EVALUATION OF LOW INPUT CHICKEN FOR IMMUNE RESPONSE AGAINST NEWCASTLE DISEASE

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CERTIFICATE

This is to certify that the thesis entitled ***"EVALUATION OF LOW INPUT CHICKEN FOR IMMUNE RESPONSE AGAINST NEWCASTLE DISEASE"*** submitted by **Mr. PRABHUDEVA, A. N**., I.D. No. **MVHK 847** in partial fulfillment of the requirements for the award of **MASTER OF VETERINARY SCIENCE** in **POULTRY SCIENCE** of the Karnataka Veterinary, Animal and Fisheries Sciences University, Bidar is a record of bonafide research work carried out by him during the period of his study in this University under my guidance and supervision, and the thesis has not previously formed the basis for the award of any degree, diploma, associate ship, fellowship or other similar titles.

Place: Bangalore
Date: November, 2010

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Dedicated to my beloved

Parents

Eswaramma and Narayanaswamy. S

Abbenahalli

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ABBREVIATIONS

BIS- Bureau of Indian Standards

BW-Body weight

DLC- Differential Leukocyte Count

DNCB- 1, Chloro- 2,4- dinitro chloro benzene

g- Gram

Hb- Haemoglobin

HI- Haemagglutination Inhibition

hr -Hour

IBDV- Infectious Bursal Disease Vaccine

Ig- Immunonoglobulin

IU- International Units

Kg- Kilogram

mg- Milligram

mm- Millimeter

NDV- New Castle Disease vaccine

PCV- Packed Cell Volume

ppm- Parts per million

SE- Standard Error

SRBC- Sheep red blood cells

TLC- Total Leukocyte Count

Introduction

I. INTRODUCTION

Poultry rearing has always been an integral component of livestock production system in India. The concept of composite farming system with crop, livestock, fish and poultry production has been practiced for centuries in India.

Poultry sector, besides providing direct and/or indirect employment to nearly 3 million people, is a potent tool for subsidiary income generation for many landless and marginal farmers and also provides nutritional security especially to the rural poor. Around twenty percent of the protein consumed in developing countries comes from poultry meat and eggs. Rural house hold production contributes seventy percent production in most low income, food deficient countries. Rural poultry is mainly indigenous or local and usually have very limited number. The output of village poultry is lower than that of intensively raised birds but is obtained with minimum input in terms of housing, disease control, management and supplemental feeding. Under rural conditions, birds are continuously exposed to pathogens and other adverse conditions. Hence survival or longevity under these conditions depends on bird's ability to withstand bacterial or viral infections.

Genetic selection and crossbreeding programmes were effectively used to produce cross-bred chickens for small holding farmers in India which would be able to withstand village production conditions with better production capacity and immunocompetence. The Department of Poultry Science, KVAFSU, Bangalore, developed three synthetic crosses, Giriraja, Swarnadhara and Raja II for backyard poultry production. They resemble, indigenous birds in having variegated plumage pattern, but are superior to

indigenous birds with respect to body weight gain, egg production, survivability under adverse climatic conditions and immunocompetence (Devegowda, 1997). Characterisation and evaluation of immune parameters in these genotypes can offer knowledge that can be incorporated into breeding programmes for enhancing the natural resistance to disease in tropical and subtropical environment.

The birds immune system is a highly specialised network of organs, glands and cells which protects the body from pathogens. The immune system consists of three basic sub-systems viz, the humoral, cellular and phagocytic. These sub-systems have different mechanisms of protecting the body from disease. Lymphoid organs provide site for maturation, differentiation of T or B lymphocytes, and interaction between lymphocytes and antigen. Likewise, the humoral immune response is the principle specific immunity against extracellular bacteria, while cell mediated immunity plays a major role in response against intracellular bacteria and viruses (Dawson and Allan, 1973). Genetic differences in immune responses have been reported, for experimental random bred, inbred lines, commercial strains and local indigenous birds. Improving genetic resistance to disease and immune capabilities of these birds is more important and desirable. Indian native breeds are considered to have comparatively better disease resistance than exotic breeds and the knowledge of this variation in immune response between different strains may be valuable in genetic selection programme.

The present study is designed to evaluate and measure the growth performance and immunocompetence of different genotypes viz., Giriraja, Swarnadhara, Raja II and

local birds being maintained at the Department of Poultry Science, Veterinary College, Bangalore, with the following objectives.

a) To assess some immunological parameters of four genotypes of low input chickens namely Giriraja, Swaranadhara, Raja II and local fowls.

b) To monitor the persistence of antibodies to Newcastle and Infectious Bursal Disease Vaccines.

c) To compare the growth performance of four synthetic crosses.

Review of Literature

II. REVIEW OF LITERATURE

Immune Response

Variation in resistance to disease is a widespread phenomenon in all species and Indian native breeds are considered to have comparatively better disease resistance than exotic breeds and the knowledge of this variation in immune response between different strains may be valuable in genetic selection programme. Various workers have adopted different methods to evaluate humoral and cell mediated immune response in poultry.

Dawson and Allan, (1973) observed that the development of active immunity in chicks was influenced by a number of factors including the level of passively acquired immunity, the age and route of administration of vaccine, the type of the vaccine virus strain and the titre of virus used for vaccination.

Balla *et al.,* (1976) noted that in a flock, moderate to high HI titres remained a good indicator system for Newcastle Disease immunity, especially in broilers.

Almassy *et al.,* (1979) compared the immune response of eye drop and drinking water method of vaccine administration with three lentogenic strain of ND vaccines and found that the eye drop method of vaccination gave more uniform and better protection of chicks against NDV infection than administration in drinking water.

Ibrahim *et al.,* (1979) evaluated a vaccination program for chicks by the use of the dipping and intra ocular method. Three days old chicks were administered with F-strain vaccine by instilling one drop into an eye or by dipping the head into the vaccine

for at least two seconds. Protection against a virulent field strain was 80-100% with either method.

Siegel and Cross, (1980) selected chicken for antibody production to sheep red blood cells (SRBC) and tested the resistance of the selected lines to infectious diseases. They found that the high antibody production lines were more resistant to mycoplasma, eimeria and spleenomegalia virus, but not to bacterial diseases when compared to low antibody production lines.

Hellar *et al.,* (1981) observed no differences in HI titres between Bedouin fowl, commercial White Leghorn and their reciprocal crosses, which were intramuscularly inoculated with either attenuated or inactivated Newcastle Disease virus at four weeks of age.

Van der Zijpp *et al.,* (1983) determined total agglutinin antibody titres against SRBC challenge in cockerels of three genotypic origins: White Plymouth Rock (WPR), White Leghorn (WL) and a medium heavy breed cross (Warren) and found significant difference in antibody titres among genetic groups. He found significant differences between genetic stocks on day 0, 3, 7 and 14 days of post inoculation of SRBC for antibody titres.

Ubosi *et al.,* (1984) studied the antibody response to SRBC in lines of chicken divergently selected for this trait and in reciprocal crosses between them. They observed significant difference between high-antibody and low-antibody lines in frequency of responders (showing detectable antiboby titres). The difference was not significant in the crosses.

Daniel King, (1986) conducted Hemagglutination-inhibition (HI) titers for Newcastle disease virus (NDV) on serum samples from eight commercial broiler breeder flocks and their progeny. The chickens sampled had been vaccinated and reared by different producers in different regions of the United States. Eighty percent or more of the samples from six of eight breeder flocks were positive, Only 3 of 8 broiler flocks had an increased frequency of titers and higher titers after vaccination.

Gyles *et al.,* (1986) challenged six breeding groups of chickens with different classes of antigens, namely Newcastle disease vaccine (ND), Infectious Bronchitis vaccine (IB), Infectious Bursal Disease viral agent (IBD), *Salmonella pullorum* antigen (P) and SRBC. They found significant differences in antibody titre among different genetic groups to ND, IB and SRBC antigens in parents at twenty weeks of age, and to ND, IB, IBD and SRBC in progenies at 1,2,3 and 4 weeks of age.

Van der Zipp *et al.*, (1986) studied humoral immune response in chicken to SRBC and found significant difference among genetic groups and that there was no correlation between antibody to SRBC and cell mediated immunity, measured by phytohemagglutination (PHA) wing web response. Commercially available vaccines were also often used to study humoral response in chicken.

Satter *et al*., (1988) concluded that vaccination through subcutaneous (s.c) route of day old chicks with LaSota, Komarov and Mukteswar strains gave 100% protection against challenge at day 23 while these vaccine strains in drinking water gave 94.3%, 99.6% and 94.3% protection respectively.

Berrio *et al.,* (1990) while studying the genetic influence on the immune response to the Lasota of Newcastle disease virus, reported that the titre of HI antibodies at 7, 14, 21, 28, 36, 42 and 56 days after vaccination were significantly higher in birds with naked neck gene than those in normal birds. These results indicate a favourable effect of the Na gene on the immune response to the Lasota strain.

Bell *et al.,* (1991) conducted a study on commercial broiler farms which was vaccinated once at 1 to 15 days of age with a live Newcastle disease virus (NDV) vaccine administered by drinking water, aerosol or coarse spray. Hatchmates were housed and similarly vaccinated in laboratory isolation pens. Samples of birds were bled at weekly to fortnightly intervals and the serums tested for haemagglutination inhibiting antibody to NDV. Differences were observed between the results obtained from parallel field and laboratory trials. The presence of maternal NDV antibody reduced the response to vaccination. The results show that this vaccine can produce an adequate serological response.

A survey data by Samina *et al.,* (1992), on differences in antibody response between heavy and light breeds of chicken following vaccination with live and inactivated Newcastle disease vaccines, showed that the heavy breeds were significantly inferior in their response to immunization when compared with light breeds.

Zulkifli *et al.,* (1993), who studied the antibody responses of dwarf and normal chickens to SRBC antigen, found no difference between dwarf and normal chicks for SRBC antibody titres. They reported similar results for dwarf and normal chicks.

Biswas *et al.,* (1996) made a comparative study on the protection of indigenous chickens against ND induced by Australian NDV4 HR and locally conventional vaccines (BCRDV, lentogenic F-strain and RDV, Mukteswas M strain). Blood were collected at intervals from all the chickens and tested by HI test. The conventional vaccines apparently conferred higher protection in the birds (93-94%) than the NDV4 HR vaccine that provided 67-88% protection.

Kundu *et al.,* (1999) tested the primary antibody response to sheep erythrocytes by haemagglutination test in Indian native breeds (Aseel, Kadakanath, Naked Neck, and Frizzle) along with imported breeds (Dahlem Red and White Leghorn, synthetic dam line of Naked Neck broiler line) and found significant variation in HA response among the various genetic groups. Amongst the native Indian breeds, the Naked neck had the highest titre on day 5 while the Aseel had highest titre on days, 12 and 19. All groups except broilers showed highest titre on day 5 post immunization.

Siddique *et al.,* (2005) conducted a serological survey on the prevalence of antibodies to Newcastle disease (ND) virus in and around District of Faisalabad. A total of 312 serum samples were collected from different commercial broiler farms and slaughter shops. Samples were divided into three groups according to the age i.e. 0-3 weeks (56 samples), 3-5 weeks (164 samples), 5-7 weeks (92 samples). Haemagglutination inhibition (HI) test was performed to determine the serum antibodies against ND virus. The results showed that the level of protection of vaccinated birds was unsatisfactory.

Msoffe *et al.,* (2006) conducted a study to evaluate the HI dynamics of six local chicken ecotypes of Tanzania to Newcastle disease vaccine. The ecotypes were locally

known as *Ching'wekwe*, *Mbeya, Morogoro-medium*, *Pemba*, *Tanga* and *Unguja*. Parents were vaccinated and HI titres measured after two weeks on hens. *Tanga* ecotype showed early protective immunity while *Morogoro-medium* and *Mbeya* ecotypes showed persistently higher responses. These results indicate that local chicken ecotypes have divergent responses towards Newcastle disease vaccine.

El-Safty *et al.,* (2006), evaluated immunological traits of two genotypes (heterozygous naked neck and normally feathered) of chicken under low ambient temperature, and found that *NaNa* hens had heavier body weight and slightly higher body temperature as compared to *nana* one. The leukocyte percentage indicated that the *nana* birds were more stressed than *NaNa* counterparts. The results of PHA-P assay showed that the *NaNa* hens had a significantly greater dermal swelling compared to normally feathered ones. Further, they recorded higher mortality and culling rate in normal plumage hens, than heterozygous naked neck hens.

Islam, *et al.,* (2008) conducted a study to determine the immune response of eight different imported live NDV vaccines in broiler chickens vaccinated with the same vaccines respectively by double eye instillation. One group was kept as unvaccinated control. From the study, it was concluded that LaSota strain produced higher immune response than all other vaccines used in this study.

Saini Samita *et al.,* (2008) evaluated the immune response of three White Leghorn and two Rhode Island Red strains using T dependent antigen. The White Leghorn selected strains had higher titre before inoculation than RIR strains while Rhode Island Red strains had lower level of antibodies against SRBC but when exposed to SRBC antigen they gave higher immune response.

Singh Paramatma *et al.,* (2009), evaluated the primary immune response to sheep red blood cells in three strains of White Leghorn, two strains of Rhodes Island Red and two cross breed groups. He found that the primary immune response was highest in WHL compared to RIR. The crosses between breeds or between strains did not exhibit superiority in HI titre.

Singh Satyendra Pal *et al.,* (2009) studied immunocompetence profile viz., humoral immune response to sheep red blood cells, cell mediated immune response, serum IgG concentration and serum lysozyme level of Kadaknath breed and found to be inferior. The improvement of immunocompetence of these birds could be achieved by selection for combination of different facets of host's immune systems.

Haematology

Normal haematology profile for chicken

Parameter	**Normal range**
Erythrocytes (/µl)	2,500,000-3,500,000
Haemoglobin (g/dl)	7-13
PCV (%)	22-35
TLC	12,000-30,000
Heterophils	3000-6000
Lymphocyte	7000-17,500
Eosinophils	0-1000
Monocytes	150-2000

Source: Bernard Feldman, (2000)

Mushi *et al.,* (1999) studied red blood cell count (RBC), haemoglobin (Hb), haematocrit (PCV), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), thrombocyte count, white blood cell count (WBC), differential white blood cell count, erythrocyte sedimentation rate (ESR) and mean coagulation time of 10 male and 90 female indigenous (Tswana) chickens in Botswana. Male chickens had higher RBC, Hb and PCV values than the females. The various parameters of the leukogram and haemogram of the Tswana chickens were comparable with other indigenous chickens.

Islam *et al.,* (2004) determined the haematological parameters in Fayoumi, Aseel and local chickens at different ages (1, 3, 6, 9 and 12 months) in Sylhet region of Bangladesh. He observed that erythrocyte numbers, hemoglobin concentration and packed cell volume increased with the advancement of age in all three breeds. The TEC was higher in Fayoumi, While hemoglobin concentration was highest in Aseel. The PCV values were similar in all three breeds. The Fayoumi showed higher ESR compared to other two breeds. Among three breeds, local chickens had higher lymphocyte percentage. The heterophils were higher in Fayoumi breed. Monocyte was lower in Aseel and Local chickens. Eosinophils were higher in number in local and Aseel compared to Fayoumi.

Cell mediated immunity

It is an established fact that direct application of compounds like DNCB to skin will result in systemic sensitization to various metabolites of the sensitizing compound. The ability of an individual to develop contact sensitivity is a measure of cellular immunity and the cutaneous sensitization test using chemical compound like 2, 4-dichloro benzene was

considered as one of the dependable tests for measuring the cell mediated immunity status and with this objective, the test was successfully carried out in man and animals from time to time (Brummerstedt and Basse, 1973; Maisel and Obgura, 1973; and Bosoworth *et al.,* 1975). Di Nitro Chloro Benzene has been shown to induce a DTH reaction in chickens (Awadhiya *et al.,* 1982). Contact sensitivity to DNCB is therefore a convenient model to investigate the basic mechanisms of the cellular immune response and its regulation in the chicken.

Rajan *et al.,* (1981) standardized DNCB test for evaluating CMI responses in goats and was found to be effective in evaluating cell mediated immunity.

Valsala *et al.,* (1981) evaluated CMI response in ducks where he observed 2 to 2.5 mm increase in thickness of skin in 24 hrs after injecting the 2-4 DNCB. They also studied the DTH reaction and histopathological features of the reaction to the chemical. Tizard, (1982) described that allergic contact dermatitis developed in skin following exposure of tissue cells to reactive chemicals, consequent to formation of protein chemical complexes and their subsequent rejection through immune response.

