synthetic broiler chicks.

Padhi *et al.*(1999b) found that the average shank lengths of the males of Black Nicobari (BN), White Nicobari (WN), Synthetic Broiler(SB), SB X BN and SB X WN were lengthier than their female counterparts by 0.39 cm, 0.26 cm, 0.29 cm, 0.21 cm and 0.39 cm respectively at 8th week of age.

Singh *et al.*(2000) observed the average shank of males of Red Cornish breed to be lengthier than females by 0.36 cm at 8th week of age.

Padhi *et al.* (2012) observed the average shank of males of Vanaraja to be significantly ($P<0.05$) lengthier than females by 0.31 cm at 6th week of age.

Singh *et al.* (2012) reported the average shank length of males of PB-2 lines (Broiler chickens) to be lengthier than females by 0.22 cm and .034 cm at 3rd and 5th week of age respectively.

Ali (2014) reported the average shank length of male and female to be 7.37, 8.74, 9.76, 10.51, 10.71 and 6.58, 8.70, 8.47, 8.65, 9.57 at 4th , 8th, 12th, 16th and 20th week respectively.

Keel length

Sharma (1984) studied the effect of sex on various genetic groups in poultry and observed that males of White Plymouth Rock (WR), Red Cornish(RC), WR(F) X RC(M) and

RC(F) X WR(M) had significantly (P<0.05) longer keels than their female counterparts by 0.97 cm, 1.00 cm, 0.88 cm and 0.93 cm respectively at 8th week of age.

Malik *et al.*(1997) reported the average keel length of males to be significantly (P<0.05) lengthier by 0.20 cm than females at 6th week of age in synthetic broiler chicks.

Singh *et al.*(2000) reported the mean keel length of males of Red Cornish breed to be lengthier than females by 0.42cm at 8th week of age.

Ali(2014) studied the genetic analysis of body weight and conformation traits in Vanaraja and Gramapriya birds and their crosses.He reported the mean keel length in VR X VR pooled over sexes to be 5.12±0.012,6.44±0.030, 6.56±0.031, 6.67±0.03 and 7.24±0.03 at 4th , 8th, 12th, 16th and 20th week respectively. The corresponding values for male and female reported to be 5.24, 6.84, 6.90, 6.94, 7.98 and 4.99, 6.04, 6.22, 6.39, 6.50 at 4th , 8th, 12th, 16th and 20th week respectively.

REVIEW ON HAEMATOLOGICAL AND BIOCHEMICAL PROFILES.

HAEMATOLOGICAL PROFILES:-

Certain hematological parameters are well established markers of certain production traits in Poultry ,such as high Packed Cell Volume(PCV) and high Hb(HGB) and these are associated with high feed conversion ratio(FCR). Any

changes in WBC is the indicator of different diseases and immune response. Changes in hematological parameter is an important tool to assess the level of stress due to environment and nutritional factors. Also this literature reveals sexual dimorphism for blood profile in chicken.The values of TEC, haemoglobin, PCV were found to differ significantly due to effect of sex at a particular age group of different breed of poultry.

HAEMOGLOBIN

Bhatti *et al.* (2002) studied the effect of Biovet in different strains of laying hens and reported Hb(gm)% in control group of crossbred, Desi, Fayoumi and Nick chick were 11.80±0.76, 12.40±0.55, 13.08±0.87 and 10.80±0.84 respectively.

Islam *et al.* (2004) studied the hematological parameters of Fayoumi, Assil and Local chickens reared in sylhet region in Bangladesh from 1st to 12 months of age. They reported that haemoglobin percentage increased with the advancement of age. They reported the average haemoglobin percent in Fayoumi to be ranged from 7.06 to 7.94, in Assil to be ranged from 8.23 to 9.54 and in local birds to be ranged from 7.73 to 9.37 gm%.

Islam *et al.* (2004) studied the effect of probiotics and antibiotic supplementation on body weight and

estimated haemato-biochemical parameters in Shaver Star Bro strain of broilers at 55 days of age and reported Hb(gm%) in control group to be 6.20± 0.71.

Rani *et al.* (2011) conducted an experiment to study hematological and biochemical changes of stunting syndrome in broiler chicken and reported Hb(gm%) in control group at 8 week and 11 weeks of age to be 8.61±0.25 and 10.57±0.51 respectively.

Elagib and Ahmed (2011) compared the hematological parameters of indigenous chicken of Sudan of three different ecotypes, at mature ages ranging from 1.5-2.0 years. They reported that sex had significant effect on Hb% in all the three ecotypes. Males had significantly ($P<0.05$) higher Hb% than their female counterparts in all the three ecotypes. Hb% in Betwil, Bare Neck and Large Beladi were reported to be 18.90, 18.59 and 20.66 respectively in males, where as the corresponding values in females were found to be 15.99,16.10 and 16.44 respectively. They however could not find significant differences among the Hb% of three different ecotypes.

Peters *et al.* (2011) studied the Hematological parameters on Frizzled and Naked neck genotypes of Nigerian natives chickens at 20 weeks of age .They reported following Hb% for different breeds of Frizzled and Naked neck to be 11.42±0.31 and 11.55±0.41 respectively.They

reported higher estimates of Hb% in male than their counterparts in both the breeds. The average estimates of male and female reported to be 12.7 and 10.13 gm%, respectively in Frizzled and 13.18 and 9.91 gm% in male and female of Naked Neck.

Prahsanth *et al.*(2012) studied the blood hematological and biochemical parameters in domestic birds with respect to strain ,age and sex and they reported haemoglobin value of domestic birds at 5 and 25 weeks of age in both the sexes. They reported the higher estimates of the average Hb% in male than the female at 25 weeks of age. The average estimates of Hb% of male and female at 25 weeks of age are reported to be 16.17 and 13.49 gm% respectively in PB1 strain and 16.13 and 12.96 gm% of male and female respectively in PB2 strain.

Ali *et al.*(2012) studied the haematological and biochemical profiles of Japanese quails (*Coturnix coturnix japonica).*They reported the mean haemoglobin percentage of Japanese quail at 5,6 and 7 weeks of age to be 12.40±0.20,13.10±0.12 and 13.20±0.12 respectively.

Sonia *et al.*(2012) studied the haematological parameters of Pearl guinea fowl and reported the mean haemoglobin percentage at 4,8,12 and 16 weeks of age to be 10.34,10.54,10.74 and 10.96 % respectively. Hb% in male and female was reported to be 10.85 and 10.44 % respectively.

Pandian *et al.*(2012) studied the haematological profiles and erythrocyte Indices in different breeds of poultry and they reported the overall mean values for haemoglobin which are presented in the following table.

BREED	**Hb%**
Kadakanath	11.10±0.38
Nicobari	12.50±0.43
Aseel	12.90±0.69
RIR	8.70±0.27
WLH	8.80±0.45
Turkey	10.03±0.31
J.quail	12.13±0.40
G.fowl	11.63±0.57
Geese	10.30±0.62

Adeyemo and Sani (2013) studied on hematological parameters and serum biochemical indices of broilers chicken in an experiment and reported Hb (gm%) to be 8.7 in control group.

Kanduri *et al.* (2013) reported Hb (gm%) at 6 weeks of age in broiler chicken to be 8.49gm/dl in control group in an experiment to study the effect of different breeds.

Kundu *et al.* (2013) studied the haematological parameters of Vanaraja, Nicobari fowls and their various F1 Crosses.They reported sexual dimorphism for Hb% and males are reported to have higher estimates of mean Hb and their counterparts. The hemoglobin percentage is reported to be ranged from 14.23 in VN x WN to 18.92 in Van x BN. Whereas in female the mean Hb% reported to be ranged from 10.88g% in Van x BN to 15.20 in BrN x

Van.The average estimates of Hb reported by them are as follows:-

Species	Sex	Hb%
Van	M	16.17±2.19
	F	12.98±0.94
WN	M	16.80±0.76
	F	12.33±0.63
BN	M	15.47±0.44
	F	11.56±0.69
BrN	M	14.37±1.42
	F	11.73±0.15
BN X Van	M	17.88±1.53
	F	12.87±0.96
Van X BN	M	18.92±0.48
	F	10.88±1.29
BrN X Van	M	18.73±0.59
	F	15.2±1.76
Van X BrN	M	14.78±2.32
	F	15.1±0.46
WN X Van	M	16.60±0.53
	F	12.43±1.78
Van X WN	M	14.23±1.27
	F	12.45±0.25

Van=Vanaraja,WN=WhiteNicobari,BN=BlackNicobari,

BrN=Brown Nicobari.

PACKED CELL VOLUME

Bhatti *et al.* (2002) reported PCV% to be 36.10±0.89, 37.20±0.84, 36.1±0.89 and 35.80±0.48 in control group of crossbreds, Desi, Fayoumi and Nick chick chickens respectively in an experiment with Biovet in different strains of laying hens.

Islam *et al.* (2004) studied on hematological parameters of Fayoumi, Assil and Local chickens reared in sylhet region in Bangladesh.The mean estimates of PCV% is reported to be increased with the advancement of age .The PCV% in Fayoumi breed is reported to be ranged from 25.56 in 1st month to 30.08% in 12 month of age. The corresponding values for Assil are reported to be ranged from 28.12 to 32.25 and in Local Chicken the corresponding values are 27.73 and 34.60.

Islam *et al.* (2004) PCV% in control group of 55 days old broilers in an experiment with probiotics and antibiotics supplementation on body weight and hematobiochemical parameters to be 32.20±0.37.

Elagib and Ahmed (2011) studied PCV% of indigenous chicken at mature ages ranging from 1.5-2.0 years under three different ecotypes in Sudan. They reported significant effect ($P<0.05$) of sex on PCV%. Males had significantly ($P<0.05$) higher PCV% than females.The PCV% in males of Betwil, BareNeck and Large Beladi were reported to be 46.30,47.70 and 49.20 respectively, whereas the corresponding values of their

female counterparts were reported to be 42.50,36.20 and 38.40 respectively.They also reported ecotypes had no significant role on PCV%.

Rani *et al.* (2011) studied the haematological and biochemical changes of stunting syndrome in broiler chickens at 8 weeks and 11 weeks of age and reported PCV% in control groups to be 32.82±0.58(%) and 32.96±0.56(%) respectively.

Peters *et al.* (2011) studied Hematological parameter on Frizzled and Naked neck genotypes of Nigerian native chickens at 20 weeks of age .The mean PCV% is reported to be 35.60±0.38,33.85±0.95 and 34.65±1.27 in normal,Frizzled and Naked Neck respectively.The magnitude of PCV% in males were reported to be higher than the female in all the breeds.

Elagib and Ahmed (2011) studied the hematological parameters of indigenous Chickens in Sudan.They reported the PCV% for different sudanese indigenous breed of chicken which are as follows:

Betwil	**Bare Neck**	**Large Beladi**
44.40±1.51	39.95±1.51	44.21±1.51
M 46.30±2.14 F 42.50 ±2.14	M 47.70±2.14 F 36.20 ±2.14	M 49.20 ±2.14 F 38.40 ±2.14

Pandian *et al.*(2012) Studied on hematological profiles and erythrocyte Indices in different breeds of poultry.They

reported the overall mean values for PCV% which are presented below:

BREED	PCV %
Kadakanath	25.16±1.53
Nicobari	28.33±1.14
Aseel	30.16±1.81
RIR	24.83±0.94
WLH	8.80±0.45
Turkey	30.66±0.91
J.quail	36.83±2.34
G.fowl	33.16±0.83
Geese	32.00±0.85

They reported the mean PCV% in White Leghorn (WLH) to be 8.80 which is the lowest whereas the mean PCV% reported to be ranged from 24.83 in RIR to 30.16 in Aseel.

Prahsanth *et al.* (2012) studied on blood haematological and biochemical parameters in domestic birds with respect to strain, age and sex and they reported PCV% of domestic birds in different age groups of different sexes which are given in following table.

Strain	Male		Female	
	5-wk old	25-wk old	5-wk old	25-wk old
PB1	34.05±1.1	42.13±0.7	36.63±1.0	39.07±0.61

	1	7	7	
PB2	35.61±1.13	41.90±0.69	33.35±2.01	38.10±0.30

Ali *et al.* (2012) studied the effect of age on the hematological and biochemical profile of Japanese quail (*Coturnix coturnix japonica*) and reported the mean PCV% in Japanese quail to be 31.45%,35.57% and 36.00% at 5th ,6th and 7th weeks of age respectively.

Sonia *et al.*(2012) studied the hematological parameters of Pearl guinea fowl influenced by rearing system ,age and sex and reported the mean PCV% at 4th ,8th,12th and 16th week of age to be 27.02,27.46,28.40 and 28.75 .The mean PCV% in male and female is reported to be 29.10 and 26.70 respectively.

Adeyemo and Sani (2013) reported PCV% to be 28.0 in hematological study of broilers chickens at 08week of age fed with Aspergillus niger hydrolysed cassava peel meal.

Abdi-Hachesoo B *et al.* (2013) studied sex related differences in biochemical and hematological parameters of adult indigenous chickens in northwest of Iran.They reported the mean PCV% in male and female to be 46.10±2.85 and 35.50±2.22 respectively.

WBC

Bhatti *et al.* (2002) studied Biochemical and Hematological parameters after treatment with Biovet in different strains of laying hens and reported the WBC count to be 14.00±0.35, 13.80±01.04, 13.32±0.58 and 12.90±0.89 (Thousand/ mm^3) in control group of crossbreds, Desi, Fayoumi and Nick chick chickens respectively.

Elagib and Ahmed (2011) studied on hematological Values of blood of indigenous chickens in Sudan and reported the mean WBC values to be 2.33,2.35 and 2.23 thousand/mm^3 of blood in Betwil , Bare Neck and Large Beladi chicken respectively in Sudan.The average WBC count for male and female of Betwil is reported to be 2.34 and 2.31 thousand/mm^3 respectively .The corresponding values for Bare Neck are reported to be 2.27 and 2.43 and for Large Beladi chicken to be 2.27 and 2.19 thousand/mm^3

Peters *et al.* (2011) studied the haematological parameters on Frizzled and Naked neck Nigerian native chickens at 20 weeks of age .The average number of WBC values for Frizzled and Naked Neck is reported to be 5590.33 and 5660.52 per cubic mm of blood respectively.The mean WBC count for male and female in Frizzled breed reported to be 5580 and 5600 respectively and the corresponding values for Naked Neck is reported to be 5760 and 5560.

Prahsanth *et al.* (2012) studied on blood hematological and biochemical parameters in domestic birds with respect to strain, age and sex.They reported TLC/WBC(X $10^3/mm^3$) of domestic birds in different age groups of different sexes .In PB1 strain TLC of male and female at 5 weeks of age is reported to be 13.58 and 12.87 thousand/mm^3 respectively .The corresponding values at 25 weeks of age were reported to be 22.20 and 22.13.In PB2 strain the TLC of male and female at 5 weeks of age is reported to be 14.33 and 12.53 thousand/mm^3 respectively. The corresponding values for male and female at 25 weeks of age are reported to be 21.57 and 19.32 thousand/mm^3.

Sonia *et al.* (2012) studied the haematological parameters of Pearl guinea fowl influenced by rearing system, age and sex. The mean values for TLC/WBC at 4,8,12 and 16 weeks to be 35.09, 34.50, 34.76 and 33.99 thousand/mm^3 respectively.The mean values for male and female were reported to be 34.22 and 34.90($10^3/mm^3$) respectively.

Adeyemo and Sani (2013) reported hematological parameters and serum biochemical indices of 08 week old aged broilers chicken in an experiment and reported WBC ($x10^9/L$) to be 7.5 in control group.

Kanduri *et al.* (2013) reported WBC ($x10^3$/cumm) at 6 weeks of age in broiler chicken to be 26.12 in control group in an experiment to study the performance

assessment of broiler poultry birds fed on herbal and synthetic amino acids.

Abdi-Hachesoo B *et al.* (2013) studied biochemical and hematological parameters of adult indigenous chickens in northwest of Iran.They reported mean values of WBC in male and female to be 9920±1560.66 and 8885±1850.39 respectively.

Kundu *et al.*(2013) studied the haematological parameters of Vanaraja,Nicobari fowls and their various F1 Crosses.The WBC values for different breed and their crosses are reported to be ranged from 76.96±11.95 in BN X Van female to 166.93±0.70 in WN thousand/µl of blood.

Species	**Sex**	**WBC(X10³/µL)**
Van	M	158.02±8.02
	F	138.18±25.54
WN	M	149.65±7.86
	F	166.93±0.70
BN	M	166.20±0.61
	F	165.72±0.62
BrN	M	163.32±4.19
	F	118.43±50.69
BN x Van	M	138.66±5.19
	F	76.96±11.95
Van x BN	M	138.62±2.41
	F	144.46±9.89
BrN X Van	M	165.25±2.74

	F	162.82±0.48
Van x BrN	M	153.02±5.76
	F	139.86±1.75
WN x Van	M	134.70±2.60
	F	156.26±8.81
Van X WN	M	135.26±2.80
	F	145.09±2.75

RBC/TEC

Bhatti *et al.* (2002) estimated the hematological parameter after treatment with Biovet in different genetic groups of laying hens and reported RBC ($X10^6$ /mm^3) to be 4.24±0.25, 4.48±0.16, 4.36±0.26 and 4.18±0.20 in crossbred, Desi, Fayoumi and Nick chick respectively in control group.

Islam *et al.*(2004) studied the haematological parameters of Fayoumi, Assil and Local chickens reared in sylhet region in Bangladesh.The average values of RBC at 1^{st} ,3^{rd} ,6^{th} ,9^{th} and 12^{th} months in Fayoumi chicken are reported to be 2.55,3.18,3.33,3.39 and 3.46(10^6/mm^3) respectively.The corresponding values for Assil and local desi fowls are depicted below.They reported that RBC count increases with the advancement of age.

Parameter	**Breed**	**1 mon**	**3 mon**	**6 mon**	**9 mon**	**12 mon**

TEC/RBC (106/mm^3)	Fayoumi	2.55±0.06	3.18±0.05	3.33±0.03	3.39±0.04	3.46±0.03
	Assil	1.76±0.27	1.93±0.09	2.58±0.13	2.89±0.08	3.05±0.09
	Local	1.70±0.04	1.74±0.02	2.43±0.12	2.69±0.08	2.98±0.21

Islam *et al.* (2004) observed the value of TEC 2.49±0.09 (X 10^6/mm^3) in control group of Shaver Star Bro strain of broilers at 55 days of age to see the effect of probiotics and antibiotic supplementation on body weight and hemato-biochemical parameters.

Elagib and Ahmed (2011) compared the haematological parameters of indigenous chicken of Sudan of three different ecotypes, at mature ages ranging from 1.5-2.0 years. They reported that sex had significant effect on RBC in all the three ecotypes. The values of RBC in males and females of Sudanese indigenous chicken were reported to be higher in males than females. Males had significantly ($P<0.05$) higher RBC (x10^6/mm^3) values than their female counterparts in all the three ecotypes.The mean estimates RBC (x10^6/mm^3) in Betwil, BareNeck and Large Beladi were reported to be 2.83,2.83 and 2.70 respectively in males, where as the corresponding values in females were found to be 2.50,1.70 and 2.10 respectively. They

however could not find significant differences among RBC ($x10^6/mm^3$) of three different ecotypes.

Peters *et al.* (2011) studied on Hematological parameters on Frizzled and Naked Neck genotypes of Nigerian natives chickens at 20 weeks of age and reported the RBC count ($10^6/mm^3$) for Frizzled and Naked neck chicken to be 3.79 and 3.91 respectively .They also reported that males had higher values for RBC count than the females. The mean RBC count for male and female of Frizzled bird to be 4.20 and 3.38 ($10^6/mm^3$) respectively.The corresponding values for Naked Neck is reported to be 4.46 and 3.36 ($10^6/mm^3$) of blood.

Rani *et al.* (2011) studied the haematological and biochemical changes of stunting syndrome in broiler chickens at 8weeks and 11 weeks of age and reported the RBC (millions/cumm) in control groups to be 3.19±0.12 and 3.21±0.13 respectively.

Prahsanth *et al.*(2012) studied on blood hematological and biochemical parameters in domestic birds with respect to strain ,age and sex.They reported TEC/RBC(X $106/mm^3$) PB1 strain to be 3.01 and 4.30 in males at 5 and 25 weeks of age .The corresponding values for females were reported to be 3.02 and 3.59 whereas in PB2 strain the RBC count in male is reported to be 2.68 and 4.20 at 5 and 25 weeks of age and the corresponding values for females were reported to be 2.40 and 3.45($10^6/mm^3$)

Sonia *et al.* (2012) studied the haematological parameters of Pearl guinea fowl influenced by rearing system, age and sex. The mean values of TEC at 4,8,12 and 16 weeks of age were reported to be 3.18, 3.13, 3.14 and 3.20 ($10^6/mm^3$) respectively. The mean TEC count in male and female reported to be 3.26 and 3.07($10^6/mm^3$) respectively.

Ali *et al* .(2012) studied the effect of age on the haematological and biochemical profiles of Japanese quails (*Coturnix coturnix japonica*) and reported the mean TEC/RBC ($10^6/\mu l$) at 5,6 and 7 weeks of age to be 2.55,2.95, and 2.45 respectively. different age of bird.

Pandian *et al.*(2012) Studied the hematological profiles and erythrocyte Indices in different breeds of poultry. They reported the overall mean values for RBC(X106/µl) which are presented in table.

BREED	**RBC(X106/µl)**
Kadakanath	2.96±0.06
Nicobari	2.93±0.08
Aseel	2.82±0.13
RIR	2.52±0.08
WLH	2.03±0.08
Turkey	2.73±0.16
J.quail	2.78±0.11
G.fowl	2.38±0.16
Geese	2.82±0.10

Adeyemo and Sani (2013) studied the hematological parameters and serum biochemical indices of 08 week old aged broilers chicken in experiment and reported RBC ($x10^9/L$) to be 2.51 in control group.

Kanduri *et al.* (2013) reported RBC ($x10^6$/cumm) at 6 weeks of age in broiler chicken to be 2.98 in control group in an experiment to study the performance assessment of broiler poultry birds fed on herbal and synthetic amino acids.

Kundu *et al.* (2013) studied the haematological parameters of Vanaraja, Nicobari fowls and their various F1 Crosses. They reported RBC values for different breeds and their crosses which have been depicted in following table. The TEC count is reported to be ranged from 0.43±0.07 in Van x BrN female to 1.53±0.22 (106/µl) in Van female.

