"The effect of various immunomodulators on certain economic traits of broiler chicken".

THESIS

SUBMITTED TO THE

RAJENDRA AGRICULTURAL UNIVERSITY

PUSA (SAMASTIPUR) BIHAR

(Faculty of Post-graduate studies)

In Partial fulfilment of the requirement

For the degree of

MASTER OF VETERINARY SCIENCE

IN

LIVESTOCK PRODUCTION AND MANAGEMENT

BY

BIRENDRA PRASAD YADAV

REG. NO. M/LPM/63/2000-2001

DEPARTMENT OF LIVESTOCK PRODUCTION AND MANAGEMENT

BIHAR VETERINARY COLLEGE

PATNA

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PATNA

2003

Dedicated

Benevolent adorable parents

Sri Sadhu Sharan Yadav

&

Smt. Fula Devi

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M.V.Sc., Ph. D.
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CERTIFICATE-I

This is to certify that thesis entitled ***"The effect of various immunomodulators on certain economic traits of broiler chicken"*** submitted in partial fulfilment of the requirements for the Degree of **Master of Veterinary Science (Livestock Production and Management)** of the Faculty of post-graduate studies, Rajendra Agricultural University, Pusa, Samastipur, Bihar, is the record of bonafied research work carried out by **Dr. Birendra Prasad Yadav**, Registration no. M/LPM/63/2000-2001, under my supervision. No part of the thesis has been submitted for any other degree or diploma.

It is further certified that the assistance and help received during the course of this investigation and preparation of the thesis have been fully acknowledged.

SSsingh 2/9/03

(***Dr. S.S. Singh***)

Major Advisor

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CERTIFICATE-II

We, the undersigned members of the Advisory Committee of **Dr. Birendra Prasad Yadav**, Registration No. M/LPM/63/2000-2001, a candidate for the Degree of Master of Veterinary Science with Major in **Livestock Production and Management** have gone through the manuscript of the thesis and agree that the thesis entitled ***"The effect of various immunomodulators on certain economic traits of broiler chicken"*** may be submitted by **Dr. Birendra Prasad Yadav** in partial fulfilment of the requirements for the degree.

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This is to certify that the thesis entitled ***"The effect of various immunomodulators on certain economic traits of broiler chicken"*** submitted by **Dr. Birendra Prasad Yadav**, Registration No. M/LPM/63/2000-2001, in partial fulfilment of the requirements for the Degree of **Master of Veterinary Science (Livestock Production and Management)** of the Faculty of Post-Graduate studies, Rajendra Agricultural University, Pusa, Samastipur, Bihar, was examined and approved on 12th December 2003.

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AUTHOR

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Date : 02-09-03

Place : Patna

Birendra

(Birendra Prasad Yadav)

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ABBREVIATIONS

%	:	Percent
Ad-lib	:	Ad Libitum
ANOVA	:	Analysis of Variance
ARC	:	Agricultural Research Council
CP	:	Crude Protein
BIS	:	Bureau of Indian Standards
D.F.	:	Degree of Freedom
DM	:	Dry Matter
e.g.	:	For Example
FCR	:	Feed Conversion ratio
gm	:	Gram
J	:	Joule
Kcal	:	Kilo Calorie
Kg	:	Kilogram
M.S.S.	:	Mean Sum of Square
ME	:	Metabolisable Energy
MS	:	Mean Square
NRC	:	National Research Council
NS	:	Non-significant
PI	:	Performance Index
S	:	Significant
SE	:	Standard Error
Wt.	:	Weight

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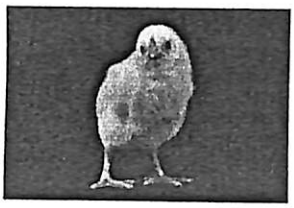
CHAPTER - I



INTRODUCTION

INTRODUCTION

The poultry farming which was a neglected operation till fifties has emerged as the fastest growing segment of agriculture. The radical change in the poultry sector has been possible mainly due to the introduction of superior germplasm, balanced feed, proper health coverage, transfer of technology package and marked support. Presently poultry farming is a specialized activity incorporated in animal husbandry which has its own significance in the country's economy by way of contributing nearly 6.8 percent of the nation's income. (Indian Economic Survey, 2002-2003).

India ranked, the fifth largest egg producing country in the world with the total production of 34 billion eggs in the year 2001-02. Similarly the broiler production in the country is around 700 million broilers. The animal husbandry industry employs 11 million people directly and 8 million people indirectly and adds Rs. 1,79,544 crore at current price which is 27.7% of 6.48,122 crore arising from whole agriculture sector. (Indian Economic Survey, 2002-2003). The present per capita annual consumption is only 35 eggs and 700 gm of poultry meat against 180 eggs and 11 kg of poultry meat recommended by National Institute of Nutrition. Thus there is tremendous scope for poultry sector in our country, especially in the broiler production (Sathe, 2000).

Being more cheaper and palatable, the broiler meat consumption is increasing much faster than goat or sheep meat. Broiler production requires less time and space and is ready for marketing within six weeks. Moreover the feed conversion efficiency of broilers is 2 : 1 as compared to 4 : 1 in pigs and 5 : 1 in sheep and goat. Also the processing losses are minimum and cooked edible portion is maximum in broilers as compared to meat obtained

from animals. For this reason, it is good time for broilers to enter the market (Bhattu, 2000).

In poultry farming, feed is the most important input contributing about 65-70 percent of total cost of production. In order to achieve goal of maximum profitability, the feed should not only be nutritionally balanced but should also be economical. Increase in cost of broiler production is directly proportional to increase in the price of feed and inversely proportional to decrease in its quality (Devegowda, 1990).

Commercial broilers available in our country are attaining around 1.5 kg of average live weight in just 42 days of age requiring only 3 kg of balanced feed. This has been possible due to well-balanced nutrition besides good management and use of growth promoters in diet.

Broilers are known for their faster growth and better feed utilization. Commercial broiler available in our country are gained near 2.00 FCR (Arbind *et al.*, 2001). This has been possible due to well balanced nutrition besides good management and use of growth promoters in their diets. Poultry is the most efficient converter of low value food into high value nutritional food for human consumption.

To boost up the growth of the broilers, various growth promoters have been tried viz. some antibiotics, hormones, surfactants, growth regulators like biostimulators and other drugs like Arsenoids and tranquilizers. The use of these synthetic drugs and chemicals as growth promoters have their inherent disadvantages such as high cost of production, toxicity from prolonged usage, contra-indications, development of resistance and health hazards. The broilers are succumbed to various kind of stress due to the intensive production pressure in the present farming system, which adversely

affect their productive performances. The dietary use of immunomodulator is gaining popularity in recent times to counteract the various stress and leads to better growth rate and FCR.

Immunomodulators are drug that directly modify a specific immune function or have a net positive or negative effect on the activity of immune system. As per Labadie (1993) "Immunomodulator activity" is a collective term indicating biological or pharmacological effects on humoral or cellular factors functioning in the immune response. Each factor and each functional system involved in the immune response may be influenced by various ways. Because of regulatory interactions between humoral and cellular immuno factors in the course of functional process of the immune response, in vitro net effect of an immunomodulators determine whether, a stimulatory or a suppressive action will result.

Thus "Immunosuppression" may result from stimulation of inhibitory cell or humoral factors as well as from inhibition of effector cells or activating humoral factors. On the other hand "Immunostimulation" arises from stimulation of effector cells or the production of their metabolic inducers and possibly from inhibition factors that limit immunogenicity. The early advances in immunopharmacology were reviewed in 1982 by *Sirois et al.* An advance account of advancement in the field appears in some reviews by Lindequist and Teusher (1985), Wagner and Proksch (1985), Wagner (1987) and Labadie *et al.* (1993). The various works has been conducted on liver tonics, herbal medicines, vitamins, minerals etc.

In the market a large number of immunomodulators are available which are used as feed additive in broilers either through water or feed. There is large variation in their cost. Further some of the concentrate

products are also available whose efficacy is yet to be tested. This requires a carefully planned work on newer feed supplements, which are unexplored as regards their effectiveness on broiler performance. Keeping in view of above; the study was undertaken with the following objectives.

OBJECTIVES OF INVESTIGATION

1. To assess the nutritional quality of commercial feed used in the experimental rations.
2. To study the supplementation of various immunomodulators on the growth performance of broilers.
3. To know the effect of various immunomodulators on the carcass quality of broilers.
4. To develop and suggest economical ration based on these findings.

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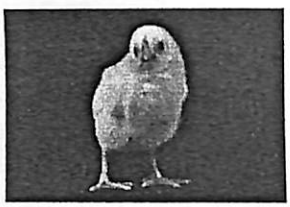
CHAPTER - II



MATERIALS AND METHODS

MATERIALS AND METHODS

The present experiment was carried out to evaluate certain immunomodulators for growth and carcass traits in broilers. The experiment was conducted for a total period of six weeks at Bihar Veterinary College, Patna, Bihar. The experiment was conducted during the months of December 02 and January 2003. The materials used and the procedures followed in conducting the experiment are described as follows.

Experimental Birds :

To start the experiment, day old, 300 broiler chicks of Vencobb strain were purchased. All the chicks were wing banded and vaccinated against Marek's disease on day one and against Ranikhet disease (Lasota strain) on day 10 of study. The birds were also vaccinated against Infectious Bursal Disease (Intermediate strain) on day 15 of study. The cost of each chick was Rs. 14.65.

Experimental design :

In the experiment, day old, 300 broiler chicks were used. After receiving chicks from hatcheries, they were weighed individually and were randomly divided into five different groups having 60 chicks in each replicated thrice of 20 chicks in each replicates. One group was kept control and the other four groups were given four separate treatments. The design of the experiment was completely randomized design.

Housing and Brooding of chicks :

The chicks were reared in deep litter system. The brooding houses were cleaned, washed and disinfected before the start of the experiment. About 5 cm thick layer of fresh, dried, clean paddy straw was used as litter

material. The wet litter was replaced with dry and clean litter during experiment and stirring was done on alternate days. The electric brooders used were also cleaned and fumigated. Each electric brooder was provided with four bulbs of 200 watt each for lighting and maintaining the temperature. The temperature of 95^0 F was maintained for first week, then the temperature was reduced by 5^0F per week upto three weeks of study. After three weeks, temperature in the brooder was maintained at 80^0F till the end of experiment. All efforts were made to maintain brooder temperature during the study period. To record the temperature inside the house, a maximum minimum thermometer was used. The managemental and housing conditions were kept identical for all groups.

Feeding and watering :

During the whole experimental period all mash feeding system was followed. The chicks were fed on broiler starter mash and finisher ration with respective immunomodulator supplementation. Weighed quantity of feed was offered and weekly records of total feed consumption were maintained throughout the study period. Feed wastage was controlled to maximum possible, however, any feed thrown out of pans was collected and weighed. Feed consumption was calculated by subtracting the feed left over on the day of weighing from the total feed offered till then. Care was taken to ensure easy approach of chicks to the feeders. Good quality maize based starter and finisher rations treated with coccidiostats were purchased. Fresh and clean drinking water was made available ad libitum to birds through out the experimental period. Feeders and waterers were cleaned daily to avoid picking of any natural infection. Following medication was provided in drinking water.

Tablet Gramoneg : A product of Ranbaxy Laboratories. Each tablet contains Nalidixic Acid 500 mg.

Doses - One tab to be given in 5 litres of drinking water for first 5 days of life.

Powder Amnovit : A product of Hoechst India Ltd. Each gm contains Vit. A-5000 IU, Vit. D_3-290 IU, Vit E-2 mg, Vit B_2-3 mg, B_6-0.6 mg, B_{12}-4 mcg, Vit. K- 0.4 mg, Niacinamide - 13.2 mg, Calcium pantothenate - 4.4 mg, folic acid 0.1 mg, Choline chloride - 1.5 mg, L-Lysine-10 mg, L-Methionine-20 mg, L-Trytophan-2 mg.

Doses - 1 gm/litre of drinking water on alternate days.

Dietary treatments and their composition :

The following treatment schedule was followed for each group after thoroughly mixing of immunomodulator with feed or water.

T_1	Commercial broiler chick diet (starter and finisher) with no supplementation of immunomodulator.
T_2	As in T_1 + 250 gm herbal liver tonic per ton of feed.
T_3	As in T_1 + 12 ml homeopathic liver tonic (*Chelidonium majus*) per 60 birds biweekly in drinking water.
T_4	As in T_1 + 0.1% neem leaves powder in feed.
T_5	As in T_1 + 75 ppm Vitamin E per ton of feed.

Details of herbal liver tonic used :

Composition	Gm. per 100 gm contains
Yavtikta	7.00
Raktapushpa	6.00
Dhaval	8.00
Varuni	6.00
Markav	8.00
Ugrangandha	5.00
Rohini	10.00
Manthpak	10.00
Dadimpushpak	6.00
Gopvadhu	7.00
Vayasi	5.00
Krishna	2.00
Katurohini	1.00
Tamalki	4.00
Vartikta	4.00
Mayurak	5.00
Pichumand	5.00
Kiratikta	1.00

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Manthpak	10.00
Dadimpushpak	6.00
Gopvadhu	7.00
Vayasi	5.00
Krishna	2.00
Katurohini	1.00
Tamalki	4.00
Vartikta	4.00
Mayurak	5.00
Pichumand	5.00
Kiratikta	1.00

Table No. 1: Composition of Broiler rations (Control)

S. No.	Ingredients	Broilers Starter Ration (Kg)	Broiler Finisher Ration (kg)
1.	Maize	44.70	46.40
2.	Rice polish	15.00	17.25
3.	Deoiled Rice bran	3.30	4.75
4.	Dried soya extract	34.00	28.60
5.	Premix	3.00	3.00
	Total	**100.00 kg.**	**100.00 kg.**

The details of ingredients of premix are given below :

Table No. 2: Composition of premix

S. No.	Ingredients	Amount (Kg.)
1.	Mineral Mixture	2.400
2.	Neftin - 200	0.050
3.	Merivite	0.010
4.	Meriplex	0.020
5.	Common Salt	0.400
6.	Coban	0.120
	Total	**3.000**

Mineral mixture : Contained Ca, P, Fe, Cu, Mn, Co, Zn as per latest recommendation of Bureau of Indian Standards (BIS).

Neftin-200 : A product containing Furazolidine 20% w/w.

Merivite : Each gram contained vitamin A - 82500 IU, B_2-52 mg, D_3-1200 IU, K-10 mg, Ca-100 mg, P-305 mg and carrier q.s.

Meriplex : Each gm contained vitamin B_1-40 mg, B_6-8 mg, B_{12} - 40 µg Vit E-40010mg, Niacin-60 mg, Ca - 180 mg, P-446 mg and carrier q.s.

Coban : 1 kg contains 100 gm Monensin sodium.