El-Safty *et al.,* (2006), evaluated immunological traits of two genotypes (heterozygous naked neck and normally feathered) of chicken under low ambient temperature. Results of cell mediated immunity for PHA-P assay showed that the *Nana* hens had a significantly greater dermal swelling compared to normally feathered ones.

Al–Shahery *et al.,* (2008) developed leukocyte-migration inhibition test for the evaluation of cell-mediated immunity for use in chickens vaccinated with Newcastle

disease vaccine. Results indicated that the leukocyte migration test was reproducible and relatively easy assay to be performed. Antibody titres were determined to study the correlation between haemagglutination inhibition titres and leukocyte-migration level using the HI test.

Saini Samita *et al.,* (2008) evaluated the cell mediated immune response in three White Leghorn and two Rhode Island Red strains for *in vivo* cell mediated immune response to mitogen Phytohaemagglutinin (PHA-P). The *in vivo* cell mediated immune response as measured by T-lymphocyte proliferation response to mitogen. Phytohaemagglutinin was highest in White Leghorn control line.

Singh Satyendra Pal *et al.,* (2009), evaluated *invivo* Cell mediated response to mitogen phytohaemaglutinin (PHA-P) in three strains of White Leghorn, two strains of Rhodes Island Red and two cross breed groups and found that, the PHA response of WLH was significantly higher than in RIR while the crosses did not elicit any higher PHA response than their corresponding pure lines.

Growth performance

The available literature on growth performance, immunocompetence of low input chicken is reviewed hereunder.

Body weight

Merat, (1979) reported that the body weight of males at eight weeks of age in normal neck feathered birds was significantly higher than the body weight of naked neck

birds having gene for dwarfism. The corresponding weights in birds without dwarf gene were 803 and 789 g in normal and naked neck feathered birds, respectively.

Barua and Howlider, (1991) compared the performance of indigenous naked neck and fully feathered chickens of Bangladesh on free range system of rearing. They observed significant difference in body weight at twenty weeks of age. The naked neck birds weighed 1010g while fully feathered birds weighed 970 g at twenty weeks of age.

Barua *et al.,* (1992) compared the performance of crosses produced from standard exotic breeds, Rhode Island Red (RIR) and White Leghorn and indigenous Naked neck stocks of Bangladesh. They reported that *RIR* x *NaNa* crossbreds showed higher growth rate and were heavier than *WL* x *NaNa* crossbreds.

Huque, (1994) made efforts to develop a breed or strain suitable for scavenging and semi-scavenging systems of rearing in Bangladesh. Of the six distinct types of pure native chicken studied, native Naked Neck, native Dwarf and Hilly were found to have better production potentialities than others. Among different combinations of native and exotic chickens, *RIR* x Fayoumi, *NN* x *RIR* and *NN* x Fayoumi had better performances under semi-scavenging conditions. Further, he observed that productivity under scavenging conditions was lower than under intensive systems, largely due to poor nutrition.

Bhatti *et al.,* (1997) compared the performance of indigenous Aseel and their crossbreds with *RIR* and *WLH* in Pakistan. They observed that crossbred birds of Aseel x *WLH* had significantly better body weight gain compared to pure Aseel breed birds.

Deeb and Cahaner, (1999) evaluated the effect of naked neck genotypes in alternating ambient temperature on the performance of broilers and observed that the three genotypes had similar body weight at seven weeks of age.

Singh *et al.,* (1999) evaluated the growth performance of the two indigenous breeds viz., Aseel and naked neck and their crosses with the exotic breed (Dahlem Red) for finding out the differences in body weights among different genetic groups under tropical conditions. The study revealed that the Aseel was found to be heaviest in body weight at 20^{th} week of age in both sexes among pure breeds. Whereas, Aseel x Dahlem Red Cross was the heaviest among the cross breeds.

Haque and Howlider, (2000) compared the body weights of Naked neck Desi (NaD) and its crossbreds with Rhode Island Red , White Leghorn and Fayoumi (Fy) breeds at 12 weeks of age. Among these different genotypes, the highest body weight was observed in *NaD* x *RIR* crossbred followed by *NaD* x *WL* and *Nad* x *Fy* crossbred strains.

Deeb and Cahaner, (2001) studied the performance of heterozygous naked neck, homozygous naked neck and normal feathered birds at low and high ambient temperatures. They observed that introduction of naked neck gene into commercial flock improved the performance especially at high ambient temperature.

Padhi *et al.,* (2001) compared the performance of naked neck, frizzzle fowls and their crossbreds with synthetic broilers in Andaman and Nicobar Islands, India. They observed that the body weights of crossbreds were significantly higher than the indigenous naked neck and Frizzle fowls.

Krishnamurthy, (2002) studied the relative performance of naked neck and their crosses with Giriraja and Girirani parent lines under intensive system of rearing. They found the genetic groups, *NN* x *NN* and *NN* x *CDC* to be superior over the *NN* x *RHR*, *NN* x *CR* and *NN* x *GR* crosses in terms of body weight and immunocompetence.

Anonymous, (2006) evaluated the comparative performance of Raja II with seven other commercial broilers at Random Sample Test Centre, Gurgaon. The average live weight of Raja II at sixth and seventh week of age was 1.28 and 1.71 kg respectively.

El-Safty *et al.,* (2006) evaluated immunological traits of two genotypes, (heterozygous naked neck and normally feathered) of chicken under low ambient temperature, and found that Nana hens had heavier body weight and slightly higher body temperature as compared to *nana* one. The results indicated that the nana birds were more stressed than *Nana* counterparts.

Norris *et al.,* (2007) estimated and compared the growth curve parameters of indigenous Venda and Naked Neck chickens from day-old to 21 weeks of age. Two hundred chickens (100 of each breed) were used, and found breed differences in the growth parameters of chickens. The Venda breed was observed to be late maturing and heavier at maturity while the Naked Neck was shown to have a higher growth rate, reaching maturity earlier but attaining a lighter mature weight.

Chatterjee *et al*., (2007) studied the growth performance of two Indian native chicks namely, Kadaknath and Aseel and found that the body weight was significantly higher at all periods in Aseel than Kadaknath.

Chatterjee *et al*., (2007) evaluated the growth performance of different crosses of Brown Nicobari with White Leghorn under intensive and extensive management systems in Andaman, India and found that the body weights of the progeny of direct and reciprocal crosses of Brown Nicobari with ILI-80 under intensive management were significantly higher than the body weight of the progeny of both direct and reciprocal crosses under backyard management at 8, 10, 12 and 14 weeks of age.

Kumaresan *et al*., (2008) analyzed village chicken production system and performance of improved dual purpose chickens (vanaraja) under a subtropical agro-ecosystem in India. They observed that the vanaraja birds weighed 623 g at six weeks of age under standard management conditions.

Doley *et al.,* (2009) evaluated the productive performance of indigenous chickens of North-Eastern region of India under intensive, semi-intensive and extensive systems and found significant differences in body weight at different stages of growth

Momoh *et al.,* (2010) evaluated the performance of the heavy and light chicken ecotypes and their crosses for growth traits under standard management conditions and found significant differences in body weight and FCR among the genetic groups. Their study demonstrated that local chickens were less efficient in feed utilization compared to other genetic groups.

Feed intake and feed efficiency ratio

Bordas *et al.* (1978) reported lower feed efficiency in the homozygous naked neck birds as compared to normal neck feathered birds reared at 31º C up to ten weeks of age.

Monnet *et al.,* (1979) reported higher feed intake and lower feed efficiency for Na/Na than *Na/na* and *na/na* genotypes reared at normal ambient temperature. Similarly, higher efficiency of feed utilization was observed in *Na/Na* genotypes at high temperatures (31ºC).

Hanzal and Somes, (1983) reported that the feed efficiency in naked neck birds tended to deteriorate as compared with that of their normal feathered counterparts at moderate temperatures. On the contrary, efficiency of feed utilization was slightly better for naked neck birds when reared at 38º C of ambient temperature.

Zein-el-dein *et al.,* (1984) observed slightly better feed conversion ratio in naked neck compared to normal feathered birds at 29º C, but the difference was not significant. The advantage was more marked when birds were fed with diets containing low protein.

Mathur and Horst, (1990) reported that the *Na* and *F* genes, together, improved the feed efficiency of the commercial broilers under heat stress.

Barua *et al.,* (1992) reported that the Rhode Island Red (*RIR*) x Naked Neck (*NaNa*) crossbred showed better feed conversion compared to White Leghorn (*WL*) x Naked Neck (*NaNa*) crossbreds. *RIR* x *NaNa* crossbred showed better feed conversion ratio of 6.19 as against 6.35 for *WL* x *NaNa* upto 25 weeks of age.

Cahaner *et al.,* (1993) observed increased feed intake in *Na/Na* birds, but the feed intake was lower relative to their growth rate, resulting in better cumulative feed efficiency at both sixth and eighth week of age.

Eberhart and Washburn, (1993) reported that the naked neck birds consumed 6.5 percent more feed than that of normal feathered birds. However, the feed efficiency was five percent less as compared to normal feathered birds reared at 32º C ambient temperature.

Haque and Howlider, (2000) compared the growth performance of indigenous naked neck (NN) and their crosses with Rhode Island Red (RIR), Fayoumi (Fy) and White Leghorn (WL) and observed superior feed efficiency in all the crossbreds i.e., in *NN* x *RIR* followed by *NN* x *Fy* and *NN* x *WL* birds at 17 weeks of age. The total feed intake and feed conversion ratio for *NN* x *RIR*, *NN* x *Fy* and *NN* x *WL* crosses from zero to seventh weeks of age were 5950 g and 5.1, 5557 g and 5.3 and 5890 g and 5.3 respectively.

Anonymous, (2006) reported feed efficiency of 2.25 for Raja II at sixth week of age.

Mortality

According to Rauen, (1985) mortality among adult birds does not differ between naked neck and normally feathered genotype at temperatures around 20º C. At 30º C or more, however, mortality was lower among heterozygous naked neck hens than among normal feathered birds.

Berrio *et al.,* (1987) observed less frequent cannibalism among birds with the naked neck gene and this trait may also contribute to their survival rate.

Fraga *et al.,* (1994) who made a comparison of heterozygous naked neck and commercial birds during the 360 days of laying period, observed a mortality rate of 12.5 percent in NaNa and 31.3 percent in Local birds.

Alam *et al.,* (1995) reported significantly higher mortality rate in commercial broilers (6 %) than in naked neck Australorp birds (2.4 %), when reared in a hot and humid environment which is similar to the result reported by Hossain *et al.,* (1991) and supports the findings of Bohren *et al.,* (1982).

Haque and Howlider, (2000) observed lowest mortality in Naked neck x Rhode Island Red and Neck neck x White Leghorn crossbreds than the pure breeds and Naked neck x Fayoumi crossbred, indicating higher survivability in naked neck genotype.

El-Safty *et al.,* (2006), evaluated immunological traits of two genotypes (heterozygous naked neck and normally feathered) of chicken under low ambient temperature, Further, they recorded higher mortality and culling rate in normal plumage hens, than heterozygous naked neck hens.

Anonymous, (2006) recorded 7.66 percent mortality in Raja II genotype during the period of 0-7 weeks.

Material and Methods

III. MATERIALS AND METHODS

A biological experiment of eight week duration was carried out at The Department of Poultry Science, Veterinary College, KVAFSU, Hebbal, Bangalore. The experiment was conducted to evaluate comparative growth performance, organs weights, certain haematological parameters and Immune responses in birds developed for low input technology.

Materials and methods employed for the present study are briefed under the following headings.

3.1 Materials

3.1 Collection of Experimental samples

3.1.1 Procurement of experimental birds.

3.1.2 Procurement of Vaccines

3.2 Experimental design

3.2.1 Randomization

3.2.2 Experimental care

3.2.3 Vaccination Regime

3.3 Growth parameters

3.3.1 Body weight

3.3.2 Feed consumption

3.3.4 Feed efficiency

3.3.5 Livability

3.4 Heamatological parameters

3.4.1 Hemoglobin (Hb)

3.4.2 Packed Cell Volume (PCV)

3.4.2 Total leukocyte count (TLC)

3.4.4 Differential leukocyte counts (DLC)

3.5 Immunological parameters

3.5.1 Lymphoid organ weights (spleen, thymus and bursa)

3.5.2 Humoral immune response

3.5.3 Cell mediated response (CMI)

3.6 Statistics

3.1 Collection of experimental samples

3.1.1 Procurement of experimental birds

The three genetic groups of chickens used in this study, Giriraja, Swarnadhara and Raja II, were obtained from the lines developed and maintained at University Poultry Farm, Bangalore. The indigenous local cross chicks were procured from Central Poultry Development Organization, Hesserghatta. The indigenous stock has been maintained without any selection while the other groups had long term selection for 5 to 6 week body weight. These synthetic lines were developed for backyard farming in rural areas. They are known to thrive in adverse environmental conditions and are resistance to common diseases affecting poultry.

3.1.1.2 The brief history of genetic stocks is as follows:

Raja II: Raja II are commercial coloured broiler chicks obtained by crossing PB1 (male line) with PB2 (female line) hen. These parental lines were maintained since 1994 and have undergone direct selection for body weight at five weeks of age. The present chicks belong to the 13^{th} generation of selection.

Giriraja: Giriraja chicks were obtained from White Plymouth rock, Red Cornish and New Hampshire parent lines maintained at the Department of Poultry Science, KVAFSU, Bangalore. These parental lines were developed since 1989 and maintained as closed flock. These lines have good body conformation and multicoloured plumage pattern.

Swarnadhara: A synthetic strain resembling native fowl in plumage, was developed and released by Department of Poultry Science, Veterinary College, KVAFSU, Bangalore for rural backyard poultry rearing system. The strain has varied levels of germplasm besides a known level of indigenous germplasm with higher disease resistance. It has undergone several selections for egg production and plumage pattern. It is light in weight, multicoloured and possesses high egg production capacity.

3.1.2 Vaccines

The following commercially available vaccines were used in the present study.

Live F strain, Newcastle disease vaccine from Institute of Animal Health and Veterinary Biologicals, Bangalore.

Live Infectious Bursal Disease Vaccine of Intermediate Type strain from Venkateshwara Hatcheries Pvt. Ltd. Ventri Biologicals, Vaccine Division, Pune.

3.2 Experimental design

3.2.1 Randomization

A total of 240 chicks of both sexes (sixty from each of four genetic origins, Giriraja, Swarnadhara, Raja II and Local cross) produced in a single hatch, were wing banded and weighed. Each genetic group had six replicates with ten birds in each replicate. Twenty four pens were made and the replicates were randomly allotted using lottery method. All the experimental chicks were healthy and received normal routine health care.

3.2.2 Experimental care

The birds were reared under standard managemental conditions including lighting programme, feeding pattern, watering methods and other routine bio-security aspects. The experiment lasted for 8 weeks. All birds were fed with starter ration from day of hatching up to fourth week of age and with finisher ration from fifth week up to eighth week of age. Birds were provided with *adlibitium* feed and water throughout the experimental period.

The starter and finisher diets had 23and 20 percent of crude protein with 2800 and 2900 Kcal/kg ME respectively. Diets were formulated using maize and soybean meal. The experimental starter and finisher rations were formulated as per BIS (1992). The ingredient composition of diet and its calculated nutrient profile are presented in Table 3.1a and 3.1b.

3.2.3 Vaccination Regime

Chicks were vaccinated against ND on 7th day with F strain vaccine by occulonasal route and IBD, (intermediate strain) on 18th day by occular route.

3.3 Growth Performance parameters

The data on the growth performance parameters viz., body weight, feed consumption, feed efficiency and liveability during the course of the experiment was collected as follows.

3.3.1 Body weight

Individual body weights were recorded at the beginning of the experiment and further body weight were recorded at the end of each week to monitor the pattern of body weight changes. Group wise average weights under different treatments were arrived. The weighing of the birds was done in the early hours of the day before feeding.

3.3.2 Feed consumption

The daily required amount of the feed was weighed and offered to the each replicate group. The feed consumption in each replicate was recorded weekly by subtracting the weight of residual feed from the total quantity of feed supplied during the respective week.

3.3.3 Feed conversion ratio

The feed conversion ratio (FCR), expressed as the relationship of amount of feed consumed to the body weight gain under each group of birds was determined. The FCR data was calculated by using following formula,

$$\text{Feed conversion ratio} = \frac{\text{Average feed consumption per bird during the week (Kg)}}{\text{Average weight gain per bird during the week (Kg)}}$$

3.3.4 Livability

Mortality in respective group was recorded as and when the birds died. Mortality and morbidity percentage in each group during the course of the experiment was recorded.