Species	**Sex**	**RBC(X106/µl)**
Van	M	0.84±0.23
	F	1.53±0.22
WN	M	1.47±0.01
	F	1.10±0.01
BN	M	1.13±0.01
	F	1.33±0.06
BrN	M	0.95±0.02
	F	1.25±0.06
BN X Van	M	0.85±0.09
	F	1.44±0.02

Van X BN	M	1.22±0.22
	F	1.01±0.19
BrN X Van	M	0.56±0.04
	F	1.24±0.18
Van X BrN	M	0.64±0.07
	F	0.43±0.07
WN x Van	M	1.06±0.16
	F	1.18±0.27
Van x WN	M	0.83±0.24
	F	0.85±0.34

BIOCHEMICAL PROFILES

Biochemical parameters like cholesterol, SGOT and SGPT are some of the important biochemical profiles .Their presence at optimum level in blood is essential to maintain the sound health. Low fat diets is valuable in correcting inherited disorder of lipoprotein metabolism and hyperlipidemia in human beings . Lower content of cholesterol in indigenous chicken may be the result of high body activity.Serum enzymes are conveniently used as markers to detect the cellular damage which ultimately helps in the diagnosis of diseases. It may be noted that SGPT is more specific for the diagnosis of liver diseases while SGOT is for heart diseases. This information, besides of diagnostic and management purposes, can be use for developing new broiler strains that genetically resistant to poultry diseases as well as for genetic improvement

programs of industrial and indigenous poultry. Therefore, it is important to investigate blood biochemical profiles of indigenous chicken in order to accurate interpretation of health status.

CHOLESTEROL

Bhatti *et al.* (2002) reported the haematological parameter after treatment with Biovet in different genetic groups of laying hens and reported cholesterol (mg/dl) to be 147.42±72.96, 145.72±62.17, 140.99 ± 61.42 and 130.77±50.55 in crossbred, Desi, Fayoumi and Nick chick respectively in control group.

Islam *et al.* (2004) reported the mean level of cholesterol to be 137.52 ± 1.72 (mg/dl) in control group of Shaver Star Bro strain of broilers at 55 days of age, in an experiment to study the effect of probiotics supplementation on body weight.

Peters *et al.* (2011) studied on Hematological studies on Frizzled and Naked Neck genotypes of Nigerian native chickens at 20 weeks of age .They reported the mean Cholesterol(mg/dl) level of Frizzled and Naked neck chicken to be 156.60 and 160.30 mg/dl. In Frizzled the mean cholesterol level of male and female reported to be 176.0 and 137.20 mg/dl .The corresponding values for Naked Neck are reported to be 183.10 and 131.50 respectively.

Prahsanth *et al.*(2012) studied on blood hematological and biochemical parameters in domestic birds with respect

to strain, age and sex, they reported the mean Cholesterol(mg/dl) level in PB1 strain of domestic birds at 5 and 25 weeks of age to be 136.8 and 103.7 mg/dl in males whereas the corresponding values for their counterparts to be 159.9 and 95.28 mg/dl respectively .In PB2 strain the average cholesterol level of males at 5 and 25 weeks of age is reported to be 155.6 and 143.4 mg/dl respectively and the corresponding values for their counterparts reported to be 147.0 and 139.3 mg/dl respectively.

Ali *et al* (2012) studied the effect of age on the hematological and biochemical profiles of Japanese quails (*Coturnix coturnix japonica*).The mean Cholesterol level at 5,6 and 7 weeks of age was reported to be 91.95,212.82 and 466.11 mg/dl respectively.

Khawaja *et al.* (2013) studied production performance, egg quality and biochemical parameters of three way crossbred chickens with reciprocal F_1 crossbred chickens in sub-tropical environment and reported that there was non-significant ($P>0.05$) difference in cholesterol values among all crossbred chickens. cholesterol value (mg/dL) in RIFI= Rhode Island Red male x Fayoumi female; FIRI= Fayoumi male x Rhode Island Red female and RLH= White Leghorn male x FIRI female 138.00±10.00 130.70±09.00 and 134.33 ± 20.20 respectively.

Kanduri *et al.* (2013) reported serum cholesterol (mg/dl) at 6 weeks of age in broiler chicken to be 148.38

mg/dl in control group in an experiment to study the performance assessment of broiler poultry birds fed on herbal and synthetic amino acids.

Abdi-Hachesoo B *et al.* (2013) studied biochemical and hematological parameters of adult indigenous chickens in northwest of Iran. They reported the mean value of Cholesterol (mg/dl) of male and female to be 167.60 and 152.60 mg/dl respectively.

AST/SGOT (IU/L)

Islam *et al.* (2004) studied the effects of probiotics supplementation on growth performance and certain hemato-biochemical parameters in broiler chicken. They reported the SGOT (IU/L) value in Broiler chicken at 55days age to be 187.32± 3.71 (IU/L) in control group.

Islam *et al.* (2004) observed the effect of probiotics and antibiotic supplementation on body weight and hematobiochemical parameters in Shaver Star Bro strain of broilers at 55 days of age and reported SGOT (IU/L) in control group to be 187.32± 3.71(IU/L).

Prahsanth *et al.*(2012) studied on blood hematological and biochemical parameters in domestic birds with respect to strain ,age and sex, they reported the mean SGOT(IU/L) level in PB1 strain of domestic birds at 5 and 25 weeks of age to be 153.3±9.26 and 137.6±9.45 IU/L in males whereas the corresponding values for their counterparts to be 136.1±6.10 and 131.3±6.45 IU/L respectively .In PB2 strain the average SGOT level of males at 5 and 25 weeks of

age is reported to be 149.8±9.63 and 138.4±8.73 IU/L respectively and the corresponding values for their counterparts reported to be 141.6±1.39 and 172.6±20.74 IU/Lrespectively.

Abdi-Hachesoo B *et al.* (2013) studied the biochemical and hematological parameters of adult indigenous chickens in northwest of Iran. They reported the mean value of SGOT(IU/L) of male and female to be 191±0.89 and125.20±11.76(IU/L) respectively.

Kanduri *et al.* (2013) reported SGOT(IU/L) at 6 weeks of age in broiler chicken to be 160.11(IU/L) in control group in an experiment to study the performance assessment of broiler poultry birds fed on herbal and synthetic amino acids.

Adriani (2014) conducted an study to get serum glutamate oxaloacetate transaminase (SGOT) in broilers at one month old aged chickens that was given noni juice (morinda citrifolia) and palm sugar (arenga piata). They reported SGOT (IU/L) level in control group to be 234.67 (IU/L).

ALT/SGPT (IU/L)

Prahsanth *et al.*(2012) studied on blood hematological and biochemical parameters in domestic birds with respect to strain ,age and sex, they reported the mean SGPT(IU/L) level in PB1 strain of domestic birds at 5 and 25 weeks of age to be 32.99±3.45 and 52.28±25.49 IU/L in males

whereas the corresponding values for their counterparts to be 15.32±0.78 and 27.09±3.45 IU/L respectively .In PB2 strain the average SGPT level of males at 5 and 25 weeks of age is reported to be 15.21±0.90 and 16.98±3.94 IU/L respectively and the corresponding values for their counterparts reported to be 17.09±0.63 and 19.54±4.81IU/L respectively.

Kanduri *et al.* (2013) reported SGPT (IU/L) at 6 weeks of age in broiler chicken to be 20.97 (IU/L) in control group in an experiment to study the performance assessment of broiler poultry birds fed on herbal and synthetic amino acids.

Abdi-Hachesoo B *et al.* (2013) studied the biochemical and hematological parameters of adult indigenous chickens in northwest of Iran. They reported the mean value of SGPT(IU/L) male and female to be 7.80±1.62 and 7.20±1.46(IU/L) respectively.

Adriani (2014) conducted an study to get serum glutamate pyruvate transaminase (SGPT) level in broilers at one month old aged chickens that was given noni juice (morinda citrifolia) and palm sugar (arenga piata). They reported SGPT level in control group to be 12.50 (IU/L).

Phenotypic correlations

The association between two characters that can be directly observed is the phenotypic correlation which may be due to genetic, environmental or due to the combination of both the factors (Falconer, 1960).

Correlations among economic traits are one of the key factors in formulating strategies in breeding experiments especially response to selection, as the direction and magnitude of correlations between two traits would determine the genetic changes in principal as well as in the correlated traits.

The estimates of phenotypic correlations among various body weight and conformation traits are summarized as below :

Table-2 : Phenotypic correlations among body weight at different weeks of age in pure and crossbred chicken

Traits	Breed of poultry	Phenotypic correlation coefficient	Authors
4-week body weight x 6-week body weight	White Leghorn	0.777	Jaya Laxmi et al.(2010)
4-week body weight x 10-week body weight		0.607	
4-week body weight x 16-week body weight		0.377	
4-week body weight x 20-week body weight		0.246	
4-week body weight x 40-week body weight		0.164	
4-week body weight		0.169	

x 52-week body weight			
4-week body weight x 64-week body weight		0.155	
6-week body weight x 10-week body weight		0.642	
6-week body weight x 16-week body weight		0. 144	
6-week body weight x 20-week body weight		0.224	
6-week body weight x 40-week body weight		0.195	
6-week body weight x 52-week body weight		0.175	
6-week body weight x 64-week body weight		0.140	
10-week body weight x 16-week body weight	White Leghorn	0.542	Jaya Laxmi et al.(2010)
10-week body weight x 20-week body weight		0.296	
10-week body weight x 40-week body weight		0.256	
10-week body weight x 52-week body weight		0.223	
10-week body weight x 64-week body weight		0.170	
16-week body weight x 20-week body weight		0.306	
16-week body weight x 40-week body weight		0.313	

16-week body weight x 52-week body weight		0.256	
16-week body weight x 64-week body weight		0.235	
20-week body weight x 40-week body weight		0.278	
20-week body weight x 52-week body weight		0.273	
20-week body weight x 64-week body weight		0.235	
40-week body weight x 52-week body weight		0.489	
40-week body weight x 64-week body weight		0.457	
52-week body weight x 64-week body weight		0.724	
20-week body weight X 40-week body weight	Vanaraja	0.36	Padhi and Chatterjee(2012)

Table-3 : Phenotypic correlations between body weight and conformation traits at different weeks of age in pure and crossbred chicken

Traits	Breed of poultry	Phenotypic correlation coefficient	Authors
20-week body weight x 16-week shank length		0.22	
20-week body		0.24	

weight x 32-week shank length			
20-week body weight x 40-week shank length	White Leghorn	0.27	Khurana *et al.* (2006)
40-week body weight x 16-week shank length		0.25	
40-week body weight x 32-week shank length		0.29	
40-week body weight x 40-week shank length		0.34	
40-week body weight x 20-week shank length		0.10	
40-week body weight x 22-week shank length	Vanaraja	0.19	Padhi and Chatterjee (2012)
40-week body		0.36	

weight x 40-week shank length			
20-week body weight x 20-week shank length		0.30	
20-week body weight x 22-week shank length	Vanaraja	0.16	Padhi and Chatterjee (2012)
20-week body weight x 40-week shank length		0.24	
3-week body weight x 3-week shank length	Broiler chickens	0.457+0.014	Singh *et al.* (2000)
5-week body weight x 5-week shank length		0.571+0.014	
20-week body weight x 16-week keel length		0.33	
20-week body weight x 32-week keel		0.28	

length			
20-week body weight x 40-week keel length		0.28	
40-week body weight x 6-week keel length	White Leghorn	0.15	Khurana *et al.* (2006)
40-week body weight x 32-week keel length		0.43	
40-week body weight x 40-week keel length		0.45	

Table-4 : Phenotypic correlations between shank length and keel length at different weeks of age in pure and crossbred chicken

Traits	Breed of poultry	Phenotypic correlation coefficient	Authors
1	2	3	4
16-week shank length x 16-week keel length		0.147+0.03	
32-week shank	White Leghorn	0.244+0.03	Khurana *et al.* (2006)

length x 32-week keel length			
40-week shank length x 40-week keel length		0.238+0.03	
20-week shank length x 22-week shank length	Vanaraja	0.44	Padhi and Chatterjee (2012)
20-week shank length x 40-week shank length		0.46	
22-week shank length x 40-week shank length		0.57	

Review of Phenotypic correlations among body weight and haematological profiles

Nowaczewski *et al.* (2011) studied haematological indices, size of erythrocytes and haemoglobin saturation in broiler chickens kept in commercial conditions and reported that the phenotypic correlations of body weight with haematological parameters as well as among various haematological parameters to be highly significant, positive and moderate to high in magnitude.

MATERIALS AND METHODS

MATERIALS AND METHODS

The experiment was conducted on the genetic group of chicken involving Vanaraja, Desi (Muzaffarpur,Gaya)and their crosses maintained at Instructional Livestock Farm Complex of B. V. College Patna. The three genetic groups were formed in the following manner for the present investigation:

1. Vanaraja ♂♂ x Vanaraja ♀♀
2. Desi(Muzaffarpur) ♂♂ x Vanaraja♀♀
3. Desi(Gaya) ♂♂ x Vanaraja ♀♀

Twenty males and 100 females under each genetic group were taken. The mating of male and female was done in the ratio of 1 : 5 in each group on random basis. All the progenies were obtained from single hatch in each group.Following are the number of male and female of each genetic group at 4th week of age.

Sl. No.	Genetic group	Male	Female	Total
1	VR♂♂ x VR♀♀	144	153	297
2	D(MZF)♂♂ x VR♀♀	137	162	299
3	D(GAYA)♂♂ x VR ♀♀	138	163	301

The birds were maintained under deep litter system. Better uniform management, standard ration and clean water were provided *ad. lib* to all the birds throughout the experiment.

The traits under study were as follow :

A. Body weight traits:

1. Day old body weight (g)
2. 4 week body weight (g)
3. 8 week body weight (g)
4. 12 week body weight (g)
5. 16 week body weight (g)
6. 20 week body weight (g)

B. Conformation traits:

(a) Shank length

1. 4^{th} week shank length (cm)
2. 8^{th} week shank length (cm)
3. 12^{th} week shank length (cm)
4. 16^{th} week shank length (cm)
5. 20^{th} week shank length (cm)

(b) Keel length

1. 4^{th} week keel length (cm)
2. 8^{th} week keel length (cm)
3. 12^{th} week keel length (cm)
4. 16^{th} week keel length (cm)
5. 20^{th} week keel length (cm)

C. Haemato-biochemical profiles

(a) Haematological profiles

1.Haemoglobin

2.PCV

3.RBC

4.WBC

(b) Biochemical profiles

1.cholesterol

2.SGOT

3.SGPT

Measurement of the traits

1. Body weight:-

Body weight of each bird was measured on zero day, 4th, 8th, 12th, 16th, and 20th week of age. It was recorded to the nearest 0.1 g sensitivity.

2. Shank length:-

This was measured with the help of slide caliper at 4th, 8th, 12th, 16th, and 20th week of age on left shank. Shank length was measured as the distance between point of hock and base of foot.

3. Keel length:-

This was also measured with the help of a slide caliper at 4th, 8th, 12th, 16th and 20th week of age. It was measured as the distance from the anterior end to the posterior end of the keel bone.

4. Haematological and biochemical profiles

For estimation of haemato-biochemical profiles,blood samples were collected from 30 male and 30 female of each genetic group at the age of 20th week .Two(2)ml blood was kept in a vial for serum collection and one(1)ml was kept in a separate vial containing 2mg EDTA for haematological tests.

- HAEMOGLOBIN was measured by a instrument Sahli's haemoglobinometer .
- PCV was measured by microhaematocrit.
- Total WBC and RBC count was measured by autohaematologyanalyser.
- SGOT and SGPT was measured by modified IFCC method.
- CHOLESTEROL was measured by CHOD/TAP method.

Statistical Analysis

All the data were analysed by fitting least squares analysis as per Harvey (1990) in the department of Animal Genetics & Breeding, BVC, Patna. Some data were analysed

by Microsoft excel 2010 and some were analysed through SPSS software. Data were standardized before analysis.

Mean, standard error and coefficient of variation:-

The mean, standard error and coefficient of variation for all the body weight, conformation traits ,hematological and biochemical profiles in all the genetic groups were computed using the formulae given by Snedecor and Cochran(1994).

$$\overline{X} = \frac{\sum_{i=1}^{n} x_i}{n}$$

$$S.E = \frac{S}{\sqrt{n}}$$

$$C.V.\% = \frac{S}{\overline{X}} \times 100$$

$$S = \sqrt{\frac{\sum x^2_i - \frac{(\sum x_i)^2}{n}}{n-1}}$$

$\overline{X}$ = Mean

X_i = Measurement of a trait on i^{th} bird

n = number of Observations

The following linear statistical model was used for studying the effect of sex on various body weight, conformation traits and haematological and biochemical profiles under study

$$Y_{ij} = \mu + S_i + e_{ij}$$

Where,

Y_{ij} is the measurement of trait on the j^{th} bird of i^{th} sex.

μ is the overall population mean

S_i is the effect of i^{th} sex.

e_{ij} is the random error assumed to be normally and independently distributed with mean 0 and variance σ^2_e i.e. NID $(0, \sigma^2_e)$.

Effect of genetic groups on various body weight, conformation traits, and haematological and biochemical profiles.

The following linear statistical model was used to study the effect of genetic groups on various body weight, conformation traits, haematological and biochemical profiles.

$$Y_{ij} = \mu + G_i + e_{ij}$$

Where,

Y_{ij} is the measurement of a trait on the j^{th} bird of i^{th} genetic group

μ is the overall population mean

G_i is the effect of i^{th} genetic group

e_{ij} is the random error assumed to be normally and independently distributed with mean 0 and variance σ^2_e i.e. NID $(0, \sigma^2_e)$.

Correlation Co-efficient:-

The simple correlation eoefficient on the basis of the phentypic values among different characters were computed by using the formula given by Snedecor and Cochran(1998):

$$r_{xy} = \frac{Covariance\ xy}{sd_x \cdot sd_y}$$

Where,

χ = represents one trait.

γ = represents another trait.

$r_{\chi\gamma}$ = Coefficient of correlation between χ and γ traits.

sd_{χ} = Standard deviation of the trait χ

sd_y = Standard deviation of the trait γ

n = paired number of observations.

$$r_{xy} = \frac{\Sigma xy - \frac{(\Sigma x)(\Sigma y)}{n}}{\sqrt{\left[\Sigma x^2 - \frac{(\Sigma x)^2}{n}\right]\left[\Sigma y^2 - \frac{(\Sigma y)^2}{n}\right]}}$$

The correlation coefficients were tested for their significance through 't' test as below :

$$t_{(N-2)d.f.} = \frac{r}{S.E.(r)}$$

Where S.E. (r) = $\sqrt{\frac{1-r^2}{N-2}}$

r = Estimate of phenotypic correlation coefficients between two traits

N = Paired number of observations.

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

Average body weight at different weeks of age of various genetic groups :

Least squares means along with their standard error (SE) and Coefficient of variation percentage (CV%) of body weights (g) Pooled over sexes at different weeks of age in various genetic groups have been presented in table-5.

Day old body weight:-

The average body weight pooled over sexes of day old chicks in VR♂♂ X VR♀♀ found to be 37.95 ± 0.15g. Padhi *et al.*(2012a and 2012b), Kalita *et al.*(2012) and Ali (2014) reported the average day old body weight of VR♂♂ x VR♀♀ Pooled over sexes to be 37.63 , 38.74,39.63 and 37.35g respectively. Jha and Prasad (2013) have reported the pooled value of VR♂♂ X VR♀♀ to be 35.91 ± 0.26g at day old of age which is in close proximity to the findings of present study .The value obtained in present study was found to be in aggrement with the findings of afforesaid authors. However the average day old body weight obtained in the present study was higher than the values obtained by Hussaini (1963), Krishanamurthy (1992) and Husain (1972) in RIR based in chicken which is a dual purpose breed and suitable poultry breed for backyard poultry farming. However the average day old body weight of Vanaraja pooled over sexes reported by Kumar (2014) was lower than the values obtained by present study. The value obtained in the

present study was found to be lower than the values obtained by Ramappa and Gowda (1973) in WR and WC, Siddappa *et al.* (1978) in WC and Singh *et al.*(2000) in Red Cornish which is one of either dual purpose or meat types breeds. However the findings of the present study has elevated values than the values obtained by Chhabra and Sapra (1973) in indigenous breed of chicken like Naked Neck. The differences among the breed may be responsible for variation in day old body weight. The elevated values of VR♂♂ X VR♀♀ day old chicks obtained in the present study than the values obtained by Kumar (2014) may be due to variation in management of different periods of time.

The average estimates of body weight of day old chicks in DESI(MZF)♂♂ X VR♀♀ Pooled over sexes was found to be 36.78±0.15g.The average body weight obtained in the present study could not be compared very much as the reports on available literature are very scanty. However ,the average body weight of DESI(MZF)♂♂ X VR♀♀ at day old obtained in the present investigation was found to be in conformity with the findings of Padhi *et al* (1999b), Haque and Howlider(2000) who obtained similar body weight in White Nicobari and Naked Neck desi chicken respectively. The average day old body weight of indigenous chicken like Naked Neck reported by Chhabra and Sapra(1973) to be much lower than the findings of the present study. However the average day old body weight pooled over sexes of Aseel reported by Chhabra and Sapra (1973) was in close proximity with findings of the present study. Sharma (2014)

RESULTS AND DISCUSSION

Average body weight at different weeks of age of various genetic groups :

Least squares means along with their standard error (SE) and Coefficient of variation percentage (CV%) of body weights (g) Pooled over sexes at different weeks of age in various genetic groups have been presented in table-5.

Day old body weight:-

The average body weight pooled over sexes of day old chicks in VR♂♂ X VR♀♀ found to be 37.95 ± 0.15g. Padhi *et al.*(2012a and 2012b), Kalita *et al.*(2012) and Ali (2014) reported the average day old body weight of VR♂♂ x VR♀♀ Pooled over sexes to be 37.63 , 38.74,39.63 and 37.35g respectively. Jha and Prasad (2013) have reported the pooled value of VR♂♂ X VR♀♀ to be 35.91 ± 0.26g at day old of age which is in close proximity to the findings of present study .The value obtained in present study was found to be in aggrement with the findings of afforesaid authors. However the average day old body weight obtained in the present study was higher than the values obtained by Hussaini (1963), Krishanamurthy (1992) and Husain (1972) in RIR based in chicken which is a dual purpose breed and suitable poultry breed for backyard poultry farming. However the average day old body weight of Vanaraja pooled over sexes reported by Kumar (2014) was lower than the values obtained by present study. The value obtained in the

RESULTS AND DISCUSSION

Average body weight at different weeks of age of various genetic groups :

Least squares means along with their standard error (SE) and Coefficient of variation percentage (CV%) of body weights (g) Pooled over sexes at different weeks of age in various genetic groups have been presented in table-5.

