EFFECT OF DIFFERENT DIETARY SUPPLEMENT ON CHOLESTEROL LEVEL IN BROILER CHICKEN

THESIS

SUBMITTED TO THE

BIHAR AGRICULTURAL UNIVERSITY

(FACULTY OF POST-GRADUATE STUDIES)

SABOUR (BHAGALPUR) BIHAR

In partial fulfillment of the requirement

FOR THE DEGREE OF

Master of Veterinary Science

(Animal Nutrition)

By

PUNITA KUMARI

Registration No. M/VAN/12/BVC/2011-2012

DEPARTMENT OF ANIMAL NUTRITION

BIHAR VETERINARY COLLEGE

PATNA (BIHAR)

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CERTIFICATE – I

This is to certify that the thesis entitled "***Effect of different dietary supplement on cholesterol level in broiler chicken***" submitted in partial fulfillment of the requirements for the Degree of Master of Veterinary Science **(Animal Nutrition)** of the faculty of post-graduate studies, Bihar Agricultural University, Sabour, Bhagalpur, Bihar is the record of bonafide research work carried out by **Dr. PUNITA KUMARI, Registration No. M/VAN/12/BVC/2011-12,** under my supervision and guidance. 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.

Endorsed

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATION

ACAT	-	Acyl CoA-Cholesterol Acyl Transferase
ALA	-	Alpha-Linoleic Acid
ALP	-	Alkaline Phosphatase
ALT	-	Alanine Transaminase
ANOVA	-	Analysis of Variance
AOAC	-	Association of Official Analytical Chemist
AST	-	Aspartate Transaminase
BIS	-	Bureau of Indian Standards
B.wt.	-	Body weight
C	-	Carbon
Ca	-	Calcium
CF	-	Crude Fibre
CHD	-	Coronary Heart Disease
CO_2	-	Carbon dioxide
CP	-	Crude Protein
CSM	-	Coriander Seed Meal
CVD	-	Cardiovascular disease
DM	-	Dry matter
EDTA	-	Ethylene diamine tetra acetate
EE	-	Ether extract
EFA	-	Essential Fatty Acid
FAO	-	Food and Agricultural Organization
FCR	-	Feed Conversion Ratio
g.	-	gram
GAIN	-	Global Agricultural Information Network
GDP	-	Gross Domestic Product
Hb	-	Haemoglobin
HDL	-	High Density Lipoprotein
HF-HC	-	High Fat-High Cholesterol

HMG-CoA	-	Hydroxy-Methyl-Glutaryl CoA
IU	-	International Unit
kcal	-	Kilocalorie
kg.	-	Kilogram
LCAT	-	Lecithin Cholesterol Acyl Transferase
LDL	-	Low Density Lipoprotein
LSD	-	Least Significant Difference
LSM	-	Linseed Meal
ME	-	Metabolizable Energy
MUFA	-	Monounsaturated Fatty Acid
NLM	-	Neem Leaf Meal
NSO	-	Neem Seed Oil
O_2	-	Oxygen
P	-	Phosphorus
PCV	-	Packed Cell Volume
PI	-	Performance index
PUFA	-	Polyunsaturated Fatty Acid
SBF	-	Sugar Beet Fiber
SBM	-	Sugar Beet Meal
SDG	-	Secoisolariciresinol- Di-Glycoside
SEM	-	Standard Error of the Mean
SFA	-	Saturated Fatty Acid
SPSS	-	Statistical Packages for Social Science
T	-	Treatment
TG	-	Triacyl glycerol
USDA	-	United States Department of Agriculture
VLDL	-	Very low density lipoprotein

CHAPTER - 1

INTRODUCTION

INTRODUCTION

India has one of the world's largest and fastest growing poultry industries, ranking third in hen egg production (USDA 2011) and fourth in broiler meat production (ICRA 2011). According to annual Report 2011-12, Department of Animal Husbandry, Dairying & Fisheries, Ministry of Agriculture, Government of India, poultry population in India is 648.9 million with an annual growth rate of 7.33%.

As per ICRA, 2011 report, Indian poultry sector has been growing at around 8-10% annually over the last decade and at more than 15% in last three years. Broiler meat production in India is around 3 million metric tons while broiler meat market is estimated around Rs. 30,000 crore.

India's per capita consumption of poultry meat and eggs are estimated at around 3 kg per annum and 51 eggs per annum respectively. Industry estimates suggest that broiler meat consumption will double by 2014-15 (Global Agricultural Information Network (GAIN) Report 2011).

Animals are one of the important components of the food chain. Besides a source of food they provide quality protein. Changes in human diet over the past 100 to 150 years particularly in terms of dietary fat intake and its effect on human health have become a major concern in the nutrition research (Simopoulos, 1998; Lichtenstein, 1999). Epidemiological and scientific evidences have shown a strong relationship among total fat intake and number of diseases including coronary heart disease (CHD), cancer, diabetes and depression (Okuyama et *al,* 1997; Henning and Watkins, 1998; Leaf and Kang, 1998; Katan, 2000). Cholesterol and fatty acids in body comes partially from dietary source, particularly animal source, which leads to cardiovascular diseases. The

relationship between cholesterol and atherosclerosis has long been a concern. Furthermore, plasma total cholesterol and low-density lipoprotein cholesterol (LDL-C) are closely related to atherosclerosis, and excessive concentration of these two substances may lead to coronary artery disease or death (Pekkanen et al. 1992). Therefore, lowering the level of cholesterol in one's diet has become an important concern for senior citizens and patients with cardiovascular diseases.

Chicken is one of the main meat products consumed by humans. It is low in cholesterol and fat and thus is considered to be healthier than other meat products, especially the red meat of mammalian origin.

Though poultry meat is known as white meat, but its cholesterol content has become a primary area of consumer concern due to increased awareness of link between higher dietary saturated fat / cholesterol intake and incidences of cardiovascular diseases (CVD). Cardiovascular affliction is considered as the world's number one peril in public health accounting for more than 25% of all deaths in the world (Gyarfas, 1992). Coronary heart disease is believed to have a non-pharmacological remedy by way of physical exercise, low salt intake and cessation of smoking, while hyper cholesterolemia is still difficult and costly to be controlled (Lonkar *et al.*, 2009).

Recently, hypercholesterolemia has been associated with enhanced oxidative stress related to increase lipid peroxidation (Adaramoye *et al.*, 2005). Increased generation of oxidized LDL is a major factor in the vascular damage associated with high cholesterol levels (Pritchard *et al*, 1995). Hence, the inhibition of oxidative stress under hypercholesterolemic conditions is considered to be an important therapeutic approach and efforts have been made to identify the

antioxidative functions of various medicinal plants (Hu *et al*, 2006; Tomotake *et al*, 2006; Visavadiya and Narasimhacharya, 2007).