Table No. 3: Chemical composition of ration (on dry matter basis) :

Nutrients	Broiler starter ration (Percent)	Broiler finisher ration (Percent)
Moisture	11.91	11.50
Crude protein	22.20	20.00
Crude fibre	5.66	6.00
Ether-extract	4.11	4.40
Total Ash	8.24	9.21
ME (M Cal/kg)	2.8	2.9

The chemical analysis of the control diet was done at Deptt. of Animal Nutrition, Bihar Veterinary College, Patna - 800 014.

Observations and Measurements :

The following parameters were studied and recorded during study.

Body weight :

The body weights of the birds were recorded individually to a minimum of 1.0 gm on the day one, followed by 7^{th}, 14^{th} 21^{st}, 28^{th}, 35^{th} and 42^{nd} day of age on Tulman weighing balance.

Weight gain :

On the basis of body weights, weight gains in different groups were calculated separately. The weight gains were recorded by subtracting the first weight from the last weight of birds, which were recorded at the end of every week.

Feed consumption :

The daily feed consumption was recorded for every group. The left over feed was weighed weekly. The feed intake in different groups were calculated by subtracting the weight of feed left over from the weight of feed offered in whole week to each group. However for calculating the analysis of variance for feed consumption, feed conversion ratio, performance index and economics, five birds from each treatment group were selected randomly and caged individually to record their individual feed consumption.

Feed Conversion Ratio (FCR) :

Body weight gains and feed consumption for a particular week were used to calculate the weekly feed conversion ratio on group basis and individual basis.

$$FCR = \frac{\text{Feed consumption (gm)}}{\text{Body weight gain (gm)}}$$

Performance Index (PI) :

The overall performance index of broilers on group basis and individual basis was calculated by using the formula.

$$PI = \frac{\text{Body weight gain (gm)}}{FCR}$$

Carcass traits :

For carcass traits study, four representative broilers from each group were slaughtered at the termination of experiment. The birds were selected in such a way that they represented the average body weight of the group. The broilers were off fed for 12 hours before slaughter. However, during this period the selected birds were provided clean and fresh drinking water ad libitum.

Before slaughter, each broiler was weighed individually. These broilers were then slaughtered by severing the juglar vein and allowed to bleed completely. After complete bleeding was ensured, manual defeathering using hot water at 50-55^{0}C was done. Head, shank and wing tips were removed by giving cuts at atlanto-occipital, hock and knee joints respectively and their weights were measured. The dressed weights were then recorded as follows.

Dressed weight = Live weight - weight loss as blood, feathers, head, shank and wing tips.

After the dressed weights were recorded, a horizontal cut was applied posterior to keel bone. Breast was pushed forward to expose the viscera, which was then pulled out. Weights of the carcasses were again recorded to calculate eviscerated weight. Liver, heart, gizzard, were detached from rest of the viscera. Gall bladder was removed from liver. Gizzard was opened, its contents were removed and epithelial linings were detached. Individual weights of various organs viz. heart, liver, gizzard were taken. The eviscerated weights were recorded as follows.

Eviscerated weight = Dressed weight - weight of viscera

The eviscerated weight with weight of giblet accounts for edible weight while weight of blood, head, feather, shank, wing tips, viscera and offal comprises of non edible weight. The data obtained from different broilers within a group were averaged and presented.

Mortality :

Separate records were maintained for mortality. The feed consumption and feed conversion ratios were corrected accordingly.

Economics of broiler production :

Following parameters were assessed in this regard.

(i) **Feed cost per kg live weight** - The cost of feed to produce 1 kg live weight of broiler was calculated in each treatment group separately.

(ii) **Return over feed cost** - It was calculated by the following formula:-

(Average body weight of a treatment group x selling price of 1 kg live weight broiler) - (Average feed consumed in kg in that treatment group x cost per kg feed)

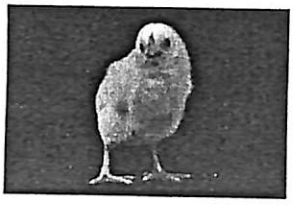
Cost per kg feed = Rs. 11.00

Selling price of one kg broiler (on live weight basis) = Rs. 50.00

Statistical Analysis :

The data obtained during the investigation was statistically analysed using Completely Randomised Design (CRD) according to Snedecor and Cochran (1989) to test the effect of treatments. For calculating the analysis of variance, the number of observations for each treatment group, were made equal by removing the extra number of birds randomly.

CHAPTER - III



REVIEW OF LITERATURE

REVIEW OF LITERATURE

Poultry production was backyard venture in South-Asian countries. However, it has witnessed faster growth than that of other sectors of livestock industry over the last three decades. From a backyard production phase, poultry farming in India has now taken a shape of large scale farming, rearing lakhs of commercial birds. In the coming years poultry farming would increase enormously.

Commercial poultry production is highly profitable. It is not only an issue of improving the profitability of farmers but in the Indian context, the development of poultry can be seen as vital to build a healthier India. It can dramatically alter the picture of animal protein availability in the country.

Commercial broiler production is a specialized and the shortest time span poultry operation. It has been observed that for every 10 kg of feed consumed, poultry yields 450 gm protein against 240 gm from dairy, 96 gm from beef cattle, 225 gm from sheep and 160 gm from swine (Rao, 1987).

The nutritive value of poultry meat is very high and it is also very easily digestible. It has higher protein content than other meats. It contains all essential aminoacids and is a good source of B-vitamins, iron and phosphorous. The fat content in poultry meat is less as compared to other meats. Most of the fat accumulated as subcutaneous fat can easily be removed during dressing. The cholesterol index is much lower in chicken meat than that of beef, veal and pork. On account of higher protein and lower fat content, poultry meat contains less calories per unit of meat.

Poultry meat is much cheaper in comparison to other red meats. This is mainly due to production and development of high potential breeds,

improved feed formulations, differences in production system and less labour involvement in poultry production.

Further the poultry meat is available in convenient sizes from 0.5 to 2.0 kg dressed weight which can be suitable for purchasing even by the persons belonging to average income group.

Status and growth of poultry production in India :

India ranks 5th in annual egg production and eighteenth in broiler production in world in 2002-03 (India, 2003). Growth has increased since 1975 among layers and after 1985 in broilers. In recent years the annual growth rate of crop production was only 1.5 to 2.0 percent while egg production and broiler production has gone up to 4 to 6 percent and 8 to 10 percent respectively during the same period.

Since the growth rate in poultry production has remained substantially above than that of human population in our country, the annual per capita availability of eggs and poultry meat has also gone up appreciably. In spite of the recent spurt, these products have not reached anywhere near the levels of their availability in other developed countries. As the country's economy continues to grow, the demand for these products is bound to go up (Prabaharan, 1999).

At present poultry meat production is estimated at 0.598 million tonnes which accounts only 12% of the total meat production from all sources. (India, 2003, Indian Economic survey 2002-2003). The value of poultry products like egg and poultry meat was about Rs. 9560 crores in 1996-97 which is almost equal to two percent of the GDP while the value of total livestock sector contribution amounts to about 9 percent of the total GDP (Prabaharan, 1999).

Consumption pattern of poultry products in India :

Though at present, the annual per capita availability of egg and poultry meat in India is about 36 eggs and 850 gm respectively, there exists a wide disparity in their consumption levels between urban and rural areas. Nearly 75 percent of eggs and poultry meat are consumed in urban areas which has only 25 percent of the population while in rural areas where 75 percent of the population is concentrated only 25 percent of the poultry products are consumed. For example, the annual per capita consumption in urban areas is above 100 eggs while the same is only about 15 eggs in rural areas (Prabaharan, 1999).

Nutrient requirements of chickens :

Nutrient requirements of chickens are influenced by many factors. These include genetic make up of the stock, factors affecting feed intake, production status of the bird, housing environment particularly temperature, bulk density fat content of diet, nutritional adequacy of diet, digestibility of ingredients and health status of the birds. Blair *et al.* (1988) reported substantial differences in the estimates of nutrient requirements used in various regions of the world for chicken and poultry. The recommendations of BIS (1992) are essentially the guidelines for feed manufactures and are given in table 2.01 and 2.02.

In India, currently in commercial practice, broilers with a live weight gain of 35 gm/bird per day with an energy intake of 200 K cal ME/bird/day reaching market weight in 42 days are used. In earlier days, however, the production potential of broilers was rather low.

In broiler diet, cereals and their by-products are commonly used as energy feeds and oil cakes and fish meal as protein supplements. The better

performance of broilers may be achieved by reducing their mortality and improving the feed efficiency ratio.

Table No.: 4. Requirements for chicken feeds on dry matter basis (BIS, 1992)

Characteristics	Broiler		Chick	Grower	Layer	Breeder
	Starter	Finisher				
Moisture % By mass, max.	11	11	11	11	11	11
Crude Protein % By mass, min.	23	20	20	16	18	18
Crude fibre % By mass, max	6	6	7	8	8	8
Acid Insoluble Ash% By mass max.	3	3	4	4	4	4
Salt (as NaCl), % By mass max.	0.6	0.6	0.6	0.6	0.6	0.6
Lysine %	1.2	1.0	0.9	0.6	0.65	0.65
Methionine %	0.50	0.35	0.30	0.25	0.30	0.30
Metabolisable energy (Kcal/kg)	2800	2900	2600	2500	2600	2600

Table No. : 5. Nutrient levels in chicken diets (BIS, 1992)

Nutrients	Broiler		Chick	Grower	Layer	Breeder
	Starter	Finisher				
Calcium % By mass, max.	1.2	1.2	1	1	3	3
Available Phosphorous % By mass, min.	0.5	0.5	0.5	0.5	0.5	0.5
Manganese (mg/kg)	90	90	90	50	55	90
Iodine (mg/kg)	1	1	1	1	1	1
Iron (mg/kg)	120	120	120	90	75	90
Zinc (mg/kg)	60	60	60	50	75	100
Copper (mg/kg)	12	12	12	9	9	12
Vitamin A (IU/kg)	6000	6000	6000	6000	8000	8000
Vitamin D_3 (IU/kg)	600	600	600	600	1200	1200
Thiamine (mg/kg)	5	5	5	3	3	3
Riboflavin (mg/kg)	6	6	6	5	5	8
Pantothenic acid (mg/kg)	15	15	15	15	15	15
Nicotinic acid (mg/kg)	40	40	40	15	15	15
Biotin (mg/kg)	0.3	0.3	0.3	0.15	0.15	0.20
Vitamin B_{12} (mg/kg)	0.15	0.015	0.015	0.010	0.010	0.010
Folic acid (mg/kg)	1.0	1.0	1.0	0.5	0.5	0.5
Choline (mg/kg)	1400	1000	1300	900	800	800
Vitamin E (mg/kg)	15	15	15	10	10	15
Vitamin K (mg/kg)	1	1	1	1	1	1
Pyridoxin (mg/kg)	5	5	5	5	5	8
Linoleic acid (g/100 gm)	1	1	1	1	1	1
Methionine + Cystinine (g/100 gm)	0.90	0.70	0.65	0.50	0.55	0.56

Immunomodulator and Liver correlations :

Liver is the largest gland in the body. It plays many important functions in the body, some of which are :

- It occupies the most important position in metabolism of carbohydrates, proteins and lipids in the body.
- Liver is also involved in production and destruction of blood cells.
- It plays an important role in synthesis of plasma proteins and proteins including those involved in blood clotting.
- It also helps in storage of glycogen, fat and fat soluble vitamins in the body.
- It is also involved in bile formation including secretion of bile salts and bile pigments.
- It is also involved in detoxification mechanism in the body.
- It plays an essential role in maintaining the biological equilibirum of the poultry birds.

The role played by liver in the removal of substances from the portal circulation makes the liver susceptible to first and persistent attack by offending agents like viruses, chemicals, toxins in feed, peroxides, drugs all culminating in liver diseases and thereby loss in productivity of the birds. Consequently, control of liver diseases has become a major goal of modern poultry practice. Today, herbal liver tonics have an acknowledged role in achieving higher performance and profitability of broiler chicken largely by improving feed conversion efficiency, body weight gain, absence of disease and low mortality (Devegowda *et al.*, 1989; Babu *et al.*, 1992; Narahari, 1995).

The present study involves the use of certain herbal liver stimulants in the broilers. The benefits of herbal products are well known for the better health and production with minimum side effects in animals and human beings. At the same time, they are cheaper and easily available sources compared to chemical factors. Whereas, a lot of work is required to be done on these resources, some scientists have already attempted this aspect and a brief resume of their achievements is being produced below :

Studies on Economic traits and Economics :

Rapid body weight gain is the prime aim of broiler producers. The success of broiler production depends on how rapidly broilers grow to attain a maximum weight in a minimum period. The early growth of broilers is mostly the development of muscular tissues that is deposition of proteins. The rate of body weight gain by the broilers is determined mainly by the species, sex and age of bird, quality of diet and the feed consumption.

Mathur and Ahmed (1968) observed 92.2 and 90 percent dressing percentage at 10 weeks of age in male and female broilers respectively while Seihkiz and Visnijie (1969) observed that the dressing percentage at 9 weeks of age of broilers was 82 percent.

Ramappa *et al.* (1975) studied the effect of Liv-52 on the growth of broiler chickens. They observed higher weight gain in broilers supplemented with either Liv-52 powder or Liv-52 drops.

Ishwar and Mohsin (1981) reported that broiler chicks of commercial strains fed with Leptaden (vet) from 5^{th} to 64^{th} day of age at doses varying from 0.25 to 3.00 mg/kg feed influenced the growth of internal organs. It increased the weight of heart at 1.0 gm/kg dose level (5.41 gm against 4.17 gm in control), liver at 1.5 gm/kg dose level (20.8 gm against 25.31 gm/kg in

control). Weight of kidney at dose level 0.5 gm, 1.0 gm, 1.5 and 2.0 gm/kg and of intestine at 1.0 gm, 1.5 gm and 2.0 gm/kg dose levels increased significantly while weight of spleen reduced at 2.5 gm and 3.0 gm dose level. The drug also reduced the weight of crop, proventriculus, gizzard, caeca and pancreas at various doses.

Khire *et al.* (1981) observed that the supplementation of layer diet with Liv-52 powder was responsible for higher body weight gain and less feed consumption per dozen of eggs produced. They also observed that the dose rate of Liv-52 @ 1.5 gm/kg feed was more economical than the dose rate @ 3 gm/kg diet. They suggested that the beneficial effect of Liv-52 was due to better assimilation of nutrients in the body.

Subramanian *et al.* (1982) observed that broiler chicks fed with Liv-52 powder gained higher body weight and better feed convention in comparison to those fed diet unsupplemented with Liv-52 powder.

Arora and Mohini (1984) studied the supplementary effect of feeding Livol as a feed additive in broiler diet. They observed that when Livol was added in the broiler diet there was stimulating effect on the growth rate of broiler with better feed conversion ratio.

Dakshinkar *et al.* (1984) suggested that supplementation of Livomyn in broiler diet at 0.1 and 0.2 percent level did not show any significant effect on the body weight gain of broilers. They suggested that estimated weights of broilers at the end of nine weeks were not comparable with the control groups i.e. unsupplemented with Livomyn.