Day old body weight:-

The average body weight pooled over sexes of day old chicks in VR♂♂ X VR♀♀ found to be 37.95 ± 0.15g. Padhi *et al.*(2012a and 2012b), Kalita *et al.*(2012) and Ali (2014) reported the average day old body weight of VR♂♂ x VR♀♀ Pooled over sexes to be 37.63 , 38.74,39.63 and 37.35g respectively. Jha and Prasad (2013) have reported the pooled value of VR♂♂ X VR♀♀ to be 35.91 ± 0.26g at day old of age which is in close proximity to the findings of present study .The value obtained in present study was found to be in aggrement with the findings of afforesaid authors. However the average day old body weight obtained in the present study was higher than the values obtained by Hussaini (1963), Krishanamurthy (1992) and Husain (1972) in RIR based in chicken which is a dual purpose breed and suitable poultry breed for backyard poultry farming. However the average day old body weight of Vanaraja pooled over sexes reported by Kumar (2014) was lower than the values obtained by present study. The value obtained in the

present study was found to be lower than the values obtained by Ramappa and Gowda (1973) in WR and WC, Siddappa *et al.* (1978) in WC and Singh *et al.*(2000) in Red Cornish which is one of either dual purpose or meat types breeds. However the findings of the present study has elevated values than the values obtained by Chhabra and Sapra (1973) in indigenous breed of chicken like Naked Neck. The differences among the breed may be responsible for variation in day old body weight. The elevated values of VR♂♂ X VR♀♀ day old chicks obtained in the present study than the values obtained by Kumar (2014) may be due to variation in management of different periods of time.

The average estimates of body weight of day old chicks in DESI(MZF)♂♂ X VR♀♀ Pooled over sexes was found to be 36.78±0.15g.The average body weight obtained in the present study could not be compared very much as the reports on available literature are very scanty. However ,the average body weight of DESI(MZF)♂♂ X VR♀♀ at day old obtained in the present investigation was found to be in conformity with the findings of Padhi *et al* (1999b), Haque and Howlider(2000) who obtained similar body weight in White Nicobari and Naked Neck desi chicken respectively. The average day old body weight of indigenous chicken like Naked Neck reported by Chhabra and Sapra(1973) to be much lower than the findings of the present study. However the average day old body weight pooled over sexes of Aseel reported by Chhabra and Sapra (1973) was in close proximity with findings of the present study. Sharma (2014)

reported the average body weight of day old chicks pooled over sexes at 50% genetic inheritance in DESI(MZF)♂♂ X VR ♀♀ to be 30.51±0.13g which is less than present investigation.

Table-5 : Least squares means along with standared error and C.V. % of body weight (g) at different weeks of age in various genetic groups of chicken (sexes pooled)

AGE(in weeks)		VR♂♂ X VR♀♀	DESI(MZF) ♂♂ X VR♀♀	DESI(GAYA) ♂♂ X VR ♀♀
One day	Mean± S.E	37.95^{a}±0.15	36.78^{b}±0.15	36.43^{b}±0.15
	C V %	8.40	8.67	8.75
4th week	Mean± S.E	300.40^{a}±2.27	278.39^{b}±2.27	271.13^{b}±2.27
	C V %	13.07	14.11	14.48
8th week	Mean± S.E	636.56^{a}±6.76	515.51^{b}±6.76	487.64^{c}±6.74
	C V %	17.08	21.09	22.30
12th week	Mean± S.E	1311.31^{a}±10.67	870.81^{b}±10.70	821.63^{c}±10.67
	C V %	12.34	18.63	19.69
16th week	Mean± S.E	1797.24^{a}±11.27	1151.43^{b}±11.27	1109.50^{c}±11.27
	C V %	9.08	14.18	14.72
20th week	Mean± S.E	2428.37^{a}±23.68	1678.43^{b}±23.68	1540.63^{c}±23.68
	C V %	14.13	20.44	22.27

Means with similar superscripts (row-wise abc) did not differ significantly.

The mean body weight of day old chicks in DESI(GAYA)♂♂ X VR♀♀ pooled over sexes was found to be 36.43±0.15g. The average day old body weight of DESI(GAYA)♂♂ X VR♀♀ obtained in the present investigation was in correspondance with the mean values of various indigenous breeds of chicken like Kadaknath and Aseel (Bhardawaj *et al* .,2006) as well as in Hazra and Aseel (Jha *et al.*,2012).The average body weight of DESI(GAYA)♂♂ X VR♀♀ at day old obtained in the present study was found to be close proximity with the findings reported by many authors like Husain (1972) in WR ,Sapra *et al.(*1972) in WR X WR and Sharma (1984) in WR X RC which are mostly meat type breed. However, the findings of the present study was not in aggrement with the findings of Ramappa and Gowda (1973),Sidapa *et al.(*1978), Padhi *et al.(*1999a) and Singh *et al.*(2000) in WR,WR X WC ,WC ,and Red Cornish respectively. Sharma (2014) reported day old body weight of DESI(GAYA)♂♂ X VR♀♀ genetic group at 50% level of genetic group at 50% level of genetic inheritance pooled over sexes to be 29.36±0.24g which is less than present investigation.

Table-6 : Analysis of variance for the effect of genetic groups on body weight at various ages.

Traits	Source of variation	D.F.	M.S.	F
Day old	Between genetic group	2	292.564	28.661**
	Error	1371	10.207	
4th week	Between genetic group	2	69452.877	45.029**
	Error	894	1542.393	
8th week	Between genetic group	2	1624977.034	137.453**
	Error	775	11822.023	
12th week	Between genetic group	2	16722930.323	638.705**
	Error	687	26182.537	
16th week	Between genetic group	2	31223893.633	1170.474**
	Error	627	26667.7427	
20th week	Between genetic group	2	44736867.522	407.117**
	Error	585	109886.977	

**-Significant at P<0.01

4th week body weight

The mean body weight at 4th week of age in VR♂♂ X VR ♀♀ pooled over sexes was estimated to be 300.40±2.27g. Ali (2014) reported the average body weight of Vanaraja pooled over sexes at 4th week of age to be 300.93±1.46g which is aggrement with the findings of the present investigation .The findings of the present study is in close proximity with the findings of the Jha and Prasad (2013) who have reported the pooled value of Vanaraja to be 316.47 ±2.47g at 4th week of age. However, Debata *et al.*(2012) reported the pooled value of Vanaraja to be 448.46±7.32g at 4th week of age which is heavier than the mean body weight obtained in the present study. Differences in body weight might be attributed to management and environmental differences.

The average body weight of DESI(MZF)♂♂ X VR♀♀ at 4th week of age pooled over sexes was found to be 278.39±2.27g. The reports on body weight at 4th week of age in DESI(MZF)♂♂ X VR♀♀ is scanty in the available literature. The average body weight pooled over sexes at 4th of age in indigenous chicken by padhi *et al.(*1999) in Naked Neck and Naked Neck cross synthetic broiler to the 94.03±5.03 and 129.66±9.53g respectively. Jha and Prasad (2013) reported the average body weight of Aseel at 4th week of age to be 127.83±1.18g. Jha *et al.* (2013) reported the average 4th week body weight pooled over sexes in Hazra, Aseel and Kadaknath to be 162.45±2.48, 127.43±1.25 and 114.86±1.63g respectively. The average estimates of body

weight of indigenous breeds of chicken pooled over sexes at 4th week of age reported by Padhi *et al.*(1999), Jha and Prasad(2013) and Jha *et al.*(2013) were more than the mean body weight obtained in the findings of the present study. Malik *et al.*(2009) reported the average 4th week of body weight pooled over sexes in CARI Shyama developed in crosses of Kadaknath and an exotic breed to be 235.88±9.47g which is also lower than the findings of the present investigation. The mean body weight of DESI(GAYA)♂♂ X VR♀♀ at 4th week of age pooled over sexes was observed to be 271.13±2.27g.The reports on 4th week body weights of crosses between indigenous breeds of chicken with Vanaraja is very scanty in the available literature .The average estimates of body weight pooled over sexes at 4th week of age in crosses between indigenous breeds of chicken and exotic breeds reported by Padhi *et al.* (1999), Jha and Prasad(2013) and Jha *et al.*(2013) were lower than the value obtained in the present study.

Table-7: Least squares means along with standared error and C.V % of body weight (g) at different weeks of age in male and female of various genetic groups of chicken.

Age (wk)		VR♂♂ X VR♀♀		DESI(MZF) ♂♂ X VR♀♀		DESI(GAYA) ♂♂ X VR♀♀	
		Male	**Female**	**Male**	**Female**	**Male**	**Female**
Day Old	Mean ± S.E.	$39.82^{a}\pm0.26$	$37.22^{b}\pm0.16$	$37.44^{a}\pm0.28$	$36.56^{b}\pm0.16$	$37.80^{a}\pm0.18$	$34.59^{b}\pm0.21$
	C.V%	7.50	7.99	8.11	8.31	7.66	8.38
4th week	Mean ± S.E.	$323.45^{a}\pm2.11$	$278.70^{b}\pm2.05$	$307.81^{a}\pm1.96$	$254.44^{b}\pm1.83$	$305.96^{a}\pm2.89$	$240.12^{b}\pm2.66$
	C.V%	7.86	9.12	7.52	9.09	11.06	14.10
8th week	Mean ± S.E.	$722.15^{a}\pm6.61$	$556.71^{b}\pm6.39$	$583.84^{a}\pm6.71$	$463.33^{b}\pm5.10$	$580.35^{a}\pm6.85$	$396.78^{b}\pm6.67$
	C.V%	10.24	13.28	12.33	15.53	13.25	19.38
12th week	Mean ± S.E.	$1421.93^{a}\pm9.56$	$1208.13^{b}\pm9.23$	$1012.98^{a}\pm14.73$	$777.15^{b}\pm13.50$	$915.71^{a}\pm7.94$	$732.34^{b}\pm7.74$
	C.V%	7.08	8.34	14.90	19.43	9.18	11.47
16th week	Mean ± S.E.	$1962.36^{a}\pm16.24$	$1649.97^{b}\pm15.33$	$1278.25^{a}\pm7.83$	$1031.66^{b}\pm7.61$	$1183.44^{a}\pm5.82$	$1044.79^{b}\pm5.44$
	C.V%	8.23	9.79	6.19	7.67	4.86	5.51
20th week	Mean ± S.E.	$2860.69^{a}\pm21.80$	$1976.20^{b}\pm21.36$	$1842.84^{a}\pm14.03$	$1541.67^{b}\pm12.80$	$1723.16^{a}\pm13.31$	$1382.43^{b}\pm12.39$
	C.V%	7.41	10.72	7.18	8.59	7.37	9.19

Means with similar superscripts (row-wise abc) did not differ significantly.

8th week body weight

The average body weight of VR♂♂ X VR♀♀ at 8th week of age pooled over sexes was obtained as 636.56±6.76g .Debata *et al.* (2012) reported the pooled body weight of Vanaraja to be 1003.08±20.28g. at 8th week of age .Jha and Prasad (2013) have reported the Pooled body weight of Vanaraja to be 832.51±4.53g at 8th week of age. The findings of the present study is lower than the findings of the above authors. Ali (2014) reported the average body weight of VR♂♂ X VR♀♀ at 8th week of age Pooled over sexes to be 639.86±4.53g which is close proximity to the findings of the present study.

The average body weight at 8th week of age pooled over sexes in DESI(MZF)♂♂ X VR♀♀ was recorded to be 515.51±6.76g.Jha and Prasad (2013) reported the average body weight of Vanaraja pooled over sexes at 8th weeks of age to be 832.51±4.53g.Ali (2014) reported the average body weight of Vanaraja in crosses with Gramapriya ,and its reciprocal crosses to be 512.72±3.52,488.28±4.84g respectively which is in close proximity to the findings of present study. Malik *et al.*(1997) reported the average body weight of CARI Shyama which has been developed by crossing between Kadaknath and exotic (Dahlem breed) at 8th weeks of age pooled over sexes to be 460.29±7.66g.The 8th week average body weight of indigenous breed reported by Jha *et al.*(2013) in Hazra, Aseel and Kadaknath to be 384.54±4.23,273.72±3.52 and 238.86±3.76 respectively

which is lower than the findings of the present study. However,Jha and Prasad (2013) ,Debata *et al.*(2012) reported the average body weight of Vanaraja and Red Cornish to be higher than the present study.

The mean body weight of DESI(GAYA) ♂♂ X VR ♀♀ at 8th weeks of age pooled over sexes to be 487.64±6.74g.The average body weight of Vanaraja in crosses with indigenous local breed is not available in the literature for comparative study .However, the pooled body weight of Vanaraja reported by Padhi *et al.*(2012a and 2012b) to be 520.24±7.51 and 565.67±0.03g respectively which is higher than the average body weight observed in the present study. The lower body weight of DESI(GAYA)♂♂ X VR♀♀ observed in the present study than the values observed in the available literature for 8th week body weight might be due to negative heterotic effect of gene.

12th week body weight

The mean body weight of VR♂♂ X VR♀♀ at 12th weeks of age pooled over sexes was estimated to be 1311.31±10.67g. Debata *et al.*(2012) and Ali (2014) reported the pooled body weight of VR♂♂ X VR♀♀ to be 1399.83±27.80 and 1313.27±6.20g respectively at 12th weeks of age .Jha and Prasad(2013) have reported the average body weight of Vanaraja pooled over sexes to be 1072.63±5.59g at 12th weeks of age. The findings of present study is in close proximity with the findings of Debata *et al.*(2012) and Ali (2014). However, the result obtained in the present study is

higher than the findings of the Jha and Prasad (2013). Differences in body weight might be attributed to management and environmental differences.

The mean body weight of DESI(MZF)♂♂ X VR ♀♀ at 12th week of age pooled over sexes was observed to be 870.81±10.70g. Sharma (2014) reported the average body weight for DESI(MZF)♂♂ X VR♀♀ at 50% level of genetic inheritance to be 896.66±18.36g. The findings of present study is in close proximity with the findings of Sharma (2014).

The mean body weight of DESI(GAYA)♂♂ X VR♀♀ at 12th week of age pooled over sexes was observed to be 821.63±10.67g. The findings of the present study could not be compare on the available literature as the reports on body weight of DESI(GAYA)♂♂ X VR♀♀ Chicken is very scanty. However the findings of the present on 12th week body weight is higher than the average body weight of indigenous breed of chicken like Hazra, Aseel and Kadaknath reported by Jha *et al.*(2013). Sharma (2014) obtained the average body weight of DESI(GAYA)♂♂ X VR♀♀ at 12 weeks of age at 50% level of genetic inheritance to be 928.19±16.22g which is higher than present investigation. Jha and Prasad (2013) also reported the lower estimate of mean body weight of Aseel than the findings of the present study.

16th week body weight

The average estimates of body weight of pooled over sexes at 16th week of age in VR♂♂ X VR♀♀ was estimated to be 1797.24±11.27g. Ali(2014) reported the average body weight of VR♂♂ X VR♀♀ at 16th week of pooled over sexes to be 1807.58±11.20g. Debata *et al.* (2012) reported the pooled body weight of Vanaraja to be 1725.75±32.48g at 16th weeks of age. Jha and Prasad (2013) have reported the mean body weight of Vanaraja pooled over sexes to be 1567.85±6.38g at 16th week of age. The findings of the present study is similar to the findings of the Debata *et al.*,(2012) and Ali (2014). However, the result obtained this investigation is higher than the reports of Jha and Prasad (2013). The differences in body weight might be attributed to managemental and environmental differences.

The average body weight of DESI(MZF)♂♂ X VR ♀♀ pooled over sexes at 16th week of age was found to be 1151.43±11.27g.However,no information was available in the literature to compare the findings of the present study.

The mean body weight of DESI(GAYA)♂♂ X VR ♀♀ pooled over sexes at 16th week of age was recorded to be 1109.50 ±11.27.However, no information in the literature was available to compare the findings of the present study.

20th week Body Weight

The average estimates of body weight at 20th week age of VR♂♂ X VR♀♀ pooled over sexes was observed to be 2448.67±23.68g. Debata *et al.*(2012) reported the average body weight of Vanaraja at 20th week of age to be 2340.26g . The average estimates of body weight of Vanaraja at 20th week of age observed in the present study was higher than the values reported by the above author.

The mean body weight of DESI(MZF)♂♂ X VR♀♀ pooled over sexes at 20th week of age was obtained as 1678.43±23.68g. Sharma (2014) obtained the average body weight of DESI(MZF)♂♂ X VR♀♀ genetic group at 50% level of genetic inheritance pooled over sexes to be 1581.77±28.13g which is less than present investigation.

The mean body weight of DESI(GAYA)♂♂ X VR♀♀ at 20th week of age pooled over sexes was found to be 1540.63±23.68g. Sharma (2014) reported the average body weight of DESI(GAYA)♂♂ X VR♀♀ genetic group pooled over sexes of 50% level of genetic inheritance to be 1549.43±25.37g. The findings of the present study is similar to the findings of the Sharma (2014).

No information in the literature to be made available on this genetic group to compare the findings of the present study. Jha and Prasad (2013) reported the average body weight of Aseel at 20th week of age pooled over sexes to be

1038.75±6.83g. Jha *et al.*(2013) reported the average body weight of indigenous breeds of chicken that is Hazra, Aseel and Kadaknath to be 1294.38±7.35, 1038.72±6.73 and 957.45±6.84g respectively. However the average estimates of body weight at 20th week of age observed in the present study was higher than the findings reported by the aforesaid authors.

Sex-wise average body weight of male and female at various weeks of age in different genetic groups.

Sex-wise least squares means along with standard error (SE) and coefficient of variation percentage (CV%) of body weight at different weeks of age of male and female in various genetic groups have been depicted in table-7

The mean body weights of day old chicks in VR♂♂ x VR♀♀ male and female were obtained as 39.82 and 37.22 g respectively. The average estimates of body weight of male and female day old chicks in DESI(MZF)♂♂ x VR♀♀ were found to be 37.44 and 36.56g respectively. The corresponding values of male and female day old chicks in DESI(GAYA)♂♂ X VR♀♀ were observed to be 37.80 ± 0.18 and 34.59 ± 0.21 g respectively. Padhi *et al.*(2012a) reported the body weight of male and female day old chicks in VR♂♂ x VR♀♀ to be 38.13±0.033 and 36.98±0.42 g respectively. Padhi *et al.* (2012b) reported the mean day old body weights in male and female in VR♂♂ x VR♀♀ to be 38.89±0.002 and 38.53±0.003g respectively. Ali(2014) reported the average body weight of male and female day old

chicks of VR ♂♂ X VR♀♀ to be 39.968±0.296 and 34.930±0.185g respectively. Kumar (2014) reported the average body weight of male and female day old chicks in VR♂♂ X VR♀♀ to be 33.83±1.14 and 36.00±1.14g respectively. The findings of present study are in close proximity with the findings of above authors. The average day old body weights of male and female chicks in Dahlem Red(D) x Aseel(A) and Dahlem Red(D) X Naked Neck reported by singh *et al.* (1999b) were similar to the findings of present study. However the average day old body weight of Aseel(A) x Dahlem Red(D) and Naked Neck(NN) x Dahlem Red(D) reported by singh *et al.* (1999b) were higher than the findings of present study . Padhi *et al.* (1999a) have reported the mean body weight of male and female day old chicks in White Nicobari to be 36.80 ± 0.43 and 35.90 ± 0.33g respectively. Differences in the body weight might be attributed to management and environmental factors.

The average estimates of body weight of day old chicks in male and female of DESI(MZF)♂♂ x VR♀♀ was found to be 37.443 and 36.556g respectively. No information in the literature to be made available on this genetic group to compare the findings of the present study.

Table-8 :Analysis of variance for the effect of sex on body weight at different weeks of age in Vanaraja ♂♂ x Vanaraja♀♀ .

Age(in week)	Source of variation	D.F.	M.S.	F
Zero day	Between sexes	1	626.335	70.11**
	Error	456	8.933	
4th week	Between sexes	1	149535.717	231.19**
	Error	295	646.808	
8th week	Between sexes	1	1770158.176	323.79**
	Error	257	5467.057	
12th week	Between sexes	1	2625010.188	258.83**
	Error	229	10141.821	
16th week	Between sexes	1	5106636	195.66**
	Error	208	26099.287	
20th week	Between sexes	1	38838412.411	851.58**
	Error	194	45607.378	

** Significant at P<0.01

Table-9 : Analysis of variance for the effect of sex on body weight at different weeks of age in DESI (Muzaffurpur) ♂♂ X Vanaraja ♀♀.

Traits	Source of variation	D.F.	M.S.	F
Zero day	Between sexes	1	67.703	7.32**
	Error	454	9.247	
4th week	Between sexes	1	197481.022	368.59**
	Error	297	535.771	
8th week	Between sexes	1	882899.543	170.40**
	Error	260	5181.358	
12th week	Between sexes	1	3173698.886	139.24**
	Error	225	22792.623	
16th week	Between sexes	1	3189935.870	509.93**
	Error	207	6255.585	
20th week	Between sexes	1	4406974.650	251.34**
	Error	192	17533.852	

** **Significant at P<0.01**

Table-10 :Analysis of variance for the effect of sex on body weight at different weeks of age in DES(GAYA)♂♂ x VANARAJA♀♀

Traits	Source of variation	D.F.	M.S.	F
Zero day	Between sexes	1	1155.095	136.63**
	Error	458	8.454	
4th week	Between sexes	1	340134.811	296.66**
	Error	299	1146.538	
8th week	Between sexes	1	2252128.927	380.89**
	Error	255	5912.814	
12th week	Between sexes	1	1932208.023	273.60**
	Error	230	7062.224	
16th week	Between sexes	1	1004680.085	303.03**
	Error	209	3315.425	
20th week	Between sexes	1	5659933.569	350.90**
	Error	196	16129.702	

** **Significant at P<0.01**

The average estimates of body weight of day old chicks in male and female of DESI(GAYA)♂♂ X VR♀♀ were obtained as 37.80 and 34.59g respectively. No information in the literature to be made available on this genetic group to compare the findings of the present study.