Gyarfas (1992) postulated that the most practical and least expensive way of overcoming the cardiovascular diseases is of resorting to non-pharmacological procedures. Thus, attempts were made to reduce serum cholesterol or lipids in mammals by administering non-pharmacological dietary hypocholesterolemic agents such as garlic, onion, neem and ginger with varying degrees of efficacy (Kender, 1987; Lata *et al.*, 1991).

The use of plant extracts in managing various disorders is currently a common practice (Philip and Cephas, 1997). Many plant materials are also in current use as supplements (Block *et al*, 2007). Sometimes the aim is to lower the levels of some markers of disease states in order to improve health conditions (Ojiako and Nwanjo, 2009). An example may be found in the use of substances that lower the cholesterol level in the system. Many studies indicate that lowering the serum cholesterol may prevent, control and even reverse artherosclerosis and coronary heart disease. Low triacylglycerol and low-density lipoprotein cholesterol (LDL-C) levels or high density lipoprotein cholesterol (HDL-C) levels are desirable health outcomes known to have resulted from the use of some plant materials (Ojiako and Nwanjo, 2009).

In recent year, on the other hand, consumer awareness of the correlation between saturated fat consumption and obesity / CHD has stimulated the demand for the low fat products of animal origin. Consumers have limited their intake of eggs and poultry meat because of adverse publicity about saturated fat and cholesterol content and thrust is being given towards vegetarianism. These conditions have become an important threat to animal producers and animal products. As producers

are poor farmers, naturally their engagement, labour and income will go away. Thus, different measures are being undertaken to reduce fats and lipids concentration in poultry and poultry products for the shake of health concerned people. Chicken meat cholesterol content can be altered by varying the composition of diet, age, and gender.

Many of feed exhibit wide range of physiological and pharmacological properties in addition to enhancing the taste and flavour of food. However, information regarding effects of various feed such as sugarbeet meal, neem leaf meal, linseed meal, & coriander meal on cholesterol content and lipid profile in broilers is very scanty.

So, this study was undertaken to investigate the above facts with following objectives:

(i) Effects of feeding of different dietary supplement such as, sugar beet meal, neem leaf meal, linseed meal, & coriander seed meal on growth performance of broilers.

(ii) Effects of feeding of different dietary supplement on carcass quality of broilers.

(iii) Effects of feeding of different dietary supplement on lipid profile in blood and meat of broiler.

(iv) Effects of feeding of different dietary supplement on cost effectiveness of feeding to the broilers.

CHAPTER - 2

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Broiler industry is an important source of nutrition, provides employment and help in poverty alleviation. The success of poultry industry in Indian Scenario is evident from the fact that with 10 kg. of similar feed, broiler type chicken gives 450 g. of protein while swine gives 160 g., beef gives 96 g and sheep and goat around 225 g. of protein (Qureshi *et al.*, 1983b). Thus, chicken and eggs are inexpensive source of protein among all animal products. But nowadays cholesterol level and amount of saturated fat cause alarm to the people.

Cholesterol a steroid lipid synthesized regularly in body is found in all parts of the body and is necessary for proper functioning of cell membranes. But high levels of cholesterol have been shown to increase the risk of heart disease and stroke. While body makes some cholesterol on its own, it can also be contributed in the system from certain food sources, such as eggs, dairy products, meat and poultry or other saturated fat sources . Cholesterol is required to produce hormones, bile acid and vitamin D, but too much cholesterol in the system can clog arteries, contributing to heart disease.It is well established that certain factors increase the risk of cardiovascular disease in man; hypercholesterolemia and hypertriacylglycerolaemia are considered major risk factors and are at the forefront of research efforts (Anderson *et al.* 1990).

Principle lipids that have metabolic significance present in animals are Triacyl glycerol (TG), phospholipids and sterol, chief of which is cholesterol. Cellular synthesis and feed sources contribute in TG level. Triacyl glycerol synthesized in liver cells and is connected to lipoprotein particles called very low density lipoproteins (VLDL). VLDL

is mainly concerned with transport of endogenous TG (Chatterjea and Shinde, 1998).

Word cholesterol is derived from Greek word meaning 'solid bile'. Cholesterol the most important sterol in human body bears molecular formula C27H45OH and have Cyclopentanoperhydrophenanthrene nucleus. Word cholesterol is derived from Greek word meaning 'solid bile'. Essentially all tissues form cholesterol but liver is the major site for cholesterol synthesis. The steps involved in the biosynthesis of cholesterol are :

(i) Synthesis of mevalonate, a 6-C compound from acetyl CoA.

(ii) Formation of Iso-prenoid units (C-5) from mevalonate by successive phosphorylations and followed by loss of CO_2.

(iii) Formation of sequalene, a 30-C aliphatic chain, formed by condensation of six isoprenoid units.

(iv) Cyclization of sequalene to form lanosterol.

(v) Conversion of lanosterol to form cholesterol (Chatterjea and Shinde, 1998).

Cholesterol in the diet is absorbed from the intestine and in company with other lipids are incorporated into chylomicrons and also to some extent VLDL. Of the cholesterol absorbed 80 to 90% in the lymph is esterified with long chian FA. Esterification may occur in intestinal mucosa. The greater part is found in the esterified form and is transported as 'lipoproteins' in plasma. Highest proportion of circulating cholesterol is found in LDL (□-lipoproteins) which carry cholesterol to tissue and also in HDL which takes cholesterol to liver from tissue for degradation (Chatterjea and Shinde, 1998).

Many factors determine the cholesterol balance at the cellular level. Synthesis of cholesterol, hydrolysis of cholesterol ester by the enzyme cholesterol ester hydrolase, uptake and delivery of cholesterol in cells by circulating LDL (by specific receptors) and cholesterol containing lipoproteins by 'non-receptor' mediated pathway increase cholesterol in cells while efflux of cholesterol from cells to HDL, esterification of cholesterol by the enzyme Acyl CoA-Cholesterol acyl transferase (ACAT), utilization of cholesterol for synthesis of steroid hormones, formation of cholic acid in liver cells and formation of vitamin D_3 decreases cholesterol in cells. Various factors influence cholesterol level in blood. They are dietary fats, dietary cholesterol, dietary carbohydrates, heredity, blood groups and life style of individual (Chatterjea and Shinde, 1998).

Relation of cholesterol and other lipids as risk factor in coronary heart disease (CHD):

Role of Cholesterol: An elevation of the total cholesterol in plasma is considered to be a prime risk factor for CHD. The Framingham study has demonstrated a linear increase in coronary risk with increment of total plasma cholesterol level. The lipids research clinics coronary primary prevention trial had presented firm proof that in humans, a lowering of plasma cholesterol level reduces the coronary thrombosis, myocardial infraction and mortality. One conclusion deducted from this pioneer work is that 1% fall in cholesterol predicts a 2% reduction in CHD risk. (Chatterjea and Shinde, 1998).