3.4 Haematological parameters

3.4.1 Haemoglobin

Haemoglobin was estimated using acid haematin method (Sahli's procedure) and expressed in gram percent. It was carried out from blood samples collected from all the 4 treatments on 56th day of experiment

3.4.2 Packed cell volume (PCV)

PCV was determined using Microhaematocrit method using Microhaematocrit reader.

3.4.3 Total leukocyte count (TLC)

TLC was carried out from blood samples collected from all the 4 treatments on 56th day of experiment, as per the method of Nambiar, (1960).

3.4.4 Differential Leukocyte count (DLC)

DLC was carried out as per Nambiar, (1960) using blood samples collected from all the four groups on 56th day of experiment.

3.5 Immunological parameters

3.5.1 Lymphoid organ weight (spleen, thymus and bursa)

At the end of eight weeks, two birds from each replicate were sacrificed. Spleen, thymus and bursa of Fabricia were removed from the bird and weighed on digital top pan electronic balance. The weights were recorded and expressed as gram percent of live weight of birds (g/100g body weight) and the group means were calculated.

3.5.2 Humoral immune response

Five ml of blood was collected from two birds in each replicates on fortnightly basis by venipuncture of brachial vein using hypodermic syringe with 20-23 gauge needle. After collection of the blood into the test tubes, it was kept in slanting position and left at room temperature, for 2-3 hours in order to separate serum from blood cells. The serum samples were then transferred to Eppendorf tubes and marked with the collection date, tag number and then stored at –20ºC until further use. The samples were analysed by the ELISA and Haemagglutination Inhibition (HI) test to assess the antibodies, levels.

3.5.2.1 Haemagglutination Inhibition (HI) Test

Haemagglutination inhibition test was used to evaluate humoral immune response. Materials required were:

a. Normal saline (0.85%)
b. 0.8 % chicken erythrocyte suspension
c. Microplates

d. Diluters and droppers.

e. Serum samples

f. NDV antigen - 4 HA units.

The micro-test method described by Allan and Gough, (1974) was used for detection of HI titers from serum samples collected at fortnightly intervals, post immunization of birds. The HI test was done manually by β- procedure in 'U' bottom micro-plates using diluters, droppers and 4 HA units of ND viral antigen.

Serial two fold dilution of serum in normal saline was taken and 25 µl per well 4 HA unit of antigen was added. Plates were incubated for 45 minutes at room temperature. Fifty µl of 0.8 percent erythrocytes were added to each well and the plates were incubated for one hr at room temperature before reading results. The titers were expressed as the reciprocal of highest dilution of serum showing the haemagglutination inhibition or button formation.

3.5.3 ELISA (Enzyme Linked Immunosorbent Assay)

Enzyme-linked-immunosorbent serologic assay was performed for assessing antibody titre against IBD Vaccine. The protocol of ELISA for assaying antibody activity was as per the manufacturer's instructions of ELISA Kits from SYNBIOTICS CORPORATION, San Diego, Canada.

3.5.4 Cell mediated immune response (CMI)

Assay of CMI using 2, 4-Dinitrochlorobenze (DNCB):

DNCB, a chemical "contact sensitizer" was used to measure the strength of the immune system. The greater the skin reaction to DNCB, and the faster it shows up, the

stronger the immune response. Cutaneous hypersensitivity test was performed as per Haribabu *et al.,* (1993) with slight modification. Interdigital skin space between the third and fourth digit as suggested by Corrier (1990) was chosen as the site for injecting 2,4-DNCB.

Materials required are

a. 1 % DNCB in acetone

b. Vernier's calipers

DNCB test was performed at the end of the experiment i.e., 8^{th} week. Twelve birds from each treatment were randomly selected and were sensitized at the foot web by using 0.1ml of 1 percent DNCB which was injected to two birds in each replicate, Intradermally at inter digital space between 3^{rd} and 4^{th} digit of right leg using 1ml tuberculin syringe. This was allowed to dry immediately by blowing air so as to prevent the solution running down the sides. The thickness of the foot web at that site was measured using digital slide calliper at (0 hr) and after (24, 48 and 72) hrs of post inoculation.

3.6 Statistical analysis

Data obtained for each of the parameters were analyzed statistically by using the Standard General Linear Model procedure of Statistical Analysis System (SAS®) software (SAS Institute, USA, 1998). The treatment means with significant differences at $P \leq 0.05$ were compared using Duncan's multiple range test (Duncan, 1955).

Table 3.1a: Composition of broiler starter and finisher diets

Ingredients (%)	**Broiler starter**	**Broiler finisher**
Yellow maize	54	63
Soyabean meal	42	33
[1]Mineral mixture	2	2
DCP	1	1
Salt	0.4	0.4
DL-Methionine	0.2	0.2
[2]Vit AB_2D_3K	0.025	0.02
[3]Vit B complex	0.030	0.030
[4]Dicirol	0.005	0.005
[5]Hepatocare	0.015	0.02
[6]Colidox	0.05	0.05
[7]Coccidiostat	0.05	0.05
[8]Biocare	0.05	0.05
[9]Ecarese	0.04	0.04

Table 3.1b: Computed Nutrient composition of broiler starter and finisher diets

Metabolizable energy KCal/ Kg	2832	2904
Crude protein (%)	23.34	20.19
Lysine (%)	1.45	1.18
Methionine (%)	0.58	0.53
Calcium (%)	1.18	1.19
Phosphorus (%)	0.53	0.51

[1] Mineral Mixture: Contains calcium–32%, phosphorus-6%, copper-100 ppm, cobalt-60 ppm, manganese-2700 ppm, iodine-100 ppm, zinc-2600 ppm, and iron-0.1%.

[2] Vit.AB_2D_3K: Per gram contains Vit. A-82, 500 IU, D_3-12,000 IU, B_2-50 mg and K-10 mg

[3] B-complex: Per gram contains Vit B_1-4 mg, B_6-8 mg, B_{12}-40 g, E-20 mg, Niacin-60mg.

[4]Dicirol (g): Each gram contains Cholecalciferol (Vit D_3)-600000 I.U.

[5]Hepatocare (g): Contains Tricholine Citrate, Protein hydrolysate, B_{12} , Vitamin E and Biotin.

[6]Colidox (g): Each gram contains Colistin Sulphate- 1000 mg, Doxycycline-10000 mg.

[7]Coccidiostat (g): Contains Maduramicin Ammonium 1% w/w

[8]Biocare (g): Each 50g contains Biotin (Vit H)- 20 mg.

[9]Ecarese (g): Each 200g contains Vitamin E-20g, Selenium-200ppm.

Results

IV. RESULTS

The findings of the experiment of 56 days duration on comparative growth performance, organs weights, certain haematological parameters and Immune responses in low input chickens conducted at the Department of Poultry Science, Veterinary College, Bangalore, are presented in this chapter under the following headings.

4.1 Growth parameters

4.1.1 Body weight

4.1.2 Feed consumption

4.1.3 Feed efficiency

4.1.5 Livability

4.2 Haematological parameters

4.2.1 Haemoglobin (Hb)

4.2.2 Packed Cell Volume (PCV)

4.2.3 Total leukocyte count (TLC)

4.2.4 Differential leukocyte counts (DLC)

4.3 Immunological parameters

4.3.1 Lymphoid organ weights (spleen, thymus and bursa)

4.3.2 Humoral immune response

4.3.3 Cell mediated immune response (CMI)

4.1 Growth parameters

4.1.1 Body weights

The average weekly body weights (g) of experimental chicks of four genetic groups recorded during the experimental period of 56 days are presented in Table 4.1a and Graphically depicted in Figure 4.1. The analysis of variance revealed significant difference ($P \leq 0.05$) in body weight among genetic stocks at all weeks of age.

First week

The respective means of body weight at first week of age for Giriraja, Swarnadahara, Raja II and Local chicks was 108, 105, 109 and 73g respectively. The highest body weight at first week of age, among various genetic groups was recorded in Raja II (109g) and the lowest of 73g in Local group. No significant differences in body weight existed among Giriraja, Swarnadahara and Raja II groups. The body weight was significantly ($P \leq 0.05$) lower in Local birds compared to other genotypes.

Second week

The mean of second week body weights of Giriraja, Swarnadahara, Raja II and Local genotypes were 227, 227, 242 and 139g respectively. The Raja II chicks were significantly ($P \leq 0.05$) heavier than Giriraja, Swarnadhara or Local counterparts. However, no significant difference in body weight existed between Giriraja and Swarnadhara groups. The body weights of Local chicks (139g) were significantly lower as compared to other genotypes.

Third week

The respective means of body weights at third week of age for Giriraja, Swarnadahara, Raja II and Local chicks were 413, 397, 435 and 225g. Among various genetic groups, highest body weight was recorded in Raja II (435g) where as lowest body weight of 225g was observed in Local group. As observed in previous week, no significant difference in body weight existed between and groups. While body weight of Raja II genetic group was significantly ($P \leq 0.05$) higher as compared to body weights of all other genotypes. Significant ($P \leq 0.05$) lower body weight existed in birds of Local group.

Fourth week

The means of fourth week body weights for Giriraja, Swarnadahara, Raja II and Local bird group were 645, 620, 717 and 347g respectively. The average fourth week body weight of birds were significantly ($P \leq 0.05$) different with lowest weight of 347g being recorded in local chicks as against the highest of 717g in Raja II genotype. There was no significant difference ($P \leq 0.05$) between Giriraja and Swarnadhara genotypes for body weight. The body weight of genetic group, Raja II showed significantly ($P \leq 0.05$) higher body weights as compared to other genotypes.

Fifth week

The respective means for body weight at fifth week of age for Giriraja, Swarnadahara, Raja II and Local groups were 869, 871, 1011 and 487g. The body weight at fifth week of age, was highest in Raja II group (1011g), where as the lowest body weight of 487g was recorded in Local group. As observed in previous weeks, no

significant difference in body weight existed between birds of Giriraja and Swarnadhara groups. Chicks of Raja II genetic stock weighed significantly higher ($P \leq 0.05$) as compared to all other genetic stocks. Whereas chicks of Local genotype weighed significantly lower when compared with other genetic stocks.

Sixth week

The mean body weights at sixth week of age for Giriraja, Swarnadahara, Raja II and Local group were 1097, 1102, 1266 and 636g respectively. The same trend as observed in previous weeks was also noted in sixth week body weight among four genetic groups.

Seventh week

The average body weights at seventh week of age for Giriraja, Swarnadahara, Raja II and Local groups were 1423, 1409, 1678 and 802g respectively. The same trend as observed in previous weeks was also noted in Sixth and Seventh week body weights among four genetic groups.

Eighth week

Comparisons among four genotypes for eighth week weights revealed significant ($P \leq 0.05$) differences with highest weight of 2017g being recorded in Raja II genotype group. The body weight at different periods varied considerably among genotypes. The respective means for Giriraja, Swarnadahara, Raja II and Local genotypes were 1695, 1696, 2017 and 945g. No significant difference in body weight was observed between chicks of Giriraja and Swarnadahara genotypes.

Table 4.1 a: Means and standard error of weekly body weights (g) of different genotypes (Giriraja, Swarnadhara, Raja II and Local bird).

Genotype	WEEK (g)							
	I	II	III	IV	V	VI	VII	VIII
Giriraja	108.33±1.0[a]	227.47±2.88[b]	413.26±05.53[b]	645.33±10.20[b]	869.21±14.01[b]	1097.84±17.43[b]	1423.34±24.93[b]	1695.40±29.32[b]
Swarnadhara	105.58±1.48[a]	227.42±3.67[b]	397.63±06.05[b]	620.60±10.16[b]	871.16±14.15[b]	1102.23±17.23[b]	1409.16±24.05[b]	1696.19±36.67[b]
Raja II	109.82±1.88[a]	242.88±4.66[a]	435.02±10.54[a]	717.21±16.00[a]	1011.07±21.99[a]	1266.18±23.69[a]	1677.79±32.18[a]	2017.37±32.09[a]
Local	73.88±1.12[b]	139.90±2.91[c]	225.72±04.28[c]	347.22±06.43[c]	487.91±09.33[c]	636.24±12.51[c]	802.26±15.52[c]	945.37±15.97[c]

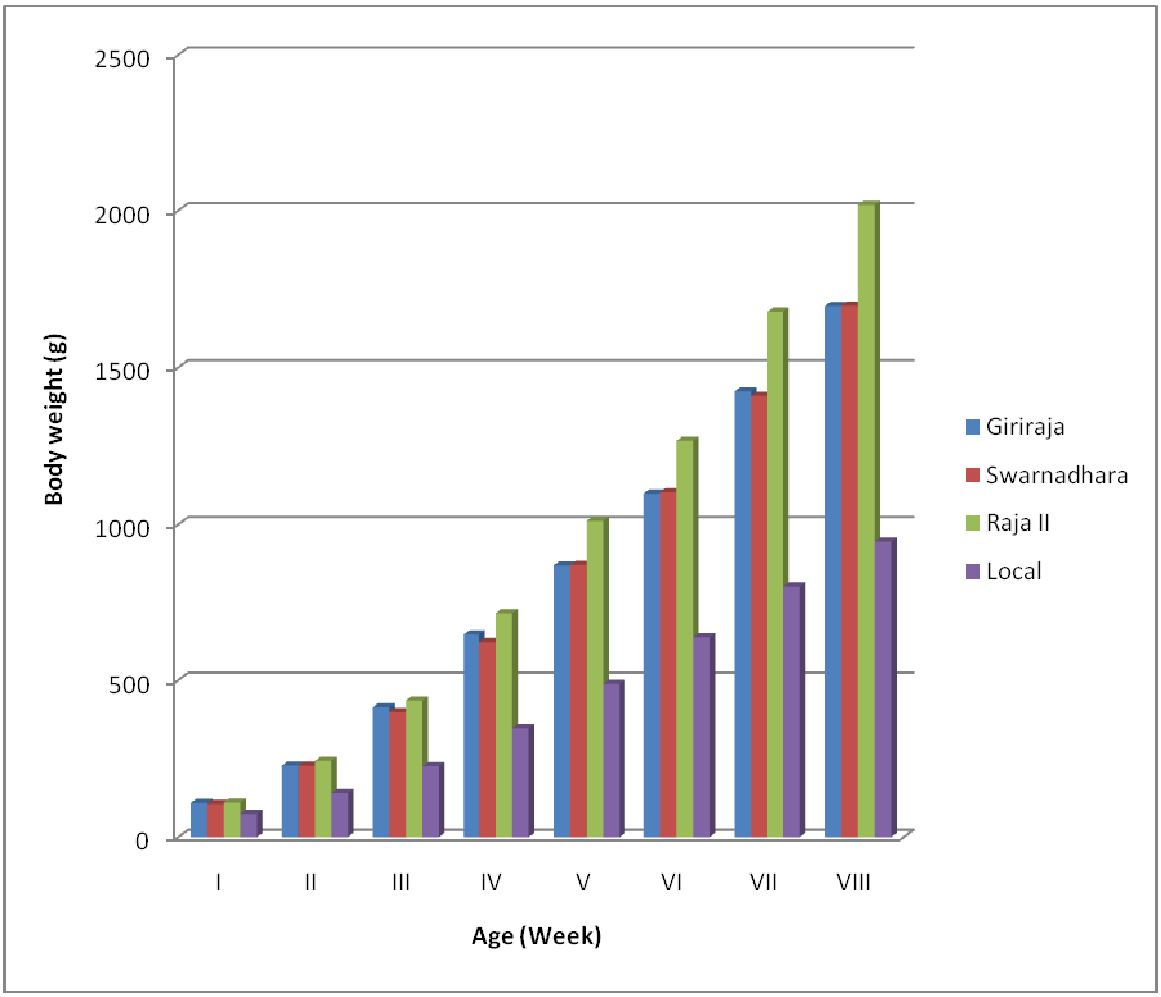
Means bearing at least one common superscript column wise do not differ significantly (P≤0.05)

Table 4.1b: Mean Square from analysis of variance for weekly body weights.

Week	Source of variation	Degrees of freedom	Mean squares	F value
I	**Treatments**	3	17028.04	125.59 *
	Error	229	135.58	
II	**Treatments**	3	128292.90	167.67 *
	Error	229	765.16	
III	**Treatments**	3	535965.30	185.49 *
	Error	228	2889.40	
IV	**Treatments**	3	1463120	202.2 *
	Error	223	7235.89	
V	**Treatments**	3	2808288	202.64 *
	Error	223	13858.67	
VI	**Treatments**	3	4038650	213.85 *
	Error	222	18885.70	
VII	**Treatments**	3	7596576	213.59 *
	Error	222	35565.38	
VIII	**Treatments**	3	11374770	226.47 *
	Error	222	50225.95	

*** –Significant (P≤0.05)**

Figure 4.1: Weekly Body weights (g) of Giriraja, Swarnadhara, Raja II and Local genotypes



4.1.2 Feed consumption

The data on average weekly feed consumption (g) of different genetic groups at various ages are presented in Table 4.2a and Graphically depicted in Figure 4.2. The statistical analysis revealed significant ($P \leq 0.05$) differences among various genotypes during all ages.