The average estimates of body weight of male and female chicks at 4th week of age of male and female in VR♂♂ X VR♀♀ were obtained as 323.45 and 278.70g respectively. Padhi *et al.* (2012a) reported the 4th week body weight of male and female in VR♂♂ X VR♀♀ to be 364.86±5.11 and 343.95±5.16g respectively. Padhi *et al.* (2012b) reported the 4th week body weight of male and female in VR♂♂ X VR♀♀ to be 327.37±0.03 and 302.81±0.04g respectively. Ali (2014) reported the 4th week of body weight male and female to be 323.47±2.09 and 278.37±2.04g respectively. The findings of present study are in aggrement with the findings of Ali (2014) . However, the results obtained in this investigation are lower than the reports of Padhi *et al.* (2012a and 2012b). Differences in the body weight might be attributed to non-genetic factor.

The average estimates of body weight male and female chicks at 4th week of age in DESI(MZF)♂♂ X VR♀♀ were found to be 307.81 and 254.44g in respectively. However no information in the literature was available to compare the findings of present study. However, padhi *et al* (1999b) reported the average 4th week body weight of indigenous

breed like Black Nicobari, White Nicobari and their crosses to be lower than the findings of present study.

The average estimates of body weight of male and female chicks at 4th week of age in DESI (GAYA)♂♂ X VR♀♀ were obtained as 305.96 and 240.12g respectively. However no information in the literature was available to compare the findings of the present study.

The average estimates of body weight of male and female chicks at 8th week of age in VR♂♂ X VR♀♀ genetic group were obtained as 722.15 and 556.71g respectively. Ali (2014) reported the average of male and female chicks at 8th week of age in VR♂♂ X VR♀♀ to be 723.97±6.53 and 555.76±6.28g respectively. Padhi *et al.*(1999b) reported the 8th week body weight of male and female in Synthetic breed 725.90±28.50 and 698.30±19.90g respectively. The findings of present study are in close proximity with the findings of above authors.

The average estimates of body weight at 8th week of age in male and female in DESI(MZF)♂♂ X VR♀♀ were found to be 583.84 and 463.33g respectively. No information in the literature was available to compare the findings of present study. However Malik *et al.* (2009) reported the 8th week body weight of male and female in CARI Shyama which is developed by cross between Dahlem Red and Kadaknath to be 545.50±17.97 and 414.54±9.03g respectively. The findings of present study are in close proximity with the findings of Malik *et al.* (2009) .The average estimates of 8th

week body weight of male and female chicks in Black Nicobari and White Nicobari and their crosses obtained by Padhi *et al* .(1999b) were lower than the findings of presentt study. The differences in body weight might be due to difference in genetic make up of the breed as well as due to differences in Environmental and managemental factors .

The average estimates of body weight of male and female at 8th week of age in DESI (GAYA)♂♂ X VR♀♀ were obtained as 580.34 and 396.78g respectively. However, no information in the literature could be made available to compare the findings of the present study.

The average estimates of body weight of male and female at 12th week of age in VR♂♂ X VR♀♀ genetic group were obtained as 1421.93 and 1208.13g respectively .Ali (2014) reported the mean body weight of male and female at 12th week of age to be 1425.90±8.85 and 1200.50±8.70g respectively. The findings of present study are in close proximity with the Ali(2014).

The average estimates of body weight of male and female at 12th week of age in DESI (MZF) ♂♂ X VR♀♀ genetic group were found to be 1012.98 and 777.15g respectively. No information in the literature could be made available to compare the findings of the present study. However, Malik *et al.* (2009) reported the 12th week body weight of male and female in CARI Shyama to be 873.34±22.70 and 725.59±27.09g respectively. The findings of Malik *et al* .(2009) are lower than the findings of present study.

The average estimates of body weight of male and female at 12th week of age in DESI (GAYA)♂♂ X VR♀♀ genetic group were obtained as 915.71 and 732.33g respectively. No information in the literature could be made available to compare the findings of the present study. Malik *et al.* (2009) reported the 12thweek body weight of male and female in CARI Shyama to be 873.34±22.70 and 725.59±27.09g. The findings of present study is comparable with above authors. Non-genetic factors might be responsible for the differences in body weight at this age.

The average estimates of body weight of male and female at 16th week of age in VR♂♂ X VR♀♀ were obtained as 1962.36 and 1649.97g respectively .Ali (2014) reported the average estimates of body weight of male and female at 16th week of age in VR♂♂ X VR♀♀ to be 1962.60±16.45 and 1652.60±15.38g respectively .The findings of present study are similar to the findings of Ali (2014).

The average estimates of body weight of male and female at 16th week of age in DESI (MZF)♂♂ X VR♀♀ were found to be 1278.25 and 1031.66g respectively. No information in the literature could be made available to compare the findings of the present study.

The average estimates of body weight of male and female at 16th week of age in DESI (GAYA)♂♂ X VR♀♀ genetic group were obtained as 1183.44 and 1044.79g respectively. No information in the literature could be made available to compare the findings of the present study.

However, Malik *et al.* (2009) reported the 16thweek body weight of male and female in CARI Shyama to be 1225.00±27.00 and 999.00±24.00g respetively.

The average estimates of body weight of male and female at 20th week of age in VR♂♂ X VR♀♀ genetic group were obtained as 2860.69 and 1976.20g respectively. Ali (2014) reported the average body weight of male and female at 20th week of age in VR♂♂ X VR♀♀ to be 2882.70 ±21.79 and1992.20±21.35g respectively. Kumar (2014) reported the average body weight of male and female in VR♂♂ X VR ♀♀ genetic group to be 2838.53±66.33 and 2176.16±66.25g respectively. The findings of present study are comparable with the findings of above authors.

The average estimates of body weight of male and female at 20th week of age in DESI (MZF)♂♂ X VR♀♀ were found to be 1842.84 and 1541.67g respectively. No information in the literature could be made available to compare the findings of the present study.

The average estimates of body weight of male and female at 20th week of age in DESI (GAYA)♂♂ X VR♀♀ genetic group were obtained as 1723.16 and 1382.43g.However, no information in the literature could be made available to compare the findings of the present study.

Effect of genetic group on body weight :

The analysis of variance for the effect of genetic group on body weight has been presented in table-6. Analysis of

variance revealed highly significant (P<0.01) effect of genetic group on body weight at different ages.

Least squares means along with standard error and CV% of body weight (g) at different weeks of age in various genetic groups pooled over sexes have been presented in table-5.

At one day it was observed that VR♂♂ x VR♀♀ and DESI(GAYA)♂♂ x VR♀♀ genetic groups had highest and lowest respectively. VR♂♂ x VR♀♀ had the significantly (P<0.05) 1.52 gm higher body weight than DESI (GAYA) ♂♂ x VR♀♀ . However, DESI (MZF)♂♂ x VR♀♀ and DESI (GAYA) ♂♂ x VR♀♀ did not differ significantly among themselves for body weight at one day.

The day-old body weight of VR♂♂ x VR♀♀ was observed to be significantly (P<0.01) higher by 1.17 than DESI(MZF)♂♂ x VR♀♀ genetic group.

At 4th week also the highest body weight was observed to be in VR♂♂ X VR♀♀ genetic group which was significantly(P<0.05) higher by 22.01 and 29.27 g than DESI(MZF)♂♂ X VR♀♀ and DESI(GAYA)♂♂ X VR♀♀ genetic groups respectively.

However, the mean body weight of DESI(MZF)♂♂ X VR♀♀ and DESI(GAYA)♂♂ X VR♀♀ genetic groups did not differ significantly among themselves at 4th week of age.

At 8th week of age also the highest body weight was observed to be 636.56±6.76g in VR♂♂ X VR♀♀ genetic

group which was significantly(P<0.05) higher by 121.05 g and 148.92 g than the DESI(MZF)♂♂ X VR♀♀ and DESI (GAYA)♂♂ X VR♀♀ genetic groups respectively. DESI (MZF)♂♂ X VR♀♀ had significantly (P<0.05) 27.87g higher body weight than DESI (GAYA)♂♂ X VR♀♀ genetic group .

The trend of growth at 12th week of age for body weight was similar to that of 8th week. The highest body weight was observed to be 1311.31±10.67g in VR♂♂ X VR♀♀ genetic group which was significantly (P<0.05) higher by 440.51 and 489.62g than the DESI(MZF)♂♂ X VR♀♀ and DESI(GAYA)♂♂X VR♀♀ genetic groups respectively. DESI(MZF♂♂ X VR♀♀ genetic group was significantly (P<0.01) heavier than DESI(GAYA)♂♂ X VR♀♀ genetic group by 49.17g. The trend of growth in body weight at 16th week of age was similar to that of 12th week of age. The 16th week of body weight was observed to be heaviest (1797.24±11.27g) in VR♂♂ X VR♀♀ genetic group which was significantly (P<0.05) heavier by 645.81 and 687.74 g than the DESI(MZF)♂♂ X VR♀♀ and DESI(GAYA)♂♂ X VR♀♀ genetic groups respectively. The second highest body weight which was observed to be 1151.43±11.27g in DESI(MZF)♂♂ X VR♀♀ genetic group which was significantly (P<0.05) higher by 41.93 g than DESI(GAYA)♂♂ X VR ♀♀ genetic group .

At 20th week of age the average estimate of body weight pooled over sexes to be 2428.37±23.68g in VR♂♂ X VR♀♀ which was significantly (P<0.05) heavier by 749.94 and

887.74 g than the DESI (MZF) ♂♂ X VR♀♀ and DESI (GAYA) ♂♂ X VR♀♀ genetic groups respectively. The 20th week body weight of DESI (MZF) ♂♂ X VR ♀♀ genetic group pooled over sexes was also observed to be significantly (P<0.05) higher by 137.80g than the DESI (GAYA) ♂♂ X VR♀♀ genetic group.

The critical analysis of table-5 clearly revealed that at all the ages VR♂♂ X VR♀♀ genetic group had the highest body weight. This might be due to the fact that Vanaraja has been developed by crossing random bred meat control population as the female line and Red Cornish population as the male line, which have better growth performance. The 2nd highest body weight was observed to be in DESI(MZF)♂♂ X VR♀♀ genetic group at all the age groups in this study which might be, possibly, due to the heterotic performance in body weight in this cross. DESI(GAYA)♂♂ X VR♀♀ had significantly(P<0.05) lower body weight than the DESI(MZF)♂♂ X VR♀♀ genetic group in all the age groups except day old and 4th week of age.

DESI(GAYA)♂♂ X VR♀♀ genetic group had the lowest body weight at almost all the age groups under study. This might be, possibly attributed to negative heterotic performance of this group.

Effect of sex on body weight :

The Analysis of variance for the effect of sex on body weight at different weeks of age in all the three genetic

groups have been presented in table 8-10. The analysis of variance revealed highly significant ($P<0.01$) effect of sex in all the three genetic groups, reflecting heavier body weight of males than the females at all the ages.

Table-7 revealed that the males of VR♂♂ X VR♀♀ , DESI(MZF)♂♂ X VR♀♀ and DESI(GAYA)♂♂ X VR♀♀ at zero day of age were significantly ($P<0.05$) heavier by 2.60 , 0.88, and 3.21 g respectively than their female counterparts. The corresponding increment at 4th week of age in male was observed to be 44.75, 53.37 and 65.84g respectively. The increase in body weight at 8th week of age in VR♂♂ X VR♀♀, DESI(MZF)♂♂ X VR♀♀ and DESI(GAYA)♂♂ X VR♀♀ genetic groups were observed to be 165.44 , 120.51 , and 183.56 g respectively. The corresponding values at 12th week of age were noted as 213.80, 235.83, and 183.38g and at 16th week of age were found to be 312.39 , 246.59 , and 138.65 g respectively. The increment in body weight at 20th week of age in corresponding groups were observed to be 890.49, 301.17, and 340.73 g respectively.

Higher body weights of males at different weeks of age in various genetic groups of chicken have also been reported by various authors. Verma *et al.* (1981) in WL x RIR cross, Gupta (1983) in White Rock, Padhi *et al.* (1999b) in Nicobari and Singh *et al.* (2000) in Red Cornish in PB-2 have reported heavier body weight of male than their female counterparts at different weeks of age in various genetic

groups of poultry which are in agreement with the findings of the present study.

Padhi *et al.* (2012a), Ali (2014) and Kumar (2014) have reported significantly ($P<0.05$) heavier male body weights than their female counterparts in Vanaraja at different age groups which are in conformity with the findings of the present study.

The critical analysis of Table -7 revealed that the sex differences between male and female chicks for body weight increased as age advanced. This might be, possibly, due to differential rate of growth of chicks of either sex to the given common environment. Besides, other physiological factors might also be responsible for this differential rate of growth as suggested by Buckner *et al.* (1949), Gilbreath and Upp (1952) and Roberts (1964).

Average Shank length at different weeks of age of various genetic groups :

Least squares means along with their standard error (SE) and coefficient of variation percentage (CV%) of Shank length (cm) pooled over sexes at different weeks of age in various genetic groups have been presented in table-11.

Table 11 : Least squares means along with standared error and C.V. % of shank length (cm) at different weeks of age in various genetic groups of chicken (sexes pooled)

Age(wks)		VR ♂♂ X VR♀♀	DESI(MZF)♂♂ X VR ♀♀	DESI(GAYA)♂♂ X VR♀♀
4th week	Mean ± S.E	$7.10^{a}\pm0.03$	$7.02^{a}\pm0.03$	$6.71^{b}\pm0.03$
	C V %	7.06	7.14	7.47
8th week	Mean ± S.E	$8.92^{a}\pm0.05$	$8.67^{b}\pm0.05$	$8.24^{c}\pm0.05$
	C V %	8.75	9.25	9.79
12th week	Mean ± S.E	$9.15^{a}\pm0.06$	$10.80^{b}\pm0.07$	$8.88^{c}\pm0.07$
	C V %	7.61	9.27	12.86
16th week	Mean ± S.E	$10.50^{a}\pm0.09$	$12.44^{b}\pm0.09$	$9.28^{c}\pm0.089$
	C V %	8.51	10.25	10.64
20th week	Mean ± S.E	$11.67^{a}\pm0.11$	$13.79^{b}\pm0.11$	$10.42^{c}\pm0.11$
	C V %	8.88	10.97	11.76

Means with similar superscripts (row-wise abc) did not differ significantly.

4th week Shank length

The mean shank length at 4th week of age in VR♂♂ X VR ♀♀ pooled over sexes was estimated to be 7.10±0.03 cm. Ali (2014) reported the average shank length of Vanaraja pooled over sexes at 4th week of age to be 7.11±0.016cm which is in aggrement with the findings of the present investigation. However, Khurana *et al.*(2006) reported the average estimate of shank length pooled over sexes of White leghorn to be 3.82±0.02 cm at 4th week of age which is comparatively shorter than the mean shank length obtained in the present study. Differences in shank length might be attributed to management and environmental differences.

The average shank length of DESI (MZF)♂♂ X VR♀♀ at 4th week of age pooled over sexes was found to be 7.02±0.03cm. The reports on shank length at 4th week of age in DESI (MZF)♂♂ X VR♀♀ is scanty in the available literature. The mean shank length of DESI (GAYA) ♂♂ X VR♀♀ at 4th week of age pooled over sexes was observed to be 6.71±0.03cm.The reports on 4th week shank length of crosses between indigenous breeds of chicken with Vanaraja is very scanty in the available literature .

Table-12 : Analysis of variance for the effect of genetic group on shank length at various ages.

Traits	Source of variation	D.F.	M.S.	F
4th week	Between genetic group	2	12.532	48.34**
	Error	894	0.259	
8th week	Between genetic group	2	59.133	88.89**
	Error	775	0.665	
12th week	Between genetic group	2	513.351	498.06**
	Error	687	1.030	
16th week	Between genetic group	2	452.476	277.76**
	Error	627	1.629	
20th week	Between genetic group	2	938.736	409.68**
	Error	585	2.291	

****Significant at P<0.01**

8th week Shank length

The average Shank length of VR♂♂ X VR♀♀ at 8th week of age pooled over sexes was obtained as 8.92±0.05cm .Ali (2014) reported the pooled shank length of Vanaraja to be 8.72±0.196cm which is in close proximity to the findings of the present study.Sharma (1984) reported the Pooled Shank lengths of White Plymouth Rock (WPR) and Red Cornish(RC) breeds of poultry and their reciprocal crosses at 8th week of age to be 6.25,6.34,6.82 and 5.42cm in WR X WR ,RC X RC ,RC XWR and WR X RC respectively Singh *et al.* (2000) have reported the pooled Shank length in control line of Red Cornish breed of poultry to be 6.24cm. The average estimates of shank length at 8th week of age obtained in

the present study were lengther than the findings of the above authors.

The average shank length at 8th week of age pooled over sexes in DESI(MZF)♂♂ X VR♀♀ was recorded to be 8.67±0.05cm. The reports on 8th week shank length of crosses between indigenous breeds of chicken with Vanaraja were very scanty in the available literature .

The mean shank length of DESI(GAYA)♂♂ X VR♀♀ at 8th week of age pooled over sexes to be 8.24 ±0.05.The average shank length of Vanaraja in crosses with indigenous local breed was not available in the literature for comparative study .

12th week Shank length

The mean shank length of VR♂♂X VR♀♀ at 12th week of age pooled over sexes was estimated to be 9.15 ±0.07cm. Ali (2014) reported the pooled shank length of VR♂♂ X VR♀♀ to be 9.11± 0.03 cm at 12th weeks of age . Mahapatra *et al.*(1983) reported the the pooled Shank length of Aseel peela, Aseel kagar, and their crossbreds to be 6.24, 6.88, and 6.79 cm respectively. The average estimates of shank length obtained in the present study were lengther than the findings of the above authors. The average shank length at 12th week of age pooled over sexes in DESI (MZF)♂♂ X VR♀♀ was recorded to be 8.92±0.07cm. The reports on 12th week shank length of crosses between indigenous breeds of chicken with Vanaraja were very scanty in the available literature for making comparison.

The mean shank length of DESI (GAYA) ♂♂ X VR ♀♀ at 12th week of age pooled over sexes to be 8.88 ±0.0.07 cm.The average shank length of Vanaraja in crosses with indigenous local breed is not available in the literature for comparative study .

16th week Shank length

The average estimates of shank length of pooled over sexes at 16th week of age in VR♂♂ X VR♀♀ was found to be 10.50±0.09 cm. Ali (2014) reported the average shank length of VR♂♂ X VR♀♀ at 16th week of age pooled over sexes to be 9.58±0.06 cm which is in close proximity to the findings of present study. Khurana *et al* .(2006) reported the pooled value of Vanaraja to be 7.18±0.03 cm at 16th week of age . The average estimates of shank length at 16th week of age obtained in the present study were lengther than the findings of the Khurana *et al.*(2006) . Differences in shank length might be attributed to non-genetic factors.

The average shank length at 16th week of age pooled over sexes in DESI(MZF)♂♂ X VR♀♀ was recorded to be 9.56±0.09 cm. The reports on 12th week shank length of crosses between indigenous breeds of chicken with Vanaraja were very scanty in the available literature .

The mean shank length of DESI(GAYA)♂♂ X VR♀♀ at 16th week of age pooled over sexes to be 9.28 ±0.09 cm.The reports on average shank length of Vanaraja in crosses with indigenous local breed were not available in the literature for comparative study .

20th week Shank length

The average estimates of shank length at 20th week age of VR♂♂ X VR ♀♀ pooled over sexes was observed to be 11.67 0.11cm. Ali (2014) reported the average shank length of VR♂♂ X VR♀♀ at 20th week of age pooled over sexes to be 10.14±0.09cm which is lengther than the findings of the present investigation. Differences in shank length might be attributed to management nd environmental differences.

The average shank length at 20th week of age pooled over exes in DESI (MZF)♂♂ X VR♀♀ was recorded to be 13.79±0.11cm. The reports on 20th week shank length of crosses between ndigenous breeds of chicken with Vanaraja is very scanty in the vailable literature .

The mean shank length of DESI (GAYA) ♂♂ X VR ♀♀ at 20th eek of age pooled over sexes to be 12.86 ±0.11.The average Shank ngth of Vanaraja in crosses with indigenous local breed was not vailable in the literature for comparative study .

ex-wise average Shank length of male and female at various eeks of age in different genetic groups.

Sex-wise the least squares means along with standard error SE) and coefficient of variation percentage (CV%) of shank length t different weeks of age of male and female in various genetic roups have been presented in table-13.

Table-13. Least squares means along with C.V % of shank length(cm) at different weeks of age in male and female of various genetic groups of chicken.

Age(week)		VR♂♂ X VR♀♀		Desi(MZF)♂♂ X VR♀♀		Desi(GAYA)♂♂ X VR♀♀	
		Male	Female	Male	Female	Male	Female
4th week	Mean±S.E	$7.40^{a}\pm0.02$	$6.98^{b}\pm0.02$	$7.36^{a}\pm0.02$	$6.74^{b}\pm0.02$	$6.98^{a}\pm0.04$	$6.30^{b}\pm0.04$
	C.V%	3.76	3.99	3.53	3.76	6.12	7.13
8th week	Mean±S.E	$8.85^{a}\pm0.06$	$7.99^{b}\pm0.06$	$8.55^{a}\pm0.06$	$7.51^{b}\pm0.05$	$8.91^{a}\pm0.05$	$8.25^{b}\pm0.05$
	C.V%	6.51	7.37	6.52	7.03	6.81	7.88
12th week	Mean±S.E	$9.57^{a}\pm0.05$	$8.32^{b}\pm0.05$	$9.45^{a}\pm0.08$	$8.01^{a}\pm0.08$	$9.32^{a}\pm0.12$	$8.96^{b}\pm0.12$
	C.V%	3.78	4.13	7.93	7.92	11.83	12.67
16th week	Mean±S.E	$10.66^{a}\pm0.09$	$8.95^{b}\pm0.09$	$9.98^{a}\pm0.12$	$8.46^{b}\pm0.12$	$9.99^{a}\pm0.10$	$9.01^{b}\pm0.10$
	C.V%	5.88	6.62	9.54	10.05	8.32	9.53
20th week	Mean±S.E	$11.01^{a}\pm0.13$	$9.98^{b}\pm0.13$	$10.42^{a}\pm0.11$	$8.89^{a}\pm0.10$	$10.02^{a}\pm0.10$	$9.95^{a}\pm0.18$
	C.V%	7.11	7.79	7.61	7.65	14.30	12.63

Means with similar superscripts (row-wise abc) did not differ significantly.