Role of LDL and HDL: LDL is the carrier of 70% of cholesterol and it transports cholesterol to tissues and thus most atherogenic agent. On the other hand, an increase of second cholesterol rich class HDL is not associated with risk at all. An inverse relationship

between CHD and HDL concentration has been found. A raised HDL concentration is beneficial and protective against CHD (Chatterjea and Shinde, 1998).

Role of TG and VLDL: Elevated VLDL and hypertriglyceridaemia may be considered a primary risk factor because it is associated in specific cases, with an increased atherogenic risk. A low blood TG level is suggestive of efficient intravascular lipolysis and thus of enhanced formation of HDL. Hypertriglyceridaemia, on the other hand indicates less effective intravascular lipolysis and hence reduced formation of HDL which is in turn associated with higher atherogenic risk (Chatterjea and Shinde, 1998).

The single largest killer of American males and females is coronary heart diseases (CHD), causing one of every five deaths. The economic cost of CHD in the United States was projected to be $299 billion for 2001 (American Heart Association, 2001). Clinical data strongly support a relationship between CHD and dietary intake of cholesterol and saturated fatty acids (SFA) (American Heart Association, 1991).

On the other hand, nature has provided us different ways and means to alter the cholesterol level and keep the animal physically fit. This idea may be introduced in animal production to have animals with low cholesterol. In result consumption of such sources of animal origin with low cholesterol will prove a boon for the poultry producers. Many of the feeds have been found to reduce the cholesterol level in the blood of broilers, suggesting its supplementation can be of value in production of quality broiler meat and making their meal acceptable to health conscious people or people with health risk.

Sugarbeet (*Beta vulgaris*)

Sugarbeet (*Beta vulgaris*) is a plant of the goosefoot family (Chenopodiaceae). It come from south of Europe and, according to some wide spead opinion, from Italy. It is derived from wild species *Beta meritima Linn* that grow freely in many marine area of the south of Europe and north of Africa.

Beetroot is a rich source of carbohydrates, a good source of protein, and has high levels of important vitamins, minerals and micronutrients. It is a good source of dietary fibre, has practically no fat, and no cholesterol. Beetroot is rich in many important minerals and micronutrients; it is a nutritious vegetable with many health-giving properties. Beetroot is a rich source of potent antioxidants and nutrients, including magnesium, sodium, potassium and vitamin C, and betaine, which is important for cardiovascular health. More recently, it has been advocated as a cancer preventative and as a means of bolstering the immune system.

In the analysis presented in McCance and Widdowson's *The Composition of Foods*, 100g of raw beetroot (peeled, but not grated) contains 87.1g of water, 7.6g of carbohydrate, 1.7g of protein and 0.1g of fat. It provides 154 kJ (36 kcal) of energy. Sugarbeet fibre contains 22-29% pectin's by weight.

Cultivated forms of *Beta vulgaris* have been utilized for their medicinal properties since ancient times. Beetroot has long been considered beneficial to the blood, heart, and the digestive system. It has been regarded as a laxative; a cure for bad breath, coughs and headaches; and even as an aphrodisiac. Betaine acts a methyl donor to affect changes

in the cardiovascular system, the liver and other organs (Stephen Nottingham 2004).

Beetroot juice has been shown to lower blood pressure and thus help prevent cardiovascular problems. Research published in the American Heart Association journal *Hypertension* showed drinking 500 ml of beetroot juice led to a reduction in blood pressure within one hour. The reduction was more pronounced after three to four hours, and was measurable up to 24 hours after drinking the juice. The effect is attributed to the high nitrate content of the beetroot. The study correlated high nitrate concentrations in the blood following ingestion of the beetroot juice and the drop in blood pressure. Dietary nitrate, such as that found in the beetroot, is thought to be a source for the biological messenger nitric oxide, which is used by the endothelium to signal smooth muscle, triggering it to relax. This induces vasodilation and increased blood flow. In the 1990s, cell culture and animal studies, such as those conducted by Edenharder *et al.* (1994) and Kapadia *et al.*(1996), respectively, confirmed that beetroot juice had significant tumour-inhibiting and antimutagenic effects. In a review of the subject, Rosenberg (1990) concluded that beetroot's effect on cancer cells is probably due to the combined effects of betanin, allantoine, vitamin C and other compounds present, such as farnesol and rutine(Stephen Nottingham 2004).

Beetroot has often been described as "blood-building", a tonic or detoxifier of the blood, or as an aid to effective blood circulation .Both the roots and leaves of beetroot contain iron, potassium and folic acid. Potassium, along with other minerals and vitamins may help to regulate blood pressure and heartbeat. Modern herbals describe beetroot as being mildly cardio-tonic(Stephen Nottingham 2004).

Betaine may protect against liver disease, particularly the buildup of fatty deposits in the liver caused by alcohol abuse, protein deficiency, or diabetes, among other causes. The blood cholesterol-lowering effect observed in one human study, where 30 g/day of sugar beet fibre were consumed daily (containing about 6 g/day of pectins).Soluble fiber helps improve blood sugar control, bowel function and weight loss, and reduces total cholesterol.

Soluble fibers attract water and form a gel, which slows down digestion. Soluble fiber delays the emptying stomach and makes feel full, which helps control weight. Slower stomach emptying may also affect blood sugar levels and have a beneficial effect on insulin sensitivity, which may help control diabetes. Soluble fibers can also help lower LDL ("bad") blood cholesterol by interfering with the absorption of dietary cholesterol.

Feeding some dietary fibers lowers plasma cholesterol concentration (Chen and Anderson 1979, Kiriyama et al. 1969). The mechanism is not fully understood. It is proposed that cecal and colonic fermentation of dietary fiber is associated with cholesterol-lowering effects of fibers (Anderson 1985, Moundras et al. 1995). Feeding of sugar-beet fiber (SBF), a highly fermentable dietary fiber, lowered plasma cholesterol concentration in rats (Aritsuka et al. 1989, Overton et al. 1994); Nishimura et al. (1993) reported that the lowering effect of the fiber disappeared when the cecum was resected. This finding shows that the large intestine is involved in the reduction of plasma cholesterol in rats fed SBF. Two possible mechanisms are proposed for the ceco-colonic–dependent decrease in plasma cholesterol. As the first mechanism, fiber or its fermentation products stimulate the large intestine, and humoral factors secreted from the large intestine or enteral nervous system modify

cholesterol metabolism. Goodlad et al. (1989) showed that colonic fermentation of dietary fiber elevates plasma enteroglucagon, and it is known that the large intestine is important for production of this hormone (Kennedy et al. 1982). In addition, the enteric nervous system in the large intestine is possibly stimulated by fiber or its fermentation products. Some neuropeptides are known to influence cholesterol and bile acid metabolism (Cho et al. 1997, Farouk et al. 1992, Gebhard et al. 1981). In these cases, the large intestine is essential for the beneficial effects of dietary fiber. Second, propionate, a fermentation product of SBF, absorbed from the intestine can modify cholesterol synthesis directly (Lin et al. 1995, Nishina and Freedland 1990). Bridges et al. (1992) suggested that acetate is involved in the serum cholesterol–lowering effect of oat bran in humans.