At the end of first week, the mean feed consumption among various genotypes ranged from 46 g/bird in Local to 54 g/bird in Giriraja group. Local genotype, showed a significant ($P \leq 0.05$) reduction in feed consumption as compared to all other genetic groups. However, there was no significant difference in feed consumption among Giriraja, Swarnadahara and Raja groups.

At second week of age, the feed consumption recorded was highest in Raja II genetic group (170g) as against lowest observed in local group (100g). Chicks of Raja II genotype (170g) consumed significantly ($P \leq 0.05$) higher feed as compared to other genotypes. Whereas, no significant difference existed between Giriraja (137g) and Swarnadhara (141g) genotypes and remained significantly different with Raja II and Local genotypes.

At third week of age, the feed consumption was higher in Raja II genotype (408g) as against lowest observed in Local genotypes (205g). Local genetic group consumed significantly ($P \leq 0.05$) less feed consumption as compared to other genetic groups. Statistical analysis revealed significant ($P \leq 0.05$) difference in feed intake among genetic stocks.

The mean feed consumption at the end of fourth week ranged from 342g/bird in Local to 478g/bird in Raja II genotypes. Analysis of variance revealed that there was no significant ($P \leq 0.05$) difference in feed consumption among Giriraja, Swarnadahara and Raja II genotypes and remained significant with Local genotype. The respective means for Giriraja, Swarnadahara, Raja II and Local were 440, 432, 478 and 342 g/bird.

The highest feed consumption at fifth week of age among various genotypes was recorded in Raja II group (638g) as against lowest observed in Local genotype (457g/bird). Among various genetic groups, Giriraja and Swarnadahara groups showed non-significant difference, but Local genotype consumed significantly ($P \leq 0.05$) less feed as compared to other genetic genotypes.

The mean feed consumption at the end of sixth week of age ranged from 499g/bird in Local to 723g/bird in Raja II group. Statistical analysis revealed that there was no significant difference in feed consumption among Giriraja, Swarnadahara and Raja II genotypes but remained significantly ($P \leq 0.05$) different with Local group. The means for Giriraja, Swarnadahara, Raja II and Local genotypes were 667, 654, 723 and 499g/bird, respectively.

The average feed consumption at the end of seventh week under different genotypes differed significantly ($P \leq 0.05$). The highest feed consumption was recorded in Raja II genotype (857g) as against lowest observed in Local genotype (593g). The respective means for Giriraja, Swarnadahara, Raja II and Local genotypes were 765, 761, 857 and 593g/bird. There was no significant difference ($P \leq 0.05$) in

Table 4.2a: Means and standard errors of weekly cumulative feed consumption (g/bird) in chicks of different genotypes (Giriraja, Swarnadhara, Raja II and Local bird).

Genotype	WEEK (g)							
	I	II	III	IV	V	VI	VII	VIII
Giriraja	54.25±3.09^{a}	137.92±06.98^{b}	349.50±22.02^{b}	440.51±24.32^{a}	568.65±24.01^{ab}	667.15±28.95^{a}	765.08±25.91^{b}	815.41±32.68^{b}
Swarnadhara	47.90±1.73^{ab}	141.05±07.26^{b}	297.72±13.83^{c}	432.94±20.12^{a}	543.21±24.95^{b}	654.41±33.11^{a}	761.01±20.54^{b}	836.10±19.98^{ab}
Raja II	53.78±1.57^{a}	170.68±03.20^{a}	408.76±09.68^{a}	478.17±15.86^{a}	638.50±32.25^{a}	723.45±27.64^{a}	857.41±12.22^{a}	884.46±18.11^{a}
Local	46.72±1.57^{b}	100.15±15.39^{c}	205.71±14.59^{d}	342.04±18.19^{b}	457.67±20.71^{c}	499.43±17.45^{b}	593.22±13.47^{c}	629.70±21.99^{c}

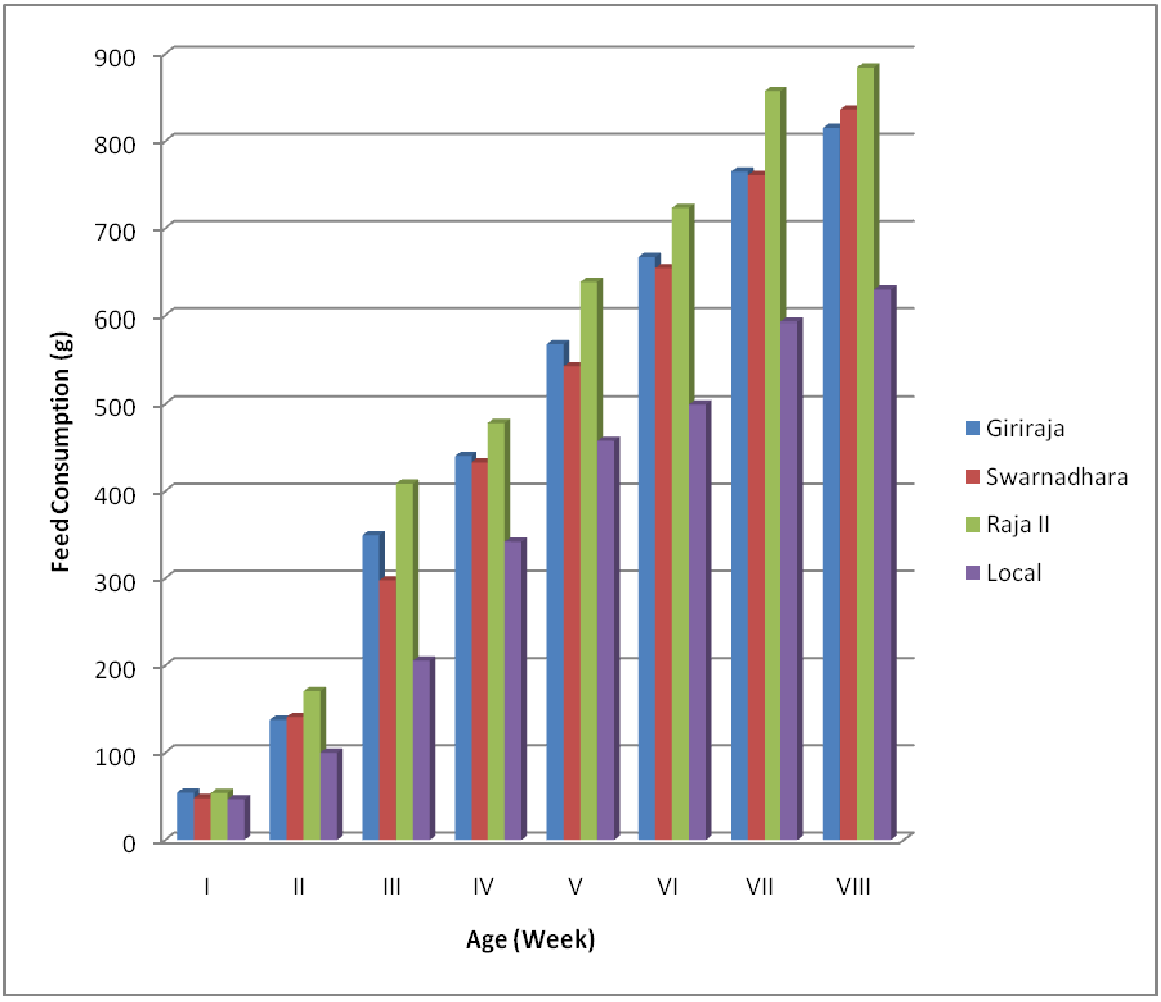
Means bearing at least one common superscript column wise do not differ significantly (P≤0.05)

Table 4.2b: Mean squares from analysis of variance from weekly cumulative feed consumption per bird

Week	Source of variation	Degrees of freedom	Mean squares	F value
I	Treatments	3	91.70	3.50 *
	Error	20	26.18	
II	Treatments	3	5018.06	9.60 *
	Error	20	522.71	
III	Treatments	3	44446.13	30.16 *
	Error	20	1473.85	
IV	Treatments	3	20006.20	9.80 *
	Error	20	2042.19	
V	Treatments	3	33472.11	8.36 *
	Error	20	4002.63	
VI	Treatments	3	55214.22	12.26 *
	Error	20	4504.79	
VII	Treatments	3	72657.96	34.02 *
	Error	20	2135.77	
VIII	Treatments	3	74764.60	25.54 *
	Error	20	2927.24	

***-Significant**

Figure 4.2: Weekly cumulative Feed consumption of Giriraja, Swarnadhara, Raja II and Local genotypes.



feed consumption between Giriraja (765g/bird) and Swarnadhara (761g/bird) genotypes and remained significantly different (P≤0.05) with Raja II and Local genetic stocks.

The respective means of feed consumption at eight week of age for Giriraja, Swarnadahara, Raja II and Local genotypes were 815, 836, 884 and 629g/bird. The highest feed consumption was recorded in Raja II (884g/bird) genotypes as against lowest observed in Local genotype (629g/bird). Analysis of variance revealed no significant difference (P≤0.05) in feed intake among Giriraja, Swarnadahara and Raja II genetic stocks. Whereas chicks of Local genotype (629g/bird) consumed significantly less feed as compared to other genotypes.

4.1.3 Feed conversion ratio

The efficiency of feed utilization of different genetic stocks from first to eight week of age are presented in Table 4.3a and Graphically depicted in figure 4.3. The analysis of variance showed significant (P≤0.05) difference in feed conversion ratio values among all genetic groups at all ages.

The feed efficiency values at first week of age were better in Swarnadhara genotype (0.45) among various genetic stocks. Whereas a poor feed efficiency was observed in Local genotype (0.63). The feed conversion ratios were not significantly different among Giriraja, Swarnadahara and Raja II but remained significantly (P≤0.05) different with Local genetic stock.

At second week of age, the FCR values ranged from 0.83 in Swarnadahara to 1.04 in Local genotypes. Statistical analysis revealed no significant difference ($P \leq 0.05$) between Giriraja and Swarnadahara and between Raja II and Local genotypes.

At third week of age, the efficiency of feed utilization was found to be best in Swarnadahara genotype (1.22) as compared to other genetic stocks. The efficiency of feed utilization was least in Local genotype (1.56). As observed in previous week, there was no difference in FCR values between the chicks of Giriraja and Swarnadahara genotypes. Similarly, the feed efficiency values remained non-significant ($P \leq 0.05$) between genetic groups, Raja II and Local and remained significantly ($P \leq 0.05$) different with chicks of Giriraja and Swarnadahara genotypes.

The feed conversion ratio at fourth week of age was found to be best in Swarnadahara genotype (1.48) and a poor feed conversion value was observed in Local genotype (2.06). The efficiency of feed utilization was significantly ($P \leq 0.05$) poor in chicks of Local group when compared with chicks of other genetic stocks. The efficiency of feed utilization of Giriraja, Swarnadahara and Raja II genotypes were significantly ($P \leq 0.05$) better than that of Local ones. However, no significant differences in feed conversion ratio existed among Giriraja, Swarnadahara and Raja II genotypes.

The feed conversion ratio at fifth week of age was found to be best in Raja II genotype (1.67) among various genetic stocks whereas a poor feed conversion value was observed in Local genotype (2.40). The efficiency of feed utilization was

Table 4.3a: Means and standard errors of weekly feed conversion ratio in chicks of different genotypes (Giriraja, Swarnadhara, Raja II and Local bird).

Genotype	WEEK							
	I	II	III	IV	V	VI	VII	VIII
Giriraja	0.52±0.04[b]	0.85±0.02[b]	1.30±0.04[b]	1.51±0.02[b]	1.77±0.03[b]	2.02±0.04[b]	2.09±0.05[b]	2.24±0.04[b]
Swarnadhara	0.45±0.01[b]	0.83±0.03[b]	1.22±0.04[b]	1.48±0.04[b]	1.68±0.02[b]	1.92±0.04[b]	2.04±0.03[b]	2.18±0.06[b]
Raja II	0.49±0.02[b]	0.93±0.04[a]	1.40±0.07[a]	1.51±0.06[b]	1.67±0.06[b]	1.95±0.07[b]	1.98±0.07[b]	2.08±0.11[b]
Local	0.63±0.02[a]	1.04±0.01[a]	1.56±0.11[a]	2.06±0.12[a]	2.40±0.09[a]	2.59±0.12[a]	2.79±0.13[a]	3.04±0.10[a]

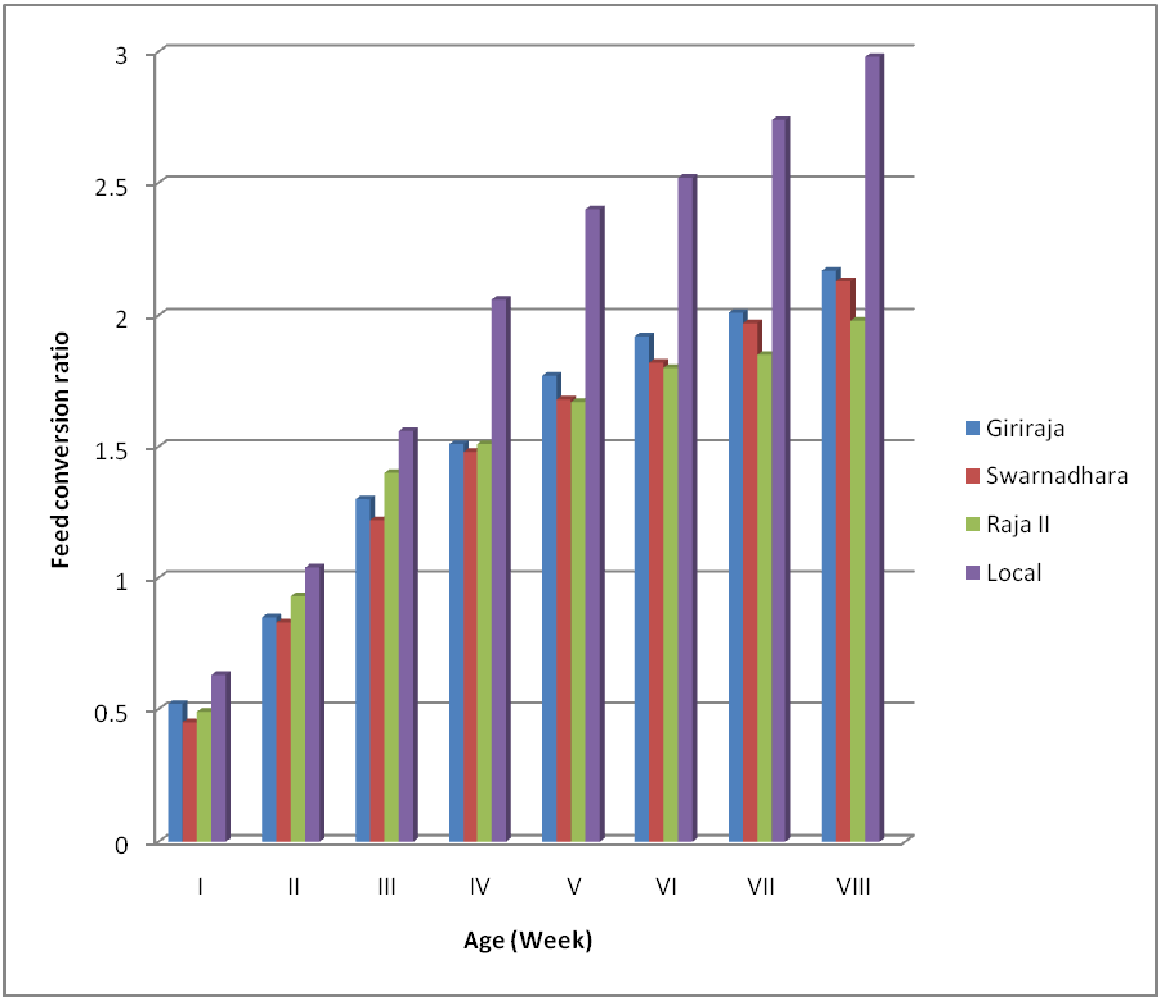
Means bearing at least one common superscript column wise do not differ significantly (P≤0.05)

Table 4.3b: Mean squares from analysis of variance for weekly feed conversion ratio

Week	Source of variation	Degrees of freedom	Mean squares	F value
I	**Treatments**	3	0.034	9.74 *
	Error	20	0.003	
II	**Treatments**	3	0.053	2.87 *
	Error	20	0.018	
III	**Treatments**	3	0.121	4.05 *
	Error	20	0.299	
IV	**Treatments**	3	0.461	15.75 *
	Error	20	0.029	
V	**Treatments**	3	0.736	38.24 *
	Error	20	0.019	
VI	**Treatments**	3	0.687	19.45 *
	Error	20	0.035	
VII	**Treatments**	3	0.985	26.35 *
	Error	20	0.037	
VIII	**Treatments**	3	1.238	30.03 *
	Error	20	0.041	

*** -Significant**

Figure 4.3: Weekly Feed conversion ratio of Giriraja, Swarnadhara, Raja II and Local genotypes



significantly (P≤0.05) poor in chicks of Local group when compared with chicks of other genetic stock. The efficiency of feed utilization of Giriraja, Swarnadahara and Raja II genotypes was significantly (P≤0.05) better than that of Local ones. However, there was no significant difference in feed conversion ratio among Giriraja, Swarnadahara and Raja II genotypes. Similar trend of feed conversion values among four genetic stocks were observed at sixth and seventh week of age.