The average estimates of shank length of male and female chicks at 4th week of age in VR♂♂ X VR♀♀ were obtained as 7.40±0.04 and 6.98±0.04 cm respectively. Ali (2014) reported the average estimates of shank length of male and female at 4th week of age were 7.37±0.02 and 6.85±0.02 cm respectively. The findings of the present study are in aggrement with the findings of Ali (2014) . Verma *et al.* (1979) reported the 4th week shank length of male and female in White Leghorn X Rhode Island Red birds to be 3.30 and 3.16 cm respectively which is shorter than the findings of the present investigation. The average estimates of shank length of male and female chicks at 4th week of age in DESI (MZF)♂♂ X VR♀♀ were found to be 7.36±0.02 and 6.74±0.02 cm in respectively. However, no information in the literature was available to compare the findings of present study.

The average estimates of shank length of male and female chicks at 4th week of age in DESI (GAYA)♂♂ X VR♀♀ were obtained as 6.98±0.04 and 6.30±0.04 cm respectively. However no information in the literature was available to compare the findings of the present study.

Table-14 : Analysis of variance for the effect of sex on shank length at different weeks of age in Vanaraja♂♂ X Vanaraja♀♀

Traits	Source of variation	D.F.	M.S.	F
4th week	Between sexes	1	19.782	246.06**
	Error	295	0.080	
8th week	Between sexes	1	86.575	210.67**
	Error	257	0.410	
12th week	Between sexes	1	56.576	205.65**
	Error	229	0.275	
16th week	Between sexes	1	157.405	177.20**
	Error	208	0.888	
20th week	Between sexes	1	105.338	65.30**
	Error	194	1.613	

**Significant at P<0.01

Table-15 : Analysis of variance for the effect of sex on shank length at different weeks of age in Desi(MZF)♂♂ X Vanaraja♀♀

Traits	Source of variation	D.F.	M.S.	F
4th week	Between sexes	1	87.4352	489.509**
	Error	297	0.070	
8th week	Between sexes	1	113.3583	86.21**
	Error	260	0.352	
12th week	Between sexes	1	0.012	.02 NS
	Error	225	.749	
16th week	Between sexes	1	25.996	17.38**
	Error	207	1.495	
20th week	Between sexes	1	0.058	0.05 NS
	Error	192	1.114	

**Significant at P<0.01

NS=Non-significant

Table-16 : Analysis of variance for the effect of sex on shank length at different weeks of age in Desi(GAYA)♂♂ X Vanaraja♀♀.

Traits	Source of variation	D.F.	M.S.	F
4th week	Between sexes	1	0.192986	1.482NS
	Error	299	0.206	
8th week	Between sexes	1	49.1180	183.291**
	Error	255	0.36057	
12th week	Between sexes	1	24.5496	2.302NS
	Error	230	11.213	
16th week	Between sexes	1	8.2378	1.186NS
	Error	209	7.0667	
20th week	Between sexes	1	4..8314	0.319 NS
	Error	196	13.5787	

****Significant at P<0.01**

NS=Non-significant

The average estimates of shank length of male and female chicks at 8th week of age in VR♂♂ X VR♀♀ genetic group were obtained as 8.85±0.06 and 7.99±0.05 cm respectively. Ali (2014) reported the average shank length of male and female chicks at 8th week of age in VR♂♂ X VR♀♀ to be 8.74±0.03 and 8.70±0.03cm respectively which is very closer the findings of the Ali (2014). Sharma (1984) reported the 8th week shank length of male WR(M) X WR(F) ,RC(M) X RC(F) ,RC(M) X WR(F) and WR(M) X RC(F) to be 6.71,6.85.7.13 and 6.90 cm respectively. The corresponding values

in female were reported to be 6.04,6.17,6.56 and 6.25 cm respectively. Venkatesh (1985) reported the 8th week shank length of males RC(M) X WR(F) and WR(M) X RC(F) genetic group to be 6.67 and 6.46 cm respectively. The corresponding values in female were reported to be 6.25 and 6.11cm respectively. Padhi *et al.*(1999b) reported the 8th week shank lengths of male Black Nicobari (BN),White Nicobari (WN), Synthetic Broiler(SB) ,SB X BN and and SB X WN to be 4.09,4.09,5.75,5.27 and 4.27 cm respectively the corresponding values for females were reported to be 3.70,3.83,5.46,5.06 and 3.88 cm respectively. The average estimates of shank length obtained in the findings reported by present study were longer than the Sharma (1984) , Venkatesh (1985) and Padhi *et al.*(1999b) . Differences in the shank length might be attributed to non-genetic factors.

The average estimates of shank length at 8th week of age in male and female of DESI (MZF) ♂♂ X VR♀♀ were found to be 8.55±0.05 and 7.51±0.05cm respectively. No information in the literature was available to compare the findings of present study. The differences in body weight might be due to difference in genetic make up of the breed. The average estimates of shank length of male and female at 8th week of age in DESI (GAYA)♂♂ X VR♀♀ were obtained as 8.91±0.05 and 8.25±0.05 cm respectively. However, no information in the literature could be made available to compare the findings of the present study.

The average estimates of shank length of male and female at 12th week of age in VR♂♂ X VR♀♀ genetic group were obtained as

9.57±0.03 and 8.32±0.03 cm respectively . Ali (2014) reported the mean shank length of male and female at 12th week of age to be 9.76 ±0.047 and 8.47±0.046 cm respectively. The findings of present study are in close proximity with the findings of Ali (2014).

The average estimates of shank length of male and female at 12th week of age in DESI (MZF) ♂♂ X VR♀♀ genetic group were found to be 9.45±0.08 and 8.01±0.07 cm respectively. No information in the literature could be made available to compare the findings of the present study.

The average estimates of shank length of male and female at 12th week of age in DESI (GAYA)♂♂ X VR♀♀ genetic group were obtained as 9.32±0.12 and 8.69±0.12 respectively. No information in the literature could be made available to compare the findings of the present study Environmental and managemental factors might be responsible for the differences in shank length at this age.

The average estimates of shank length of male and female at 16th week of age in VR♂♂ X VR♀♀ were obtained as 10.66±0.09 and 8.95±0.09 cm respectively. Ali (2014) reported the average estimates of shank length of male and female at 16th week of age in VR♂♂ X VR♀♀ to be 10.51± 0.096 and 8.65±0.090 cmrespectively. The findings of present study are similar to the findings of Ali (2014).

The average estimates of shank length of male and female at 16th week of age in DESI(MZF)♂♂ X VR♀♀ were found to be

9.98±0.12 and 8.46±0.12cm respectively. No information in the literature could be made available to compare the findings of the present study.

The average estimates of shank length of male and female at 16th week of age in DESI(GAYA)♂♂ X VR♀♀ genetic group were obtained as 9.99±0.10 and 9.01±0.10 cm respectively. No information in the literature could be made available to compare the findings of the present study. Differences in shank length might be attributed to management and environmental differences.

The average estimates of shank length of male and female at 20th week of age in VR♂♂ X VR♀♀ genetic group were obtained as 11.01±0.14 and 9.98±0.14 cm respectively. Ali (2014) reported the average shank length of male and female at 20th week of age in VR♂♂ X VR♀♀ to be 10.71 ± 0.129 and 9.57±0.127 cm respectively. The findings of present study are comparable with the findings of above authors.

The average estimates of shank length of male and female at 20th week of age in DESI (MZF)♂♂ X VR♀♀ were found to be 10.40±0.11 and 8.89±0.10 cm respectively. No information in the literature could be made available to compare the findings of the present study.

The average estimates of shank length of male and female at 20th week of age in DESI (GAYA)♂♂ X VR♀♀ genetic group were obtained as 10.02±0.19 and 9.95±0.18 cm. However, no

information in the literature could be made available to compare the findings of the present study.

Effect of genetic group on shank length :

Analysis of variance indicated highly significant (P<0.01) effect of genetic group on shank length at various ages. Least squares means (table 12) revealed that VR ♂♂ x VR ♀♀ genetic group had 0.39 cm significantly (P<0.01) lengthier shank than DESI (GAYA)♂♂ X VR ♀♀ genetic group at 4th week age.

At 4th week of age the mean shank length of DESI (MZF)♂♂ X VR♀♀, and VR♂♂ x DESI (GAYA)♀♀ genetic group differ significantly(P<0.01) by 0.31 cm. However, the mean shank lengths of VR ♂♂ x VR ♀♀ and DESI (MZF) ♂♂ X VR♀♀ genetic groups did not differ significantly.

At 8th week of age the lengthiest and shortest shank lengths were obtained in VR♂♂ x VR♀♀ and DESI (GAYA)♂♂ X VR♀♀ genetic groups and the values differed significantly (P<0.05) by 0.64 cm. The mean estimates of shank length of VR♂♂ X VR♀♀ and DESI (MZF)♂♂ X VR♀♀ genetic groups differed significantly (P<0.05) by 0.25 cm. At 8th week of age the mean shank length of DESI (MZF)♂♂ X VR ♀♀, and DESI(GAYA) ♂♂ X VR ♀♀ genetic groups differed significantly(P<0.05) by 0.43 cm.

At 12th, 16th and 20th week of ages also the lengthiest and shortest shank lengths were observed to be in VR♂♂ X VR♀♀ and DESI(GAYA)♂♂ X VR♀♀ genetic groups respectively. The mean shank lengths of VR♂♂ X VR♀♀ were found to be significantly

(P<0.01) lengthier by 0.23 and 0.27cm than DESI (MZF)♂♂ X VR ♀♀, and DESI(GAYA)♂♂ X VR♀♀ genetic groups respectively at 12th week of age. The corresponding increment at 16th week of age were noted to be 0.94 and 1.22 cm, whereas the corresponding increment at 20th week of age were found to be 0.69 and 1.25 cm respectively . The mean shank length of DESI (MZF)♂♂ X VR ♀♀ was found to be significantly (P<0.01) lengthier by 0.04 cm than DESI(GAYA)♂♂ X VR ♀♀ genetic group at 12th week of age. The corresponding increment at 16th week of age were noted to be 0.28 cm whereas the corresponding increment at 20th week of age were found to be 0.56 cm .

Variation in shank length in different genetic groups of poultry at different ages have been reported by various authors (Chhabra *et al.* 1972 ; Aggarwal *et al.* 1979; Verma *et al.* 1979; Mahapatra *et al.* 1983; Sharma, 1984; Padhi *et al.* 1999 a; Singh *et al.*, 2000; Khurana *et al.* 2006; Kalita *et al.* 2012, Padhi and Chatterjee, 2012 and Jha and Prasad, 2013. Padhi *et al.* (2012 a) have reported mean shank length at 4th week of age in Vanaraja to be 7.33 cm and 7.02 cm in males and females respectively, whereas Padhi and Chatterjee (2012) obtained 10.657 cm mean shank length of Vanaraja at 20 week of age which are in close proximity to the findings of the present study. Variations in shank lengths in different genetic groups at the same environment and same age may, possibly, be attributed to differences in gene combinations of different genotypes.

Effect of sex on shank length

The analysis of variance for the effect of sex on shank length at different weeks of age in all three genetic groups indicate highly significant (P<0.01) effect of sex on shank length (table 14-16). Least squares means of shank length as presented in table - clearly reflects significantly (P<0.01) lengthier shank in males than their counterpart females in all the genetic groups at all the ages except at 4th ,12th 16th and 20th weeks in genetic group DESI(GAYA)♂♂ X VR ♀♀ genetic group. It was observed that VR♂♂ X VR ♀♀, and DESI(MZF) ♂♂ X VR♀♀ males had significantly (P<0.05) lengthier shank than their female counterparts by 0.42 cm and 0.62 cm respectively at 4th week of age . At 8th week of age males of VR♂♂ X VR♀♀ , DESI(MZF)♂♂ X VR♀♀ and DESI(GAYA)♂♂ X VR ♀♀ had significantly (P<0.05) lengthier shank by 0.86, 1.04 and 0.66 cm than their female counterparts respectively. The males of genetic groups VR♂♂ X VR♀♀ , and DESI(MZF)♂♂ X VR ♀ had significantly (P<0.05) lengthier shank by 1.25 and 1.44 cm respectively than their female counterparts at 12th week of age. The shank length of male than their female counterparts at 12th week of age in DESI(GAYA)♂♂ X VR ♀♀ genetic group was, however, non-significant. The corresponding significant (P<0.01) increment at 16th week of age were observed to be 1.71cm and 1.52 cm respectively. At 20th week of age males of VR♂♂ X VR♀♀ and DESI(MZF)♂♂ X VR♀♀ had significantly (P<0.05) lengthier shank by 1.03 and 1.53 cm respectively than their female counterparts.

However, the increase in shank length of DESI(GAYA)♂♂ X VR♀♀ was found to be non-significant at this age.

Lengthier shank of males than their female counterparts in various genetic groups of poultry at different ages have also been reported by various authors (Sharma, 1984; Malik *et al.*, 1997; Padhi *et al.* 1999 b, Singh *et al.*, 2000) which are in conformity with the findings of the present study. Padhi *et al.* (2012a) also reported lengthier shank of males in Vanaraja than their female counterparts which is similar to the findings of the present study. Padhi and Chatterjee (2012) have also recorded as longer as 106.57 mm shank at 20th of age in PD (Vanaraja male line) which is in close proximity with the findings of the present study.

Differences in shank length of males and females might he attributed to differential rate of growth of chicks of either sex to the given common environment along with other physiological factors.

Average Keel length at different weeks of age of various genetic groups :

Least squares means along with their standard error (SE) and Coefficient of variation percentage (CV%) of keel length (cm) Pooled over sexes at different weeks of age in various genetic groups have been presented in table-17.

4th week keel length

The mean keel length at 4th week of age in VR♂♂ X VR ♀♀ pooled over sexes was estimated to be 5.16±0.02 cm. Ali (2014) reported the average keel length of Vanaraja pooled over sexes at 4th week of age to be 5.12±0.012 cm which is in aggrement with the findings of the present investigation.

The average keel length of DESI (MZF)♂♂ X VR♀♀ at 4th week of age pooled over sexes was found to be 4.73±0.02 cm. The reports on keel length at 4th week of age in DESI (MZF)♂♂ X VR♀♀ is scanty in the available literature. The mean keel length of DESI (GAYA) ♂♂ X VR♀♀ at 4th week of age pooled over sexes was observed to be 4.69±0.02 cm.The reports on 4th week keel length of crosses between indigenous breeds of chicken with Vanaraja is very scanty in the available literature .

Table-17 : Least squares means along with standared error and C.V. % of keel length (cm) at different weeks of age in various genetic groups of poultry (sexes pooled)

Age(WKS)		VR♂♂ X VR♀♀	DESI(MZF) ♂♂ X VR♀♀	DESI(GAYA) ♂♂ X VR♀♀
4th week	Mean ± S.E	5.16^{a}±0.02	4.73^{b}±0.02	4.69^{b}±0.02
	C V %	8.11	8.77	8.85
8th week	Mean ± S.E	6.48^{a}±0.03	6.03^{b}±0.03	5.91^{c}±0.03
	C V %	7.01	7.48	7.64
12th week	Mean ± S.E	8.37^{a}± 0.05	7.30^{b}± 0.05	7.13^{c}±0.05
	C V %	8.52	9.76	10.00
16th week	Mean ± S.E	9.71^{a}±0.05	8.59^{b}±0.05	7.71^{c}±0.05
	C V %	7.17	8.09	9.03
20th week	Mean ± S.E	10.59^{a}±0.06	10.18^{b}±0.06	10.01^{b}±0.06
	C V %	7.14	8.26	8.39

Means with similar superscripts (row wise-abc) did not differ significantly.

8th week keel length:-

The average keel length of VR♂♂ X VR♀♀ at 8th week of age pooled over sexes was obtained as 6.48±0.03cm. Ali (2014) reported the pooled Shank length of Vanaraja to be 6.44±0.03cm

which is close proximity to the findings of the present study. Khurana *et al.*(2006) reported the pooled value of Leghorn to be7.22 ±0.03cm at 8th week of age. The findings of the present study is similar to the findings of the Khurana *et al.*(2006) . Singh *et al.*(2000) reported keel length of pooled Red Cornish to be 8.02 which is longer than present study. Differences in keel length might be attributed to managemental and environmental differences.

Table-18 : Analysis of variance for the effect of genetic groups on keel length at various ages.

Traits	Source of variation	D.F.	M.S.	F
4th week	Between genetic group	2	16.739	95.08**
	Error	894	0.176	
8th week	Between genetic group	2	19.059	88.08**
	Error	775	0.216	
12th week	Between genetic group	2	103.680	200.38**
	Error	687	0.517	
16th week	Between genetic group	2	86.198	174.73**
	Error	627	0.498	
20th week	Between genetic group	2	183.107	258.73**
	Error	585	0.707	

The average keel length at 8th week of age pooled over sexes in DESI(MZF)♂♂ X VR♀♀ was recorded to be 6.03±0.03cm. The reports on 8th week keel length of crosses between indigenous breeds of chicken with Vanaraja is very scanty in the available literature .

The mean keel length of DESI(GAYA)♂♂ X VR♀♀ at 8th week of age pooled over sexes to be 5.91±0.03.The average keel length of Vanaraja in crosses with indigenous local breed is not available in the literature for comparative study .

12th week keel length:-

The mean keel length of VR♂♂ X VR♀♀ at 12th week of age pooled over sexes was estimated to be 8.37±0.05cm. Ali (2014) reported the pooled keel length of VR♂♂ X VR♀♀ to be 6.56± 0.03cm at 12th week of age which is shorter than present study. Mahapatra *et al.(*1983) reported the the pooled keel length of Aseel peela, Aseel kagar, and their crossbred to be 7.61cm at 12th week of age . The result obtained in the present study is close promixity to the the findings of the Mahapatra *et al.(*1983). Differences in keel Length might be attributed to non-genetic factors.

The average keel length at 12th week of age pooled over sexes in DESI(MZF)♂♂ X VR♀♀ was recorded to be 7.30±0.05cm. The reports on 12th week keel length of crosses between indigenous breeds of chicken with Vanaraja is very scanty in the available literature .

The mean keel length of DESI (GAYA)♂♂ X VR♀♀ at 12th week of age pooled over sexes to be 7.13 ±0.05. The average keel length of Vanaraja in crosses with indigenous local breed is not available in the literature for comparative study .

16th week keel length:-

The average estimates of keel length of pooled over sexes at 16th week of age in VR♂♂ X VR♀♀ was found to be 9.71±0.05cm. Ali (2014) reported the average keel length of VR♂♂ X VR♀♀ at 16th week of age pooled over sexes to be 6.67±0.03cm which is shorter than the findings of the present study. Khurana *et al.*(2006) reported the pooled value of White Leghorn to be 10.25±0.05cm at 16th week of age. The findings of the present study is close proximity to the findings of the Khurana *et al.*(2006) . The average keel length at 16th week of age pooled over sexes in DESI(MZF)♂♂ X VR♀♀ was recorded to be 8.59±0.05cm. The reports on 16th week keel length of crosses between indigenous breeds of chicken with Vanaraja is very scanty in the available literature .

The mean keel length of DESI(GAYA)♂♂ X VR ♀♀ at 16th week of age pooled over sexes to be 7.71 ±0.05.The average keel length of Vanaraja in crosses with indigenous local breed is not available in the literature for comparative study .

20th week keel length:-

The average estimates of keel length at 20th week age of VR♂♂ X VR ♀♀ pooled over sexes was observed to be 10.59 ±0.06cm. Ali (2014) reported the average keel length of VR♂♂ X VR♀♀ at 20th week of age pooled over sexes to be 7.24±0.03cm which is shorter than the present investigation.

The average keel length at 20th week of age pooled over sexes in DESI(MZF)♂♂ X VR♀♀ was recorded to be 10.18±0.06cm. The reports on 20th week keel length of crosses between indigenous breeds of chicken with Vanaraja is very scanty in the available literature .

The mean keel length of DESI(GAYA)♂♂ X VR♀♀ at 20th week of age pooled over sexes to be 10.01±0.06. The average keel length of Vanaraja in crosses with indigenous local breed is not available in the literature for comparative study .

Sex-wise average keel length of male and female at various weeks of age in different genetic groups.

Sex wise the least squares means along with standard error (SE) and coefficient of variation percentage (CV%) of keel length at different weeks of age of male and female in various genetic groups have been presented in table-

The average estimates of keel length of male and female chicks at 4th week of age in VR♂♂ X VR♀♀ were obtained as 5.25±0.02 and 5.01±0.02cm respectively. Ali (2014) reported the 4th week of male and female keel length is 5.24±0.017 and 4.99±0.017cm respectively. The findings of present study are in aggrement with the findings of Ali(2014).

Table-19 : Least squares means along with standard error and C.V % of keel length (cm) at different weeks of age in male and female of various genetic groups of Poultry

Age(Weeks)		VR♂♂ X VR♀♀		Desi(MZF)♂♂ X VR♀♀		Desi(Gaya)♂♂ X VR♀♀	
		Male	Female	Male	Female	Male	Female
4th week	Mean±S.E	5.25^{a}±0.02	5.01^{b}±0.02	4.92^{a}±0.02	4.56^{b}±0.02	5.04^{a}±0.05	4.40^{b}±0.04
	C.V%	3.905	4.21	4.07	4.43	10.69	12.16
8th week	Mean±S.E	6.83^{a}±0.04	6.05^{b}±0.04	6.20^{a}±0.03	5.89^{b}±0.03	6.13^{a}±0.03	5.70^{b}±0.02
	C.V%	7.20	8.04	5.02	5.30	4.58	4.86
12th week	Mean±S.E	8.67^{a}±0.05	8.09^{b}±0.05	7.34^{a}±0.07	7.32^{a}±0.06	7.35^{a}±0.08	6.91^{b}±0.07
	C.V%	5.59	6.20	9.80	9.74	10.80	10.83
16th week	Mean±S.E	10.02^{a}±0.05	9.43^{b}±0.04	9.20^{a}±0.08	8.06^{b}±0.08	8.43^{a}±0.03	7.60^{b}±0.03
	C.V%	4.57	4.92	8.56	9.80	3.88	4.18
20th week	Mean±S.E	10.09^{a}±0.04	9.67^{b}±0.048	10.37^{a}±0.09	10.01^{b}±0.08	9.51^{a}±0.06	9.45^{b}±0.06
	C.V%	3.28	3.73	7.73	8.06	5.39	6.05

Means with similar superscripts (row wise-abc) did not differ significantly .