Numerous theories have been proposed concerning the mechanisms by which dietary fibres interact with dietary lipids. However, all of these theories have limitations, mainly as a result of the great chemical diversity of dietary fibres and difficulties in the measurement of reactions occurring in the body and small intestine (Furda, 1990). The theory receiving the greatest attention is that dietary fibres increase bile acid and neutral sterol excretion and in so doing prevent resorption by binding or absorbing these sterols (Anderson & Tietyen-Clark, 1986). The fundamental problem with this theory is that there is no basis for chemical binding of bile acids to dietary fibres (Furda, 1990) although physical entrapment of lipids by dietary fibres may be possible. Alternatively, soluble dietary fibres (e.g. pectins) may inhibit lipid absorption by increasing digesta viscosity (Johnson & Gee, 1981). Dried sugar-beet pulp which has a high dietary fibre content and is rich in pectins has been shown to increase faecal bile acid excretion in rats (Gallaher *et al.* 1992).

Chickens usually adapt to fibre-rich diets by increasing the volume of the digestive tract (Hikansson *et al.* 1978) and consequently improve relative feed intake and growth. Soluble dietary fibres such as pectins have been shown to decrease the rate of diffusion of glucose in gut sections ***in vitro*** (Johnson & Gee, 1981) and ***in vivo*** in man (Flourie *et al.* 1984), and it is likely that lipid micelles also diffuse inefficiently under viscous conditions. Entrapment of bile acids by soluble dietary fibres and consequent inhibition of bile acid resorption (Ebihara & Schneeman, 1989) would also lower serum cholesterol levels. In study on broiler chickens fed on diets including conventionally-dried (standard pulp) or vacuum-dried (Fipec pulp) sugar-beet pulp at inclusion levels of 23, 46 and 92 g/kg showed chickens given the 23 g sugar-beet pulp/kg diets consumed more feed, increased body weights and converted feed more efficiently, reduced total serum cholesterol concentrations (Pettersson and Razdan ,1993). According to Arslan and Saatci (2003) diet replacement by 5 to10 % with alfalfa, grass and sugar beet pulp at starter and grower period in geese was showed significant effect on live weight. The feeding regime was significantly affect carcass yield. Diet replacement by alfalfa, grass and sugar beet pulp significantly decreased both mesenterial and abdominal fat percentage in carcass weight compared to the control. Serum cholesterol, total lipid, total protein and albumin levels were significantly ($P<0.05$) decreased and AST, ALT levels were significantly ($P<0.05$) increased by bulky feed replacement. Although there was no constant trend between the group in terms of glucose and triglyceride a statistically significant differences were observed.

Beet pulp is an excellent source of highly digestible fiber and has a crude protein content of 7%. Beet pulp has a high level of calcium (over 1%) but very little phosphorus. The digestible energy content of beet

pulp is greater than most hay and less than most grain ingredients, making its reputation as a weight building feed supplement well deserved.

Neem (*Azadirachta indica*)

Neem (*Azadirachta indica*) is a large fast growing perennial tree and the species belongs to the family Meliaceae. Presently neem is widely cultivated in Arid, semi-arid, wet-tropical, tropical and sub-tropical regions of the Indian subcontinent. The sanskrit name of the neem tree is 'Arishtha' meaning 'reliever of sickness' and hence is considered as 'Sarbaroganibarini'.The tree is still regarded as 'village dispensary' in India.

Neem has been identified among the tropical plant that has been used as livestock feed resource (Sokunbi and Egbunike, 2000a, b; Akpan *et al.*, 2008; Kausik *et al.*, 2008; Ogbuewu *et al.*, 2008; Ogbuewu *et al.*, 2009). Chemical analysis revealed that neem leaf meal is relatively high in crude protein (20.69%) (Esonu *et al.*, 2006) and low in metabolisable energy (0.34KJ / Kg DM) (Bakshi *et al.*, 2006). Neam leaf meal has a proximate composition of 92.42 dry matter; 7.58% moisture; 20.68% crude protein; 16.60% crude fibre; 4.13% Ether extract; 7.10% Ash and 43.91% Nitrogen free extract.

Its bitter taste is due to an array of complex compounds called "limonoids". The most important bio-active principal is azadirachtin (repellent); other compounds are melacin, valasin, gedunin (anti-malarial), nimbin (anti-inflammatory, anti-pyretic), nimbidin (antibacterial), nimbidol (anti-malarial, anti-pyretic), quercentin (anti-malarial), salannun (repellent), and sodium nimbinate (spermicide), nimbinene , acetylnimbinase, nimbandial, nimbolide and many other derivatives of these principles. Miliacin forms the bitter principles of

neem seed oil (NSO). The seed also contain tignic acid (5-methyl- 2-butanic acid) responsible for the distinctive odor of the oil (Akpan *et al.*, 2008).

Neem leaves like most tropical tree leaves contain bioactive compounds (Kausik *et al.*, 2008; Akpan *et al.*, 2008) which may affect nutrient utilization. These bioactive compounds may also alter the hematological and serum biochemical parameters of animals. Alcoholic extract of neem leaf reduced serum cholesterol by approximately 30 percent two hours after its administration in human .

It appeared that neem leaf meal indirectly inhibit HMG - COA reductase, a key enzyme in cholesterol biosynthesis. Chemical analysis revealed that Neem leaf extract contains the following compounds: Quercetin-3-O-β-D-glucoside, Myricetin-3-O-rutinoside, Kaempferol-3-O-β-D-glucoside, Quercetin-3-O-glucose and L-rhamnoside (Chattopadhyay, 1996). It is presumed that these compounds either partially or wholly may be responsible for anti- hyperlipidermic activity of Neem leaf. A recent study showed that Neem lowered high cholesterol levels when either Neem leaf extract or capsules were taken for a month. Neem preparations fed to laying hens have been reported by Sadre *et al.*, (1984) and Gowda *et al.*, (1998) to significantly reduce the content of haemoglobin, erythrocyte count and packed cell volume.

The serum cholesterol and serum glucose value were observed to decrease progressively with increasing levels of neem leaf meal in the diets. Hypocholesmic effects of neem earlier reported by Ogbuewu *et al.* (2008) in rabbit bucks and Oforjindu (2006) in broiler birds. It appeared that neem leaf meal indirectly inhibit HMG - COA reductase, a key enzyme in cholesterol biosynthesis. Offorjindu (2006)

also reported a decline in blood cholesterol levels of broilers and rats fed Neem leaf meal.