At eight week of age, the feed conversion value was found to be best in Raja II group (2.08) among four genetic stocks. Whereas poor feed efficiency of 3.04 was observed in Local genotype. As observed in earlier weeks, there was no difference in feed conversion efficiency among Giriraja, Swarnadahara and Raja II genotypes but remained significantly (P≤0.05) better when compared with Local genotype.

4.1.4 Livability

The overall livability percentage for various genetic groups from zero to eight weeks is presented in Table 4.4 and Graphically depicted in Figure 4.4.

The percentage survivability of birds under different genetic groups ranged from 95.00 per cent (Swarnadhara, Raja II and Local genotype) to 96.67 per cent (Giriraja genotype).

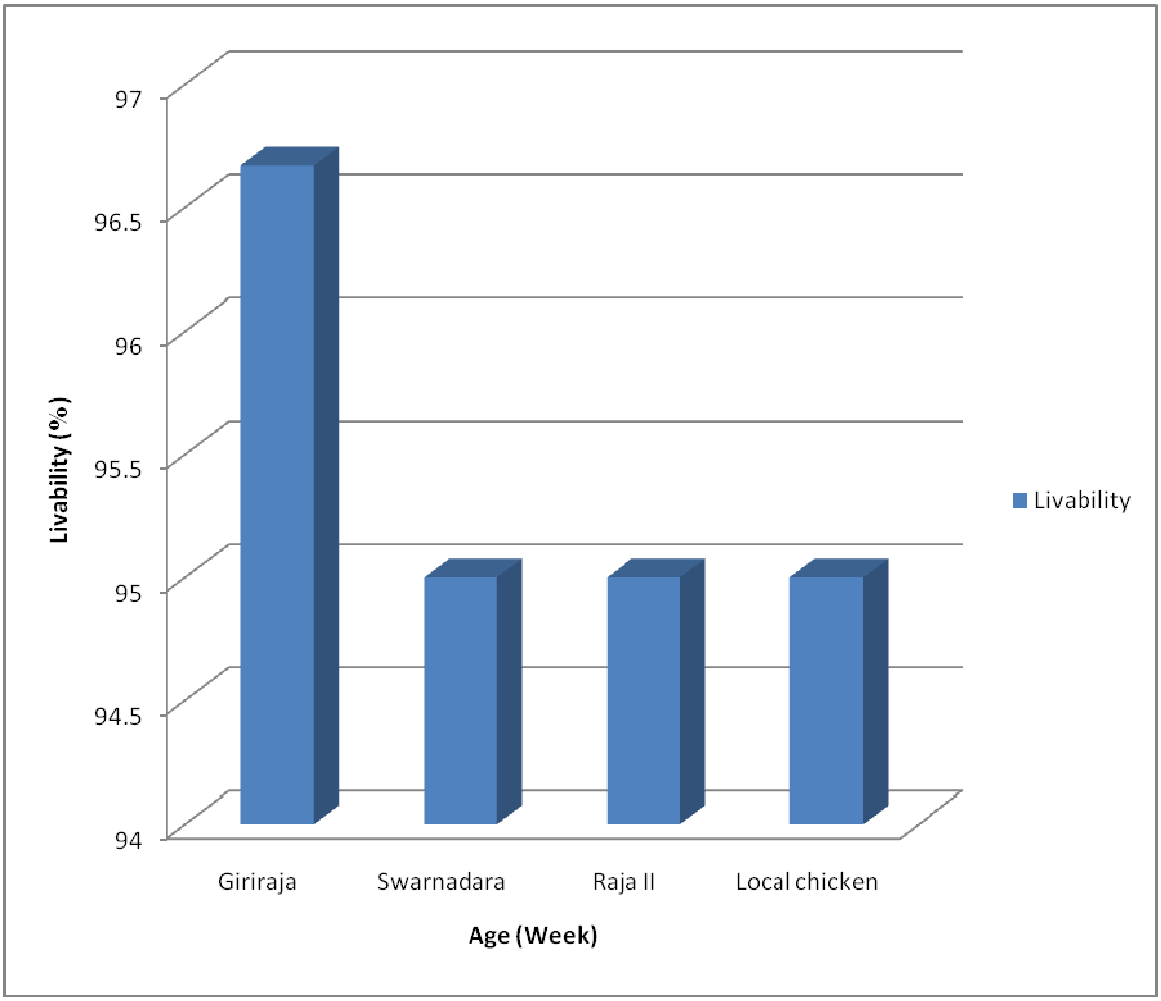
4.2 Haematological Parameters

The data on Haematological parameters in low input chickens are presented in Table 4.5a and Graphically depicted in Figure 4.5. Analysis of variance showed significant variations in mean Hb concentration, packed cell volume values, total

Table 4.4: Survivability percentage from 0–8 weeks in different genotypes (Giriraja, Swarnadhara, Raja II and Local bird).

Genotype	Survivability percentage (%)
Giriraja	96.67
Swarnadara	95.00
Raja II	95.00
Local chicken	95.00

Figure 4.4: Survivability percentage from 0-8 weeks in Giriraja, Swarnadhara, Raja II and Local genotypes



leukocyte counts and differential counts among different genotypes except for eosinophill count.

4.2.1 Haemoglobin concentration (g/dL)

The mean values of Hb ranged from 9.75 per cent in Giriraja to 10.5 per cent in Swarnadhara. Statistical analysis revealed that except for Giriraja, all other genotypes have significantly (P≤0.05) higher haemoglobin concentration as compared to Giriraja. However, Raja II had a similar (9.85 per cent) haemoglobin levels as compared to that of Giriraja which was 9.75 per cent. The Hb concentration of Swarnadhara (10.5 per cent) was significantly (P≤0.05) higher when compared to Giriraja genotype (9.85 per cent) and remained non-significant with Local genotype (10.20 per cent).

4.2.2 Packed cell volume

The data on packed cell volume values (percentage) in Low input chicken is presented in the Table 4.5a and Graphically depicted in the Figure 4.5. Analysis of variance revealed significant (P≤0.05) effect of treatments on packed cell volumes. The highest PCV value was recorded in the Swarnadhara group (34.1 per cent) as against the lowest value recorded in Giriraja group (31.4 per cent). Statistical analysis revealed that Swarnadhara, Raja II and Local genotype had significantly (P≤0.05) higher packed cell volume values as compared to Giriraja group. Swarnadhara genotype showed significantly higher PCV value when compared with Giriraja, Raja II and local birds. The PCV values were found non-significant among Giriraja, Raja II and local birds

4.2.3 Total leukocyte count

The data on total leukocyte counts for four low input chickens is presented in Table 4.5a and Graphically represented in Figure 4.6. Statistical analysis revealed

significant (P≤0.05) difference in total leukocyte counts among different genotypes. Among various genotypes, highest TLC value was recorded in Swarnadhara genotype ($17.9X10^3$) as against the lowest value recorded in Giriraja genotype ($16.9X10^3$). There was no significant difference in total leukocyte counts among Giriraja, Raja II and Local genotypes. Similarly, no statistical difference was observed among Swarnadhara, Raja II and Local genotypes. Swarnadhara genotypes had significantly (P≤0.05) increased total leukocyte count as compared to Giriraja group but remained non significant with Raja II and local genetic groups.

4.2.4 Differential leukocyte count

The results on differential leukocyte counts (per cent) in four genetic stocks is presented in Table 4.5b and Graphically depicted in Figure 4.7. Statistical analysis revealed significant (P≤0.05) effect of genotypes on white blood cell counts except for eoisinophils. Among various genotypes, highest percentage of heterophills was recorded in Swarnadhara genotype (59 per cent) as against the lowest count recorded in Giriraja genotype (57 per cent). The percentage of heterophills counts were found significantly (P≤0.05) higher in Swarnadhara genotype as compared to Giriraja genotype. Swarnadhara, Raja II and Local genotypes had significantly (P≤0.05) higher heterophill counts as compared to Giriraja genotypes but remained non significant among each other.

4.2.4.1 Eoisinophills

Eoisinophill counts (per cent) was found to be highest (2.5%) in Swarnadhara and Raja II genetic groups as against lowest value of 2 per cent recorded in Giriraja and Local

genetic groups. Analysis of variance showed non-significant (P≤0.05) difference in eoisinophill counts among various stocks.

4.2.4.2 Lymphocytes

The mean value of lymphocyte count ranged between 33.9 per cent in Giriraja to 34.9 per cent in Local group. Analysis of variance revealed significant (P≤0.05) differences in lymphocyte counts among various genetic stocks, Swarnadhara showed significantly (P≤0.05) higher lymphocyte count when compared to Giriraja group (34 per cent) and remained non-significant with Raja II and Local chicken genotypes. Whereas Raja II (34 per cent) and Local (34 per cent) genotypes showed similar counts compared to Giriraja (34 per cent). There was no significant difference in lymphocyte counts among Giriraja, Raja II and Local birds.

4.2.4.3 Monocytes

The mean value of Monocyte count ranged between 3.4 per cent in Local chicken to 6.6 per cent in Giriraja group. Analysis of variance revealed significant (P≤0.05) differences on Monocytes count. Among the various genotypes, Swarnadhara showed significantly (P≤0.05) lower monocyte count when compared to Giriraja group (6.6 per cent) and remained non-significant with Raja II (3.90 per cent) and Local chicken (4.30 per cent) genetic stock. The monocyte count was significantly higher in Giriraja group but remained non-significant with Raja II and Local chicken. No significant differences were observed in monocyte count among Swarnadhara, Raja II and Local chicken genotype.

Table 4.5a: Means and standard errors of Haematological parameters pertaining to different genotypes (Giriraja, Swarnadhara, Raja II and Local bird)

Genotype	Haematological Parameters		
	Hb (%)	PCV (%)	TLC (10^3)
Giriraja	09.75 ± 0.05^{a}	31.4 ± 0.40^{a}	16.9 ± 0.10^{a}
Swarnadhara	10.50 ± 0.05^{bc}	34.1 ± 0.05^{b}	17.9 ± 0.10^{bc}
Raja II	09.85 ± 0.05^{ad}	32.0 ± 0.05^{ac}	17.0 ± 0.15^{ac}
Local chicken	10.20 ± 0.05^{bd}	32.4 ± 0.40^{ac}	17.3 ± 0.30^{ca}

Means bearing at least one common superscript column wise do not differ significantly (P<0.05)

Table 4.5b: Means and standard errors of differential leukocyte count in different genotypes (Giriraja, Swarnadhara, Raja II and Local bird).

Genotype	Differential Leukocyte Count			
	Heterophills	Eosinophills^{NS}	Lymphocytes	Monocytes
Giriraja	57.5 ± 0.40^{a}	2.00 ± 0.02	33.90 ± 0.10^{a}	6.60 ± 0.50^{a}
Swarnadhara	59.0 ± 0.10^{b}	2.50 ± 0.50	35.10 ± 0.20^{bc}	3.40 ± 0.80^{bc}
Raja II	58.8 ± 0.10^{b}	2.50 ± 0.50	34.80 ± 0.25^{ab}	3.90 ± 0.35^{ca}
Local chicken	58.8 ± 0.30^{b}	2.00 ± 0.08	34.90 ± 0.15^{ab}	4.30 ± 0.10^{ba}

NS*- Non-significant. Means bearing at least one common superscript column wise do not differ significantly (P<0.05)

Table 4.5c: Mean squares from analysis of variance for Haematological parameters

Parameters	Source of variation	Degrees of freedom	Mean squares	F value
Hb	**Treatments**	40	0.200	40.00*
	Error	6	0.005	
PCV	**Treatments**	40	2.610	16.10 *
	Error	6	0.162	
TLC	**Treatments**	40	0.425	6.41 NS
	Error	6	0.066	
Heterophills	**Treatments**	40	0.935	7.71 *
	Error	6	0.121	
Eoisinophills	**Treatments**	40	0.167	0.66NS
	Error	6	0.250	
Lymphocytes	**Treatments**	40	0.543	8.05 *
	Error	6	0.067	
Monocytes	**Treatments**	40	3.930	7.70 *
	Error	6	0.511	

***- Significant (P<0.05)**

NS- Non- significant

Figure 4.5: Hemoglobin and Packed cell volume of Giriraja, Swarnadhara, Raja II and Local genotypes

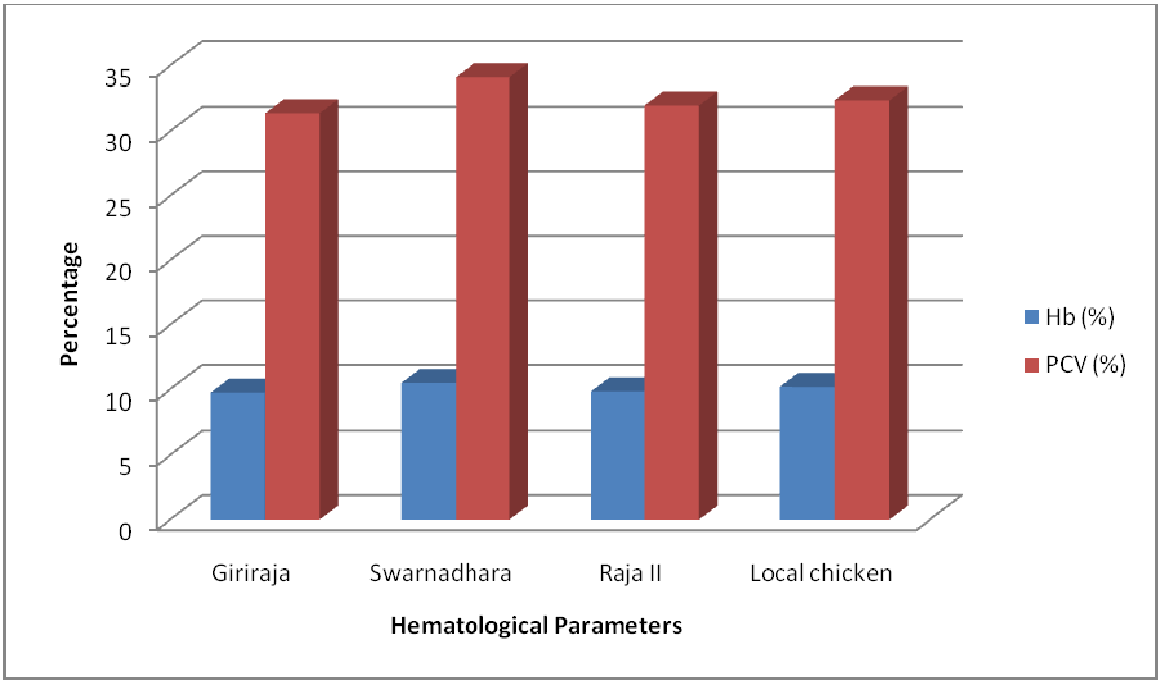


Figure 4.6: Total leukocyte count (10^3) of Giriraja, Swarnadhara, Raja II and Local genotypes