The average estimates of keel length of male and female chicks at 4th week of age in DESI(MZF)♂♂ X VR♀♀ were found to be 4.92±0.02and 4.56±0.02 in respectively. However no information in the literature was available to compare the findings of present study.

The average estimates of keel length of male and female chicks at 4th week of age in DESI(GAYA)♂♂ X VR♀♀ were obtained as 5.04±0.05 and 4.39±0.04cm respectively. However no information in the literature was available to compare the findings of the present study.

The average estimates of keel length of male and female chicks at 8th week of age in VR♂♂ X VR♀♀ genetic group were obtained as 6.83±0.05 and 6.05±0.05cm respectively. Ali (2014) reported the average keel length of male and female chicks at 8th week of age in VR♂♂ X VR♀♀ to be 6.84±0.04 and 6.04±0.04cm respectively which is close proximity the findings of the Ali (2014). Sharma (1984) reported the 8th week keel length of male WR(M) XWR(F), RC(M) X RC(F), RC(M) X WR(F) and WR(M) X RC(F) to be 8.02,8.20,8.67 and 8.30 cm respectively the corresponding values in female were observed to be 7.05 ,7.20 ,7.79 and 7.37cm respectively. Venkatesh (1985) reported the 8th week keel length of males RC(M) X WR(F),WR(M) X RC(F) to be 7.68 and 7.56 cm respectively the corresponding values in female were observed to be 7.29 and 7.04cm respectively. The findings of present study are similar to the Sharma (1984) and Venkatesh (1985) .

The average estimates of keel length at 8th week of age in male and female of DESI(MZF)♂♂ X VR♀♀ were found to be 6.20±0.03 and 5.89±0.03cm respectively. No information in the literature was available to compare the findings of present study. The differences in keel lengtg might be due to difference in genetic makeup of the breed as well as due to differences in Environmental and managemental factors .

Table-20 : Analysis of variance for the effect of sex on keel length at different weeks of age in Vanaraja♂♂ X Vanaraja ♀♀

Traits	Source of variation	D.F.	M.S.	F
4th week	Between sexes	1	4.341	95.43**
	Error	295	0.045	
8th week	Between sexes	1	39.494	161.71**
	Error	257	0.244	
12th week	Between sexes	1	19.261	79.49**
	Error	229	0.242	
16th week	Between sexes	1	18.165	83.62**
	Error	208	0.217	
20th week	Between sexes	1	120.499	690.78**
	Error	194	0.174	

Table-21:- Analysis of variance for the effect of sex on keel length at different weeks of age in Desi(MZF)♂♂ X Vanaraja ♀♀

Traits	Source of variation	D.F.	M.S.	F
4th week	Between sexes	1	9.564	224.89**
	Error	297	0.042	
8th week	Between sexes	1	6.303	61.89**
	Error	260	0.101	
12th week	Between sexes	1	0.032	0.06 NS
	Error	225	0.523	
16th week	Between sexes	1	68.725	108.42**
	Error	207	0.633	
20th week	Between sexes	1	6.360	9.72**
	Error	192	0.654	

Table-22 : Analysis of variance for the effect of sex on keel length at different weeks of age in Desi(GAYA)♂♂ X Vanaraja♀♀

Traits	Source of variation	D.F.	M.S.	F
4th week	Between sexes	1	30.470	104.18**
	Error	299	0.292	
8th week	Between sexes	1	11.749	143.33**
	Error	255	0.081	
12th week	Between sexes	1	10.769	16.92**
	Error	230	0.636	
16th week	Between sexes	1	36.281	338.07**
	Error	209	0.107	
20th week	Between sexes	1	61.665	184.86**
	Error	196	0.333	

The average estimates of keel length of male and female at 8th week of age in DESI (GAYA)♂♂ X VR ♀♀ were obtained as 6.13±0.03 and 5.70±0.03 cm respectively. However, no information in the literature could be made available to compare the findings of the present study.

The average estimates of keel length of male and female at 12th week of age in VR♂♂ X VR ♀♀ genetic group were obtained as 8.67±0.05 and 8.09±0.05 cm respectively . Ali (2014) reported the mean keel length of male and female at 12th week of age to be 6.90 ±0.04 and 6.22±0.04 cm respectively. The findings of present study are in longer than Ali (2014).

The average estimates of keel length of male and female at 12th week of age in DESI (MZF) ♂♂ X VR♀♀ genetic group were found to be 7.34±0.07 and 7.32±0.07 cm respectively. No information in the literature could be made available to compare the findings of the present study.

The average estimates of keel length of male and female at 12th week of age in DESI (GAYA)♂♂ X VR ♀♀ genetic group were obtained as 7.35±0.08 and 6.91±0.08 respectively. No information in the literature could be made available to compare the findings of the present study .

The average estimates of keel length of male and female at 16th week of age in VR♂♂ X VR♀♀ were obtained as 10.02±0. 04 and 9.43±0.04cm respectively. Ali (2014) reported the average estimates of keel length of male and female at 16th week of age in

VR♂♂ X VR ♀♀ to be 6.94± 0.047 and 6.39±0.044 respectively. The findings of present study are longer than the findings of Ali (2014). Non-genetic factors might be responsible for the differences in keel at this age.

The average estimates of keel length of male and female at 16th week of age in DESI(MZF)♂♂ X VR ♀♀ were found to be 9.20±0.08 and 8.06±0.08 respectively. No information in the literature could be made available to compare the findings of the present study.

The average estimates of keel length of male and female at 16th week of age in DESI(GAYA)♂♂ X VR♀♀ genetic group were obtained as 8.43±0.03 and 7.60±0.03 cm respectively. No information in the literature could be made available to compare the findings of the present study.

The average estimates of keel length of male and female at 20th week of age in VR♂♂ X VR ♀♀ genetic group were obtained as 10.09±0.04 and 9.67±0.04 respectively. Ali (2014) reported the average keel length of male and female at 20th week of age in VR♂♂ X VR♀♀ to be 7.98 ± 0.04 and 6.50±0.04cm respectively. The findings of present study are longer then the findings of Ali (2014).

The average estimates of keel length of male and female at 20th week of age in DESI (MZF)♂♂ X VR ♀♀ were found to be 10.37±0.09 and 10.01±0.08cm respectively. No information in the literature could be made available to compare the findings of the present study.

The average estimates of keel length of male and female at 20th week of age in DESI (GAYA)♂♂ X VR ♀♀ genetic group were obtained as 9.51±0.06 and 9.45±0.06 cm respectively. However, no information in the literature could be made available to compare the findings of the present study.

Effect of genetic group on Keel length

The analysis of variance depicted in table-18 manifested that genetic groups had significant (P<0.01) effect on keel length at various ages under this study.

Least squares means as mentioned in table-17 reflected that VR ♂♂ x VR ♀♀ and DESI(GAYA)♂♂ X VR♀♀ had significantly (P<0.05) lengthiest and shortest keel lengths respectively at all age groups of the present investigation.

At 4th week of age VR♂♂ x VR♀♀ genetic group had significantly (P<0.05) lengthier keel by and 0.43cm respectively than DESI(MZF) ♂♂ X VR♀♀ and DESI(GAYA)♂♂ X VR♀♀ genetic groups. The mean keel lengths of DESI(MZF) ♂♂ X VR♀♀ genetic group did not differ significantly from DESI(GAYA)♂♂ X VR♀♀ genetic group.

At 8th week of age the mean keel length of VR ♂♂ x VR ♀♀ genetic group, which was lengthiest, was significantly (P<0.01) lengthier by 0.40 cm and 0.52 cm than DESI(MZF) ♂♂ X VR♀♀ and DESI(GAYA)♂♂ X VR♀♀ genetic groups respectively. The mean keel lengths of DESI(MZF) ♂♂ X VR♀♀ genetic group had also significantly (P<0.01) lengthier keel by 0.12 cm than DESI(GAYA)♂♂ X VR♀♀ genetic group. At 12th week of age the

mean keel lengths of VR♂♂ X VR♀♀ genetic group had significantly (P<0.05) lengthier keel by 1.07 cm and 1.24 cm than DESI(MZF)♂♂ X VR♀♀ and DESI(GAYA)♂♂ X VR♀♀ genetic groups respectively. Besides, the mean keel length of DESI(MZF)♂♂ X VR♀♀ had also significantly (P<0.05) lengthier keel by 0.17 cm than DESI(GAYA)♂♂ X VR♀♀ genetic group.

At 16th week of age the mean keel length of VR ♂♂ x VR ♀♀ genetic group had also significantly (P<0.01) lengthier keel by 1.12 cm and 2 cm than DESI(MZF)♂♂ X VR♀♀ and DESI(GAYA)♂♂ X VR♀♀ genetic groups respectively. Besides, DESI(MZF)♂♂ X VR♀♀ genetic group had also 0.88 cm significantly (P<0.05) lengthier keel than DESI(GAYA)♂♂ X VR♀♀ genetic group.

At 20th week of age the average keel length of VR♂♂ X VR♀♀ genetic group had significantly (P<0.05) lengthier keel by 0.41 cm and 0.58 cm than DESI(MZF)♂♂ X VR♀♀ and DESI(GAYA)♂♂ X VR♀♀ genetic groups respectively. Besides, DESI(MZF)♂♂ X VR♀♀ genetic group had also significantly (P<0.05) lengthier keel by 0.17 cm than DESI(GAYA)♂♂ x VR♀♀ . Variations in keel length in different genetic groups at various ages in poultry have also been reported by many research workers (Mahapatra *et al.*, 1983; Sharma, 1984; Venkatesh, 1985; Singh *et al.*, 1999 a; Singh *et al.*, 2000 and Kalita *et al.*, 2012). Differences in keel lengths of various genetic groups might be, possibly, attributed to different gene combinations .

Effect of Sex on Keel length :

The analysis of variance depicted in tables -20, 21 and 22 revealed highly significant ($P<0.01$) effect of sex on keel length at different ages in all the three genetic groups under study.

Least squares means of keel length as mentioned in table - indicates that males of all the three genetic groups had significant ($P<0.05$) lengthier keel than their female counterparts at all the ages under this study.

The mean keel length of male of VR♂♂ X VR♀♀, DESI(MZF)♂♂ X VR♀♀ and DESI(GAYA)♂♂ X VR♀♀ genetic groups had significantly ($P<0.05$) lengthier by 0.23, 0.36 and 0.64 cm respectively than their female counterparts at 4th week of age. The corresponding increment in male keel lengths were significantly ($P<0.05$) noted to be 0.78, 0.31, and 0.43 cm at 8th week of age. The mean keel lengths of male of VR♂♂ X VR♀♀ and DESI(GAYA)♂♂ X VR♀♀ genetic groups had significantly ($P<0.05$) lengthier keel by 0.58 and 0.44 cm. respectively than their female counterparts at 12th week of age. Although males of DESI(MZF)♂♂ X VR♀♀ genetic group had 0.02 cm lengthier keel than their female counterparts at 12th week of age, yet the difference was found to be statistically non-significant. The mean keel lengths of male of VR♂♂ X VR♀♀ , DESI(MZF)♂♂ X VR♀♀ and DESI(GAYA)♂♂ X VR♀♀ genetic groups had significantly ($P<0.05$) by 0.59 cm, 1.14 cm, and 0.83 cm respectively lengthier keel than their female counterparts at 16th week of age. Similarly, the corresponding

significant (P<0.01) increment in male keel lengths over their female counterparts were observed to be 0.42 cm, 0.36cm,and 0.06cm at 20th week of age.

Sharma (1984), Venkatesh (1985), Malik *et al.* (1997) and Singh *et al.* (2000) have also reported lengthier keels in males than their female counterparts in different genetic groups of poultry at various ages which are in conformity with the findings of the present study.

Differences in keel length of males and females might be, possibly, due to differential rate of growth of both sexes as well as other physiological factors.

HAEMATO-BIOCHEMICAL PROFILES

Least squares means along with standard error (SE) and coefficient of variation percentage (CV%) of different haemato-biochemical parameters of Vanaraja and its crosses with desi chicken native to Bihar at 20 weeks of age pooled over sexes have been presented in table-23.

HAEMOGLOBIN

The least squares means of haemoglobin percentage (Hb%) at 20 weeks of age pooled over sexes in VR♂♂ X VR♀♀ was estimated to be 13.24 ± 0.22 g%. The corresponding values for DESI(MZF)♂♂ X VR♀♀ and DESI(GAYA)♂♂ X VR ♀♀ were reported to be 13.074 ± 0.22 and 12.32 ± 0.22g% respectively. Bhatti *et al.*(2002) reported the Hb% in control group of crossbreed, Desi and Fayoumi to be 11.80 ± 0.76,12.40 ± 0.55 and 13.08 ± 0.87g%

respectively. The values obtained by Bhatti *et al.* (2002) were in close proximity to the values obtained in the present study. Peters *et al.*(2011) reported the average Hb% in Frizzled and Naked Neck chicken to be 11.42 ± 0.31 and 11.55 ± 0.41g% respectively which is close proximity to the present investigation. Pandian *et al.* (2012) reported the Hb% of various indigenous chicken like Kadaknath, Nicobari and Aseel to be 11.10 ± 0.38,12.50 ± 0.43 and 12.90 ± 0.69 g% respectively.The values obtained by Pandian *et al.*(2012) are in aggrement with the findings of the present study .

However, they observed lower estimates of Hb% in RIR and WLH as compared to findings of the present study. As compared to the findings of the present study lower magnitude of Hb% have also been reported by many authors. Islam *et al.* (2004) reported the average Hb% in Fayoumi chicken to be ranged from 7.06 to 7.94 g%. In Aseel to be ranged from 8.23 to 9.54 g% and in local birds to be ranged from 7.73 to 9.37g% from 1 to 12 months of age. Lower magnitudes of Hb% were also reported by Rani *et al.*(2012) in control group of chicken at 8(8.61g%) and 11(10.57g%) weeks of age, Adeyemo and Sani (2013) and Kanduri *et al.*(2013) have reported in broiler chicken.

Sex-wise least squares means along with standard error (SE) and coefficient of variation percentage (CV%) of Hb% of various genetic groups of chicken have been presented in table –25

The average estimates of Hb% of male and female in VR♂♂ X VR♀♀ were found to be 14.29±0.0.02 and 12.19 ± 0.23g%

respectively. The corresponding values for male and female at 20th week of age in DESI(MZF)♂♂ X VR♀♀ were estimated to be 14.36±0.24 and 11.79±0.24 g% respectively. In DESI(GAYA)♂♂ X VR♀♀ the average estimates of Hb% in male and female were obtained as 13.56 ± 0.20 and 11.08 ± 0.20 g% respectively. Peters *et al.* (2011) reported the Hb% of male and female in Frizzled fowl to be 12.7 and 10.13g% respectively whereas 13.18 and 9.91 g% in male and female chicks of Naked Neck at 20 weeks of age. The values obtained by Peters *et al.*(2011) are in close proximity with the findings of present study.

Prahsanth *et al.*(2012) reported average estimates of Hb% of male and female at 25 week of age to be 16.17 and 13.49g% respectively in PB1 strain .The corresponding values for male and female in PB2 strain were reported to be 16.13 and 12.96g% respectively. Elagib and Ahmed (2011) reported the Hb% of male in Betwil, Bare Neck and Large Beladi indigenous chicken of Sudan to be 18.90, 18.59 and 20.66g% respectively, whereas the corresponding values in female were reported to be 15.99, 16.10 and 16.44 g% respectively.

The average estimates of Hb% of male and female chicks reported by Prahshanth et al.(2011) and Elaqib and Ahamed (2012) were higher than the values obtained than the findings of the present study. The difference in Hb% of different breeds might be due to differences in genetic makeup of the breeds as well as due to management and environmental differences.

Effect of genetic group on haemoglobin

The analysis of variance for the effect of genetic group on hemato-biochemical profiles has been presented in table. Analysis of variance revealed non-significant effect of genetic group on haemoglobin percent at 20th week of age.

Least squares means along with standard errors and CV% of haemato-biochemical profiles at 20th week of age in various genetic groups pooled over sexes have been depicted in table-23 . From the table it could be revealed that VR♂♂ X VR ♀♀ and DESI(GAYA)♂♂ X VR ♀♀ significantly (P<0.05) highest and lowest haemoglobin percent respectively at 20th week of age in the present investigation.

At 20th week of age the VR♂♂ X VR ♀♀ genetic group had significantly (P<0.05) 0.92 (g%) higher level of haemoglobin than DESI(GAYA)♂♂ X VR♀♀ .The haemoglobin level of VR♂♂ X VR ♀♀ and DESI(MZF)♂♂ X VR ♀♀ genetic group did not differ significantly. Similarly DESI(MZF)♂♂ X VR ♀♀ did not differ significantly from DESI(GAYA) ♂♂ X VR ♀♀ genetic group.

Effect of sex on Haemoglobin

The analysis of variance for the effect of sex on haemoglobin at 20th week of age in all the three genetic groups have been presented in table-25. The analysis of variance revealed highly significant (P<0.05) effect of sex in all the three genetic groups, reflecting higher level of haemoglobin of male than their female counterparts at 20th week of age.

Least squares means along with standard errors and CV% of means as mentioned in table- which reflected that the males of VR♂♂ X VR ♀♀ , DESI(MZF)♂♂ X VR ♀♀ and DESI(GAYA)♂♂ X VR ♀♀ have significantly (P<0.05) 2.11, 2.57 and 2.48 g% than higher level of haemoglbin than their female counterparts at 20th week of age of the present investigation.

PACKED CELL VOLUME (PCV%)

The least squares means of PCV% at 20 weeks of age pooled over sexes in VR♂♂ X VR♀♀ was estimated to be 40.03±0.67%. The corresponding values for DESI(MZF)♂♂ X VR♀♀ and DESI(GAYA)♂♂ X VR♀♀ were found to be 39.29±0.67 and 37.85±0.67% respectively. Bhatti *et al.* (2002) reported the PCV% in control group of crossbreed, Desi and Fayoumi to be 36.10±0.89, 37.20±0.84 and 36.1±0.89% respectively. The values obtained by Bhatti *et al.* (2002) were in close proximity to the values obtained in the present study.

Peters *et al.* (2011) reported the average PCV% in Frizzled and Naked Neck chicken to be 33.85±0.95 and 34.65±1.27% respectively. The values obtained by Peters *et al.*(2011) are in aggrement with the findings of the present study .

As compared to the findings of the present study lower magnitudes of PCV% have also been reported by many authors. Islam *et al.* (2004) reported the average PCV% in Fayoumi chicken to be ranged from 25.56 to 30.08%. In Aseel reported to be ranged from 28.12 to 32.25% and in local birds to be ranged from 27.73

and 34.60% from 1 to 12 months of age. Islam *et al.* (2004) reported 32.20±0.37% of PCV in control group of 55 days old broilers. Ahmed *et al.* (2007) reported 27.99±0.18% of PCV in control group of broilers at 6 weeks of age. Lower magnitudes of PCV% were also reported by Rani *et al.* (2012) in control group of chicken at 8 and 11 weeks of age, Pandian *et al.* (2012), Adeyemo and Sani (2013) and Kanduri *et al.* (2013) in broiler chicken.

Sex-wise least squares means along with standard error (SE) and coefficient of variation percentage (CV%) of PCV% of various genetic groups of chicken have been presented in table –25.

The average estimates of PCV% of male and female in VR♂♂ X VR♀♀ were found to be 44.57±0.41 and 35.50±0.41% respectively. The corresponding values for male and female at 20 weeks of age in DESI(MZF)♂♂ X VR ♀♀ were estimated to be 44.26±34.32 and 34.32±0.43% respectively. In DESI(GAYA)♂♂ X VR♀♀ the average estimates of PCV% in male and female were obtained as 42.28±0.43 and 33.42±0.43% respectively. Peters *et al.* (2011) reported the PCV% of male and female in Frizzled fowl to be 37.70±0.54% and 30.00±0.52% respectively whereas 39.80±0.80 and 29.50±0.56% in male and female chicks of Naked Neck at 20th week of age. Prahsanth *et al.* (2012) reported average estimates of PCV% of male and female at 25 weeks of age to be 42.13±0.77 and 39.07±0.61% respectively in PB1 strain. The corresponding values for male and female in PB2 strain were reported to be 41.90±0.69 and 38.10±0.03 % respectively. The values obtained by the above

authors are in close proximity with the findings of the present the study.

Elagib and Ahmed (2011) reported the PCV% of male in Betwil, Bare Neck and Large Beladi indigenous chicken of Sudan to be 46.30±2.14,47.70±2.14 and 49.20 ± 2.14 % respectively, whereas the corresponding values in female were reported to be 42.50±2.14, 36.20 ±2.14 and 38.40 ±2.14 % respectively. Abdi-Hachesoo *et al.* (2013) reported the PCV% of male and female to be 46.10±2.85 and 35.50±2.22 respectively in adult indigenous chickens.

The average estimates of PCV% of male and female chicks reported by Elagib and Ahmed (2012) and Abdi-Hachesoo B *et al.* (2013) were higher than the values obtained the findings of the present study. The differences in PCV% of different breeds might be due to differences in genetic makeup of the breeds as well as due to management and environmental differences.

Effect of genetic group on PCV%

The analysis of variance for the effect of genetic group on hemato-biochemical profiles has been presented in table-24. Analysis of variance revealed non-significant effect of genetic group on PCV% at 20th week of age.

Least squares mean along with standard errors and CV% of hemato-biochemical profiles at 20th week of age in various genetic groups of chicken pooled over sexes have been depicted in table-23.

PCV% in VR♂♂ X VR ♀♀, DESI(MZF)♂♂ X VR ♀♀ and DESI(GAYA) ♂♂ X VR ♀♀ genetic groups did not differ significantly at 20th week of age .

Effect of sex on PCV%

The analysis of variance for the effect of sex on PCV% at 20th week of age in all three genetic groups have been presented in table-26.The analysis of variance revealed highly significant (P<0.05) effect of sex in all the three genetic groups, reflecting higher percentage of PCV in male than their female counterparts at 20th week of age.

Least squares means along with standard errors and CV% of means as depicted in table-23 reflected that PCV% in VR♂♂ X VR ♀♀ male was 9.07% which significantly (P<0.05) higher than the female. Similarly, the male of to DESI(MZF)♂♂ X VR♀♀ and DESI (GAYA)♂♂ X VR♀♀ had significantly (P<0.05) 9.94% and 8.86% higher PCV% than their corresponding females .