Increase in blood sugar level was reported on feeding the dietary Neem leaf meal though birds generally maintain a high and relatively constant blood sugar level even in low feed intake (Liukkonen-Anttila, 2001).

Interest to consider neem leaves meal as hypocholesteromic agent arose from a broiler study where a significant reduction in abdominal fat was observed (Chowdhury et al 2004). Haemoglobin and packed cell volume are very sensitive to the levels of protein intake as the values increase with increase in dietary protein concentration (Edozien and Switzer, 1977). The use of leaf meals of plants as feed ingredients as alternative to conventional feed resources is a novel area of research in animal nutrition. One of the tropical plants that have attracted attention of animal nutritionists in recent time is the neem tree (*A. indica*). Various parts of the tree have medicinal value (Chakraborty *et al.,* 1989) and recent studies by Esonu *et al.* (2006) have shown that its leaf meal could be of some value in the diet of laying hens both as feed ingredient and egg yolk pigmenter. According to Esonu et al (2006)Neem leaf meal did not show any appreciable difference in weight gain between the birds at 0% and those at 5%, 10% dietary levels. Carcass weight, dressed weight, liver, heart and gizzard weights were significantly ($P<0.05$) increased at 5% dietary level of NLM. There were no significant difference in Hb and PCV between birds on 0% and 5% treatment diets. However, these differed significantly ($P<0.05\%$) from those of birds on 10% and 15% treatment diets. There were variations in the differential leucocyte count but marked lymphocytopenia adversely affected the total leucocyte counts in the birds on 5%, 10% and 15% treatment diets. The results of this study

suggest that laying birds could up to 15% dietary inclusion of NLM without deleterious effects.

As per Obikaonu et al (2012) Fed neem leaf meal as broiler starter diets at 0, 2.5,5.0, 7.5 and 10% levels and found haemoglobin (Hb) and packed cell volume (PCV) significantly ($P<0.05$) reduced but not below the level considered normal for birds. Blood sugar was significantly raised ($P<0.05$) by the leaf meal but cholesterol was significantly ($P<0.05$) decreased. Alkaline phosphatase (ALP), alanine transaminase (ALT) and aspartate transaminase (AST) decreased with increase in leaf meal ($P<0.05$). The haematological and serum biochemical parameters obtained from this study suggested that dietary Neem leaf meal has no deleterious effects on the internal physiology of starter broilers.

According to Ogbuewu et al (2010) feeding of neem leaf meal based diets to chinchilla rabbit does,serum cholesterol and serum alkaline phosphatase concentrations were significantly($P<0.05$) reduced by the treatment. The serum globulin and serum glucose concentrations were significantly lowered relative to control rabbits.

Flax (*Linum usitatissimum*)

Flax (*Linum usitatissimum*) is an annual species of the *Linaceae* family.

Linseed meal is an important feedstuff for cattle but its use in poultry feeds is limited. Flaxseeds are known for providing a wide variety of health benefits when consumed as whole seeds or in milled or oil form. Flaxseeds and flaxseed oil are a good source of Omega-3 essential fatty acids (EFAs) and may help to reduce the risks and effects of heart disease, cancer, stroke, diabetes and other conditions. Its active principle are mucilage, pectin, acid (chlorogenic,oleic,linoleic,alpha- linoleic and

palmitic), linamarin, linustatin, protein, fiber, magnesium, phosphorus, potassium, iron.

The most active ingredient in flaxseed oil is its fatty acids which influences specifically the thyroid and adrenal functions, for healthy blood, nerves and arteries and to breakdown cholesterol in our body.

For those who are suffering from the ill effects of too much saturated fat in the diet, and the resultant high levels of cholesterol, flaxseed oil, with its abundant Omega 3fatty acids, will work to eliminate these fats and cholesterol from body.

Flax-seed oil contains both Omega 3 and Omega 6 essential fatty acids, with the greater portion being Omega 3, at a 4:1 ratio to Omega 6. Consuming flaxseed oil helps to increase Omega 3 in the diet and to secure the important life giving balance of Omega3 and Omega 6 fatty acids. Omega 6 stimulates blood clotting and Omega 3 helps reduce blood clotting, so striking a balance between the two is highly recommended. The proper balance is 1:2, but most people maintain an unhealthy balance of 1:20. When the fatty acids in flaxseed oil are metabolized into prostaglandins, they are anti-inflammatory and work to relieve conditions such as arthritis. The essential fatty acids also, "protect against heart disease by reducing blood clotting, lowering triglycerides and causing vascular dilation." Flaxseed oil even effectively treats eczema, which is caused by either an imbalance or deficiency of essential fatty acids, or both.

Flaxseed is a good source of dietary fiber and omega-3 fatty acids. The fiber in flaxseed is found primarily in the seed coat. Researchers believe this fiber binds with cholesterol in the intestine and

prevents it from being absorbed. Flaxseed also seems to make platelets, the blood cells involved in clotting, less sticky. Overall, flaxseed's effects on cholesterol and blood clotting may lower the risk of "hardening of the arteries" (atherosclerosis). Flaxseeds contain ~30% dietary fibers of which one third are water-soluble and belonging to a group of heterogeneous polysaccharides (Naran R,*et al.*2008). Warrand and colleagues found that the water extractable neutral monosaccharides from flaxseed were a mixture of three major families of polymers: arabinoxylans with a A/X ratio of ~0.25, and various amount of galactose and fucose residues. Thus, the lower A/X ratio compared to wheat arabinoxylans, which are mainly insoluble, results in different physicochemical properties. Also, flaxseeds contain some pectins. Flaxseed fibers form highly viscous solutions upon hydration, which is similar to those observed for other gums (Cui W *et al.*1994 , Goh KKT *et al.*2006).

In study the use of whole ground flaxseed have been reported to reduce the plasma and hepatic cholesterol in suitable mice models. This reduction in the cholesterol level has been attributed to the reduced absorption of cholesterol and/or bile acid reabsorption (Pellizzon et al. 2007; Cintra et al. 2006). The most plausible mechanism of action is through an interference with bile acid metabolism, where an increased intraluminal viscosity can 1) hinder micelle formation and thus diminish lipid uptake and 2) inhibit re-uptake of bile acids causing increased hepatic synthesis of bile acids which diverts cholesterol away from lipoprotein synthesis in the liver, thereby reducing serum cholesterol (Theuwissen E, Mensink RP. 2008). Short chain fatty acid production has also been proposed to play a role, and although flaxseed dietary fibers have been shown to be highly fermentable in rats (Berggren AM *et*

*al.*1993), this mechanism has not been confirmed in humans (Theuwissen E, Mensink RP.2008).