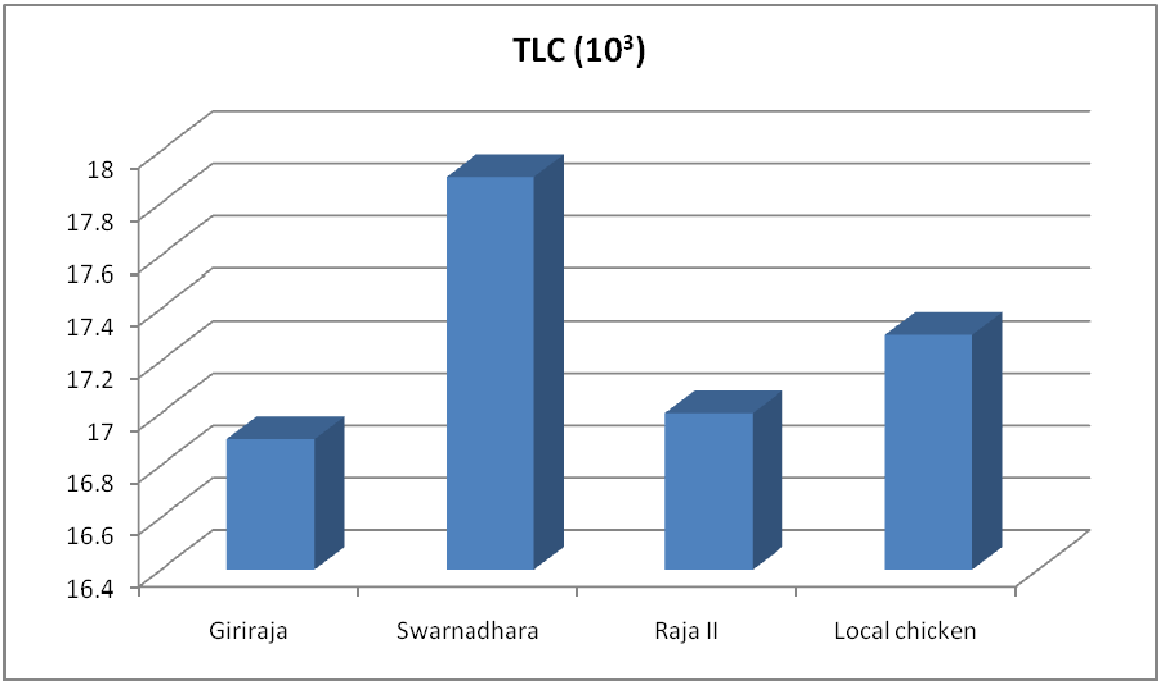
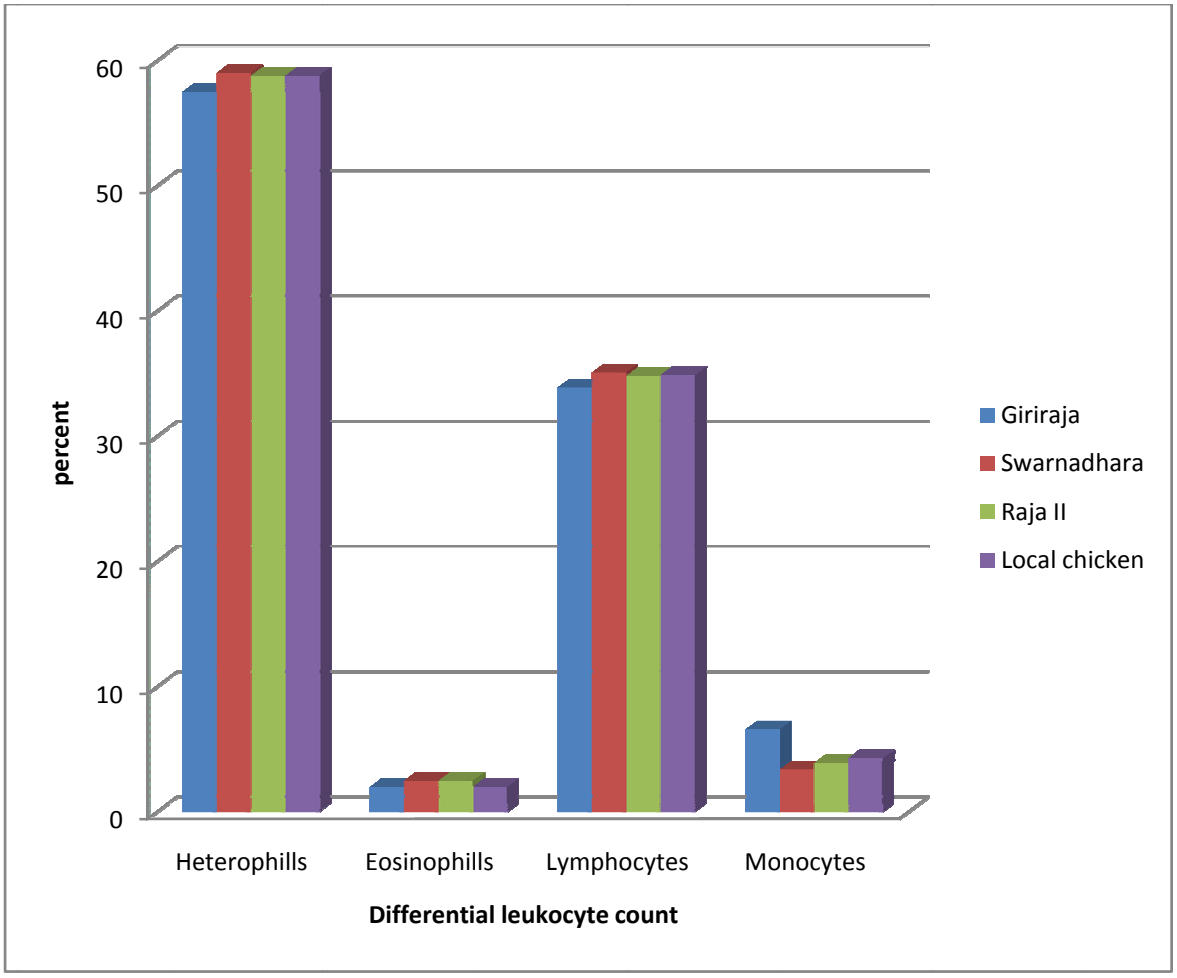


Figure 4.7: Differential leukocyte counts of Giriraja, Swarnadhara, Raja II and Local genotypes



4.3 Immunological Parameters

The results of the effect of immune response of low input chicken on Immunological Parameters are presented in this chapter.

4.3.1 Lymphoid organ weight

4.3.1.1 Spleen

The mean and standard errors of the relative weight of spleen for low input birds at 56th day of experimental period is presented in Table 4.6a and Graphically depicted in Figure 4.8.

The relative mean weight of spleen ranged between 0.177 per cent in Giriraja to 0.234 per cent in Raja II. Among various treatment groups, Swarandhara showed maximum relative weight (0.234 per cent) as against lowest relative weight of 0.177 per cent recorded in Giriraja genotype. Statistical analysis revealed that the mean weight of spleen differed significantly ($P \leq 0.05$) among genetic groups, Grirraja and Swarnadahara and Raja II. There was no significant difference ($P \leq 0.05$) in relative bursal weights among Giriraja, Raja II and Local genotypes.

4.3.1.2 Bursa

The mean and standard errors of the relative weight of bursa for low input birds at 56th day of experimental period is presented in Table 4.6a and Graphically depicted in Figure 4.8.

The mean relative weight of bursa ranged from 0.071 per cent in Raja II to 0.166 per cent in Local. Among various genotypes, Local genotype showed maximum relative weight (0.166 per cent) as against lowest relative weight of 0.071 per cent recorded in Raja II. Statistical analysis revealed that the mean relative weights of bursa among genetic groups, Giriraja, Swarnadahara, and Raja II were found to be non-significant ($P \leq 0.05$) and remained significantly ($P \leq 0.05$) lower when compared with Local genotype. The bursal percentage of local genotype was significantly ($P \leq 0.05$) higher than that of Giriraja, Swarnadhara and Raja II genotypes.

4.3.1.3 Thymus

The mean and standard errors of the relative weight of thymus for low input birds at 56^{th} day of experimental period is presented in Table 4.6a and Graphically summarised in Figure 4.8.

The mean relative weight of thymus ranged from 0.263 per cent in Raja II to 0.453 per cent in Swarnadahara. Among various genetic groups, Swarnadahara showed maximum relative weight (0.453 per cent) as against lowest relative weight of 0.263 per cent recorded in Raja II. Statistical analysis revealed that the mean relative weights of thymus between genetic genotypes, Raja II and Local were found to be non-significant ($P \leq 0.05$) and remained significantly ($P \leq 0.05$) lower when compared with Giriraja. There was no significant difference in relative thymus weights among Giriraja and Swarnadhara and also among rest of the treatment groups.

Table 4.6a: Means and standard errors of lymphoid organ weights recorded in different genotypes (Giriraja, Swarnadhara, Raja II and Local bird)

Genotypes	Lymphoid Organs (g/100g body weight)		
	Bursa	Spleen	Thymus
Giriraja	0.095 ± 0.019^{b}	0.177 ± 0.012^{b}	0.398 ± 0.033^{a}
Swarnadhara	0.108 ± 0.012^{b}	0.234 ± 0.018^{a}	0.453 ± 0.031^{a}
Raja II	0.071 ± 0.007^{b}	0.182 ± 0.013^{b}	0.263 ± 0.029^{b}
Local	0.166 ± 0.021^{a}	0.213 ± 0.015^{ab}	0.300 ± 0.031^{b}

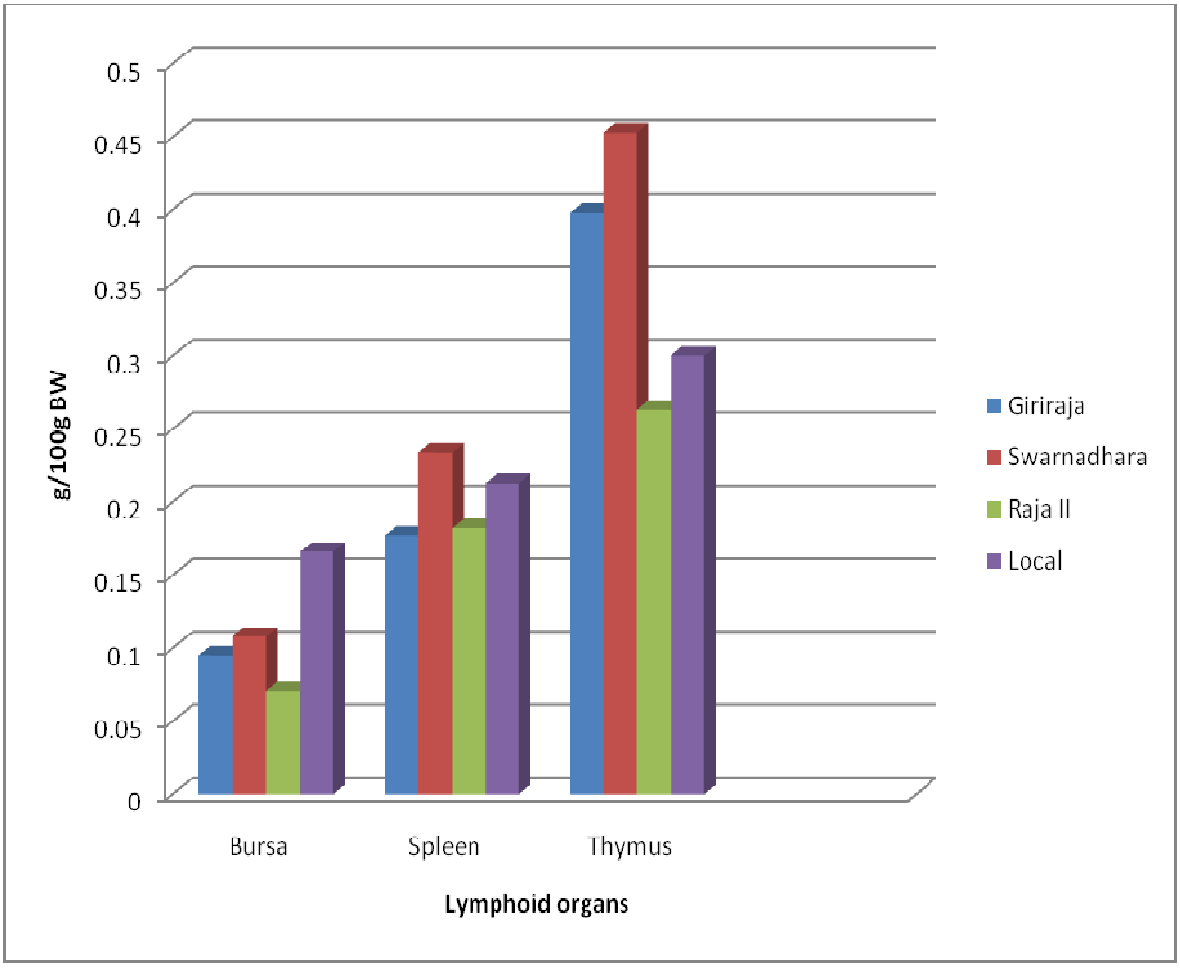
Means bearing at least one common superscript column wise do not differ significantly (P≤0.05)

Table 4.6b: Mean squares from analysis of variance for weights of spleen, thymus and bursa

Parameters	Source of variation	Degrees of freedom	Mean squares	F value
Spleen	**Treatments**	8	0.005	1.85 *
	Error	39	0.002	
Thymus	**Treatments**	8	0.036	2.73 *
	Error	39	0.013	
Bursa	**Treatments**	8	0.008	2.68 *
	Error	39	0.003	

***- significant (P≤0.05)**

Figure 4.8: Relative lymphoid organ weights (g/100 g BW) for chicks of Giriraja, Swarnadhara, Raja II and Local genotypes.



4.3.2 Humoral Immune Response

4.3.2.1 Haemagglutination inhibition test

The titers of antibodies in sera of different genotypes against Newcastle disease vaccine at third, fifth, seventh and eight week of age are presented in Table 4.7a and Graphically depicted in Figure 4.9.

The analysis of variance revealed a significant ($P \leq 0.05$) variability of HI response among various genetic groups at second and seventh week of post vaccination while remained non-significant at fourth and sixth week of age.

The mean HI titer values at second week after vaccination ranged from 181 units in (Local birds) to 320 units in Giriraja genotypes. Statistical analysis revealed significant ($P \leq 0.05$) differences in mean HI titer values between Giriraja and Raja II genotypes. The highest levels of antibodies occurred in Giriraja genotype at 3 weeks after vaccination and remained non-significant with Swarnadhara and local genotypes.

The mean HI titer values ranged at fourth week of post vaccination from 112 units in Raja II to 256 units in Giriraja. Statistical analysis revealed no significant ($P \leq 0.05$) differences in antibody response to NDV vaccination among four genotypes.

The mean HI titer values ranged from 85.33 units in Swarnadahara and Raja II to 160 units in Local genotypes at sixth week of post inoculation to ND Vaccine. Statistical analysis revealed that the genotypes responded with the same degree to ND vaccination.

Table 4.7a: Means and standard errors of antibody titers against Newcastle disease vaccine for chicks of different genotypes (Giriraja, Swarnadhara, Raja II and Local bird).