WBC (TLC)

The least squares means of WBC count at 20 weeks of age pooled over sexes in VR♂♂ X VR♀♀ was estimated to be146.20±2.30(Thousand/µl).The corresponding values for DESI(MZF)♂♂ X VR ♀♀ and DESI(GAYA)♂♂ X VR♀♀ were reckoned to be 144.20±2.30 and 142.40±2.30(Thousand/µl) respectively. No information was available in the literature to compare the findings of the present study .

As compared to the findings of the present study lower magnitudes of WBC count have also been reported by many authors. Bhatti *et al.* (2002) reported the WBC count in control

group of crossbreed, Desi and Fayoumi to be 14.00±0.35, 13.80±01.04 and 13.32±0.58(Thousand/mm^3) respectively. Peters *et al.*(2011) reported the average WBC count in Frizzled and Naked Neck chicken to be 5590.33 and 5660.52 per cubic mm respectively. Adeyemo and Sani (2013) reported WBC ($x10^9$/L) count in control group to be 7.5 of 08 week old aged broilers chicken. Kanduri *et al.* (2013) reported WBC ($x10^3$/cumm) at 6 weeks of age in broiler chicken to be 26.12 in control group. The difference in WBC count of different breeds might be due to differences in genetic makeup of the breeds as well as due to managemental and environmental differences.

Sex-wise least squares means along with standard error (SE) and coefficient of variation percentage (CV%) of WBC of various genetic group of chicken have been presented in table --25.

The average estimates of WBC count of male and female in VR♂♂ X VR ♀♀ were found to be 159.87±2.25 and 132.13±2.25 (Thousand/µl) respectively. The corresponding values for male and female at 20 weeks of age in DESI(MZF)♂♂ X VR ♀♀ were estimated to be 156.73±2.25 and 131.67±2.25(Thousand/µl) respectively. In DESI(GAYA)♂♂ X VR♀♀ the average estimates of WBC count in male and female were obtained as 154.60±2.27 and 130.20±2.27(Thousand/µl)respectively. Kundu *et al.* (2013) reported the WBC count of male and female in Vanaraja to be 158.02±8.02 and 138.18±25.54(Thousand/µl) respectively which is in close proximity with the findings of present study.

Peters *et al.* (2011) reported the WBC count of male and female in Frizzled fowl to be 5580 and 5600 per cubic mm respectively where as 5760 and 5560 per cubic mm in male and female chicks of Naked Neck at 20 weeks of age .

Prahsanth *et al.* (2012) reported average estimates of WBC count of male and female at 25 week of age to be 22.20 and 22.13 thousand/mm^3 respectively in PB1 strain .The corresponding values for male and female in PB2 strain were reported to be 21.57 and 19.32 thousand/mm^3 respectively. Elagib and Ahmed (2011) reported the WBC count of male in Betwil, Bare Neck and Large Beladi indigenous chicken of Sudan to be 2.34,2.27 and 2.27 respectively where as the corresponding values in female were reported to be 2.31, 2.43 and 2.19 thousand/mm^3 respectively. The average estimates of WBC count of male and female chicks reported by Peters *et al.* (2011), Prahshanth *et al.* (2011) and Elagib and Ahmed (2012) were lower than the values obtained in the findings of the present study. The difference in WBC count of different breeds might be due to differences in genetic makeup of the breeds as well as due to management and environmental differences.

Effect of genetic group on WBC

The analysis of variance for the effect of genetic group on hemato-biochemical profiles has been presented in table-24. Analysis of variance revealed non-significant effect on genetic group on WBC count at 20 week of age.

Least squares means along with standard errors and CV% of hemato-biochemical profiles at 20 weeks of age in various genetic groups pooled over sexes have been depicted in table-23.

WBC count in VR♂♂ X VR♀♀, DESI(MZF)♂♂ X VR ♀♀ and DESI(GAYA)♂♂ X VR♀♀ genetic groups did not differ significantly at 20th week of age .

Effect of sex on WBC

The analysis of variance for the effect of sex on WBC at 20th week of age in all three genetic group have been presented in table-26. The analysis of variance revealed highly significant ($P<0.01$) effect of sex in all the three genetic groups, reflecting higher value of WBC count of male than their female counterparts at 20 week of age.

Least squares means along with standard errors and CV% of WBC as mentioned in table-25 reflected that VR♂♂ X VR♀♀, DESI(MZF)♂♂ X VR ♀♀ and DESI (GAYA)♂♂ X VR ♀♀ male have significantly ($P<0.01$) higher value of WBC count then their female counterparts. WBC ($10^3/mm^3$) count in VR♂♂ X VR ♀♀ male was 27.74($10^3/mm^3$) which was significantly ($P<0.05$) higher than the female. Similar to VR♂♂ X VR ♀♀, DESI(MZF)♂♂ X VR ♀♀ and DESI(GAYA)♂♂ X VR♀♀ male was found to have significantly ($P<0.05$) 25.06($10^3/mm^3$)and 24.40($10^3/mm^3$) higher values than their female counterparts respectively at 28th week of age of the present investigation.

Table:-23 Least squares means along standard error and CV% of different haemato-biochemical parameters at 20 weeks of age in various genetic groups of poultry (sexes pooled)

Hemoglobin		VR♂♂ X VR♀♀	DESI(MZF)♂♂ X VR♀♀	DESI(GAYA)♂♂ X VR♀♀
	Mean ±S.E.	$13.241^{a}\pm0.221$	$13.074^{ab}\pm 0.221$	$12.322^{b}\pm0.221$
	C.V%	12.921	13.08	13.89
PCV	Mean ±S.E.	$40.031^{a}\pm0.673$	$39.290^{a}\pm0.673$	$37.846^{a}\pm0.673$
	C.V%	13.019	13.265	13.774
RBC	Mean ±S.E.	$1.263^{a}\pm 0.047$	$1.247^{a}\pm0.047$	$1.215^{a}\pm0.047$
	C.V%	28.820	29.191	29.960
Cholesterol	Mean ±S.E.	$161.97^{a}\pm 1.49$	$160.47^{a}\pm1.44$	$155.98^{b}\pm1.18$
	C.V%	7.13	6.95	5.86
SGOT	Mean ±S.E.	$195.833^{a}\pm1.176$	$192.066^{ab}\pm1.176$	$189.933^{b}\pm1.176$
	C.V%	4.650	4.742	4.795
SGPT	Mean ±S.E.	$9.319^{a}\pm0.236$	$8.923^{a}\pm0.236$	$9.270^{a}\pm0.236$
	C.V%	19.605	20.475	19.717
WBC	Mean ±S.E.	$146.200^{a}\pm2.306$	$144.200^{a}\pm2.306$	$142.400^{a}\pm2.306$
	C.V%	12.215	12.384	12.542

Means with similar superscripts (row wise-abc) did not differ significantly.

RBC (TEC)

The least squares means of RBC count at 20 weeks of age pooled over sexes in VR♂♂ X VR♀♀ was estimated to be 1.26±0.05(10^6/mm^3).The corresponding values for DESI(MZF)♂♂ X VR♀♀ and DESI(GAYA)♂♂ X VR♀♀ were observed to be 1.25±0.05 and 1.22±0.05(10^6/mm^3) respectively. Islam *et al.*(2004) reported the RBC count in Fayoumi chicken are to be 2.55,3.18,3.33,3.39 and 3.46(10^6/mm^3) respectively at 1st, 3rd, 6th, 9th and 12th months of age.The corresponding values for Aseel is 1.76±0.27,1.93±0.09, 2.58±0.13, 2.89±0.08 and 3.05±0.09 and in desi chicken to be 1.70±0.04, 1.74±0.02, 2.43±0.12, 2.69±0.08 and 2.98±0.21 respectively which is in aggrement with the findings of the present investigation Islam *et al.* (2004) reported the RBC count in control group of Shaver Star Bro strain of broilers at 55 days of age is 2.49±0.09 (X 10^6/mm^3). Ahmed *et al.*(2007) reported TEC content (million/mm^3) to be 2.71±0.04 in control group of broilers at six weeks of age. Pandian *et al.*(2012) reported the overall mean values for RBC(X106/µl) in Kadakanath, Nicobari and Aseel is 2.96±0.06, 2.93±0.08 and 2.82±0.13 respectively. Kanduri *et al.* (2013) reported RBC (x10^6/cumm) at 6 weeks of age in broiler chicken to be 2.98 in control group. The findings of the present study are close proximity with the above authors.

As compared to the findings of the present study higher magnitude of RBC count have also been reported by many authors.

Bhatti *et al.*(2002) reported the RBC count in control group of crossbreed, Desi and Fayoumi to be4.24±0.25, 4.48±0.16, 4.36±0.26 and 4.18±0.20 (x10^6/cumm) respectively. Peters *et al.*(2011) reported the average RBC count in Frizzled and Naked Neck chicken to be 3.79 and 3.91 (10^6/mm^3) respectively. Rani *et al.* (2011) reported RBC (millions/cumm) in control groups to be 3.19±0.12 and 3.21±0.13 respectively in broiler chickens at 8weeks and 11 weeks of age.

Table:-24 Analysis of variance for the effect of genetic group on haemato-biochemical profiles at 20 weeks of age.

Blood Profiles	Source of variation	D.F.	M.S.	F
Hemoglobin	Between genetic group	2	14.394	4.902*
	Error	177	2.936	
PCV	Between genetic group	2	74.103	2.720NS
	Error	177	27.239	
WBC	Between genetic group	2	194.400	0.609NS
	Error	177	319.310	
RBC	Between genetic group	2	0.036	0.264NS
	Error	177	0.137	
SGOT	Between genetic group	2	535.488	6.451*
	Error	177	83.004	
SGPT	Between genetic group	2	2.789	0.831NS
	Error	177	3.357	
Cholesterol	Between genetic group	2	581.506	5.095**
	Error	177	114.135	

The difference in RBC count of different breeds might be due to differences in genetic makeup of the breeds as well as due to managemental and environmental differences.

Sex-wise least squares means along with standard error (SE) and coefficient of variation percentage (CV%) of RBC of various genetic group of chicken have been presented in table –25.

The average estimates of RBC count of male and female in VR♂♂ X VR♀♀ were found to be 0.92±0.03 and 1.61±0.03 (10^6/mm^3) respectively. The corresponding values for male and female at 20th week of age in DESI (MZF)♂♂ X VR ♀♀ were estimated to be 0.93±0.03 and 1.57±0.03 (10^6/mm^3) respectively. In DESI (GAYA)♂♂ X VR♀♀ the average estimates of RBC count in male and female were obtained as 0.87±0.03 and 1.56±0.03(10^6/mm^3)respectively. Kundu *et al.*(2013) reported the RBC count of male and female in Vanaraja, to be 0.84±0.23 and 1.53 ±0.22 in BrN to be 0.95±0.02 and 1.25±0.06, and in BrN X Van to be 0.85±0.09 and 1.44±0.02 (10^6/mm^3) respectively. The higher values of RBC count obtained by Kundu *et al.* (2013) are in close proximity with the findings of the present study.

However, the higher values of RBC count of male than the female have also been reported by many authors.Peters *et al.*(2011) reported the RBC count of male and female in Frizzled fowl to be 4.20 and 3.38 (10^6/mm^3) respectively whereas 4.46 and 3.36 (10^6/mm^3) in male and female chicks of Naked Neck at 20 weeks of age indicating higher RBC count in male than the female.

The difference in RBC count of different breeds might be due to differences in genetic makeup of the breeds as well as due to managemental and environmental differences.

Sex-wise least squares means along with standard error (SE) and coefficient of variation percentage (CV%) of RBC of various genetic group of chicken have been presented in table –25.

The average estimates of RBC count of male and female in VR♂♂ X VR♀♀ were found to be 0.92±0.03 and 1.61±0.03 (10^6/mm^3) respectively. The corresponding values for male and female at 20th week of age in DESI (MZF)♂♂ X VR ♀♀ were estimated to be 0.93±0.03 and 1.57±0.03 (10^6/mm^3) respectively. In DESI (GAYA)♂♂ X VR♀♀ the average estimates of RBC count in male and female were obtained as 0.87±0.03 and 1.56±0.03(10^6/mm^3)respectively. Kundu *et al.*(2013) reported the RBC count of male and female in Vanaraja, to be 0.84±0.23 and 1.53 ±0.22 in BrN to be 0.95±0.02 and 1.25±0.06, and in BrN X Van to be 0.85±0.09 and 1.44±0.02 (10^6/mm^3) respectively. The higher values of RBC count obtained by Kundu *et al.* (2013) are in close proximity with the findings of the present study.

However, the higher values of RBC count of male than the female have also been reported by many authors.Peters *et al.*(2011) reported the RBC count of male and female in Frizzled fowl to be 4.20 and 3.38 (10^6/mm^3) respectively whereas 4.46 and 3.36 (10^6/mm^3) in male and female chicks of Naked Neck at 20 weeks of age indicating higher RBC count in male than the female.

Table-25:Least squares means along with standared error and C.V.% of Haematological parameter at 20 weeks of age in male and female of various genetic groups of chicken.

GENETIC GROUPS		HAEMOGLOBIN		PCV		RBC		WBC	
		Male	Female	Male	Female	Male	Female	Male	Female
VR♂♂ X VR♀♀	Mean±S.E.	$14.29^{a}\pm0.28$	$12.19^{b}\pm0.23$	$44.57^{a}\pm0.41$	$35.50^{b}\pm0.41$	$0.92^{a}\pm0.03$	$1.61^{b}\pm0.03$	$159.87^{a}\pm2.25$	$132.13^{b}\pm2.55$
	C.V%	8.69	10.20	5.05	6.34	17.27	9.89	7.72	10.58
VR X ♂♂ DESI (MZF) ♀♀	Mean±S.E.	$14.36^{a}\pm0.24$	$11.79^{b}\pm0.24$	$44.26^{a}\pm0.43$	$34.32^{b}\pm0.43$	$0.93^{a}\pm0.03$	$1.57^{b}\pm0.03$	$156.73^{a}\pm2.25$	$131.67^{b}\pm2.25$
	C.V%	9.08	11.056	5.28	6.82	15.99	9.43	7.85	9.36
VR♂♂ X DESI(GAYA) ♀♀	Mean±S.E.	$13.56^{a}\pm0.20$	$11.08^{b}\pm0.20$	$42.28^{a}\pm0.43$	$33.42^{b}\pm0.43$	$0.87^{a}\pm0.03$	$1.56^{b}\pm0.03$	$154.60^{a}\pm2.27$	$130.20^{b}\pm2.27$
	C.V%	8.16	9.98	5.51	6.97	16.33	9.15	8.05	9.55

Means with similar superscripts (row wise-abc) did not differ significantly.

Table -26:Analysis of variance for the effect of sex on Haematological parameters at 20 weeks of age in different genetic group.

GENETIC GROUP	SOURCE OF VARIATION	D. F	HAEMOGLOBIN		PCV		RBC		WBC	
			M.S	F	M.S	F	M.S	F	M.S	F
VR X VR	Between sexes Error	1 58	66.718 1.556	42.87**	1234.517 5.069	243.51**	7.045 0.026	263.34**	11537.066 152.395	75.71**
VR X DESI(MZF)	Between sexes Error	1 58	99.536 1.706	58.32**	1482.849 5.472	270.94**	6.208 0.022	277.60**	9425.066 151.871	62.06**
VR X DESI(GAYA)	Between sexes Error	1 58	92.603 1.234	75.00**	1177.848 5.426	217.05**	7.031 0.020	335.28**	8930.400 154.793	57.69**

Elagib and Ahmed (2011) reported the RBC count of male in Betwil ,Bare Neck and Large Beladi indigenous chicken of Sudan to be 2.83,2.83 and 2.70 respectively whereas the corresponding values in female were reported to be 2.50,1.70 and 2.10 respectively. Prahsanth *et al.*(2012) reported average estimates of RBC count of male and female at 25 weeks of age to be 4.30 and 3.59(10^6/mm^3) respectively in PB1 strain. The corresponding values for male and female in PB2 strain were reported to be 4.20 and 3.45(10^6/mm^3) respectively.

The average estimates of RBC count of male and female chicks reported by Peters *et al.*(2011), Elagib and Ahmed (2011) and Prahshanth *et al.* (2012) were higher than the values obtained by the findings of the present study. The difference in RBC count of different breeds might be due to differences in genetic makeup of the breeds as well as due to management and environmental differences.

Table-27:Least squares means along with standared error and C.V.% of Biochemical parameter at 20 weeks of age in male and female of various genetic groups of chicken.

GENETIC GROUPS		CHOLESTEROL		SGPT		SGOT	
		Male	Female	Male	Female	Male	Female
VR♀♀ X VR♂♂	Mean±S.E.	169.81^{a}±1.48	154.67^{b}±1.82	10.42^{a}±0.26	8.21^{b}±0.26	196.40^{a}±1.67	195.27^{a}±1.67
	C.V%	4.63	5.48	13.45	17.07	4.68	4.71
VR ♀♀ X DESI(MZF) ♂♂	Mean±S.E.	167.90^{a}±1.19	153.03^{b}±1.83	10.30^{a}±0.27	7.55^{b}±0.27	195.53^{a}±1.51	188.60^{b}±1.51
	C.V%	3.72	5.55	14.41	19.67	4.22	4.37
VR♂♂ X DESI(GAYA) ♀♀	Mean±S.E.	162.37^{a}±1.02	149.60^{b}±1.36	9.97^{a}±0.28	8.56^{b}±0.28	191.13^{a}±1.69	188.73^{a}±1.69
	C.V%	3.44	4.98	15.20	17.72	4.86	4.90

Means with similar superscripts (row wise-abc) did not differ significantly .

Effect of genetic group on RBC

The analysis of variance for the effect of genetic group on hemato-biochemical profiles has been presented in table-24 Analysis of variance revealed that genetic group had no significant effect on RBC count at 20th week of age in chicken

Least squares means along with standard errors and CV% of hemato-biochemical profiles at 20 weeks of age in various genetic groups pooled over sexes have been depicted in table-23.

RBC count in VR♂♂ X VR♀♀, DESI (MZF)♂♂ X VR♀♀ and DESI(GAYA) ♂♂ X VR♀♀ genetic groups did not differ significantly at 20th week of age .

Effect of sex on RBC

The analysis of variance for the effect of sex on RBC at 20 week of age in all the three genetic groups have been presented in table-26. The analysis of variance revealed highly significant ($P<0.01$) effect of sex in all the three genetic groups, reflecting higher values of RBC count of female than their male counterparts at 20th week of age.

Least squares means along with standard errors and CV% of means as mentioned in table-25 reflected that VR♂♂ X VR♀♀ , DESI(MZF)♂♂ X VR ♀♀ and DESI(GAYA)♂♂ X VR ♀♀ female have significantly ($P<0.05$) higher values of RBC count than their male counterparts. RBC ($10^3/mm^3$) count in VR♂♂ X VR♀♀ female was 0.69($10^6/mm^3$) which was significantly ($P<0.05$) higher than the male. Similar to VR♂♂ X VR♀♀, DESI(MZF)♂♂ X VR ♀♀ and

DESI(GAYA)♂♂ X VR ♀♀ female was 0.64 (10^6/mm^3)and 0.69 (10^6/mm^3) significantly higher RBC count than corresponding male respectively at 20th week of age of the present investigation.

SGOT (AST)

The least squares means of SGOT at 20th week of age pooled over sexes in VR♂♂ X VR♀♀ was estimated to be 195.83±1.18 (IU/L). The corresponding values for DESI (MZF)♂♂ X VR ♀♀ and DESI (GAYA)♂♂ X VR♀♀ were estimated to be 192.07±1.18 and 189.93±1.18(IU/L) respectively. Islam *et al.* (2004) reported the SGOT level in Shaver Star Bro strain of broiler chicken at 55 days age to be 187.32± 3.71 (IU/L) in control group. The findings of the present study are close proximity with the findings of Islam *et al.* (2004). As compared to the findings of the present study the higher magnitudes of SGOT level have also been reported by Adriani (2014) he reported SGOT (IU/L) level in broilers at one month old age chickens in control group to be 234.67 (IU/L).

Kanduri *et al.* (2013) reported SGOT (IU/L) at 6 weeks of age in broiler chicken to be 160.11(IU/L) in control group which is lower than findings of the present investigation.

The difference in SGOT (IU/L) level of different breeds might be due to differences in genetic makeup of the breeds as well as due to management and environmental differences.

Sex-wise least squares means along with standard error (SE) and coefficient of variation percentage (CV%) of

SGOT(AST) of various genetic group of chicken have been presented in table –27.

The average estimates of SGOT level of male and female in VR♂♂ X VR♀♀ were found to be 196.40±1.67 and 195.27±1.67 (IU/L) respectively. The corresponding values for male and female at 20 weeks of age in DESI (MZF)♂♂ X VR♀♀ were estimated to be 195.53±1.51 and 188.60±1.51(IU/L)respectively. In DESI(GAYA)♂♂ X VR♀♀ the average estimates of SGOT level in male and female were obtained as 191.13±1.69 and188.73±1.69(IU/L)respectively.

Abdi-Hachesoo B *et al.* (2013) reported the mean value of SGOT (IU/L) of male and female to be 191±0.89 and125.20±11.76(IU/L) respectively. The values obtained by Abdi-Hachesoo B *et al.*(2013) are in close proximity with the findings of the present study. Prahsanth *et al.* (2012) reported average estimates of SGOT of male and female at 25 weeks of age to be 137.6±9.45 and 131.3±6.45 IU/L respectively in PB1 strain .The corresponding values for male and female in PB2 strain were reported to be 138.4±8.73 and 172.6±20.74 IU/L respectively which is lower than the findings of the present investigation.

The difference in SGOT level of different breeds might be due to differences in genetic makeup of the breeds as well as due to management and environmental differences.

Effect of genetic group on SGOT

The analysis of variance for the effect of genetic group on hemato-biochemical profiles has been presented in table-24

Analysis of variance revealed significant (P<0.05) effect of genetic group on SGOT at 20th week of age.

Least squares means along with standard errors and CV% of hemato-biochemical profiles at 20th week of age in various genetic groups pooled over sexes have been depicted in table-23.

SGOT level in VR♂♂ X VR♀♀ was significantly (P<0.05) different form DESI(GAYA)♂♂ X VR♀♀. However, DESI(MZF)♂♂ X VR♀♀ did not differ significantly from VR ♀♀ x VR♂♂ and DESI(GAYA)♂♂ X VR♀♀ genetic groups.