The increase in fecal energy and fat excretion is in accordance with previous studies on flaxseed fibers showing a reduction in energy digestibility and weight gain in growing Wistar rats fed a diet with 10% of flaxseed dietary fibers (Kristensen *et al.*2011, Flaxseed dietary fibers reduce apparent energy and fat digestibility and weight gain in growing rats, submitted). Studies using other viscous dietary fibers have shown similar results (Kelsay JL *et al.*1978 , Rigaud *et al.* 1987).

Flaxseed lowers cholesterol by increasing secretion of bile, which contains large quantities of cholesterol, according to a study.In the study on laboratory animals, diets supplemented with 15 percent whole flaxseed or flaxseed oil for 90 days did not significantly change levels of high-density lipoprotein -- HDL cholesterol. However, low-density lipoprotein, or LDL cholesterol, and triglycerides were slightly lower in the group that consumed whole flaxseed. The researchers concluded that increased secretion of bile may account for the cholesterol-lowering effect and that other components of flaxseed that have not yet been identified may also contribute.

Flaxseed provides at least three methods of protection for the cardiovascular system, according to the October 2009 issue of the journal "Applied Physiology, Nutrition and Metabolism." Whole flaxseed contains the omega-3 fatty acid alpha-linolenic acid, dietary fiber and lignins, which have phytoestrogen effects. Flaxseed's fiber component and phytoestrogenic lignins are thought to have cholesterol-lowering properties, while its omega-3 fatty acid content offers anti-inflammatory effects and prevents plaque formation in arteries, making it a useful food

for lowering cholesterol and preventing cardiovascular disease, the researchers found.

In the study on laboratory animals, a high-fat diet, along with 15 mg per kg of body weight of flaxseed oil per day for 22 weeks reduced total cholesterol, LDL cholesterol and urea -- a marker of kidney stress. Flaxseed oil improved impaired lipid composition caused by elevated cholesterol in the kidneys, thereby protecting the kidneys and improving cholesterol levels.

According to Professor Lilian U. Thompson, an internationally renowned flaxseed researcher from the University of Toronto says the lignans in flaxseed, which have both phyto (plant) estrogen and antioxidant qualities, may interfere with the growth and spread of tumors, block hormone metabolizing enzymes and provide some protection against hormone-sensitive cancers.

Cholesterol-lowering effects of flaxseed are the result of the synergistic benefits of omega 3 ALA, fiber and lignans. Preliminary research suggests that daily intake of the lignans in flax may modestly improve blood sugar in adults with Type 2 diabetes.

Research indicates that including flax in poultry diets can have positive effects on broiler performance and egg fatty acid profiles. Ajuyah et al. (1991) included 10 percent or 20 percent flax in broiler diets and found less carcass fat and larger leg weights in flax-fed chickens. Additionally, they reported increased omega-3 fatty acids in meat from chickens fed flax diets. In a companion study, Ajuyah et al. (1993) fed 15 pecent flax to broilers and determined that dark meat had higher levels of ALA than white meat, with meat from flax-fed broilers higher in omega-3 fatty acids, compared with meat from chickens fed the control diet.

Eggs can be enriched with ALA easily because the fat content of eggs is influenced to a large degree by the laying hen's ration (Jiang et al., 1991). Caston and Leeson (1990) reported that including 10 percent or 20 percent flax in laying hen rations increased ALA content in eggs 10-fold or 20-fold, respectively.

Scheideler et al. (1994) fed laying hens one of eight diets: a control diet and the control diet with added fish oil (1.5 percent DM), or whole or ground flax at 5 percent, 10 percent or 15 percent of diet DM. Hens fed 5 percent whole flax, 5 percent ground flax and 15 percent ground flax had reduced feed intake, compared with the control diet; however, flax-fed laying hens had greater egg production (percent). Egg ALA content increased linearly from 0.26 g/100 g fatty acids in the control diet to 7.07 g/100 g for eggs from hens fed 15 percent whole flax.

The antioxidant capacity of flaxseed lignin (SDG) is related to the suppression of the oxidant conditions of the reactive species of oxygen. Secoisolariciresinol diglycoside and its aglycone secoisolariciresinol display a very high antioxidant capacity and act as protectors against damage to DNA and liposomes especially in the epithelial cells of the colon exposed to these compounds –during the metabolism of colon bacteria which transform them into mammal lignans (Rajesha *et al.*, 2006; Hu *et al.*,2007). Another important component of flaxseed is Mucilage. This is obtained from aqueous extractions and its composition presents a heterogeneous mixture of polysaccharides made up of xylose, glucose, galactose, arabinose, ramnose, fucose and galacturonic acid(75% neutral and 2 acid fractions).

Linseed oil is highly unsaturated. It is rich in linolenic acid which contains 3 double bonds with its first double bond 3 carbons from the terminal end (omega-3). The beneficial effects of consuming omega-3

fatty acids from fish include reducing heart disease, reducing circulating cholesterol levels and suppressing inflammation in humans (Klatt, 1986). This has prompted studies on the effect of feeding linseed oil or feedstuffs containing it to poultry as a means of increasing linolenic acid in eggs and poultry meat. As early as 1950, Chu and Kummerow reported that feeding a high level (25%) of linseed oil to chickens caused increased linolenic acid in the fat of the skin and gizzard. Kummerow et al. (1948) also reported that feeding linseed oil to turkeys increased the iodine number of the fat and it was less stable to oxidation. Klose et al. (1952) showed that including 2% of linseed oil in a turkey ration caused a large increase in the linolenic acid in the depot fat, a marked reduction in the induction period for fat oxidation and a marked fishy odor of the tissue. The effect of linseed oil on fatty acid composition in broiler chickens has been studied at 56 days of age by Phetteplace and Watkins (1989) and for shorter periods by Olomu and Baracos (1991). Linseed oil fed at from 1.5% to 5% increased the incorporation of omega-3 fatty acids into chicken muscle lipids with the longer chain fatty acids influenced less than linolenic acid. While there was an increase in the omega-3 fatty acids, there was a slight decrease in the long chain omega-6 fatty acids. This may be due to competition of fatty acids resulting in decreased activity of the delta-6-desaturase enzyme. There are other effects of the omega-3 fatty acids upon fatty acid metabolism which are not completely understood.