Dakshinkar *et al.* (1985) supplemented Liv-52 at 0.1, 0.2 and 0.3 percent level in broiler diets. They observed a significant gain in body weight at nine weeks age. The gain in body weights was more by 39.40,

64.13 and 105.5 gm dressing percentage 96.90, 96.41, 90.88 and edibles meat % 75.19, 73.47 & 70.22 respectively in Liv-52 supplemented groups than the control.

Pandey and Shrivastava (1985) studied the effect of Livol administration in different species. They observed that it was beneficial in checking the hepatic damage and restoring the functions of liver in short period.

Sundararasu *et al.* (1985) studied the effect of supplementation of Livogen at the rate of 10 ml/day per 100 broilers. They concluded that supplementation of Livogen has improved the body weight gain and profit of margin.

Kuppuswamy (1986) studied the supplementation of Livol to toxic diets of broilers. It was found that Livol counteracted the effect of aflatoxin to a greater extent thereby improving the performance of broilers.

Marsh *et al.* (1986) showed that dietary vitamin E and selenium deficiencies depressed the ability of splenocytes to proliferate in culture in response to mitogen. This depression did not appear to be due to reduced lymphocyte viability in culture. Single nutrient deficiency also had a negative effect on mitogen-induced proliferation, with a Se deficiency resulting in a significant impairment of splenocyte responsiveness.

Reddy and Reddy (1986) observed that the inclusion of Liv-52 powder in broiler diet did not significantly influence their weight gains. Addition of Liv-52 was beneficial only upto 2 gm/kg of feed. When Liv-52 was added at the rate of 2.5 gm/kg of feed, there was a depressant effect.

Pradhan *et al.* (1987) fed Livol @ 0.5 and 0.75 gm/bird/day in feed to both male and female broilers separately. They observed that average liver

weight as well as percentage of liver weight in relation to body weight of both male (14.84 gm, 15.58 gm and 1.35, 1.38 percent) and female (12.45gm, 12.68 gm and 1.33, 1.38 percent) broilers fed Livol as 0.5 and 0.75 gm levels differed significantly from their control group (10.25 gm and 1.21 percent , 8.80 and 1.19 percent respectively), although the group fed with Livol did not differ significantly among themselves.

Thangavel *et al.* (1987) studied the supplementary effect of using 1 and 2 percent Livol in broiler diet on their performance. They observed that supplementation of Livol at 2 percent level was responsible for improved performance in comparison to those received 1 percent Livol or without Livol diets. The feed consumption was also higher ($P<0.05$) in broilers received 2 percent Livol diet. However, feed conversion efficiency has not established any significant difference but better efficiency was noted in Livol supplemented groups.

Babu *et al.* (1988) studied the effect of Tefroli in broilers fed at an inclusion rate of 0.1 percent and 0.2 percent level. Significant difference ($P<0.05$) in fed consumption was recorded but feed efficiency has shown no significant difference.

Pradhan and Mishra (1988) studied the efficacy of Livol as a feed additive on the egg production of layers. They observed that the group which received 0.5 gm of Livol per day had increased its egg production from 79.07 percent to 84.07 percent which was followed by 82.25 percent in group which received 0.72 gm of Livol/bird per day. However, considering the cost of extra eggs produced due to feeding of Livol, it was realized that feeding of Livol at dose rate of 0.50 gm per bird per day could bring an extra income (34 paisa per bird per month) to the farmers.

Sapra and Mehta (1988) conducted comparative clinical trial using Livol and antibacterial agent as growth promoter in broilers. These growth promoters were fed at recommended levels to two weeks old commercial broilers for six weeks. It was found that there was reduced percentage mortality and morbidity in Livol fed groups.

Babu *et al.* (1989) conducted an experiment by the supplementation of Nitromin-B in crossbred broiler chickens. They concluded that net profit per broiler in Nitromin-B supplemented group (Rs. 3.36) was significantly higher as compared to control group.

Devegowda *et al.* (1990) studied the effect of Livol supplementation in broiler diet. Dietary treatment consisted of two levels of Livol (0.25 and 0.5 percent of the diet) and one group served as a control. They observed that body weight gain of Livol supplemented groups was significantly ($P<0.01$) superior to control group at all ages. Among the two levels of Livol which were tested, the body weights of broilers which received 0.5 per cent Livol diet were superior than those receiving 0.25 per cent Livol diet.

Koul *et al.* (1990) showed that Neem extract had suppressed pathogenic bacteria including *Staphylococcus aureus*. *Mycobacteria, Salmonella paratyphi* and *Klebsiella pneumonia* and also been used as antimalarial febrifuge, enthelmentic, vermifuge, antiseptic, antimicrobial and as an external applicant against various skin disorder. They also showed that Neem extract inhibited Ranikhet disease virus both in vitro and in vivo.

Roy *et al.* (1990) compared the efficacy of an Indian herbal product IHP-250 and Bifuran against experimental *Eimeria tenella* infection and mixed infection in broiler chicks. The result were assessed by comparison of mortality, faecal oocyst count, lesion score. In all respects, the herbal

products gave better results, when added at 0.3 percent concentration to the feed, than 0.2 percent concentration or 0.125 percent concentration of Bifuran. The product also showed growth promoting activity in both infected and uninfected birds.

Sapra and Mehta (1990) did a comparative study in addition of Livol, CHQ-60, 3-Nitro and TM-10 in the diets of broiler chicks. They observed that Livol fed chicks showed maximum body weight (1302 gm) followed by TM-10 (1291 gm), CHQ-60 (1242 gm), control (1214 gm) and 3-Nitro (1190 gm) groups.

Mishra (1991) assayed the efficacy of Livol powder on broiler chicken with aflatoxin (B_1 and B_2) contaminated feed. They observed that Livol powder counteracts the damaging effects of aflatoxin in feed and allows better survival in broiler chicks.

Panda (1991) did not observe any difference in the weight of liver as well as of spleen and bursa in the Livol fed group @ 0.75 percent, 0.5 percent and 0.25 percent in feed) in comparison to control group (0 percent Livol).

Panda (1991) reported that treatment with Livol is of great help in reducing the toxic effects of carbon tetrachloride by replacing the hepatic cells damaged by carbon tetrachloride in white leghorn cockerels.

Babu *et al.* (1992) studied the effect of Crown Grofit (a herbal tonic powder) as a supplement in broiler diet. It was used at the rate of 0.40 percent in broiler diet. They observed significant ($P<0.05$) improvement in body weight gain in broilers.

Huang *et al.* (1992) fed diets supplemented with 1% mixture of Chinese medicinal herbs, *Astragalus chinesis, Poligonum multiforum* plus

malt, yeast and *ziziphus zuzba* var. spinosa in 400 broilers. They recorded that for broiler of two strains, weight gain was increased by 6.37 and 6.09 per cent. Thus it was concluded that Chinese medicinal herbs had a stimulating effect on growth of broilers.

Narahari (1992) evaluated the relative efficacy of "Actilive forte" on the performance of broilers. In their study, one group of broilers was fed control diet, while second and third groups were fed diet supplemented with Actilive Forte powder (50 gm/quintal of feed) or Actilive Forte liquid (20 ml / 100 birds per day) through drinking water. The Actilive Forte powder was fed through finisher diet for 29-50 days while liquid was given from 30-45 days of age. He observed that administration of "Actilive forte" either through feed or water had resulted in better body weight in broilers.

NRC (1992) found that Neem contains several active ingredients which chemically resemble steroidal compounds, which include cortisone, birth control pills and many valuable pharmaceuticals and belong to a general class of natural products called trniterpenes, more speciafically, limnoids. These compounds are Nimbin, Azadirachtol, Azadirachnol, Azadirone, Azadirachtin, Salan nolides etc. Azadirachtin is a well known compound and active ingredient in Neem extract.

Babu and Panda (1993) studied the immuno stimulating effect of Livol against New Castle disease virus in chicken. They reported that Livol supplementation helped in improving the immune status of the birds.

Dey and Samanta (1993) supplemented garlic *(Allium sativum)* at the rate of 0.25 and 0.5 per cent in the diet of caged broilers. They found that there was gain in body weight of broilers which were fed garlic diets.

McIlroy *et al.* (1993) found improved performance in commercial broiler flocks with sub clinical infectious bursal disease when fed diets containing increased concentration of vitamin E. The economic effects of increased vitamin E supplementation in 79 commercial broiler flock incorporating over 1.5 million birds was assessed. Approximately half of the flocks were fed on either a high (178 IU/kg) or normal (481U/kg) vitamin E containing diet. In addition, in approximately half of the flocks sub clinical IBD was present. Analysis of the performance data showed that flocks with sub clinical IBD were consistently worse for net income, feed conversion ratio and average weight per bird than flocks without sub clinical disease. The trial also indicated that the average net income of flocks with sub clinical IBD and fed a high vitamin E containing diet was of better than that from flocks with sub clinical IBD and fed a normal vitamin E containing diet. The trial also showed that the difference between the average net income achieved by flocks without sub clinical IBD and being fed on either a high or a normal vitamin E containing diet was only 2% and not significantly different. It was suggested that the improved performance from high vitamin E containing diet recorded in flocks with sub clinical IBD is due to enhanced immunocompetence and increased resistance to disease. It was also suggested that under field conditions high dietary inputs of vitamin E are most beneficial where there is a challenge to the defence system of the host and that significantly improved performance would occur more predicatably under such conditions.

Prasad and Sen (1993) fed diets containing Livol, Leptaden or Biospur (Growth promoters) to different groups of fowl in which one group was kept

control. They observed that Livol significantly improved the feed conversion efficiency in broilers.

Sinha *et al.* (1993) used Liv-52 at the rate of 1 mg/kg in the basal diet of day old chickens for 7 days. It was found that Liv-52 improved the feed conversion efficiency of broilers.

Wang and Hacker (1993) observed the addition of 3500 mg/kg of diaoxinxuekang, an extract from wild plant containing saponins did not affect the heart weight of broilers. When this extract was given in higher doses, the liver weights in fowls were higher than in controls.

Abdulhamid *et al.* (1994) supplemented diets containing gibberellic acid @ 1,5,25 and 125 mg/kg for 3 weeks and observed that carcass weight and muscle protein decreased and fat percent increased significantly in broilers.

Ali *et al.* (1994) reported that Livol treatment improved the survival rate, dressing percent and eviscerated meat yield percent but had no effect on abdominal fat.

Ali *et al.* (1994) conducted an experiment in which Livol was fed to the broiler chickens at the dose rates of 0,0.25, 0.50 and 0.75 per cent from 1 day to 8 weeks of age. They concluded that Livol reduced the production cost of broilers at inclusion rates of 0.25 and 0.50 percent in the diet.

Chatterjee *et al.* (1994) investigated the immunomodulatory effect of herbal product IMMU-21 (research name) in different laboratory animals. He found that animals treated with IMMU-21 (20 mg/kg) significantly increased the microbicidal activity of neutrophils in the experimental animals, it may be due to its decreasing effect on circulating level of corticosteroids under the basal level. Increase in soluble immune complex in

the serum of the experimental animals also indicated immunopotentiating action of IMMU-21. At a dose of 20 mg/kg it caused a significant increase in the antibody titres in both the primary and secondary immunity assay while a higher dose (200 mg/kg) of IMMU-21 did not significantly alter the antibody titre and showed slight immunosuppressive effect.

El Gendi *et al.* (1994) supplemented the diet of day old chickens with herbal growth promoters (Cocci-Nel and Lomoton). They concluded that when Lomoton or Cocci-Nel was given at the rate of 500 gm per ton of feed, there was improvement in feed conversion efficiency of the chicks.

Pande and Vijay Kumar (1994) studied the immunomodulatory effect of zeetress in chicken vaccinated against ND (F strain) virus. Zeetress was administered at the rate of 5 g/1000 chicks through the drinking water for first 10 consecutive days and thereafter at the rate of 10 g/1000 birds from 24 to 35 days. On 35 day serum samples were collected for HI test. It was found that antibody titres, body weight gain and feed efficiency were significantly higher than untreated vaccinated control.

Panda and Rao (1994) observed the effect of a vitamin E-Selenium combination in chickens infected with infectious bursal disease virus. Ninty male chicks from a single hatch were divided into 6 groups and infected with infectious bursal disease virus by intraconjunctival inoculation at one day old. Two groups of IBD infected birds and 2 of uninoculated birds were stimulated with a subcutaneous injection of *Brucella abortus* antigen at the end of the second weeks (Primary stimulation) and third week (Secondary stimulation). A vitamin E selenium supplement (E care Se), at the rate of 25 mg/bird orally in drinking water on alternate days from one day old throughout the experiment, was given to 2 group of birds (one IBD infected

and *B. abortus*, stimulated and one non-IBD infected but *B. abortus* stimulated). Serum samples were collected weekly from one week after the secondary stimulation for 4 weeks and the humoral response measured by the tube agglutination test. Birds were killed by the end of the seventh week. Birds with a bursa : body weight index lower than 0.85 were considered to have bursal atrophy. Antibody titres were detected only in response to *B. abortrus* stimulation. The immunosuppressive effect of the IBD virus was indicated by the fact that the IBD infected untreated (with vitamin E-selenium) birds had the lowest geometric mean titres. The vitamin E-selenium treatment significantly boosted both the GMT in IBD infected birds in comparison with untreated, infected birds. There was no significant difference between the GMT of untreated uninfected birds and treated, infected birds. The supplementation had no effect on bursa : body weight ratio in IBD-infected birds and the bursa of these birds showed IBD specific lesions in about 50% of the follicles. The findings strongly suggest the enhancement of immune responses due to vitamin E–selenium supplementation in IBD infection.

Rao and Reddy (1994) studied the effect of Livol at the rate of 0.25 percent on performance of broilers fed on aflatoxin supplemented diet. They observed that weight gain was poor in broilers fed diet containing aflatoxin but without Livol supplementation. It was 21.07 percent less in comparison to control birds but was increased in birds fed aflatoxin and Livol. It was concluded that Livol is effective in reducing the adverse effect of aflatoxin in poultry.

Narahari (1995) studied the economics as well as performance promoting ability of Livfit in broilers. He observed that feeding commercial

broilers with a diet containing 0.2 percent Livfit from 0 to 50 days of age have resulted in improved net profit (8.63 percent) and benefit cost ratio (1.41 percent) and thus resulting in an additional net profit of Rs. 1.18 per broiler.

Parida *et al.* (1995) conducted an experiment on three groups of 1 day old broiler chicks having control feed, aflatoxin at 2 ppm or aflatoxin 2 ppm plus Livol 0.2 percent powder until 8 weeks of age. It was observed that histopathological changes in liver, kidney, heart, bursa, brain and lungs of aflatoxin fed chicks were very severe in comparison to chicks fed aflatoxin plus Livol, thus indicating the protective action of Livol.