GENOTYPE	HI titer (weeks after vaccination)			
	II ^{S}	IV ^{NS}	VI ^{NS}	VII ^{S}
Giriraja	320.00±64.00^{a}	256.00±57.24^{a}	106.66±13.49^{a}	042.66±06.74^{b}
Swarnadhara	192.00±28.62^{ab}	160.00±71.55^{a}	085.33±13.49^{a}	042.66±06.75^{b}
Raja II	288.00±77.06^{ab}	112.00±32.79^{a}	085.33±13.49^{a}	053.33±06.74^{b}
Local birds	181.33±72.81^{b}	192.00±28.62^{a}	160.00±42.93^{a}	149.33±35.69^{a}

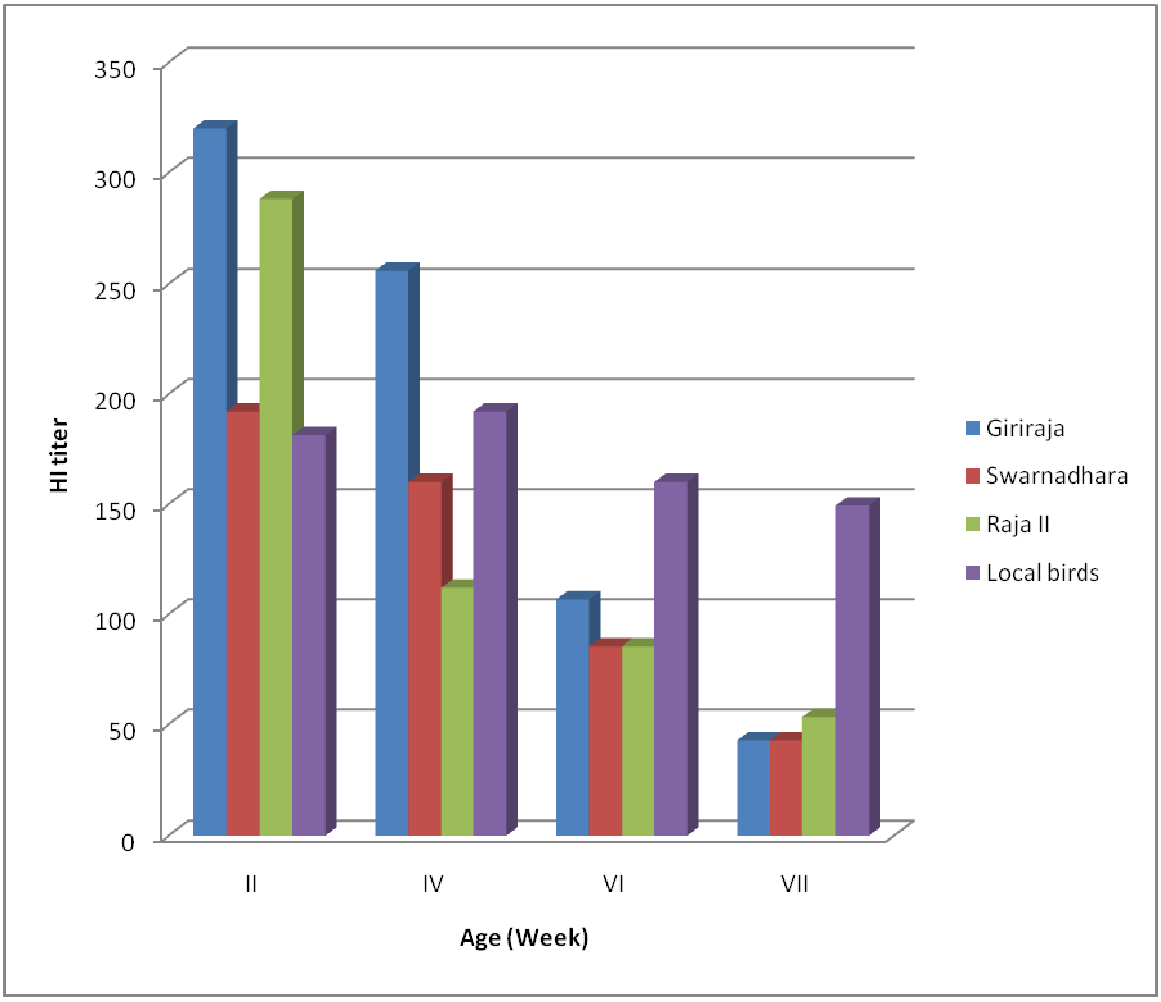
NS* Non-significant. Means bearing at least one common superscript column wise do not differ significantly (P≤0.05)

Table 4.7b: Mean squares from analysis of variance for HI titer value against NDV

Week	Source of variation	Degrees of freedom	Mean squares	F value
II	**Treatments**	3	45098.67	2.66*
	Error	20	16938.67	
IV	**Treatments**	3	20480.00	0.9^{NS}
	Error	20	22732.80	
VI	**Treatments**	3	7452.44	2.08^{NS}
	Error	20	3584.00	
VII	**Treatments**	3	16099.56	7.6*
	Error	20	2116.26	

***- Significant (P≤0.05)**
NS- Non- significant

Figure 4.9: Antibody titers against Newcastle disease vaccine for chicks of Giriraja, Swarnadhara, Raja II and Local genotypes.



Significant differences (P≤0.05) among genetic stocks were found on seventh week post inoculation for antibody titers. Comparisons among chickens from Giriraja, Swarnadhara, Raja II and Local genotypes for ability to produce antibody to NDV showed that the Local birds (149) produced the most antibody and the Giriraja and Swarnadhara, the least. There was no significant difference in antibody response among Giriraja, Swarnadhara and Raja II genotypes.

4.3.2.2 ELISA FOR IBD

The results of the effect of immune response of low input chicken against IBD vaccine at first, third, fifth and sixth week of age are presented in Table 4.8a and Graphically depicted in Figure 4.10.

The analysis of variance revealed a significant difference (P≤0.05) among various genetic stocks at fifth week of post vaccination and remained non-significant at first, third and sixth week of post inoculation for antibody titer.

The mean ELISA titer values ranged from 3543 units in Swarnadahara to 6132 units in Local genotypes. Statistical analysis revealed no significant (P≤0.05) difference in mean ELISA titer values among Giriraja, Swarnadahara and Raja II and remained significantly (P≤0.05) lower when compared with local genotype.

Table 4.8a: Means and standard errors of ELISA titers against IBD vaccine for chicks of different genotypes (Giriraja, Swarnadhara, Raja II and Local bird)

Genotype	IBD titer (weeks after vaccination)			
	I ^{NS}	III ^{NS}	V	VI ^{NS}
Giriraja	930.83±62.40	2664.67±47.34	4075.67±57.35^{b}	3475.17±43.62
Swarnadhara	825.50±39.53	2797.50±48.76	3543.33±46.75^{b}	3802.67±77.66
Raja II	954.33±64.54	2090.33±61.66	4703.17±53.32^{ab}	5186.67±40.29
Local birds	847.83±36.16	3787.67±62.02	6132.83±64.93^{a}	3518.00±48.27

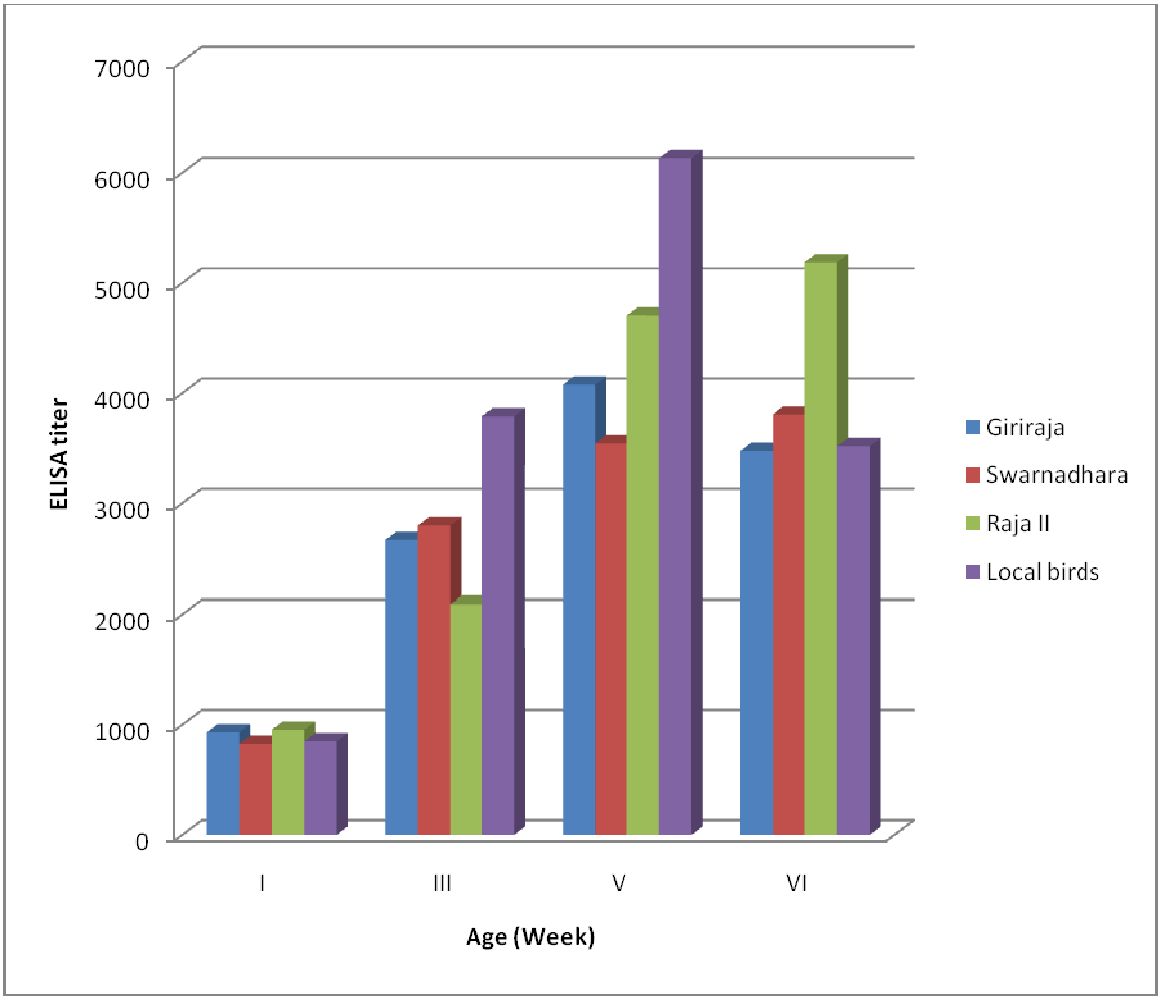
NS* Non- significant. Means bearing at least one common superscript column wise do not differ significantly (P≤0.05)

Table 4.8b: Mean squares from analysis of variance for ELISA titer value against IBD

Week	Source of variation	Degrees of freedom	Mean squares	F value
I	**Treatments**	**3**	23487	1.61 ^{NS}
	Error	**20**	14611	
III	**Treatments**	**3**	2985044	1.16^{NS}
	Error	**20**	1858785	
V	**Treatments**	**3**	7501870	4.01*
	Error	**20**	1871028	
VI	**Treatments**	**3**	3904869	1.35 ^{NS}
	Error	**20**	2902315	

***- Significant (P≤0.05)**
NS- Non- significant

Figure 4.10: ELISA titers against IBD vaccine for chicks of Giriraja, Swarnadhara, Raja II and Local genotypes.



4.3.3 Cell mediated immunity

The results of cell mediated immune response to DNCB recorded at zero, twenty four, forty eight and seventy two hours in different genetic stocks at foot web region is presented in Table 4.9a and Graphically depicted in Figure 4.11. Statistical analysis revealed significant ($P \leq 0.05$) variability of immune response to DNCB among various genotypes at 24 and 48 hours post injection.

At zero hour no reaction was noticed at the site of test injection. Increase in skin thickness became evident at 24 hrs post injection. The foot web region was swollen, erythematous, hot and oedematous. All the three genetic groups viz, Giriraja, Swarnadhara and Raja II showed significantly ($P \leq 0.05$) higher cell mediated immune response when compared to Local genotype and the difference between them was not significant at 24 hrs of post injection.

The mean thickness of foot web at forty eight hour measurements was highest in Swarnadhara group (2.25 mm) as against lowest recorded in Local genotype (1.95 mm). Among various different genetic stocks, Swarnadhara genotype recorded significantly ($P \leq 0.05$) higher cell mediated immune response to DNCB when compared to Local alone and remained non-significant with Giriraja and Raja II group. The mean thickness of foot web measured at seventy two hour remained non-significant among different genetic groups.

Table 4.9a: Means and standard errors for cell mediated immunity in chicks of different genotypes (Giriraja, Swarnadhara, Raja II and Local bird).

Genotype	Thickness (mm)			
	0hr	24 hr	48 hr	72hr
Giriraja	1.15±0.048[a]	1.62±0.06[a]	2.02±0.08[ab]	1.64±0.07[a]
Swarnadara	1.11±0.065[a]	1.65±0.05[a]	2.26±0.07[a]	1.66±0.07[a]
Raja II	1.23±0.045[a]	1.69±0.04[a]	2.23±0.06[ab]	1.63±0.04[a]
Local bird	0.95±0.030[b]	1.43±0.08[b]	1.95±0.01[b]	1.30±0.04[a]

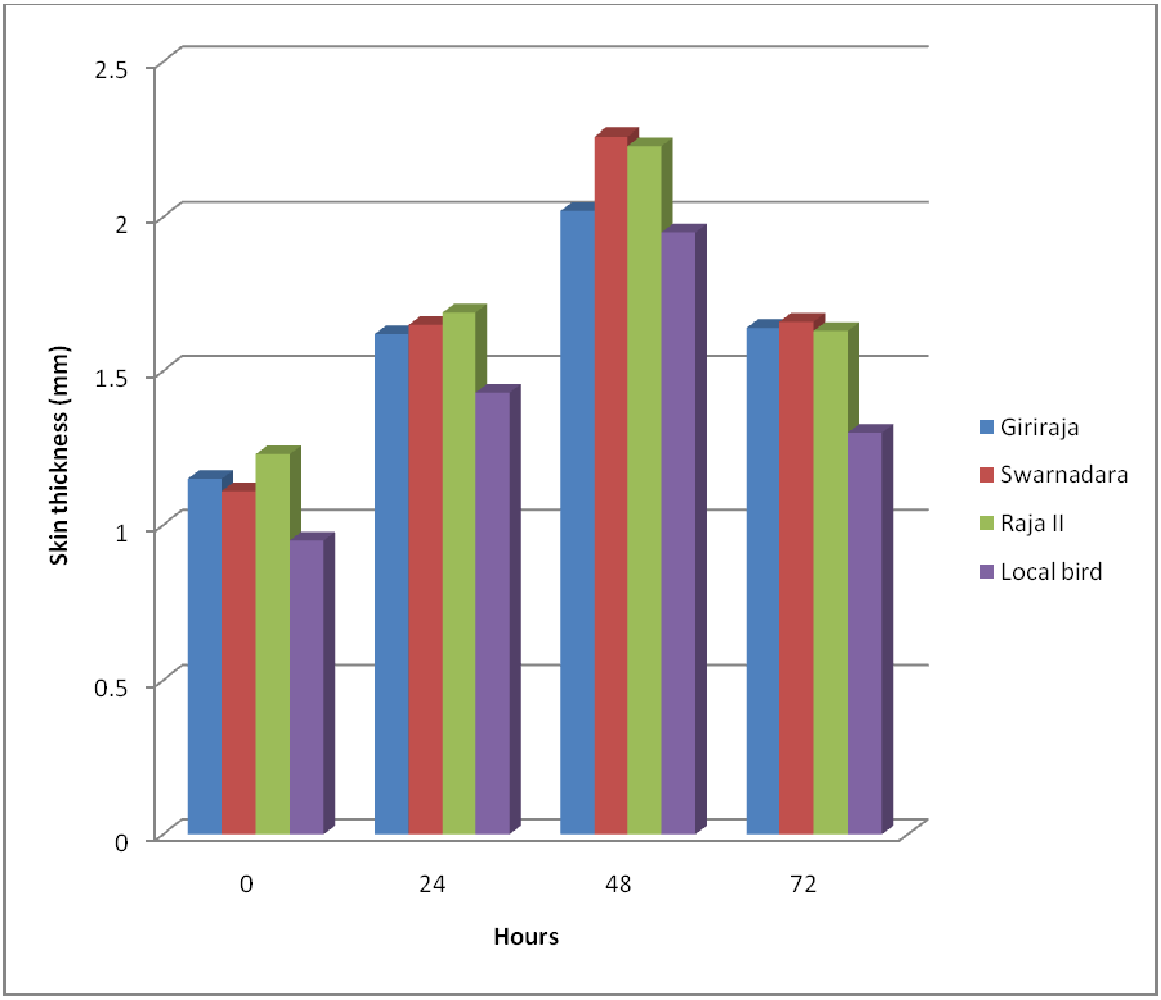
Means bearing common superscript column wise do not differ significantly (P≤0.05)

Table 4.9b : Mean squares from analysis of variance for DNCB at foot web region

Time (hrs)	Source of variation	Degrees of freedom	Mean squares	F value
0	**Treatments**	**3**	0.174	6.45 [NS]
	Error	**44**	0.027	
24	**Treatments**	**3**	0.262	5.52 [*]
	Error	**44**	0.047	
48	**Treatments**	**3**	0.277	2.56 [*]
	Error	**44**	0.108	
72	**Treatments**	**3**	0.271	1.01 [NS]
	Error	**44**	0.208	

***- Significant (P≤0.05)**
NS- Non- significant

Figure 4.11: Cell mediated immune response in chicks of Giriraja, Swarnadhara, Raja II and Local genotypes



Discussion

V. DISCUSSION

The findings of the experiment of fifty six days duration on comparative growth performance, organs weights, certain haematological parameters, in low input chickens are discussed in this chapter under the following heading

5.1 Growth parameters

5.1.1 Body weight

The results of the present study indicated that genotypes had significant influence over body weight at different weeks of age. It was observed that the body weight of Swarnadhara genotype was significantly higher than the other genetic groups at day old. The Giriraja and Swaranadhara genotypes did not differ in their potential for body weight gain. This superiority decreased as age advanced. The body weight up to end of the experimental period was highest for Raja II, followed by Giriraja and Swarnadhara genotypes. Birds of Local genotype exhibited significantly lower body weight at all ages throughout the experimental period when compared with birds of other genotypes. However, the difference between the two genotypes, Giriraja and Swarnadhara groups was not significant.