In 1990, Caston and Leeson reported on feeding 10, 20 and 30% flaxseed to laying hens for a 28-day period and collecting eggs for analysis in the last 3 days of the period. There were large increases in omega-3 fatty acids in the eggs at all levels of flax seed supplementation. Cheronian and Sim (1991) fed flax seed to laying hens at 8 and 16% in

diets which were supplemented with pyridoxine. They reported increased omega-3 fatty acids in the eggs, and brain tissue of embryos and chicks from the hens fed the ground flaxseed. The increase in linolenic acid in eggs from hens fed flax seed was mainly in the triglycerides. The longer chain omega-3 fatty acids were deposited exclusively in the phospholipids (Jiang et al., 1991). The fatty acid composition of chicks was significantly altered by egg yolk lipids. The percentage incorporation of omega-3 fatty acids into the chick, however, increased when the yolk sources of these fatty acids were low. There is evidence that elongation of omega-3 fatty acids occurs during incubation (Cherian and Sim, 1993). Jiang et al. (1992) reported that about 36% of the sensory evaluations reported a fishy or fish-related flavor in the eggs from hens fed flaxseed. This was not noted in eggs from hens fed the control diet or diets containing high oleic acid or high linoleic acid sunflower seeds. Aymond and Van Elswyk (1995) reported that feeding both 5% and 15% flaxseed caused increased total omega-3 fatty acids in the eggs and that the ground seeds caused a greater level of these fatty acids at the 15% level of feeding than the whole seed. Yolk thiobarbituric acid reactive substances, a measure of rancidity, were not influenced by feeding flaxseed up to the 15% level. Feeding 3% of linolenic acid to hens increased the omega-3 fatty acids in the total lipids of the eggs and there were no differences in the lipid deposition in 7 strains of chickens which were tested (Ahn et al., 1995). The flavor scores of eggs from the control group were more favorable than those of the enriched eggs, but the differences were not great. Farrell (1995) studied human volunteers who consumed ordinary eggs or omega-3 enriched eggs at a rate of 7 eggs per week. After 20 weeks, the plasma levels of omega-3 fatty acids in volunteers consuming the enriched eggs were significantly higher than in those consuming the ordinary eggs and the ratio of omega-6 to omega-3 fatty acids was reduced. There were only small differences in

the plasma cholesterol. He concluded that an enriched egg could supply approximately 40-50% of the daily requirement for omega-3 polyunsaturated fatty acids. In a Texas study (Marshall et al., 1994), it was found that 65% of the consumers surveyed reported a willingness to purchase omega-3 enriched eggs, and of that number, 71% would be willing to pay an additional $.50 per dozen. The responsible component for the assumed cardioprotective effect of flaxseeds may well be the fiber component according to Pan A et al (2009). *In vitro* and *in vivo* studies in animal models suggest that the flaxseed and flaxseed oil have the ability to lower blood cholesterol levels as per Pascos et al. (2007); Pellizzon et al. (2007). The hypocholesterolemic effect of flaxseed mucilage is attributed to the fact that the mucilage is changed into short chain fatty acids in the colon, which in turn inhibits liver cholesterol synthesis, thereby, increasing the clearance of LDL from the body.

Coriander (*Coriander sativum*):

Coriander (*Coriander sativum*) is an umbelliferous annual plant of parsley family. The name coriander is derived from the Greek word *koris*, which means bug. It may have earned this name because of the "buggy" offensive smell that it has when unripe. It is valued for the dry ripe fruits, called coriander seeds and also for the fresh green leaves.

Coriander seed contain 14 % protein, 2900 ME k cal/kg, 16 % fat, 23 % carbohydrate and 32 % fiber. Also, each 100 gm have 630 mg calcium, 18 mg iron, 300 mg B. carotene equivelent, 0.20 mg thiamine, 0.20 mg riboflavin, 2.3 mg niacin and trace of ascorbic acid (Platt, 1962). Coriander is also a reference to be as cilantro (leaves and seeds). Coriander is naturally low in sodium and saturated fat and is a good source of vitamin C, dietary fiber, iron, and calcium.

Coriander's volatile oil is rich in beneficial phytonutrients, including carvone, geraniol , limonene, borneol, camphor , elemol , and linalool. Coriander's flavonoids include quercitin, kaempferol, rhamnetin, and epigenin . Also coridander contains active phenolic acid compounds, including caffeic and chlorogenic acid.

As a medicinal plant, coriander seed has been used as antispasmodic, carminative, stimulant, cytotoxic, lipolytic, antioxidant, antibacterial, fungicidal and stomachic compound. (Mirinova, 1991). Coriander has also exhibited hypoglycemic activity (Chithra and Leelamma, 1997; Leung and Foster, 1996).

Coriander contains about 1% volatile oil (Mainly linalool), 20% oleic, Petroselinic and linolenic fatty acids, monoterpene hydrocarbons (anethole and camphor), up to 26% flavonoid glycosides and 11-17% proteins (Budvari, 1996; Klasing, 1998; Leung and Foster, 1996).

Coriander is also rich in of dietary fiber. 100 g seeds provide 41.9 g of fiber. Much of this fiber is metabolically inert insoluble fiber, which helps increase bulk of the food by absorbing water throughout the digestive system and help easing constipation condition.

In addition, dietary fibers bind to bile salts (produced from cholesterol) and decrease their re-absorption in colon, thus help lower serum LDL cholesterol levels. Together with flavonoid anti-oxidants, fiber composition of coriander helps protect the colon mucus membrane from cancers.

Coriander has been reported to markedly reduce lipid biosynthesis and have protective role against the promoter effects of some

lipids on experimental colon carcinogenesis (Chithra and Leelamma; 2000).

Chithra and Leelamma (1997) have reported that *Coriander sativum* decreases lipid uptake and enhanced lipid break down, resulting in lipolytic effects. A study has shown that the formation of lipid peroxides declined whereas activities of antioxidant enzymes (Catalase, glutathione peroxidase) increased in rats treated by *Coriander sativum.* (Chithra and Leelamma, 1999).

The antioxidant property of coriander seed is related to the large amounts of tocopherols, carotenoids and phospholipids (Ramadan and Morsel, 2004), which act through different mechanisms. Carotenoids act as primary antioxidants by quenching singulet oxygen. Tocopherols and sterols interact with oil surfaces and release hydrogens, inhibiting the propagation step of radical reactions (Reische *et al.*, 2002). Synergetic effects were evidenced with combinations of carotenoids and tocopherols (Haila *et al.,* 1996; Reische *et al.,* 2002). Although the exact mechanism of antioxidative action of phospholipids is not still fully established, these substances would synergistically act with tocopherols, would form barrier for O_2 between air / oil enterfaces, would favour Maillard like compounds with oxidation products or would chelate pro-oxidant metals with phosphate groups (Haila *et al.,* 1996 ; Hudson *et al.,* 1984).

The effect of a dietary supplement coriander seeds on the fatty acid composition of breast muscle in Japanese quail, studied by Ertas *et al.* (2005) concluded that dietary supplementation by coriander seeds greatly affected the lipid composition of carcass by decreasing saturated fatty acids (SFA) content (Palmitic and Stearic acids) and by increasing monounsaturated and polyunsaturated fatty acids (MUFA and PUFA) proportions in comparison to the control group ($P<0.01$). The highest

dosage of coriander seeds (4% added to the ration) has systematically induced the greatest effects on fatty acid composition. Dietary supplementation by coriander seeds would improve the quality of lipid carcass of quails by lowering SFA proportions and by enhancing contents of PUFA, particularly of n-3 PUFA.