Gowda *et al.* (1996) studied on effect of feeding Neem *(Azadirachta indica)* kernel meal on the performance of White Leghorn layers. The response of White Leghorn layers to dietary neem kernel meal (NKM) employed at 10% level for part of soybean meal and rice bran in a standard layer mash (DI) either as such (D2) or pretreated with 2% aqueous NaOH (1:1:2) for 24 hrs (D3) was examined. Each of the three diets was offered to 16 hens housed individually in laying cages at 48-wk of age for a 12-wk period. Observations on feed intake, egg production and quality were made periodically. Mean feed intake in groups D1, D2 and D3 was 104, 105 and 108 (± 0.89) g/d, respectively. Values for percent egg production were 76, 77 and 77 (± 0.26) and for egg weight 56.6, 56.4 and 56.3 gm (± 0.34 g) respectively. Feed required to produce one kg egg mass was found to be similar at 2.4 ± 0.03 kg in all the groups. Corresponding mean values for egg shape index were 73, 73 and 72 (± 0.29); for albumen index 0.07, 0.07 and 0.06 (± 0.002); for yolk index 0.40, 0.39 and 0.38 (± 0.002); for Haugh unit 74, 75 and 71 (± 0.78) and for yolk colour index 8.8, 8.5 and 8.6 (±0.06).

broilers with a diet containing 0.2 percent Livol ... tion of delayed type of have resulted in improved net profit (8.63 percent ... (1.41 percent) and thus resulting in an additional ... s disinfectant in poultry shed broiler.

Parida *et al.* (1995) conducted an experiment on ... ain was significant (P<0.05) old broiler chicks having control feed, aflatoxin at 2ppm ... f various feed additives on plus Livol 0.2 percent powder until 8 weeks of age ... Neem leaves powder for a histopathological changes in liver, kidney, heart, bursa ... ght of 1883 ± 29 gm and aflatoxin fed chicks were very severe in comparison to ... t. It indicates that Neem plus Livol, thus indicating the protective action of Livol ... h other additives, but

Gowda *et al.* (1996) studied on effect of feeding ... *indica)* kernel meal on the performance of White ... chicks were response of White Leghorn layers to dietary neem ... m 80 mg/kg) employed at 10% level for part of soybean meal and ri ... an in thesis was layer mash (DI) either as such (D2) or pretreated with 2% aqu ... gh dietary (1:1:2) for 24 hrs (D3) was examined. Each of the three diets wa ... he serum 16 hens housed individually in laying cages at 48-wk of age fo ... hile their period. Observations on feed intake, egg production and quality ... y vitamin periodically. Mean feed intake in groups D1, D2 and D3 was 10 ... d with a 108 (± 0.89) g/d, respectively. Values for percent egg production ... on after 77 and 77 (± 0.26) and for egg weight 56.6, 56.4 and 56.3 gm (... did not respectively. Feed required to produce one kg egg mass was fo ... similar at 2.4 ± 0.03 kg in all the groups. Corresponding mean valu ... n E (0, shape index were 73, 73 and 72 (± 0.29); for albumen index 0.07, ... year, 0.06 (± 0.002); for yolk index 0.40, 0.39 and 0.38 (± 0.002); for H ... 9.5%, 74, 75 and 71 (± 0.78) and for yolk colour index 8.8, 8.5 and 8.6 ... 2.36

The mean egg shell thickness was found at 0.32, 0.32 and 0.33 (±0.06) mm. This data suggest that feeding NKM to hens upto 10% dietary level had no adverse effect on any of the above parameters. Besides, no change in taste or appearance of eggs received from NKM-feed hens were noticed.

Haq, *et al.* (1996) studied Neonatal immunity of chicks hatched from breeders fed on diets supplemented with β-carotene, canthaxanthin, lutein or vitamin E was studied. Broiler breeders were fed on a control diet or diets supplemented with 0.04% β-carotene, 0.04% canthaxanthin, 0.04% lutein, 0.03% α-tocopherol acetate, or 0.04% β-carotene plus 0.03% α-tocopherol acetate. Three weeks after initiation of experimental feeding, birds were vaccinated against Newcastle disease virus. Chicks hatched from the eggs of these breeders were used to study neonatal immune responses. There were no significant differences in weight gain and antibody titres of 3-week-old chickens. ^{3}H-Thymidine uptake by bursal lymphocytes when stimulated with tetrahydrofuran was significantly higher for chicks hatched from breeders supplemented with vitamin E, or vitamin E plus β-carotene, than in controls. ^{3}H-Thymidine uptake by splenic lymphocytes when stimulated with concanavalin A and phorbol 12-myristate-13-acetate was significantly higher for chicks hatched from breeders supplemented with vitamin E or β–carotene alone, or vitamin E plus β-carotene, than for control chicks. Chicks hatched from hens given vitamin E had significantly higher antibody titres at 1 and 7 days of age than chicks from the control group. It is concluded that vitamin E supplementation of breeder birds increased the immune response of their progeny.

Jamkhedkar (1996) found that Neem acts as immunomodulator by anti complementary activity in classical and alternate pathways, adjuvant activity

The mean egg shell thickness was found at 0.32, 0.32 and 0.33 (±0.06) mm. This data suggest that feeding NKM to hens upto 10% dietary level had no adverse effect on any of the above parameters. Besides, no change in taste or appearance of eggs received from NKM-feed hens were noticed.

Haq, *et al.* (1996) studied Neonatal immunity of chicks hatched from breeders fed on diets supplemented with β-carotene, canthaxanthin, lutein or vitamin E was studied. Broiler breeders were fed on a control diet or diets supplemented with 0.04% β-carotene, 0.04% canthaxanthin, 0.04% lutein; 0.03% α-tocopherol acetate, or 0.04% β-carotene plus 0.03% α-tocopherol acetate. Three weeks after initiation of experimental feeding, birds were vaccinated against Newcastle disease virus. Chicks hatched from the eggs of these breeders were used to study neonatal immune responses. There were no significant differences in weight gain and antibody titres of 3-week-old chickens. ^{3}H-Thymidine uptake by bursal lymphocytes when stimulated with tetrahydrofuran was significantly higher for chicks hatched from breeders supplemented with vitamin E, or vitamin E plus β-carotene, than in controls. ^{3}H-Thymidine uptake by splenic lymphocytes when stimulated with concanavalin A and phorbol 12-myristate-13-acetate was significantly higher for chicks hatched from breeders supplemented with vitamin E or β–carotene alone, or vitamin E plus β-carotene, than for control chicks. Chicks hatched from hens given vitamin E had significantly higher antibody titres at 1 and 7 days of age than chicks from the control group. It is concluded that vitamin E supplementation of breeder birds increased the immune response of their progeny.

Jamkhedkar (1996) found that Neem acts as immunomodulator by anti complementary activity in classical and alternate pathways, adjuvant activity

on specific antibody production and induction of delayed type of hypersensitivity.

Prakash *et al.* (1996) used Neem extract as disinfectant in poultry shed housing with 0.3% Neem spray. Body weight gain was significant ($P<0.05$) over other type of disinfectant.

Wanjane *et al.* (1996) studied the effect of various feed additives on the performance of broilers and found that 0.1% Neem leaves powder for a period of 8 week of age gives average body weight of 1883 ± 29 gm and cumulative feed efficiency 2.35 at end of experiment. It indicates that Neem leaves powder at 0-17 has shown comparable result with other additives, but better economic efficiency in broiler ration.

Wen *et al.* (1996) studied from 1 to 28 days of age 672 chicks were given diets containing different concentrations of vitamin E (40, 80 mg/kg) and ascorbic acid (200, 400, 800 mg/kg). Ascorbic acid synthesis was increased in those on high dietary vitamin E (80 mg/kg), but high dietary ascorbic acid did not compensate for low dietary vitamin E. The serum vitamin E of the chicks declined rapidly with increasing age, while their capacity to synthesize ascorbic acid increased with age. High dietary vitamin E (80 mg/kg) increased the HI antibody titre in chicks immunized with a Newcastle disease vaccine and also lymphocyte transformation after stimulation with phytohaemagglutinin; ascorbic acid in their diet did not have these effects.

Coskun *et al.* (1997) studied, when 3 different levels of vitamin E (0, 5, 35 or 70 IU/kg feed) were added to the diet of 864 laying hens for a year, the mean egg production of the 4 groups was 79.9, 80.6, 77.2 and 79.5%, respectively, and the feed consumption for 1 kg of eggs was 2.23, 2.23, 2.36

and 2.20 kg. There were no differences in blood vitamin E levels, T lymphocyte percentages, spleen plasma cell counts, or antibody titres to Newcastle disease vaccination. Their chicks did not differ in maternal antibody titres or in the histological findings in the spleen, bursa fabric, thymus or ileum.

Gore *et al.* (1997) showed that three days prior to hatch, the amnion of turkey embryos was injected with vitamin E 10, 20 or 30 IU (experiments 1 and 2). In experiment 3, broiler embryos received vitamin E 10 IU. In all 3 experiments, sham-injected control embryos received saline 300 µl. In experiments 1 and 2, vitamin E 20 and 30 IU reduced ($P \leq 0.05$) hatchability by 30 to 56% below that of controls. At hatch, poults exhibited a dose-related increase ($P<0.05$) in plasma vitamin E levels. Mean liveweight gain up to 35 days, relative bursa of fabricius and spleen weights were not different among treatments. When challenged at 7 days post hatch, total anti-sheep red blood cell (SRBC) ($P<0.05$) and IgM ($P<0.08$) antibodies were higher in poults treated with vitamin E 10 IU than in controls. IgG levels did not differ between treatment groups. Poults treated with Vitamin E 10 IU had higher ($P<0.002$) numbers of Sephadex elicited inflammatory exudates cells, as well as a greater percentage of phagocytic macrophages ($P<0.0001$). Percentage of phagocytic macrophages and the number of SRBC internalized by each phagocytic macrophage were higher ($P<0.0001$) in poults treated with vitamin E 10 IU compared with control poults. In experiment 3, chick embryos exposed to vitamin E 10 IU, showed no differences in hatchability, liveweight gain or bursal and splenic weights compared with the sham-exposed group. However, total antibody and IgM antibody responses against SRBC were greater ($P<0.01$) at 7 days post-

injection. A secondary SRBC challenge given 14 days after primary injection resulted in higher total antibody ($P<0.07$) and lgG ($P<0.04$) antibody responses compared with the control group; vitamin E-treated chickens also has more Sephadex-elicited abdominal exudates cells ($P<0.07$), greater macrophage phagocytic potential ($P<0.0001$) and increased production of nitrite by macrophages ($P<0.04$). The results demonstrate an enhanced antibody and macrophage response and suggest that in-ovo exposure with vitamin E may improve post-hatch poult and broiler quality.

Mezes *et al.* (1997) vitamin E was estimated in blood plasma and liver of chickens during the first 5 weeks of life, and in geese, during the first 40 days. The results showed that plasma vitamin values increased constantly in both species, whereas liver vitamin E concentrations decreased sharply, especially within the first weeks of life, due probably to changes in the activity of tocopherol reductase.

Prajapati (1997) conducted a trial on commercial broilers in which Livfit vet premix was incorporated at the rate of two kg per ton of feed from 1-42 days of age. He concluded that cost benefit analysis revealed net additional gain of Rs. 1.84 per bird which was attributed to Livfit supplementation.

Prajapati (1997) conducted experiment in which Livfit Vet premix was incorporated at the rate of two kg per ton of feed in one group and other group was kept control. There was improved feed conversion ratio in group fed with Livfit premix compared to untreated control.

Raza *et al.* (1997) used two hundred and ten broiler chicks, 1 day old, were assigned to 3 groups and fed for 49 days on a diet containing normal, excess (300IU/kg) or deficient vitamin E. Vitamin E supplementation had

beneficial effects on liveweight gain, weight of lymphoid organs, feed intake, feed conversion efficiency, serum antibody development against Newcastle virus disease vaccination, phagocytic index and delayed hypersensitivity index, while vitamin E deficiency adversely affected all these parameters, vitamin E supplementation or deficiency had no significant effect on haematological values.

Rajamane *et al.* (1997) conducted an experiment to study the efficiency of "Stressroak" a herbal preparation in stress condition on broilers. It was observed that birds under stress, when supplemented with "Stressroak" showed significant improvement of 15-19 percent in live weights, feed consumption and feed conversion ratio.

Dua (1998) supplemented Livfit vet concentrate @ 500 gm per ton of feed from 0 to 42 days of age in broilers. He obtained a highly favorable cost benefit ratio with supplementation of Livfit vet.

Kurtoglu *et al.* (1998) showed the effect of vitamins A or E, or both, on antibody titres and blood T-lymphocyte percentage values was studied in chickens vaccinated with Gumboro. Blood immunoglobulin (Ig) G increased considerably after vaccination. Vitamin A excess, 80000 IU/kg diet, suppressed antibody titres and increased T-lymphocyte and IgG values. Vitamins A and E given together reduced the level of increase in T-lymphocyte values.

Qiao *et al.* (1998) reported in their laboratory and field experiments that Heartway, a Chinese herbal medicine was very effective in preventing and controlling ascites in broiler chickens.

Sadekar *et al.* (1998) reported the usefulness of *Ocimum sanctum* (tulsi) dry leaves as immunomodulator in poultry, naturally infected with

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Sadekar *et al.* (1998) reported the usefulness of *Ocimum sanctum* (tulsi) dry leaves as immunomodulator in poultry, naturally infected with

IBD virus. He found that HI titre against ND vaccination in *Ocimum sanctum* treated groups was significantly higher in comparison to unvaccinated and untreated control as well as vaccinated untreated control groups. Attainment of significant high titres at the end of 45 days of *Ocimum sanctum* administration seemed to have overcome the immunosuppressive effect of IBD on lymphoid organs and has stimulated antibody production in these birds.

Sadekar *et al.* (1998) evaluated immunopotentiating effects of *Azadirachta indica* (Neem) dry leaves powder in broilers, naturally infected with IBD virus. Commercial broilers were divided into 3 groups at 6 weeks of age. The birds had been vaccinated with NDV (Lasota strain) at one day of age and had survived a natural outbreak of IBD. Group, 1 were control, group, 2 were given a booster vaccination (NDV strain R_2B) and group, 3 were given a booster vaccination and fed with powdered neem leaves (125 mg/bird) daily for 2 weeks. Treatment with neem leaves significantly enhanced the antibody titres against NDV antigen and also potentiated inflammatory reactions to dinitrochlorobenzene in skin test. It is concluded that feeding neem leaves to immunosuppressed birds increases their humoral and cell mediated immune responses. It is suggested that neem leaves may be useful for treatment of immunosuppressive diseases, such as IBD in birds.

Shadaksharappa *et al.* (1998) evaluated the immunomodulatory effect of vitamin E, vitamin C and levamisole hydrochloride on immune response against IBD vaccination in broilers. They observed that the mean antibody titre were comparatively higher but non-significant in both the vitamin E and vitamin C treated and levamisole treated and vaccinated groups than vaccinated control group. The mean antibody titres showed appreciable

increase when combined treated with both vitamin E and levamisole hydrochloride as compared to that of either vitamin E or levamisole hydrochloride alone. This observation indicated the synergistic action of these compounds.