The body weights observed in the present study in four different genetic groups at 0 day, first, second, third, fourth, fifth, sixth, seventh and eight week of age were above the averages reported by Haque and Howlider (2000), Singh *et al*., (1999), Krishnamurthy (2002) and Kumaresan *et al*., in (2008) for genetic stock reared under

village chicken production systems. This might be due to different histories of genetic background of the stocks and the intensive system of rearing adopted in the present study.

Momoh *et al*., (2010) evaluated the performance of the heavy and light chicken ecotypes and their crosses for growth traits under standard management conditions and found significant differences in body weight. Local chicken weighed less compared to other genetic groups.

The varied body weights observed among genetic stocks could be because of the varied levels of different exotic germ plasm involved in the constitution of the synthetic crosses possibly arising from combining abilities for body weight. This was suggestive of possible differences in the genetic control mechanism on the body weight due to varied levels of exotic as well as indigenous germ plasm in the synthetic flocks of Giriraja, Swarandhara and Raja II.

5.1.2 Feed consumption

The study revealed significant influence of different genotypes on cumulative feed consumption. Among various genetic stocks, feed consumption was significantly lower in Local genotype at all weeks of age. No significant variation in feed consumption existed among Giriraja, Swarnadhara and Raja II at the end of first week of age. However, from second week of age onwards, the feed consumption was recorded highest in Raja II as compared to other genetic stocks. This superiority was maintained throughout the experimental period of eight weeks. Giriraja and Swaranadhara genotypes showed non-significant difference in feed consumption.

The values obtained for cumulative feed consumption at various age intervals in the present study were below the results reported by Deeb and Cahaner *et al*., (2001), Krishnamurthy (2002) for naked neck crosses. Singh *et al*., (1999) and Momoh *et al*., (2010) reported similar low feed consumption in Local chicks compared to other genetic groups reared under different ecosystems. This could be because of genetic makeup of the birds, varied agro-climatic and other environmental conditions.

5.1.3 Feed conversion ratio

Significant variations had been observed in efficiency of feed utilization among various genotypes. The Local genotype showed poor feed utilization efficiency compared to all other genotypes at all weeks of age. The Swarnadhara genotype showed better feed efficiency during first week. The same trend in feed efficiency was observed during second and third week also. From fourth week onwards till eight week of age, there was no difference in feed conversion efficiency among Giriraja, Swarnadahara and Raja II genotypes.

The slight variations in feed efficiency observed in the present study could be attributed to the genetic makeup and differential rate of metabolism among birds. The results of the present findings were lesser than those reported by Haque and Howlider (2000), Singh *et al*., (1999), Krishnamurthy (2002) for genotypes reared under village production system. The findings support the findings of Momoh *et al*., (2010) who evaluated the performance of the heavy and light chicken ecotypes and their crosses for growth traits under standard management conditions and found significant

differences in FCR among the genetic groups. Their study demonstrated that Local chickens were less efficient in feed utilization compared to other genetic groups.

5.1.4 Livability

The results of the study revealed good livability of birds among different genetic groups. Livability percentage was higher in Giriraja genotype as compared to other genetic groups during the period upto eight week of age. The livability percentages recorded in the present study was similar to the observations of Haque and Howlider (2000) who recorded lower mortality in naked neck and their crosses with Rhode Island Red. El-Safty *et al.*, (2006), recorded higher mortality and culling rate in normal plumage hens than heterozygous naked neck hens.

5.2 Haematological parameters

5.2.1 Haemoglobin

It is evident from present findings that the haemoglobin concentrations across all the genetic groups were within the normal range (7-13g/dl). Swarnadhara had greater haemoglobin concentration compared to all other genotypes. No significant difference was observed between Swarnadhara and Raja II genotypes. Variation in Hb concentration observed in the present study could be due to breed differences. The haemoglobin concentration recorded in all genetic groups was higher than results reported by Islam (2004) for Fayoumi, Aseel and local birds.

5.2.2 Packed cell volume

The results of the study indicated a significant difference in PCV values among genetic stocks. The highest PCV value was recorded in Swarnadhara genotype as against the lowest value recorded in Giriraja genotype. Swarnadhara had significantly increased packed cell volume value as compared to Giriraja, Raja II and Local genotypes. The PCV values were found non-significant among Giriraja, Raja II and local genotypes. The results of PCV of all genetic stocks are slightly higher than the results reported by Islam *et al*., (2004) for Fayoumi, Aseel and local breeds. Variation in PCV is due to age, sex and present status of birds have been reported by Lucas (1961).

5.2.3 Total leukocyte count

The total leukocyte count values observed in the present study showed significant difference among the genotypes. Among various genetic groups, highest TLC value was recorded in Swarnadhara genotype as against the lowest value recorded in Giriraja genotype. Giriraja, Raja II and Local genotypes had similar total leukocyte counts.

5.2.4 Differential leukocyte count

Heterophills:

The values indicate significant difference among genotypes. Swaranadhara, Raja II and local genotypes had significantly higher heterophills compared to Giriraja genotype. Whereas heterophill numbers are similar in Swarandhara, Raja II and local genotypes. Higher heterophill count observed in this study was in contrast to the findings of Islam *et al*., (2004) who reported lower heterophil count for Fayoumi, Aseel and Local breeds.

5.2.4.1 Lymphocytes

There was significant difference in lymphocyte counts among various genetic stocks. Swarnadhara showed higher lymphocyte count when compared to Giriraja genotype and remained non-significant with Raja II and Local chicken genotypes. Whereas Raja II and Local genotype had similar lymphocyte number compared to Giriraja genotype. Variations observed in lymphocyte number among different genetic stocks could be due to breed differences. Islam *et al*., (2004) reported higher lymphocyte count in Fayoumi, Aseel and Local chickens.

5.2.4.2 Monocytes

The monocyte values showed statistical difference among different genotypes. The monocyte count was significantly higher in Giriraja genotype but remained non-significant with Raja II and local chicken. The monocyte count in their study was consistent to the findings of Sturkie (1965).

5.3 Immunological parameters

5.3.1 Lymphoid organs weight

There was a significant difference among genetic groups for relative weights of lymphoid organs viz., Bursa, Spleen and Thymus. Local genotype showed relatively higher weight of bursa compared to Giriraja, Swarnadhara and Raja II genotypes. The bursa of Fabricius is primary lymphoid organ where B-cell precursors differentiate and undergo maturation. The humoral antibody response is dependent on this key organ (Sharma, 1967). High antibody response to SRBC has been associated with a large bursa

size in White Leghorn chicken strain. In the present study, similar high antibody response against ND vaccine had been recorded in the local genotype at seventh and eight week of post immunization. The present results indicated that there was no significant difference among Giriraja, Swarnadhara and Raja II genotypes for relative bursal weight. Spleen is a secondary lymphoid organ which reacts to antigens in blood stream and is important in both antibody mediated and cell mediated immunity. With respect to relative Spleen weight it could be noticed that the relative spleen weight was not influenced by Giriraja, Raja II and Local genotypes. However, the Swarnadhara genotype had significantly higher relative spleen weight compared to Giriraja and Raja II genotypes. A similar variation in relative size of spleen among avian species had been described by Ubosi *et al*., (1984).

Concerning relative thymus weight, the Swarnadhara genotype showed significantly higher relative thymus weight compared to Raja II and local genotypes. Conversely, the relative thymus weight was significantly affected by Raja II and local genotypes. The cell mediated immune response was comparatively less as compared to Giriraja, Swarnadhara and Raja II genotypes. In the present study, higher antibody titer against IBD vaccine was associated with smaller size of thymus in Raja II genotypes and similarly high antibody titer against NDV had smaller thymus in local genotype. The present study indicated that size of bursa and thymus affected the humoral and cell-mediated immune response ability of different genetic stock. Ubosi *et al*., (1984) observed that high antibody titer had smaller thymus and large bursa than low antibody titer, relative to body weight.

5.3.2 Humoral Immune Response

5.3.1 Heamagglutination inhibition test

The weekly titers in response to ND vaccine were significantly different among genetic stocks on third and eight week of age. All the stocks elicited maximum primary immune response on third week and these levels were maintained through fifth week. Then the levels reduced and become non-significant at seventh week. In this study, the antibody titer in local birds was fairly consistent from third week to eight week of age and elicited significantly higher antibody titer as compared to other genotypes at eight week of age. Comparisons among chickens from different genotypes for ability to produce antibody to NDV at eight week of age showed that the Local genotype produced the most antibody and the Giriraja and Swarnadhara, the least. There was no significant difference in antibody response among Giriraja, Swarnadhara and Raja IIgenotypes.

The avian immune system is highly evolved and its efficient functioning is important for resistance to poultry diseases. Both structural and regulatory genetic factors determined the individual immunocompetence and ability to attack a particular disease organism. It is well documented that immunocompetence is influenced by genetic and non-genetic factors. The results suggested that chicken population used in this study differ widely with respect to primary immune response to NDV. Differences in antibody response to SRBC in varieties of domestic birds selected for antibody response have been reported previously by Gross *et al*., (1980) and Gyles *et al*., (1986). The genetic group differences to NDV antibody, as observed in this

investigation was also consistent with reports of Balcarova *et al*., (1973), Van der Zijpp (1978), Siegel and Gross (1980) and Singh *et al*., (2009). Genetic group differences observed in NDV titer response probably indicates variation in number of antibody producing cells. Such differences may be partly due to the difference at the major histo-compatability complex, immunoglobulins allotypes and to genes not associated with MHC or allotypes (Dunnington *et al*., 1984). Further, Van der Zijpp (1980) suggested that chicks had a genetic constitution, which geared either to higher antibody titers or vice versa.

Differences in antibody responses recorded at different weeks, in the present study agreed with those of Balcarova *et al*., (1973). Further, the variations observed in the persistence of titers among genotypes confirm the findings of Siegel and Gross (1980). The local genotype showed superior immunocompetence as compared to exotic crosses, Giriraja, Swarnadhara and Raja II. These results demonstrated strong and persistent immune response to vaccination in local genotype, and would be more resistant to viral diseases.

5.3.2.2 ELISA FOR IBD

Immunological studies using IBD vaccine showed significantly higher ELISA values among various genetic stocks at seventh week of age and remained non-significant at third, fifth and eight week of post inoculation for antibody titer. The ELISA titer values revealed no difference among Giriraja, Swarnadhara and Raja II and remained significantly lower when compared with local genotype. Findings obtained from the experiment were similar to the findings of Gyles *et al*., (1986)

5.3.3 Cell mediated immune response

Dinitro-chloro-Benzine test

It is evident from this study that differences among birds of different genetic origin could be detected for the cell mediated response in DNCB injected foot web. Among different genotypes, Raja II showed higher cell mediated immune response when compared to local genotype and remained non-significant with Giriraja and Swarnadhara genotypes. The response was greater to 2,4-DNCB on forty eight hours compared to twenty four hours. Similar results were obtained by Singh *et al*., (2009), in pure and cross breeds. The results suggested that Giriraja, Swarnadhara and Raja II genotypes had a significantly higher cell mediated immune response to DNCB compared to local genotypes. It is well known that cell mediated immunity play an important role in controlling and eliminating intracellular bacteria or parasites (Al–Shahery et al., 2008). The study implies that the genotypes, Giriraja, Swarandhara and Raja II could be more resistant to intracellular infections.

Summary

VI. SUMMARY

A biological experiment was conducted to evaluate comparative growth performance, organs weights, haematological parameters and Immune response in four genotypes of low input chicken (Giriraja, Swarnadhara, Raja II and Local). In this study two hundred and forty day old chicks, each genotype comprising sixty chicks were used in a completely randomised design with four groups and six replicates in each group with ten birds per replicate. They were reared in floor pens for 56 days. Data on growth performance, haematology, immune response to NDV, IBD vaccine were collected.

The results of the present study indicated significant influence of genotypes on body weight at all ages. The body weight upto the end of the experimental period was highest for Raja II, followed by Giriraja and Swarnadhara genotypes. Birds of local genotype exhibited significantly lower body weight. The difference between, Giriraja and Swarnadhara genotypes was not significant.

The study revealed significant influence of genotypes on cumulative feed consumption. Among various genetic stocks, feed consumption was significantly lower in local genotype. The feed consumption was highest in Raja II as compared to other stocks. Giriraja and Swarnadhara genotypes showed non-significant difference in feed consumption.

Significant variations were observed in feed conversion ratio among various genotypes. The local genotype showed poor feed utilization efficiency compared to

all other genotypes at all weeks of age. There was no difference in feed conversion efficiency among Giriraja, Swarnadhara and Raja II genotypes.

The percentage liveability of birds under different genetic groups ranged from 95.00 per cent to 96.67 per cent. The Survivability in Giriraja genotype was 96.67 percent, whereas it was 95 percent in other genetic groups. (Swarnadhara, Raja II and Local genotypes)

Significant variations in mean Hb concentration, packed cell volume values, total leukocyte counts and differential leukocyte counts were observed among different genotypes. Swarandhara had greater Haemoglobin concentration compared to all other genotypes. No significant difference was observed between Swarnadhara and Raja II genotypes. Swarnadhara had significantly increased packed cell volume value as compared to Giriraja, Raja II and Local genotypes. Giriraja, Raja II and Local genotypes had similar total leukocyte counts. Swarnadhara, Raja II and Local genotypes had significantly higher heterophils compared to Giriraja genotype. Swarnadhara showed higher lymphocyte count when compared to Giriraja genotype and remained non-significant with Raja II and Local genotypes. The monocyte count was significantly higher in Giriraja genotype but remained non-significant with Raja II and Local chicken.

Local genotypes showed relative higher weight of bursa compared to Giriraja, Swarnadhara and Raja II genotypes. Whereas Swarnadhara genotype showed significantly higher relative thymus weight compared to Raja II and Local genotypes. There was no significant difference among Giriraja, Swarnadhara and Raja II genotypes

to relative bursal weight. Relative spleen weight was not influenced by Giriraja, Raja II and Local genotypes

Significant differences were found for NDV antibody titers at 51st day of post vaccination among various genetic groups at all ages. The local genotype showed highest titer till the end of the experimental period. The lowest was observed in Giriraja and Swarnadhara genotypes. Elisa titer for IBD was significant at 36th day of post vaccination. Highest titer was observed in Local and poor titer was encountered in Swarnadhara genotype.

Significant variability of immune response to DNCB among various genotypes was recorded at 24 and 48 hours of post injection. The response was greater to 2, 4-Dinitro-Chloro-Benzene on 48 hrs compared to 24 hrs. Among various different genetic stocks, Swarnadhara genotype recorded higher cell mediated immune response to DNCB when compared to Local alone and remained non-significant with Giriraja and Raja II group.

CONCLUSION

The results of present investigation, leads to the following conclusions.

Genetic groups (Giriraja, Swarnadhara, Raja II and Local birds) evaluated showed that they are significantly different in their performance with respect to growth as well as immune response.

Among four genetic groups of low input chicken evaluated, the performance of Raja II was superior to other genotypes with respect to growth and feed efficiency whereas the Local genotype demonstrated strong and persistent immune response to vaccination.

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Abstract

VIII. ABSTRACT

This current study was carried out to evaluate the comparative growth performance, organs weights, certain haematological parameters and Immune responses in low input chickens. A total of 240 chicks of both sexes (about 60 from each of four genetic origins, Giriraja, Swarnadhara, Raja II and Local cross) produced in a single hatch, were wing banded and weighed. Each genetic group had six replicates with ten birds in each replicate. Twenty four pens were made and the replicates were randomly allotted using lottery method. The experiment lasted for 56 days.

There was significant difference observed throughout the experimental period in body weight, cumulative feed consumption, feed conversion ratio, haematological parameters and Immune responses among various genetic groups at all ages. The cumulative feed consumption was lowest in Local genotype and highest in Raja II and no significant difference between Giriraja and Swarnadhara genotypes. From fifth week feed conversion ratio was better in Raja II and poor FCR with Local genotype. The significant changes in mean Hb concentration, packed cell volume values, total leukocyte counts and differential counts among various genetic groups except for eosinophill count. The relative weight of lymphoid organs viz., spleen, bursa of fabricius and thymus differ significantly among four genetic groups

The local genotype showed highest titre for NDV and IBD antibody titre till the end of the experimental period. The lowest was observed in Giriraja and Swarnadhara genotypes. CMI response was greater to 2, 4-Dinitro-Chloro-Benzene on 48 hrs compared to 24 hrs. Swarnadhara genotype recorded higher cell mediated immune response to DNCB when compared to Local. The study revealed significant genetic differences for comparative growth performance, organs weights and certain haematological parameters and immune response, the Local genotype demonstrated strong and persistent immune response to vaccination as compared to exotic crosses, Giriraja, Swarandhara and Raja II.