Effect of sex on SGOT

The analysis of variance for the effect of sex on SGOT at 20th week of age in all the three genetic groups have been presented in table-28. The analysis of variance revealed highly significant (P<0.01) effect of sex in all the three genetic groups, reflecting higher level of SGOT of male than their female counterparts at 20th week of age.

nalysis of variance revealed significant (P<0.05) effect of genetic roup on SGOT at 20th week of age.

Least squares means along with standard errors and CV% of ematо-biochemical profiles at 20th week of age in various genetic roups pooled over sexes have been depicted in table-23.

SGOT level in VR♂♂ X VR♀♀ was significantly (P<0.05) fferent form DESI(GAYA)♂♂ X VR♀♀. However, DESI(MZF)♂♂ X R♀♀ did not differ significantly from VR ♀♀ x VR♂♂ and ESI(GAYA)♂♂ X VR♀♀ genetic groups.

ffect of sex on SGOT

The analysis of variance for the effect of sex on SGOT at 20th eek of age in all the three genetic groups have been presented in ble-28. The analysis of variance revealed highly significant <0.01) effect of sex in all the three genetic groups, reflecting gher level of SGOT of male than their female counterparts at 20th eek of age.

Table-28:Analysis of variance for the effect of sex on Biochemical parameters at 20 weeks of age in different genetic group.

ENE [C ROU	SOURCE OF VARIATI ON	D. F	CHOLESTEROL		SGPT		SGOT	
			M.S	F	M.S	F	M.S	F
R♂♂ R♀♀	Betwee n sexes Error	1 58	3162.0 42 82.296	38.42**	73.30 5 1.977	37.06* *	19.26 6 84.63 9	0.23NS
ESI(ZF) ♂ X R ♀♀	Betwee n sexes Error	1 58	3257.5 64 70.836	45.987* *	113.8 77 2.210	51.51* *	721.0 66 68.04 5	10.59 **
ESI(AYA) ♂ X R♀♀	Betwee n sexes Error	1 58	2444.8 17 43.348	56.400* *	30.18 9 2.309	13.07* *	86.40 0 86.36 7	1.00NS

** Significant

NS- Non-significant

Least squares means along with standard errors and CV% of means as dipicted in table-28 reflected that SGOT (IU/L) level in VR♂♂ X VR♀♀ male and DESI (GAYA)♂♂ X VR ♀♀ male shows non- significant effect with corresponding female. DESI (MZF)♂♂ X VR ♀♀ male was 6.93(IU/L) significantly higher than counterpart female respectively at 20 week of age of the present investigation.

SGPT (ALT)

The least squares means of SGPT at 20 weeks of age pooled over sexes in VR♂♂ X VR♀♀ was estimated to be 9.32±0.24(IU/L).

The corresponding values for DESI (MZF)♂♂ X VR ♀♀ and DESI (GAYA)♂♂ X VR♀♀ were found to be 8.92±0.24 and 9.27±0.24(IU/L) respectively. Adriani (2014) reported SGPT level in control group of broilers at one month is 12.50 (IU/L). The findings of the present study are close proximity with the findings of Adriani (2014). Kanduri *et al.* (2013) reported SGPT (IU/L) at 6 weeks of age in control group of broiler chicken to be 20.97 (IU/L) which is higher than the findings of the present investigation.

The difference in SGPT (IU/L) level of different breeds might be due to differences in genetic make up of the breeds as well as due to management and environmental differences.

Sex-wise least squares means along with standard error (SE) and coefficient of variation percentage (CV%) of SGPT(ALT) of various genetic groups of chicken have been presented in table –27.

The average estimates of SGPT level of male and female in VR♂♂ X VR♀♀ were found to be 10.42±0.26 and 8.21±0.26(IU/L) respectively. The corresponding values for male and female at 20 weeks of age in DESI (MZF)♂♂ X VR♀♀ were estimated to be 10.30±0.27and 7.55±0.27(IU/L) respectively. In DESI GAYA)♂♂ X VR♀♀ the average estimates of SGPT level of male and female were obtained as 9.97±0.28 and 8.56 ±0.28(IU/L)respectively.

Abdi-Hachesoo B *et al.* (2013) reported the mean value of SGPT(IU/L) of male and female to be 7.80±1.62 and

7.20±1.46(IU/L) respectively. The values obtained by Abdi-Hachesoo B *et al.*(2013) are in close proximity with the findings of present study .Prahsanth *et al.*(2012) reported average estimates of SGPT of male and female at 5 weeks of age to be 32.99±3.45 and 15.32±0.78 IU/L respectively in PB1 strain .The corresponding values for male and female in PB2 strain were reported to be 15.21±0.90 and 17.09±0.63 IU/L respectively which is higher than the findings of the present investigation.

The difference in SGPT level of different breeds might be due to differences in genetic make up of the breeds as well as due to management and environmental differences.

Effect of genetic group on SGPT

The analysis of variance for the effect of genetic group on hemato-biochemical profiles has been presented in table-24 Analysis of variance revealed significant ($P<0.05$) effect of genetic group on SGPT at 20 week of age.

Least squares means along with standard errors and CV% of hemato-biochemical profiles at 20th week of age in various genetic groups pooled over sexes have been depicted in table-23.

SGPT level in VR♂♂ X VR♀♀, DESI(MZF)♂♂ X VR♀♀ DESI(GAYA) ♂♂ X VR♀♀ genetic groups did not differ significantly .

Effect of sex on SGPT

The analysis of variance for the effect of sex on SGPT at 20th week of age in all three genetic group have been presented in table-

28. The analysis of variance revealed highly significant (P<0.01) effect of sex in all the three genetic groups, reflecting higher level of SGPT of male than their female counterparts at 20th week of age.

Least squares means along with standard errors and CV% of means as mentioned in table-27 reflected that VR♂♂ X VR♀♀ , DESI(MZF)♂♂ X VR ♀♀ and DESI(GAYA)♂♂ X VR ♀♀ male have significantly (P<0.05) higher values of SGPT than female counterparts. SGPT (IU/L) level in VR♂♂ X VR♀♀ male was 2.21(IU/L) significantly (P<0.05) higher than the female. Similarly the male of DESI(MZF)♂♂ X VR ♀♀ and DESI(GAYA)♂♂ X VR ♀♀ had significantly (P<0.05) 2.75 (IU/L) and1.41 (IU/L) values higher than their corresponding female counterparts respectively.

Cholesterol

The least squares means of cholesterol at 20th week of age pooled over sexes in VR♂♂ X VR♀♀ was estimated to be 161.97±1.49mg/dl. The corresponding values for DESI (MZF)♂♂ X VR ♀♀ and DESI (GAYA)♂♂ X VR♀♀ were reported to be 160.47±1.44 and 155.98±1.18mg/dl respectively. Peters *et al.* (2011) reported the mean Cholesterol level of Frizzled and Naked Neck chicken to be 156.60 and 160.30mg/dl respectively which is close proximity to the findings of the present study. Lower values are reported by many authors. Bhatti *et al.*(2002) reported cholesterol (mg/dl) level to be 147.42±72.96, 145.72±62.17, 140.99±61.42 and 130.77±50.55 in crossbred, Desi, Fayoumi and Nick chick respectively in control group. Kanduri *et al.*

(2013) reported serum cholesterol at 6 weeks of age in broiler chicken to be 148.38 mg/dl in control group. The difference in cholesterol level of different breeds might be due to differences in genetic makeup of the breeds as well as due to managemental and environmental differences.

Sex-wise least squares means along with standard error (SE) and coefficient of variation percentage (CV%) of Cholesterol of various genetic group of chicken have been presented in table –27.

The average estimates of cholesterol level of male and female in VR♂♂ X VR♀♀ were found to be 169.31±1.48 and 154.67±1.82mg/dl respectively. The corresponding values for male and female at 20th week of age in DESI (MZF)♂♂ X VR♀♀ were estimated to be 167.90±1.19 and 153.03±1.83mg/dl respectively. In DESI(GAYA)♂♂ X VR♀♀ the average estimates of cholesterol level in male and female were obtained as 162.37±1.02 and 149.60±1.36mg/dl respectively. Peters *et al.* (2011) reported the mean cholesterol level of male and female in Frizzled to be 176.0 and 137.20 mg/dl .The corresponding values for Naked Neck are reported to be 183.10 and 131.50 respectively . Abdi-Hachesoo B *et al.* (2013) reported the mean value of cholesterol in male and female to be 167.60 and 152.60mg/dl respectively. The values obtained by Peters *et al.* (2011) and Abdi- Hachesoo B *et al.* (2013) are in close proximity with the findings of present study.

Prahsanth *et al.*(2012) reported average estimates of Cholesterol of male and female at 25 week of age to be 137.6±9.45 and 131.3±6.45 IU/L respectively in PB1 strain which is lower than the findings of the present investigation.The difference in Cholesterol level of different breeds might be due to differences in genetic makeup of the breeds as well as due to managemental and environmental differences.

Effect of genetic group on Cholesterol:-

The analysis of variance for the effect of genetic group on haemato-biochemical profiles has been presented in table-24 Analysis of variance revealed significant effect on genetic group on at 20 week of age.

Least squares means along with standard errors and CV% of haemato-biochemical profiles at 20th week of age in various genetic groups pooled over sexes have been depicted in table-23

Cholesterol level in VR♂♂ X VR♀♀ genetic group did not differ significantly with DESI (MZF)♂♂ X VR♀♀ . VR♂♂ X VR♀♀ and DESI (MZF)♂♂ X VR♀♀ genetic group significantly ($P<0.01$) different with DESI (GAYA) ♂♂ X VR♀♀ .

Effect of sex on Cholesterol

The analysis of variance for the effect of sex on cholesterol at 20th week of age in all three genetic group have been presented in Table- .The analysis of variance revealed highly significant ($P<0.01$) effect of sex in all the three genetic groups, reflecting

higher level of cholesterol of male than their female counterparts at 20th week of age.

Phenotypic correlations among various body weight and conformation traits in different genetic groups

Phenotypic corelations among body weights at different ages :

The phenotypic correlations along with their standard errors among body weights at different weeks of ages in all the three genetic groups have been depicted in table-29.

It was observed that the estimates of r_p between day old body weight and body weight at subsequent ages in all the three genetic groups in general, were very low non-significant and positive. Kaniska (1970), Potemskowska *et al.* (1970) and Rao (1984) also reported non-significant values of r_p between zero day body weight and body weight at subsequent ages which are similar to the findings of the present study. Besides, it was also observed that the magnitude of phenotypic correlations of day old chick weight, in general, had a declining tendency with that of body weights at subsequent ages. This might be, possibly, due to the dilution of maternal influence as the age advances. The very low and non-significant estimates of r_p between zero day and body weights at higher ages might suggest that zero day body weight would not be a suitable criterion for the selection for body weights.

Phenotypic correlation of 4th week body weight with body weights at subsequent ages revealed values were in general observed to be positive low in magnitude and statistically non-

ek with body weights at higher ages 3 estimates were
o be in positive direction of which 1 were found to be
(P<0.01). Thus, it was observed that out of 30 estimates
en body weights at 4th week onwards with body weights
ges (P <0.05). Positive estimates of r_p between 4th week
ht and body weights at higher ages have also been
various authors in different genetic groups of poultry
rma, 1983; Sharma, 1984 and Jaya Laxmi *et al.*, 2010)
in conformity with the findings of the present study.
Chatterjee (2012) obtained positive estimate of r_p
th week body weight and 40th week body weight in
he trend of which is similar to the findings of the
dy. Positive and significant estimates of r_p between

ble-29 : Phenotypic correlations along with their standard ors among body weights at different ages in various genetic ups of chicken.

	VR♂♂ X VR♀♀	DESI(MZF)♂♂ X VR♀♀	DESI(GAYA)♂♂ X VR ♀♀
Y OLD			
DY WT			
X 4 WK B.W	0.078±0.057	-0.005±0.058	-0.068±0.057
X 8 WK B.W	-0.068±0.062	0.023±0.062	-0.116±0.061
12 WK B.W	-0.02±0.066	-0.127±0.065	-0.219±0.064
16 WK B.W	0.166*±0.068	-0.233±0.067	-0.110±0.068
20 WK B.W	-0.352±0.067	0.037±0.071	-0.140±0.071
VK B.W			
8 WK B.W	0.087±0.062	0.045±0.062	0.300**±0.059
12 WK B.W	0.109±0.065	-0.159**±0.065	0.056±0.066
16 WK B.W	-0.051±0.069	0.063±0.069	-0.121±0.068
20 WK B.W	0.013±0.071	-0.055±0.071	-0.048±0.071
WK B.W			
12 WK B.W.	0.148**±0.065	-0.033±0.066	-0.018±0.066
16 WK B.W.	0.196**±0.067	0.013±0.069	-0.060±0.069
20 WK B.W.	0.187**±0.0705	0.008±0.071	-0.006±0.071
WK B.W			
16 WK B.W	0.035±0.069	0.127±0.068	0.106±0.068
20 WK B.W	0.124±0.071	0.051±0.071	0.233**±0.069
WKB.W			
20 WK B.W	-0.038±0.071	0.181**±0.0706	-0.069±0.071

ıterrelationship among body weight and conformation traits

henotypic correlation between:

ody weight and shank length

The estimates of r_p along with their standard errors between ɔdy weight and shank length at different ages in all the three roups have been presented in table -30.

Table -30 revealed that all the estimates of r_p between day old ɔdy weight and shank lengths at different ages in all the three enetic groups were non-significant except few. Besides, a few of ıem had also negative but non-significant correlations. These ndings suggested that day old body weight and shank length at arious ages in all the three genetic groups are not phenotypically ɔrrelated and day old body weight would not be the suitable riterion for selection of shank length in any of the genetic group. harma (1984) also obtained non-significant phenotypic ɔrrelations between zero day body weight and 8-week shank ngth in Red Cornish and White Plymouth Rock, a trend, which is imilar to the findings of the present study.

Out of 50 estimates of r_p between body weights at 4th week nwards and shank length at 4th week onwards (table-30), 37 stimates were observed to be positive of which 17 were stastically ignificant ($P<0.05$) in VR♂♂ x VR♀♀ genetic group. The orresponding number in DESI(MZF) ♂♂ x VR ♀♀ and DESI(GAYA) ♂♂ x VR♀♀ were noted as 12, and 16. Chhabra *et al.* (1972), ggarwal *et al.* (1979), Verma *et al.* (1979) and Sharma (1984) have

obtained positive and significant estimates of r_p between body ht and shank length in different genetic groups in poultry h are similar to the findings of the present study. Padhi and terjee (2010) have also reported positive estimates of r_p of erate magnitude between body weight and shank length in araja, the trend of which is similar to the findings of the ent investigation.

These findings suggested that body weight and shank length more correlated in VR♂♂ x VR♀♀ genetic group than other tic groups. The 4th week body weight was highly, positively significantly (P<0.01) correlated with shank length at 4, 8, 12, nd 20 weeks of age suggesting 4th week body weight might be of criteria for selection of shank length at different ages in this tic group. Besides, selection for 4 week body weight would also simultaneous improvement in shank length at different ages.

weight x keel length

The estimates of r_p between body weight and keel length at ous ages in all the three genetic groups have been depicted in e -30.

The trend of phenotypic correlations between day old body ght x keel length at different ages were similar to that of body ght x shank length. All the estimates were found to be stically non-significant. Besides, a few non-significant negative nates were also obtained. Sharma (1984) also observed non-ificant estimate of r_p between day old body weight x 8 week length in Red Cornish, a trend similar to the findings of the

present study. Non-significant estimates of r_p might suggest again hat day old body weight might not be a suitable criterion for election of keel length at any age in any of the genetic group nder study.

Table -30 revealed that out of 25 estimates of r_p between body eights at 4th week onwards and keel length at 4th week onwards 0 estimates were observed to be positive out of which 8 are ignificant (P<0.05 or 0.01) in VR ♂♂ x VR ♀♀ genetic group. The orresponding figures in DESI(MZF) ♂♂ x VR♀♀ and DESI(GAYA) ♂x VR ♀♀ were obtained as 18, and 12 out of which 7 and 8 are ignificant. It was further observed that the estimates of r_p between th week body weight x keel length at different ages were stronger, f high magnitude with low value of standard error in VR ♂♂ x VR ♀ genetic group, as obtained in case of estimates of r_p between 4th . eek body weight x shank length at different ages. Ayoub *et al.* 1980) and Sharma (1984) also reported positive and significant henotypic correlation coefficients of high magnitude between body eight x keel length from 4th week of age onwards in crossbreds of oultry, a similar trend, obtained in the present investigation. ositive and significant estimates of r_p of high magnitude with low stimate of standard error would reflect that selection for body eight at different ages would also bring simultaneous nprovement in the correlated keel length at that age.

Table-30 : Phenotypic correlations along with their standard errors between body weight and conformation traits at different ages in various genetic groups of poultry.

TRAITS	VR♂♂ X VR♀♀	DESI (MZF)♂♂ XVR ♀♀	DESI(GAYA)♂♂ X VR ♀♀
DAY OLD BODY WT			
X 4 WK S.L.	0.103*±0.057	0.023±0.058	-0.006±0.058
X 8 WK S.L.	-0.086±0.062	0.015±0.062	-0.09±0.062
X 12 WK S.L	-0.017±0.066	-0.057±0.066	-0.187±0.065
X 16 WK S.L.	0.227**±0.067	-0.098±0.069	0.066±0.069
X 20 WK S.L.	-0.208±0.0702	0.009±0.071	-0.19±0.0704
X 4 WK KL	-0.039±0.057	0.009±0.058	-0.082±0.057
X 8WK KL	-0.16±0.061	-0.019±0.062	-0.016±0.062
X 12WK KL	-0.029±0.066	-0.067±0.066	-0.206±0.064
X 16WKKL	0.226**±0.067	-0.199±0.067	0.077±0.069
X 20WK KL	-0.396±0.065	-0.069±0.071	-0.175±0.0706

4 WK B.W			
X 4 WK S.L.	0.938**±0.0201	0.869**±0.028	0.861**±0.029
X 8 WK S.L.	0.063±0.062	-0.021±0.062	0.253**±0.0603
X 12 WK S.L.	0.118*±0.065	0.01±0.066	-0.023±0.066
X 16 WK S.L.	-0.107±0.068	0.188**±0.068	0.017±0.069
X 20 WK S.L.	-0.025±0.071	0.07±0.071	-0.043±0.071
X 4 WK K.L.	0.76**±0.037	0.804**±0.034	0.791**±0.035
X 8 WK K.L.	0.084±0.062	0.068±0.062	0.291**±0.059
X 12 WK K.L.	0.072±0.066	0.037±0.066	-0.046±0.066
X 16 WK K.L.	-0.054±0.069	0.164*±0.068	-0.027±0.069
X 20 WK K.L.	0.009±0.071	-0.022±0.071	-0.043±0.071

8 WK B.W			
X 4WK S.L.	0.117**±0.057	0.069±0.057	0.118*±0.057
X 8 WK S.L.	0.92**±0.024	0.83**±0.032	0.945**±0.0204
X 12 WK S.L.	0.131*±0.065	-0.052±0.066	0.049±0.066
X 16 WK S.L.	-0.015±0.069	-0.036±0.069	0.081±0.069
X 20 WK S.L.	0.179*±0.0706	0.152*±0.0709	-0.067±0.071
X 4WK K.L.	0.06±0.057	0.093±0.057	0.435**±0.052
X 8 WK K.L	0.783**±0.038	0.745**±0.041	0.784**±0.038
X 12 WK K.L.	0.056±0.066	0.005±0.066	0.053±0.066
X 16 WK K.L.	0.086±0.069	0.037±0.069	0±0.069
X 20 WK K.L.	0.099±0.071	-0.086±0.071	-0.031±0.071

12 WK B.W			
X 4 WK S.L.	0.121**±0.057	-0.11±0.057	0.072±0.057
X 8WK S.L	0.107±0.062	-0.037±0.062	-0.047±0.062
X 12 WK S.L.	0.928**±0.024	0.211**±0.064	0.267**±0.063
X 16 WK S.L.	-0.062±0.069	-0.2±0.067	-0.292±0.066
X 20 WK S.L.	-0.001±0.071	0.009±0.071	0.392**±0.066
X 4 WK K.L.	0.099±0.057	-0.154±0.057	0.084±0.057
X 8 WK K.L.	0.178**±0.061	-0.021±0.062	-0.078±0.062
X 12 WK K.L.	0.723**±0.045	0.186**±0.065	0.247**±0.064
X 16 WK K.L.	0.099±0.068	-0.099±0.068	-0.262±0.066
X 20 WK K.L.	0.155*±0.0709	-0.052±0.071	0.357**±0.067

16 WK B.W			
X 4 WK S.L.	-0.045±0.057	-0.018±0.058	-0.068±0.057
X 8WK S.L	0.109±0.062	0.001±0.062	-0.022±0.062
X 12 WK S.L.	0.046±0.066	0.001±0.066	0.038±0.066
X 16 WK S.L.	0.734**±0.047	0.37±0.064	-0.14±0.068
X 20 WK S.L.	-0.108±0.071	-0.028±0.071	0.196**±0.0704
X 4 WK K.L.	-0.169±0.057	0.001±0.058	-0.055±0.057
X 8 WK K.L.	0.004±0.062	0.008±0.062	-0.075±0.062
X 12 WK K.L.	-0.066±0.066	0.063±0.066	0.032±0.066
X 16 WK K.L.	0.817**±0.04	0.677**±0.051	-0.194±0.068
X 20 WK K.L.	-0.068±0.071	0.143*±0.071	0.078±0.071

20 WK B.W.			
X 4 WK S.L	0.031±0.057	-0.033±0.057	-0.053±0.057
X 8WK S.L	0.097±0.062	0.005±0.062	-0.014±0.062
X 12 WK S.L.	0.107±0.065	-0.04±0.066	0.235**±0.064
X 16 WK S.L.	-0.232±0.067	0.079±0.069	-0.138±0.068
X 20 WK S.L.	0.592**±0.057	-0.007±0.071	-0.022±0.071
X 4 WK K.L.	0.034±0.057	-0.053±0.057	-0.074±0.057
X 8 WK K.L.	0.185**±0.061	0.039±0.062	-0.067±0.062
X 12 WK K.L.	0.124±0.065	0.019±0.066	0.202**±0.064
X 16 WK K.L.	-0.299±0.066	0.058±0.069	-0.131±0.068
X 20 WK K.L.	0.947**±0.023	0.397**±0.065	0.794**±0.043