Ye *et al.* (1998) studied the effect of herbal bioactive substances (HBAS) on the growth rate of broilers. The studied diets containing 0.10 percent (T_1) and 0.15 percent (T_2) HBAS were fed until 42 days of age. A control group was also supplemented with antibiotics. There was an improvement in feed conversion ratio by 8.9 percent when 0.10 percent HBAS was added in the diet.

Biswas *et al.* (1999) recorded the performance of broilers given low or normal energy diets containing or not containing commercial enzyme preparation (Anizyme) or herbal preparation (Digestovet) for 6 weeks. Weight gains were more in enzyme and herbal treated groups than control groups.

Kolte *et al.* (1999) evaluated the immunomodulatory effect of dry powder of *Ocimum sanctum* (Tulsi) and leaf gall of Ficus racemosa (Gular) leaves in broilers, stunted and immunosuppressed by IBD virus. Result indicated that HI titre against NDV was lower in all groups before drug treatment. The titre was found significantly raised in drug treated groups. Birds which received a combination of both the birds revealed the highest HI antibody titre as compared to other treatment group. These observations were clearly indicative of the fact the all the tested plant preparations have specific immunostimulatory effect on humoral immune response. Cellular reaction at the DNCB skin contact site revealed that reaction was intense in *O. sanctum* treated and *O. sanctum* plus leaf gall treated group. This

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observation indicated that the said plant preparations also potentiated the non specific cell mediated immunity in IBD affected birds.

Saravanabava *et al.* (1999) planned an experiment to assess the effect of Tuftsin (a tetrapeptide) on immune response of birds immunosuppressed to IBD virus. The result indicated that the seroconversion to NDV vaccine as assessed by HI and ELISA were found to be higher in the birds vaccinated along with Tuftsin as compared to the birds vaccinated without tuftsin both in the immunosuppressed and immunocompetent birds. The percentage of leucocyte migration inhibition was also found to be more in the tuftsin administered birds as compared to the birds without tuftsin. Percentage of survivability was found to be more in birds vaccinated along with tuftsin as compared to the birds vaccinated without tuftsin. All the unvaccinated birds succumbed to new castle disease. Administration of tuftsin alone (without vaccine) did not produce any significant reversing effect in birds. It was concluded that tuftsin produced significant reversing effect of immunosuppression caused by IBDV infection and significant immune enhancement in immunocompetent birds irrespective of the schedule of vaccination and type of vaccine virus used.

Hindustani (2000) analysed the efficacy of certain agents on enhancement of immune responses to intermediate plus infectious bursal disease virus vaccine in broiler chicken. He utilized E-care Se, famitone, zeetress and combination of Homoeopathic drugs (*Carbo vegetabilis 200, Carbo enmalis 200 and Thuja occidentalis 200*) as immunomodulator to different groups. At the end of experiment (on 42nd day) final body weight recorded were 1219.80, 1211.90, 1255.20 and 1358.10 gm respectively whereas the feed conversion ratio were 2.355, 2.367, 2.308 and 2.269

respectively. The homoeopathic drugs treated group was having only 11.54% mortality while the untreated control has 20.27%.

Kumar (2000) treated IBD vaccinated birds with different immunomodulators. He evaluated vitamin A, Vitamin C, Livol, Levamisol, homeopathic liver tonic *(Carbo veg)* and sporlac as immunopotentiator in different groups and after 47 day of age and obtainted body weight 1534.28; 1515.15, 1502.85, 1680.88, 1713.23 and 1551.56 gm respectively where as FCR recorded were 2.20, 2.37, 2.50, 21.45, 2.20 and 2.40, respectively. The various treatments also reduced mortality.

Arbind *et al.* (2001) were able to increase FCR 2.13 with various combination of vitamin E and organic selenium in broilers. They also shown significant weight gain in broilers with these combination. Dressing yield difference was non significant where as various immunological parameters viz. bursa, spleen, thymus etc., Elisa test for IBD and ND shown significant difference. Effect of dietary inclusion of organic selenium at two levels 0.10 and 0.15 ppm along with vitamin E at two levels 50 ppm and 75 ppm on growth, FCR, feather score, dressing, weight of thymus, bursa and spleen and various ages, Elisa titre levels of IBD and ND and Se concentration in liver and meat were studied. Growth and feather score traits were studied for males and females separately in 2 x 2 x 2 factorial experiment whereas other traits were studied with sexes intermingled in 2 x 2 factorial experiment. Males were heavier than females at 42 day age ($P<0.01$). Females had better feather score at 28 days but by 42 days, feather score of males was compared to that of females. Level of organic selenium did not influence these traits. Higher vitamin E level (75 ppm) resulted in higher body weight, better feather score and better FCR ($P<0.01$). Mortality was not noticed in any

group during the course of trial. Overall, a combination of organic Se at 0.10 ppm and vitamin E at 75 ppm was found to give consistently superior results for growth traits, while a combination of Se at 0.15 ppm and vitamin E at 75 ppm gave superior result for immunological traits.

Kujur (2001) evaluated certain immunomodulatory agents in countering immunosuppressive effects of vaccine strain of infectious bursal disease virus in chicken. She treated vaccinated birds with IMMU-21, Charak-E-sel, Neem leaves powder, Tulsi and homoeopathic drug *(Thuja Oc.)* to different treated groups. On 42nd day final body weight were 1097.38, 1097.38, 1056.67, 1131.19 and 1034.29 gm respectively and feed conversion ratio were 2.10, 2.22, 2.21, 2.28 and 2.12 respectively in different treated groups IMMU-21, Charak-E-sel, Neem leaves powder, Tulsi and homoeopathic drug.

Kumar (2002) evaluated Levamisole, polyzyme vitamin E, Bhang, Amla and *Carbo animalis* in reversing the immuno suppressive effects of infections bursal disease virus vaccine in chicken. He observed final body weight 1501.49, 1453.72, 1603.04, 1616.33, 1561.46 and 1488.74 gm in treated group Levamisole, Polyzyme, Vit. E, Bhang, Amla and *Carbo animalis,* respectively, on 45th day of age. FCR were 2.28, 2.33, 2.38, 2.45, 2.39 and 2.30 in treatment group with Levamisole. Polyzyme, Vit. E, Bhang, Amla and *Carbo animalis* respectively. The result showed significant difference in feed conversion ratio and final body weight gain.

Rawat *et al.* (2002) studied immunomodulatory effect of vitamin E on immune response of *P. multocida* (P_{52}) whole cell vaccine prepared as multiple emulsion was studied in rabbits. D-tocopherykl acetate was blended with multiple emulsion vaccine (MEHS) @ 30 mg/ml before immunization.

Two groups of 6 healthy adult rabbits each, were immunized by 2 ml I/M dose of ME vaccine with (MEHS-E) and without (MEHS-P) vitamin E. Humoral and cell mediated immune response were monitored by IHA, ELISA and LMIT, respectively. All the immunized rabbits along with 2 controls were challenged with 10 LD_{50} dose of 18 hr old growth of *P. multocida* (P_{52}) on 21st day post-immunization. Mean IHA and ELISA log antibody titres in group immunized with MEHS-E vaccine on 21st DPI were 5.12 ± 0.17 and 7.37 ± 0.19 respectively. The mean IHA and ELISA titres of group immunized with plain MEHS vaccine were lower, with values of 4.99 ± 0.26 and 7.06 ± 0.09 respectively. Not much difference in the migration index (MI) was observed between the two immunized groups on the day of challenge. A 100% protection was observed in groups immunized with ME vaccine along with vitamin E, whereas only 80% protection could be observed in rabbits immunized with ME vaccine alone. The findings suggested that vitamin E augmented the immune response of rabbits not only in terms of humoral antibody titres but also in terms of protection after direct challenge test.

Satturwar *et al.* (2002) studied the immunomodulatory effect of a polyherbal formulation, *Haridradi gharita*, a ghee based formulation claimed to be an immunopotentiator and hepatoprotective. The ingredients in the drug contained Cow's ghee, *Embilica officinalis, Terminalaia chebula, Terminalaia bellirica, Azadiracta indica, Sida cordifolia* and *Glycorrhiza glarbra*. The trial was carried out in wistar rats, where the formulation was fed orally at a dose of 100 mg/kg and 200 mg/kg daily. The assessment of the immunomodulatory action was carried out by testing the haemagglutinating antibody titre (HA titre) for humoral and delayed type

hypersensitivity (DTH response) for cellular immune responses to the antigenic challenges with sheep RBCs and by Neutrophil adhesion test. Increase in both, HA titre and DTH response indicated that the *Haridradi ghrita* potentiates humoral as well as cellular immunity. The neutrophil adhesion was increased as compared to control. It was concluded that *Haridradi ghrita* promises strong utility in clinical practice.

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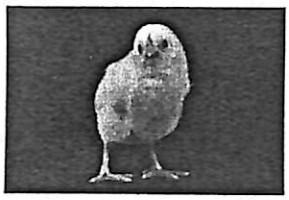
CHAPTER - IV



RESULTS AND DISCUSSION

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Body weight :

Average body weight of broiler chicken at different weeks of age are presented in Table No. : 6. On 7th day, average body weight were 112.4, 117.96, 117.83, 110.55, 118.93 gm per chick respectively, in group T_1, T_2, T_3, T_4 and T_5. On 14th day average body weight were 227.57, 262.67, 250.23, 262.42 and 262.9 gm per chick respectively, in group T_1, T_2, T_3, T_4 and T_5. On day 21st, the average body weight was maximum in group T_5 (525.46 gm per chick) followed by T_2 (523.93 gm per chick), T_4 (495.05 gm per chick), T_3 (480.00 gm per chick) and minimum in control T_1 (448.58 gm per chick). On 28th day average body weight were 731.79, 866.68, 752.88, 807.23 and 892.27 gm per chick respectively, in group T_1, T_2, T_3, T_4 and T_5. On 35th day of experimental period highest average body weight was recorded in group T_5 (1132.41 gm per chick) followed by T_2 (1094.07 gm per chick), T_4 (983.88 gm per chick), T_3 (949.68 gm per chick) and minimum in control group T_1 (922.08 gm per chick). At the end of experimental period i.e. on 42nd day maximum average body weight was recorded in treatment group T_5 (1455.28 gm per chick), followed by T_2 (1401. 43 gm per chick) and minimum in control group (1128.61 gm per chick).

Body weight gain :

Weekly body weight gain (gm/chick) has been presented in Table No.: 7 and Analysis of variance has been presented in Table No. : 8. The result of analysis of variance on body weight gain during all weeks revealed highly significant difference ($P<0.01$) among various treatment means. Critical difference (C.D.) test of 1st week of age revealed that there was significant

Table No. : 6.

Mean ± SE and CV (in %) of body weight (in grams) of broiler chicken at different weeks of age.

Period (in days) / Treatment groups	7th days		14th days		21st days		28th days		35th days		42nd days	
	Mean ± SE	CV%	Mean ± SE	CV%	Mean ± SE	CV%	Mean ± SE	CV%	Mean ± SE	CV%	Mean ± SE	CV%
T_1	112.4 ± 1.115	7.69	227.57 ± 1.677	5.611	448.58 ± 2.239	3.8	731.79 ± 1.968	2.01	922.08 ± 1.729	1.40	1128.61 ± 1.975	1.308
T_2	117.97 ± 1.059	6.96	262.67 ± 1.383	4.08	523.93 ± 1.83	2.71	816.68 ± 1.22	1.08	1094.07 ± 1.556	1.083	1401.43 ± 1.632	0.88
T_3	117.83 ± 1.043	6.86	250.23 ± 1.15	3.56	480.00 ± 1.213	1.96	752.88 ± 1.355	1.38	949.68 ± 1.89	0.95	1211.14 ± 1.91	0.75
T_4	110.55 ± 1.038	7.154	262.42 ± 1.49	4.08	495.05 ± 1.10	1.66	807.23 ± 1.517	1.42	983.88 ± 1.44	1.09	1245.8 ± 1.39	0.84
T_5	118.93 ± 1.008	6.56	262.9 ± 1.374	4.05	525.46 ± 1.828	2.70	892.27 ± 1.94	1.67	1132.41 ± 1.71	1.48	1455.28 ± 1.69	0.88

Table No. : 7.

Mean ± SE and CV (in %) of body weight gain (g/chick) of broiler chicken at different experimental periods.

Period (in days) / Treatment groups	0-7th days		7-14th days		14-21st days		21-28th days		28-35th days		35-42nd days		0-42nd days	
	Mean ± SE	CV %	Mean ± SE	CV %	Mean ± SE	CV %	Mean ± SE	CV %	Mean ± SE	CV %	Mean ± SE	CV %	Mean ± SE	CV %
T_1	68.75^{b} ± 0.411	4.63	115.55^{a} ± 0.455	3.00	221.17^{a} ± 0.74	2.55	282.29^{b} ± 0.83	2.201	192.9^{b} ± 0.771	2.99	205.29^{a} ± 0.869	3.16	1082.18^{a} ± 1.069	0.74
T_2	75.68^{e} ± 0.29	2.97	149.77^{d} ± 0.463	2.39	256.12^{d} ± 0.45	1.36	343.52^{d} ± 0.556	1.243	231.67^{d} ± 0.71	2.33	305.30^{c} ± 0.93	2.33	1357.45^{d} ± 0.63	0.35
T_3	72.71^{c} ± 0.34	3.67	134.8^{b} ± 0.480	2.76	229.82^{b} ± 0.81	2.74	271.29^{a} ± 0.897	2.54	197.17^{c} ± 0.70	2.68	258.38^{b} ± 0.55	1.62	1167.14^{b} ± 0.536	0.35
T_4	66.62^{a} ± 0.518	5.93	152.48^{e} ± 0.665	3.32	242.90^{c} ± 0.841	2.64	312.93^{c} ± 0.768	1.85	175.82^{a} ± 0.98	4.17	260.30^{b} ± 0.792	2.276	1201.82^{c} ± 0.729	0.45
T_5	74.5^{d} ± 0.373	3.89	143.97^{c} ± 0.544	2.93	262.2^{e} ± 0.707	2.09	366.80^{e} ± 0.921	1.928	290.10^{e} ± 2.64	2.04	322.80^{d} ± 0.781	1.843	1411.275^{e} ± 0.933	0.503
CD (P<0.05)	1.084		1.47		2.02		2.23		2.12		2.206		2.20	

Means bearing a common superscript in a column do not differ significantly (P<0.05)

Table No. : 8.

Analysis of variance of body weight gain during different experimental periods.

Periods	0-7th day			7-14th day			14-21st day			21-28th day		
Sources of variation	Degree of freedom	Mean squares	F	Degree of freedom	Mean squares	F	Degree of freedom	Mean squares	F	Degree of freedom	Mean squares	F
Between Treatment	4	875.215	94.863**	4	12970.75	790.46**	4	17612.907	569.72**	4	94764.10	2518.31**
Error (within treatment)	293	9.226		291	16.409		291	30.915		285	37.63	
Total	297			295			295			289		

Periods	28-35th day			35-42nd day			0-42nd day		
Sources of variation	Degree of freedom	Mean squares	F	Degree of freedom	Mean squares	F	Degree of freedom	Mean squares	F
Between Treatment	4	42459.77	1265.94**	4	120317.10	3323.676**	4	1069385.83	29154.446**
Error (within treatment)	281	33.54		281	36.20		281	36.68	
Total	285			285			285		

* Significant at 5% L.S. (P<0.05)

** Significant at 1% L.S. (P<0.01)

difference among all the treatment groups. During first week group T_2 showed highest weight gain. During 2nd week the C.D. test revealed that there was significant difference among all treatment groups but highest body weight gain was found in group T_4. During 3rd week the critical difference (C.D.) test revealed that there was significant difference among all the groups but highest body weight gain was found in group T_5. During 4th and 5th week the result showed similar fashion like during 3rd week. But during 6th and final week critical difference (C.D.) test revealed non-significant difference between group T_3 and T_4 whereas other groups differ significantly from each other. During this week also highest body weight gain was recorded in group T_5 with average 322.80 gm.

When we consider body weight gain during whole experimental period (i.e. 0-42nd and days), the result of analysis of variance, revealed highly significant difference ($P<0.01$) among various treatment means. Critical difference (C.D.) test revealed that there was significant difference between all the treatment group. The body weight gain was 1082.18 gm, 1167.14 gm, 1201.82 gm, 1357.45gm and 1411.275 gm per chick respectively, in treatment groups T_1, T_3, T_4, T_2 and T_5. These differences seems to be due to difference in treatment of various immunomodulators.

Ramappa *et al.* (1975), Khaire *et al.* (1981), Ishwar and Mohsin (1981), Subramanian *et al.* (1982), Reddy and Reddy (1986), Pradhan (1987), Sapra and Mehta (1988), Devegowda *et al.* (1990), Sapra and Mehta (1990), Roy *et al.* (1990) Narahari (1992), Chatterjee *et al.* (1994), Rao and Reddy (1994) and Rajamane *et al.* (1997) observed similar result with herbal liver tonic treated diets.

Dakshikar (1984) observed non-significant effect on body weight gain of broiler with supplementation of a herbal drug ciromyn. Huang *et al.* (1992) observed significant body wt gain with Chinese herbal treated feed fed to broilers. Wanjane *et al.* (1996), Gowda *et al.* (1996) and Kujur (2001) found significant body weight gain with neem leave powder treated group in broiler which matched with our result. Kumar (2000) and Kumar (2002) showed similar pattern of result in body weight gain with homeopathic medicine treated group where as Mcllory *et al.* (1993), Panda and Rao (1994), Haq *et al.* (1996), Wen *et al.* (1996), Coskun *et al.* (1997), Gore *et al.* (1997) Raza *et al.* (1997), Mezes *et al.* (1997), Arbind *et al.* (2001), Rawat *et al.* (2002) and Kumar (2002) observed similar result with vitamin E treated alone or in combination form supplemented to diet in broiler.

Feed Consumption :

Table No. : 9 present the result of average feed consumption of different groups during experimental period at different weeks of age on group replicate basis and their result of analysis of variance in table No. : 10.

As far as this particular trait is concerned i.e. average feed consumption, result revealed non-significant difference between group T_1, T_2, T_4 & T_5, T_3 & T_4 whereas other group differ significantly from each other during 1st week of age. In this week, group T_5 had least feed consumption average whereas the birds of group T_1 consumed maximum of average of feed i.e. 101.47 gm feed per chick. The result of analysis of variance during all the weeks showed highly significant differences among all the treatment group. During 2nd week critical difference test revealed that all the five groups differ significantly among each other. During this week feed consumption was minimum in group T_5 with 200.11 gm per chick and

Table No. : 9.

Mean ± SE and CV (in %) of feed consumption (g/chick) of broiler chicken at different experimental periods.

Period (in days) / Treatment groups	0 – 7th days		7 – 14th days		14 – 21st days		21 – 28th days		28 – 35th days		35 – 42nd days		0-42nd days	
	Mean ± SE	CV %	Mean ± SE	CV %	Mean ± SE	CV %	Mean ± SE	CV %	Mean ± SE	CV %	Mean ± SE	CV %	Mean ± SE	CV %
T_1	101.47^{c} ± 0.123	0.21	219.5^{b} ± 2.29	1.80	481.48^{a} ± 11.87	4.27	605.22^{a} ± 3.35	0.96	509.25^{a} ± 3.19	1.08	686.79^{a} ± 2.69	0.68	2603.72^{a} ± 8.87	0.59
T_2	99.97^{c} ± 0.575	1.0	262.99^{d} ± 1.30	0.56	518.38^{bc} ± 3.18	1.064	690.47^{c} ± 5.70	1.415	638.71^{c} ± 0.587	0.87	866.81^{d} ± 0.57	0.12	3077.33^{e} ± 4.68	0.26
T_3	96.55^{b} ± 0.377	1.03	237.51^{c} ± 8.60	0.27	491.81^{ab} ± 9.89	3.48	602.26^{a} ± 3.78	1.089	544.97^{b} ± 1.79	0.57	725.32^{b} ± 1.36	0.33	2698.42^{b} ± 4.39	0.28
T_4	95.93^{ab} ± 0.577	1.04	282.08^{e} ± 1.73	1.07	522.23^{c} ± 9.30	3.08	663.72^{b} ± 1.542	2.49	502.08^{a} ± 1.5	0.52	752.02^{c} ± 3.04	0.70	2817.06^{c} ± 3.544	0.22
T_5	95.36^{a} ± 1.36	1.36	200.11^{a} ± 1.39	1.20	477.12^{a} ± 9.09	3.30	773.94^{d} ± 6.06	1.358	605.05^{d} ± 1.34	0.39	882.74^{e} ± 1.18	0.23	3034.24^{d} ± 4.00	0.22
CD (P<0.05)	1.763		13.058		28.817		19.426		7.584		6.3263		15.3329	

Means bearing a common superscript in a column do not differ significantly (P<0.05).

Table No. : 9.

Mean ± SE and CV (in %) of feed consumption (g/chick) of broiler chicken at different experimental periods.

Period (in days) / Treatment groups	0 – 7th days		7 – 14th days		14 – 21st days		21 – 28th days		28 – 35th days		35 – 42nd days		0-42nd days	
	Mean ± SE	CV %	Mean ± SE	CV %	Mean ± SE	CV %	Mean ± SE	CV %	Mean ± SE	CV %	Mean ± SE	CV %	Mean ± SE	CV %
T_1	101.47^{c} ± 0.123	0.21	219.5^{b} ± 2.29	1.80	481.48^{a} ± 11.87	4.27	605.22^{a} ± 3.35	0.96	509.25^{a} ± 3.19	1.08	686.79^{a} ± 2.69	0.68	2603.72^{a} ± 8.87	0.59
T_2	99.97^{c} ± 0.575	1.0	262.99^{d} ± 1.30	0.56	518.38^{bc} ± 3.18	1.064	690.47^{c} ± 5.70	1.415	638.71^{c} ± 0.587	0.87	866.81^{d} ± 0.57	0.12	3077.33^{e} ± 4.68	0.26
T_3	96.55^{b} ± 0.377	1.03	237.51^{c} ± 8.60	0.27	491.81^{ab} ± 9.89	3.48	602.26^{a} ± 3.78	1.089	544.97^{b} ± 1.79	0.57	725.32^{b} ± 1.36	0.33	2698.42^{b} ± 4.39	0.28
T_4	95.93^{ab} ± 0.577	1.04	282.08^{e} ± 1.73	1.07	522.23^{c} ± 9.30	3.08	663.72^{b} ± 1.542	2.49	502.08^{a} ± 1.5	0.52	752.02^{c} ± 3.04	0.70	2817.06^{c} ± 3.544	0.22
T_5	95.36^{a} ± 1.36	1.36	200.11^{a} ± 1.39	1.20	477.12^{a} ± 9.09	3.30	773.94^{d} ± 6.06	1.358	605.05^{d} ± 1.34	0.39	882.74^{e} ± 1.18	0.23	3034.24^{d} ± 4.00	0.22
CD (P<0.05)	1.763		13.058		28.817		19.426		7.584		6.3263		15.3329	

Means bearing a common superscript in a column do not differ significantly (P<0.05).

Table No. : 10.

Analysis of variance of feed consumption during different experimental periods.

Periods	Degree	0-7th day		7-14th day		14-21st day		21-28th day		28-35th day		35-42nd day		0-42nd day	
Sources of variation	of freedom	Mean Square	F	Mean Square	F	Mean Square	F	Mean Square	F	Mean Square	F	Mean Square	F	Mean Square	F
Between Treatment	4	21.88135	23.293**	3248.998	63.053**	1314.669	5.239*	13004.942	131.575**	10785.7068	649.058**	22886.2067	1892.388**	127698.5388	1797.520**
Error (within treatment)	10	0.093936		51.528		250.93298		114.0409		16.61748		12.09382		71.0415	
Total	14														

* Significant at 5% L.S. (P<0.05)

** Significant at 1% L.S. (P<0.01)

Table No. : 11.

Analysis of variance of feed conversion ratio during different experimental periods.

Periods	Degree	0-7th day		7-14th day		14-21st day		21-28th day		28-35th day		35-42nd day		0-42nd day	
Sources of variation	of freedom	Mean Square	F	Mean Square	F	Mean Square	F	Mean Square	F	Mean Square	F	Mean Square	F	Mean Square	F
Between Treatment	4	0.0213	88.75**	0.12045	4015.0**	0.0652956	32.677*	0.017079	4.87609*	0.080052	575.0862**	0.475071	344.355**	0.0276126	20.348**
Error (within treatment)	10	0.00024		0.00003		0.0019982		0.0035026		0.0001392		0.0005084		0.001357	
Total	14														

* Significant at 5% L.S. (P<0.05)

** Significant at 1% L.S. (P<0.01)

maximum in group T_4 with 282.08 gm per chick. During 3rd week, critical difference test revealed that group T_1, T_3 & T_4, group T_2 & T_4 and group T_2 & T_3 do not differ significantly. Rest all differ significantly. Again during this week group T_5 birds feed minimum with 477.12 gm feed per chick whereas birds of group T_4 feeds maximum with 522.23 gm of feed per chick. During 4th week, critical difference test revealed that group T_1 & T_3 do not differ significantly but all other groups differ significantly. In this week birds of group T_3 feeds minimum i.e. 602.26 gm per chicks whereas group T_5 feeds maximum i.e. 773.94 gm per chick. During 5th week, critical difference test revealed that except between groups T_1 and T_4, difference between groups were significant. The data showed that birds of group T_5 feeds maximum with average 605.05 gm feed per chick and group T_4 birds feed minimum with 502.08 gm feed per chick. During 6th week, critical difference test revealed that all the five groups differ significantly among each other. In this week average feed consumption was 686.79, 725.32, 752.02, 866.81 and 882.74 gm per chick in group T_1, T_3, T_4, T_2 and T_5 respectively.

When we consider during whole experimental period (0-42nd days), the result of analysis of variance is highly significant ($P<0.01$). The critical difference test reveal that all the five groups differ significantly among each other. The bird consumed 2603.72, 3077.33, 2698.42, 2817.06 and 3034.24 gm feed (average) per chick in group T_1, T_2, T_3, T_4 and T_5 respectively during entire experimental period. Thus group T_1 feeds minimum whereas group T_2 feeds maximum feed per chick during entire experimental period. It is almost proven that treatment of various immunomodulator affects feed consumption significantly.

maximum in group T_4 with 282.08 gm per chick. During 3rd week, critical difference test revealed that group T_1, T_3 & T_4, group T_2 & T_4 and group T_2 & T_3 do not differ significantly. Rest all differ significantly. Again during this week group T_5 birds feed minimum with 477.12 gm feed per chick whereas birds of group T_4 feeds maximum with 522.23 gm of feed per chick. During 4th week, critical difference test revealed that group T_1 & T_3 do not differ significantly but all other groups differ significantly. In this week birds of group T_3 feeds minimum i.e. 602.26 gm per chicks whereas group T_5 feeds maximum i.e. 773.94 gm per chick. During 5th week, critical difference test revealed that except between groups T_1 and T_4, difference between groups were significant. The data showed that birds of group T_5 feeds maximum with average 605.05 gm feed per chick and group T_4 birds feed minimum with 502.08 gm feed per chick. During 6th week, critical difference test revealed that all the five groups differ significantly among each other. In this week average feed consumption was 686.79, 725.32, 752.02, 866.81 and 882.74 gm per chick in group T_1, T_3, T_4, T_2 and T_5 respectively.

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Similar conclusion was drawn by Khire *et al.* (1981), Babu *et al.* (1988) Sapra and Mehta (1990), Babu *et al.* (1992), Narahari *et al.* (1992) Pande and Vijay Kumar (1994) and Parida *et al.* (1995) while experimenting with herbal liver tonic, Hindustani (2000) and Kumar (2002) while experimenting with homeopathic liver medicine, Wanjane *et al.* (1996), Gowda *et al.* (1996) and Kujur (2001) while experimenting with neem leave powder and Panda and Rao (1994), Haq *et al.* (1996), Arbind *et al.* (2001) and Kumar (2002) while experimenting with vitamin E or their combination.

Feed Conversion Ratio (FCR) :

Weekly feed conversion ratio has been presented in table No. : 12 and Analysis of variance has been presented in table No. : 11. The result of analysis of variance of feed conversion ratio during all weeks of age revealed highly significant difference ($P<0.01$) among various treatment means. Result of critical difference test during 1st week of age revealed that there is non-significant difference between group T_2 and T_3 while all other groups differ significantly among each other. The minimum feed conversion ratio was 1.28 in group T_5, while maximum was 1.476 in group T_1. During 2nd week of age, result of critical difference test revealed similar result like during 1st week of age. During 3rd week result of critical difference test revealed that there is no significant difference between groups T_1, T_3 and T_4 while there is significant difference among each other groups. In this period minimum feed conversion ratio was 1.82 of group T_5 while maximum of group T_1, 2.177. During 4th week of age the result of critical difference test revealed that there is non-significant difference between groups T_1, T_3, T_4 & T_5 and T_2 & T_5 while in other groups, there is significant difference among themselves. In this age group minimum feed conversion was 2.010 for group

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Table No. : 12.

Mean ± SE and CV (in %) of feed conversion ratio of broiler chicken at different experimental periods.

Period (in days) / Treatment groups	7th days		7-14th days		14-21st days		21-28th days		28-35th days		35-42nd days		0-42nd days	
	Mean ± SE	CV %	Mean ± SE	CV %	Mean ± SE	CV %	Mean ± SE	CV %	Mean ± SE	CV %	Mean ± SE	CV %	Mean ± SE	CV %
T_1	1.476^{d} ± 0.005	0.59	1.9^{d} ± 0.004		2.177^{c} ± 0.005	0.44	2.144^{b} ± 0.007	0.582	2.964^{d} ± 0.01	0.584	3.34^{d} ± 0.005	0.299	2.406^{d} ± 0.006	0.43
T_2	1.321^{b} ± 0.003	0.45	1.756^{b} ± 0.001	0.11	2.024^{b} ± 0.006	0.49	2.010^{a} ± 0.056	4.70	2.757^{b} ± 0.004	0.25	2.839^{c} ± 0.008	0.489	2.267^{b} ± 0.004	0.36
T_3	1.328^{b} ± 0.005	0.69	1.762^{b} ± 0.001	0.11	2.14^{c} ± 0.03	2.47	2.22^{b} ± 0.045	3.58	2.764^{b} ± 0.006	0.43	2.807^{b} ± 0.004	0.249	2.312^{bc} ± 0.008	0.62
T_4	1.44^{c} ± 0.004	0.55	1.85^{c} ± 0.002	0.22	2.15^{c} ± 0.03	2.58	2.121^{b} ± 0.003	0.355	2.850^{c} ± 0.005	0.38	2.88^{c} ± 0.017	1.04	2.344^{cd} ± 0.01	0.74
T_5	1.28^{a} ± 0.02	2.70	1.39^{a} ± 0.004	0.585	1.82^{a} ± 0.03	3.43	2.11^{ab} ± 0.02	1.708	2.52^{a} ± 0.005	0.40	2.73^{a} ± 0.02	1.32	2.15^{a} ± 0.045	3.63
CD (P<0.05)	0.01		0.012		28.81		0.011		0.021		0.041		0.067	

Means bearing a common superscript in a column do not differ significantly (P<0.05).

T_2, while maximum was of group T_3, 2.22. During 5th week of age, the result of critical difference test revealed that there is significant difference among different groups except between groups T_2 and T_3. The control T_1 has maximum feed conversion ratio of 2.964 while group T_5 has minimum with 2.52. During last week of age critical difference test revealed significant difference among treatment means of FCR of different groups except between group T_2 and T_4. There was 2.73, 2.807, 2.839 2.88 and 3.34 feed conversion ratio to the treatment groups T_5, T_3, T_2, T_4 and T_5 respectively.

When we consider during whole experimental period (0-42nd day), the result of analysis of variance was highly significant ($P<0.01$). The critical difference test revealed that there is non-significant difference between treatment groups T_2 & T_3, T_3 & T_4 and T_1 & T_4 while in others, there exist significant difference. During whole period feed conversion ratio was 2.15, 2.267, 2.312, 2.344 and 2.406 in to the treatment groups T_5, T_2, T_3, T_4 and T_1 respectively. These differences seem to be due to treatment with various immunomodulators. Thus group T_5 had minimum feed conversion ratio and group T_1 had maximum feed conversion ratio.

Similar conclusion on feed conversion ratio was drawn by Subramanian *et al.* (1982). Arora and Mohini (1984), Thangavel *et al.* (1987), Babu *et al.* (1989) Devegowda (1990), Panda (1991), Prasad and Sen (1993), Sinha *et al.* (1993), EL Gendi *et al.* (1994) and Prajapati (1997) experimenting with supplementation of herbal liver tonic in their diet. Use of herbal liver stimulants improved FCR because of their stomachic, demulcent and tonic activities. Moreover herbal growth promoters increase anabolic, adoptogenic, immunostimulent and rejuvenate functions which may be responsible for improved FCR in broiler chicken. Similar result on feed

conversion ratio was observed by Wanjane *et al.* (1996), Gowda *et al.* (1996) and Kujur *et al.* (2001) experimenting with neem leaves powder while Raza *et al.* (1997), Arbind *et al.* (2001) and Kumar (2002) experimenting with vitamin E supplementation in diet.

Performance Index :

Table No. : 13 present the result of average performance index of different groups during experimental period at different weeks of age and their result of analysis of variance in Table No. : 14.

The result of analysis of variance during all the weeks showed highly significant differences among all the treatment group. During 1st week of experimental period, critical difference test revealed that there is significant difference among various treatment means except between groups T_1 & T_4 and T_2 & T_5. Highest performance index was observed in group T_3 (54.75) followed by T_5, (58.20), T_2, (57.29), T_1 (46.57) and T_4 (46.26) respectively. During 2nd week of age, performance Index in different treatment groups was highly significant and all treatment means differ significantly among each other. T_5 had highest performance Index (103.57) followed by, T_2, (85.29), T_4, (82.42), T_3, (76.50) and T_1, (60.81) respectively. During 3rd week of experimental period, result was similar to result during 2nd week of age, during 4th week, difference was significant among all treatment means. Highest performance index was shown by group T_5 (173.84) followed by group T_2, (170.90), T_4, (147.57), T_1 (131.66) and T_3 (122.20) respectively. During 5th week of experimental period critical difference test revealed that there in significant difference among different treatment means. The highest performance Index was 95.27 of group T_5 while minimum was 61.69 of group T_4. During 6th week of age critical difference test revealed that there is

Table No. : 13.

Mean ±SE and CV (in %) of performance index of broiler chicken at different experimental periods.

Period (in days) / Treatment groups	0-7th day		7-14th day		14-21st day		21-28th day		28-35th day		35-42- day		0-42nd day	
	Mean ± SE	CV%	Mean ± SE	CV%	Mean ± SE	CV%	Mean ± SE	CV%	Mean ± SE	CV%	Mean ± SE	CV%	Mean ± SE	CV%
T_1	46.57^{a} ± 0.15	0.59	60.81^{a} ± 0.61	1.74	101.60^{a} ± 0.31	0.53	131.66^{b} ± 0.41	0.54	65.08^{b} ± 0.40	1.09	61.46^{a} ± 0.43	1.23	449.78^{a} ± 2.56	0.98
T_2	57.29^{b} ± 0.57	1.40	85.29^{d} ± 0.38	0.78	126.54^{d} ± 0.18	0.25	170.90^{d} ± 0.28	0.28	84.02^{c} ± 0.22	0.45	107.53^{c} ± 0.19	0.31	598.78^{d} ± 1.93	0.56
T_3	54.75^{c} ± 0.37	1.20	76.50^{b} ± 0.41	0.94	107.39^{b} ± 0.38	0.62	122.20^{a} ± 0.87	1.24	71.33^{d} ± 0.59	1.43	92.05^{b} ± 0.87	1.64	504.81^{b} ± 1.20	0.41
T_4	46.26^{a} ± 0.69	2.58	82.42^{c} ± 0.32	0.69	112.97^{c} ± 0.52	0.79	147.50^{c} ± 0.43	0.51	61.69^{a} ± 0.61	1.72	90.38^{b} ± 0.77	1.49	512.72^{c} ± 1.70	0.575
T_5	58.20^{b} ± 0.48	1.45	103.57^{e} ± 0.55	0.93	144.06^{e} ± 0.59	0.72	173.84^{e} ± 0.29	0.29	95.27^{e} ± 0.29	0.53	118.24^{d} ± 0.19	0.29	656.4^{e} ± 0.58	0.15
CD (P<0.05)	1.473		1.486		1.327		1.565		1.426		1.797		5.48	

Means bearing a common superscript in a column do not differ significantly (P<0.05).

Table No. : 14.

Analysis of variance of performance index during different experimental periods.

Periods	Degree of freedom	0-7th day		7-14th day		14-21st day		21-28th day		28-35th day		35-42nd day		0-42nd day	
Sources of variation		Mean Square	F	Mean Square	F	Mean Square	F	Mean Square	F	Mean Square	F	Mean Square	F	Mean Square	F
Between Treatment	4	100.87	153.988**	716.3504	1072.14**	868.1831	1615.104**	1588.067	2051.713**	585.09	957.12**	1384.7804	138.108**	20268.80348	2254.44**
Error (within treatment)	10	0.65505		0.66815		0.53754		0.77402		0.614511		0.9759		8.99061	
Total	14														

* Significant at 5% L.S. (P<0.05)

** Significant at 1% L.S. (P<0.01)

Table No. : 14.

Analysis of variance of performance index during different experimental periods.

Periods	Degree of freedom	0-7th day		7-14th day		14-21st day		21-28th day		28-35th day		35-42nd day		0-42nd day	
Sources of variation		Mean Square	F	Mean Square	F	Mean Square	F	Mean Square	F	Mean Square	F	Mean Square	F	Mean Square	F
Between Treatment	4	100.87	153.988**	716.3504	1072.14**	868.1831	1615.104**	1588.067	2051.713**	585.09	957.12**	1384.7804	138.108**	20268.80348	2254.44**
Error (within treatment)	10	0.65505		0.66815		0.53754		0.77402		0.614511		0.9759		8.99061	
Total	14														

* Significant at 5% L.S. (P<0.05)

** Significant at 1% L.S. (P<0.01)

significant difference among all the treatment means except between groups T_3 & T_4. The highest performance Index was observed in group T_5 (118.24) followed by group T_2 (107.53), T_3 (92.05), T_4 (90.38) and T_1 (61.46) respectively.

The result of analysis of variance during whole experimental period (0-42nd day) is highly significant ($P<0.01$). The critical difference test revealed that there is significant difference among all the treatment means. It is almost proved that treatment group receiving vitamin E had better performance index then other group followed by group receiving herbal liver tonic, Neem leaves powder, homeopathic liver tonic and least in control respectively.

Similar findings has been reported by Arora and Mohini (1984) Pandey and Srivastava (1985), Kuppuswamy (1986), Pradhan and Mishra (1988), Babu *et al.* (1989), Narahari (1992) and Qiao *et al.* (1998) experimenting with herbal liver supplementation, Wanjane *et al.* (1996) and Kujur (2001) experimenting with neem leaves powder, and Pande and Rao (1994), Haq *et al.* (1996) Arbind *et al.* (2001) and Kumar (2002) while experimenting with vitamin E supplementation in diet of broiler chicken.

Dressed weight :

Perusal of data of Table No. : 15 revealed a highly significant difference ($P<0.01$) among the treated groups whereas critical difference test revealed non-significant difference between T_1 & T_3 and T_2, T_4 & T_5. However other differs significantly. Highest average dressed weight percentage was observed in care of T_5 followed by T_2, T_4, T_1 and T_3 respectively.

Table No. : 15.

Mean ± SE and CV (in %) of various carcass trait (in Arcsin Unit) at end of experimental period.

Character	Dressed Weight		Eviscerated Weight		Gizzard Weight		Liver Weight		Heart Weight		Giblet Weight	
Treatment group	Mean ± SE	CV%	Mean ± SE	CV%	Mean ± SE	CV%	Mean ± SE	CV%	Mean ± SE	CV%	Mean ± SE	CV%
T_1	63.67^{a} ± 0.62	1.972	57.36^{a} ± 0.189	0.66	8.56^{a} ± 0.03	0.90	9.38^{b} ± 0.101	2.171	4.62^{a} ± 0.023	(1.020)	13.42^{a} ± 0.094	1.403
T_2	66.58^{b} ± 0.27	0.834	61.21^{e} ± 0.09	0.294	10.89^{a} ± 0.10	1.95	9.38^{b} ± 0.031	0.681	5.44^{d} ± 0.032	1.191	15.36^{e} ± 0.046	0.611
T_3	62.94^{a} ± 0.36	0.154	57.44^{a} ± 0.054	0.189	9.37^{b} ± 0.03	0.810	9.03^{a} ± 0.072	1.597	4.69^{a} ± 0.014	0.612	13.95^{b} ± 0.091	1.311
T_4	66.31^{b} ± 0.40	1.215	59.74^{b} ± 0.13	0.439	9.90^{c} ± 0.038	0.784	9.29^{b} ± 0.074	1.592	4.79^{b} ± 0.031	1.333	14.53^{c} ± 0.129	1.783
T_5	66.84^{b} ± 0.09	0.296	61.22^{c} ± 0.15	0.505	10.52^{d} ± 0.76	1.448	9.37^{b} ± 0.105	2.248	5.29^{c} ± 0.021	0.802	14.88^{d} ± 0.055	0.745

Means bearing a common superscript in a column do not differ significantly (P<0.05).

In the study, the present dressed weight percentage of broilers ranged from 79.02% to 84.29%, was better than those reported earlier. Smith (1970) reported 77% dressed weight at 9 weeks of age while Mishra (1970) reported 75% at 8 weeks of age. The results obtained during the study was in agreement with other reports which also observed increased dressed weight percentage with dietary addition of herbal growth promoters (Ali *et al.*; 1994) homeopathic drug (Kumar, 2000), neem leaves powder (Kujur, 2001) and Vitamin E (Arbind *et al.*, 2001, Kumar, 2002).

Eviscerated weight :

Depicted in Table No. : 16 are the results of analysis of variance for eviscerated weight of experimental broilers. In this case also there was highly significant difference ($P<0.01$) among the treatment means. The study of critical difference test revealed a non-significant difference between T_1 & T_3 and T_2 & T_5 where as other means differ significantly from each other. Highest eviscerated weight was observed in T_5 followed by T_2, T_4, T_1 and T_3 respectively.

The higher body weights and lesser offal weights were obtained due to the use of various immunomodulator, so the eviscerated weight were also expected to be higher in treated groups than control. This is in agreement with the reports of Sapra and Mehta (1990), Ali *et al.* (1994), Kujur (2001), Arbind *et al.* (2001) and Kumar (2002).

Gizzards weight :

Presented in Table No. : 16 are the results of analysis of variance for Gizzard weight percentage of experimental broilers in which various treatment means were found to be highly significant ($P<0.01$). There was significant difference between all treatment groups. Highest gizzard weight

Table No. : 16.

Analysis of variance of various carcass traits during end of experimental periods.

Different carcass traits	Degree of freedom	Dressed Weight		Eviscerated Weight		Gizzard Weight		Liver Weight		Heart Weight		Giblet Weight	
Sources of wariation		Mean Square	F	Mean Square	F	Mean Square	F	Mean Square	F	Mean Square	F	Mean Square	F
Between Treatment	4	13.2954	21.4490**	14.72713	211.779**	3.4327	322.016**	0.8966645	3.376*	0.5508075	209.59**	2.3361175	80.417**
Error (within treatment)	15	0.61986		0.06954		0.01066		0.026559		0.002628333		0.02905	
Total	19												

* Significant at 5% L.S. (P<0.05)

** Significant at 1% L.S. (P<0.01)

was 3.41% of group T_2 followed by 3.22% of T_5, 2.81% of T_4, 2.50% of T_3 and 2.06% of T_1.

The result showed that the gizzard weight percentage improved by the addition of immunomodulator and this result is in close confirmation with Singh *et al.* (1996).

Liver weight :

Presented in Table No. : 16 are the result of analysis of variance for liver weight percentage of experimental broilers in which various treatment means were found to be highly significant ($P<0.01$). Critical difference test revealed that there is non significant difference between T_1, T_2, T_4 & T_5 while other means differ significantly, lowest liver weight percentage was found to be in group T_3 while highest was in group T_3.

The result show that liver weight percentage was not improved by addition of immunomodulators. This result are close confirmation with Arbind *et al.* (2001), Kujur (2001) and Kumar (2002).

Heart weight :

Depicted in Table No. : 16 are the result of analysis of variance for heart weight percentage of experimental broilers. In this case also there was a highly significant difference ($P<0.01$) among treatment means. The study of critical difference test revealed a non-significant difference between T_1 & T_3 groups whereas the other means differed significantly from each other. Highest heart weight percentage was observed in treatment group T_2 followed by T_5, T_4, T_3 and T_1.

Result show that heart weight percentage was improved by addition of immunomodulators. This result is in close confirmation with Kumar (2000), Kujur (2001) and Kumar (2002).

Giblet weight :

Presented in Table No. : 15 and 16 are the average giblet weight percentage and results of variance for giblet weight percentage respectively. The study for analysis of variance revealed highly significant difference ($P<0.01$) among various treatment means where all the treatment means differ significantly from each other. Highest Giblet weight percentage was observed in T_2 group followed by group T_5, T_4, T_3 and T_1 respectively.

Although the average giblet weight percentage was more in treated groups the liver weight percentage was similar in these groups. It reveals that these immunomodulators have promoted the efficacy of liver and prevented liver from any damage, as a result the liver was prevented from tissue regeneration and unnecessary increase in weight. Mehra and Handa (1968), Kirtikar and Basu (1975), Dwivedi *et al.* (1986) and Peer *et al.* (1990) also reported that immunomodulator have hepatoprotective property.

Mortality :

Presented in Table No. : 17, showing mortality in number and percentage in different period of experiment. The immunomodulators were found to have marked effect on survival rate of broilers. The mortality rate during entire experimental period was within normal limit. Highest mortality was observed in group T_1 and T_4 while T_2, T_3 and T_4 had 0.33% of mortality during entire period. The highest mortality was observed during the period of 28-35th day of experiment which was due to intense cold wave.

Therefore, it may be concluded that immunomodulator drug modified the immune system of body. Moreover, these immunomodulators protected

Table No. : 17.

Showing mortality in no and % in different period of experiment.

Period (in days)	0-7th day		7-14th day		14-21st day		21-28th day		28-35th day		35-42nd day		0-42nd day	
Treatment groups	No.	in %	No.	in %	No.	in %	No.	in %	No.	in %	No.	in %	No.	in %
T_1	0	0.0	0	0.0	2	0.671	0	0.0	0	0.0	0	0.0	4	1.33
T_2	0	0.0	0	0.0	0	0.0	0	0.0	2	0.66	0	0.0	2	0.66
T_3	0	0.0	0	0.0	0	0.0	0	0.0	2	0.66	0	0.0	2	0.66
T_4	2	0.66	0	0.0	0	0.0	0	0.0	2	0.671	0	0.0	4	1.33
T_5	0	0.0	0	0.0	0	0.0	0	0.0	2	0.66	0	0.0	2	0.66

the body from damage caused by contagious and non-contagious diseases by counteracting with the ill effect of feed toxins and other feed contaminants thereby reducing mortality in treated groups.

Similar conclusions on mortality percentage were also drawn by Sapra and Mehta (1988), Roy *et al.* (1990), Mishra *et al.*, (1991), Babu and Pande (1993), Narhari (1995), Devegowda (1996), Ye *et al.*, (1998), Mao *et al.*, 1998) and Singh and Saraswat (2000) while experimenting with herbal liver tonic. Similar conclusion on mortality percentage were drawn by Marsh *et al.* (1986), Mcllroy *et al.* (1993), Panda and Rao (1994), Haq *et al.* (1996), Wen *et al.* (1996). Mezes *et al.* (1997), Kurtogulu *et al.* (1998), Shadaksharappa *et al.* (1998), Arbind *et al.* (2001) and Manoj (2002) while experimenting with vitamin E. while, Koul *et al.* (1990), Prakash *et al* (1996), Gowda *et al.* (1996), Jamkhedkar *et al.* (1996), Sadekar (1998b) Kujur (2001) and Satturwar (2002) found the same result experimenting with neem leaves powder in broilers. Hindustani (2000), Kumar (2000) and Kumar (2002) observed the mortality pattern in broilers when treated with different homeopathic liver drugs.

Economics :

Presented in Table No. : 18 in the economics of broiler production on group basis. It is evident that from table that Maximum feed cost per kg weight gain was observed in case T_1 (26.89 Rs/kg weight) followed by group T_5 (24.06 Rs/kg weight) T_4 (23.48 Rs/kg weight), T_3 (23.44 Rs/kg weight) and least in group T_2 (22.67 Rs/kg weight). Return over feed cost was maximum in group T_2 (27.25 Rs), T_3 (26.03 Rs) T_4 (25.98 Rs), T_5 (24.35 Rs) and minimum in control group T_1 (19.62 Rs.).

The findings related to economics of broiler production indicate that the feed cost per kg weight gain was minimum while return over feed cost was maximum in broilers fed diet supplemented with herbal liver tonic. Hence it was realised that supplementation of herbal liver tonic in diet of broiler was responsible for better utilization of feed and assimilation of nutrient in their body. Thus it was concluded that if broilers are reared for heavy weight then use of herbal liver tonic will be most economical followed by homeopathic liver tonic, neem leaves powder and vitamin E.

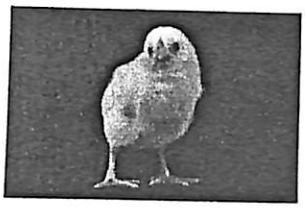
Our findings are in close confirmation with the result drawn by Sundararasu *et al.* (1985), Dua (1988), Prajapati (1997) and Ali *et al.* (1994) who concluded that herbal growth promoters supplemented in the diets of broilers definitely give better results in terms of economic broiler production. Haq *et al.* (1996) and Arbind *et al.* (2001) observed similar economics with vitamin E supplementation in diet where as Jamkhedkar (1996). Sadekar (1998) and Kujur (2001) calculated similar economics with neem leaves powder supplemented diet.

Table No. – 18

Average feed cost per kg weight (Rs.) and average return over feed cost (Rs.) from different treatment group during end of experimental period.

Cost/Return reatment group	Feed cost per kg weight (Rs.)	Return over feed cost (Rs.)
T_1	26.89	19.62
T_2	22.67	27.25
T_3	23.44	26.03
T_4	23.48	25.98
T_5	24.06	24.35

CHAPTER - V



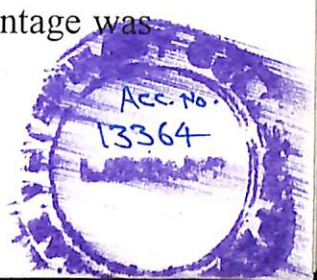
SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSIONS

It is an established fact that feed cost alone accounts more than 70% of the total expenditure in broiler production. Therefore, it is essential to reduce feed costs by means of reducing feed wastage and applying suitable measures to improve feed utilization in order to increase the dressing percentage in a comparatively shorter period. This may be achieved by addition of immunomodulators in diets of broiler to counteract various stress and lead to better growth rate and feed conversion ratio.

The present study was undertaken for evaluation of certain immunomodulators on certain economic traits in broilers. To achieve the goal, an experiment was conducted on 300 day-old chicks, for a period of six weeks. These broiler chicks were procured, wing banded, weighted individually and divided into five groups randomly of 60 chicks each, replicated thrice of 20 chicks in each replicate. All five groups were housed randomly and provided with identical management, nutritional and environmental conditions. The first group T_1 acted as control which were fed with commercial broiler chick diet with no supplementation of immunomodulator. T_2 was treated with 250 gm herbal liver tonic per ton of feed, T_3 with 12 ml homeopathic liver tonic *(Chelidonium majus)* per 60 birds biweekly in drinking water, T_4 with 0.1% neem leaves powder in feed and T_5 with 75 ppm vitamin E in feed.

In the study, performance of broilers in terms of body weight gain, feed consumption, feed conversion ratio and performance index was recorded. The economics of broiler production and mortality percentage was



also calculated. After six weeks of experiment, four birds from each group were slaughtered for carcass trait studies.

Data related to growth performance of broilers indicated that at sixth week of age, best performance in term of body weight was recorded in T_5 group (1411.275 gm) which was supplemented with vitamin E @ 75 ppm in diet. This was followed by T_2 (1357.45 gm), T_4 (1201.82 gm), T_3 (1167.14 gm) and least body weight was recorded in T_1 (1082.18 gm) which acted as control group. The difference between mean body weights among all groups were significant ($P<0.01$).

The total amount of feed consumed by experimental broilers at the end of sixth week in different treatment groups were 2603.72 gm, 3077.33gm, 2698.42 gm, 2817.06 gm and 3034.24 gm in T_1, T_2, T_3, T_4 and T_5 respectively. Highest amount of feed was consumed by birds of group T_2 while least by birds of group T_1. The total amount of feed consumed by different groups differed significantly ($P<0.01$).

The feed conversion ratio were calculated for all treatment groups at end of experiment which were 2.15, 2.267, 2.32, 2.344 and 2.406 for T_5, T_2, T_3, T_4 and T_1 group respectively. Thus group T_5 had best FCR and control T_1 had poorest FCR. The result of analysis of variance was highly significant ($P<0.01$). Result of CD test show that there is no significant difference between treatment group T_2 & T_3 and T_3 & T_4, while in others there is existence of significant difference.

The performance index mainly depends on body weight gained by bird and its feed conversion ratio. It was found to be best in T_5 group (656.40) followed by group T_4 (598.78), T_4 (512.72). T_3 (504.81) and least performance index was observed in T_1 (449.78) group. The difference for

performance indices were found to significant ($P<0.01$) among treatment groups.

On critical perusal of data, it was concluded that T_5 group which was supplemented with vitamin E @ 75 ppm in feed was most beneficial among all treated groups. However supplementation of all other immunomodulators give better result than control. Supplementation of immunomodulators increased the feed consumption of broilers to greater extent as a result nutrients availability was higher leading to more protein synthesis and higher body weight gain. It was also realized that supplementation of immunomodulators in broiler diet resulted in better assimilation and utilization of nutrients in their body, due to which better feed conversion ratio was obtained leading to superior performance of these groups.

Perusal of data related to carcass yield of broiler revealed that maximum dressing weight percentage was of group T_5 (84.29%) while minimum was of group T_1 (79.94%). However there was non-significant difference between T_1 & T_3 and T_2, T_4 & T_5, but other differs significantly. Result of eviscerated weight percentage revealed a non-significant difference between T_1 & T_3 and T_4 & T_5 where other means differ significantly from each other. Maximum eviscerated weight percentage was of group T_5 (76.48%) while minimum was of group T_3 (70.50). Result of gizzard weight percentage revealed that there is significant difference between all the treatment groups. Highest gizzard weight was 3.41% of group T_2, followed by 3.22% of T_5, 2.81% of T_4, 2.50% of T_3 and 2.06% of T_1. Result of liver weight percentage revealed that there is non-significant difference between T_1, T_2, T_4 & T_5 while T_3 differ significantly from others.

The study of critical difference test of heart weight percentage revealed a non-significant difference between T_1 & T_3 group whereas the other means differed significantly from each other. Highest heart weight percentage was observed in treatment group T_2 (0.90%), followed by T_5 (0.85%), T_4 (0.70%), T_3 (0.67%) and least by control group T_1 (0.65%). Data revealed giblet weight percentage of broilers, indicated that highest percentage was in group T_2 (6.78%) followed by group T_5 (6.29%), T_4 (6.00%), T_3 (5.58%) and least by control group T_1 (5.21%). The difference between mean body weights among all groups were significant ($P<0.01$).

Thus, it was observed that the diet supplemented with immunomodulators i.e. vitamin E, herbal liver tonic, or neem leaves powder when composed with control diet produced beneficial effect on carcass yield of broilers, although effect was not observed with homeopathic liver tonic. This addition gain in carcass yield in terms of increased dressed, eviscerated and edible weight was due to the use of immunomodulators which mostly acted as growth promoters. Due to more weight attained by the broilers, automatically, it resulted in more carcass yield. There was no significant difference in liver weight gain percentage between control and immunomodulator treated groups. This is due to that these immunomodulators have promoted the efficacy of liver and prevented liver from any damage, as a result the liver was prevented from tissue regeneration and unnecessary increased in weight.

As regard to the efficacy of these immunomodulators on resistance of body against feed toxins and infectious and non-infectious diseases, it was found that group T_2, T_3 and T_5 were most effective (mortality 0.66%). The mortality in control group and T_4 group fed with neem leaves powder, were

highest (1.33%). Higher mortality percentage in group T_4 may be due to presence of some toxin in neem leaves powder. However the mortality percentage was minimal and within normal range. Minimum mortality percentage in immunomodulator fed groups may be due to the fact they modify the immune system and thus provide more strength to fight against the disease.

Considering the economics of broiler production, it was clearly observed that feed cost per kg weight gain was minimum in group T_2 (22.67 Rs./kg) followed by T_3 (23.44 Rs./kg), T_4 (23.48 Rs/kg), T_5 (24.06 Rs./kg) and maximum in control group (26.89 Rs/kg) while return over feed cost was maximum in group T_2 (27.25 Rs./kg) followed by T_3 (26.03 Rs/kg), T_4 (25.98 Rs./kg), T_5 (24.35 Rs/kg) and least by control T_1 (19.62 Rs/kg). After performing best in growth traits by groups T_5, its economic return is poor compared to other groups which were fed to immunomodulators in their diet is due to high cost of vitamin E in market. However all immunomodulator treated groups performed better as compared to control groups and provided better economic return.

SUGGESTION FOR FUTURE WORK :

The present study was undertaken to evaluate certain immunomodulators for growth and carcass traits in broilers. Detailed studies should be conducted on complete blood parameter of broilers. Studies on similar lines should be conducted in chicks of laying strain, growers, layers and breeders. Evaluation of immunomodulators should be done in different seasons, with various forms of feed having different dietary energy levels and on different sexes. Similarly all type of immunomodulators available in

market should be used for comparative studies. Studies on similar pattern should be conducted using different strains of broilers separately.

CONCLUSION :

(i) Diet containing immunomodulator performed better than control.

(ii) Diet containing vitamin E @ 75 ppm in feed performed best in growth parameters.

(iii) Simultaneously herbal liver tonic, homeopathic liver tonic and neem leaves powder feeding produced desired result in growth parameters.

(iv) Feed conversion ratio was best in vitamin E treated group (2.15) while poorest in control (2.406).

(v) Performance index was also best in vitamin E treated group (656.4) while poorest in control (449.78)

(vi) Dietary treatment had impact on carcass quality of birds and performed better in immunomodulators treated group.

(vii) Mortality during entire experimental period in different dietary treatment was within normal limit.

(viii) Performing best in growth traits by vitamin E treated group but most beneficial economic return was provided by herbal liver tonic treated group.

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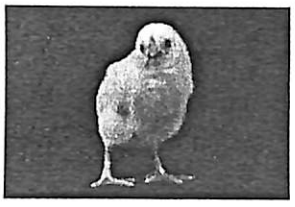

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