Lal *et. al.* (2004) suggested that in the biphasic model of triton-induced hyperlipidemia C.sativum at a dose of 1g/kg bodyweight reduced cholesterol and triglycerides levels in both synthesis and excretory phases in rats and the results were comparable with the liponil, a commercially available herbal hypolipidemic drug. Their results suggested that coriander decreases the uptake and enhances the break down of lipids. They assumed that coriander has the potential to be popularized as a household herbal remedy with preventive and curative effect against hyperlipidemia.

Coriander seeds have a health-supporting reputation that is high on the list of the healing spices. In parts of Europe, coriander has traditionally been referred to as an "anti-diabetic" plant. In parts of India, it has traditionally been used for its anti-inflammatory properties. In the United States, coriander has recently been studied for its cholesterol lowering effects. Recent research studies have confirmed its effects on control on blood sugar, cholesterol and free radical production (though still on animals).

Dhanapakiam *et al.* (2008), who illustrated that the concentration of LDL was decreased. While, the HDL cholesterol was increased ($P<0.05$) in animal fed coriander seed. This could be due to the inhibition in the enzyme activity maybe due to that this is the key enzyme in pathway of cholesterol biosynthesis in the liver is 3-Hydroxy -3-methylglutaryl CoA (HMG-CoA) reductase activity (Crowell, 1999).

Since the coriander oil reduces the activity of this enzyme HMG-CoA which is the regulatory enzyme in cholesterol synthesis . As a result, a hypocholestemic effect of coriander oil can be expected. Case et at.(1995) illustrated that a 5% inhibition of HMG-CoA reductase lowered serum cholesterol by 2% in poultry. Chithra and Leelamma (1997) reported that coriander enhance bile acid synthesis and increased degradation of cholesterol to fecal bile acid and natural sterol which resulted in lowering serum cholesterol.

Coriander as a cholesterol lowering herbal, it is a diuretic in nature that makes the kidneys perform their roles of excretion better. Therefore, the kidneys flush out the excess unneeded cholesterol from the body.

When coriander was added to the diet of diabetic mice, it helped to stimulate their secretion of Insulin and lowered their blood sugar. When given to rats, coriander reduced the amount of damaged fats (lipid peroxides) in their cell membrance. And when given to rats fed high-fat, high-cholesterol diet, coriander lowered levels of total cholesterol and LDL (the bad cholesterol), while actually increasing levels of HDL (the good cholesterol).

Research also suggested that the volatile oils found in the leaves of the coriander plant, commonly known as cilantro, may have antimicrobial properties. Coriander contains an antibacterial compound that may prove to be a safe, natural means of fighting Salmonella, a frequent and sometimes deadly cause of food borne illness, suggests a study published in the June 2004 issue of the *Journal of Agriculture and Food Chemistry*. Working together, U.S. and Mexican researchers isolated the compound - Dodecenal - which laboratory tests showed is twice as effective as the commonly used antibiotic drug gentamycin at killing

salmonella. (Chithra and Leelamma, 1997; 1999; Delaquis *et al.,* 2002; Gray *et al.* 1999; Kubo *et. al.,* 2004).

The use of antibiotics as growth promoters has been an economically viable method for improving animals and poultry performances for many years (Younis,1987). Indeed, the European Union had indicated its intention to remove all growth promoting antibiotics. Therefore, the search for alternative to antibiotics as growth promoters that can give similar results in improving poultry performances particularly weight gain and feed efficiency or in the prevention or control of infections diseases is the target of numerous lines of investigation. Nowadays there is an increase demand for using these herbal plants in therapy instead of synthetic drugs (Mandour *et. al.,* 1998).

The present of antioxidants and phenolic substance in coriander oil may be the main cause of improvement in breast percent of broilers carcass. The presence of harmful bacterial populations in the gastrointestinal tract may cause breakdown of amino acids and thereby reduce their absorption as antimicrobial substances are present in coriander oil can reduce the harmful bacterial populations in the gastrointestinal tract and improve the levels of absorbed amino acids (Lee, K.W. *et al.* 2003, Gülçin I *et al.*2004) . The carvacrol in herbal planet has stimulatory effects on pancreatic secretions (SAS Institute. 2001) by increasing the secretions of digestive enzymes more amounts of nutrients like amino acids can be digested and absorbed from the digestive tract and thereby improve carcass traits. Else increasing the percents of gizzard and liver by use of coriander oilcan have positive effects via physically grinding and increasing bile secretion on nutrient digestion. With increased amounts of absorbed amino acids, organs like breast and thigh drawn more growth.

Al-Kassie(Al-Kassie, G.A 2009) who found that herbal planet effect on the live weight gainand the improvement of the health of poultry, in addition to other performance traits,feed conversion ratio and feed intake.

Langhout, P., 2000., who showed that herbal planet could stimulate the digestion system in poultry, improve the function of liver and increase the pancreatic digestive enzymes. Enhancement of the metabolism of herbal planet, carbohydrates and proteins in the major organs would increase growth rate of these organs (Mellor, S., 2000a , Mellor, S., 2000b.) According to Dhanapakiam et al (2008) coriander seeds had a significant hypolipidemic action in rats. The level of low density lipoprotein (LDL) and very low density lipoprotein (VLDL) cholesterol decreased while that of high density lipoprotein (HDL) cholesterol increased .The increased activity of plasma lecithin cholesterol acyl transferase (LCAT), enhanced degradation of cholesterol to fecal bile acids and neutral sterols appeared to account for its hypocholesterolemic effect.

Joshi et al (2012) investigated hypolipidemic and antioxidant action of *Coriandrum sativum* in cholesterol-fed rabbits. Reduced serum lipid profile and elevated HDL ratio was observed after administration of *coriander. Coriander* extract feeding increased the faecal excretion of cholesterol and phospholipids. Histology studies showed less cholesterol deposits in the aorta of high cholesterol diet animals given *C. sativum* compared to the high cholesterol diet animals not given *C. sativum* supplement. This study exhibited that *C. sativum* is a potent hypolipidaemic agent and provide protection against oxidative stress. In addition, *C. sativum* also reduced cholesterol deposition in the aorta of high cholesterol diet animals.

According to Saeid and Al-Nasry (2010) birds fed with 0.3% coriander seed diet exhibited the largest body weight gain, feed conversion ratio and carcass yield and decreased feed intake and fat pad (%BW). There was differences in PCV%, RBC counts and Hb concentration in 0.3% coriander seed supplemented groups, but differences of the other group were not statistically important. There was no difference in total number of WBC, H/L as well as H/L ratio among the treatment groups. There was no significant difference for GPT and GOT enzyme activity between the treatments. The coriander seed supplementation also led to decrease the glucose and cholesterol concentration in blood serum.

CHAPTER - 3

MATERIALS AND METHODS

MATERIALS AND METHODS

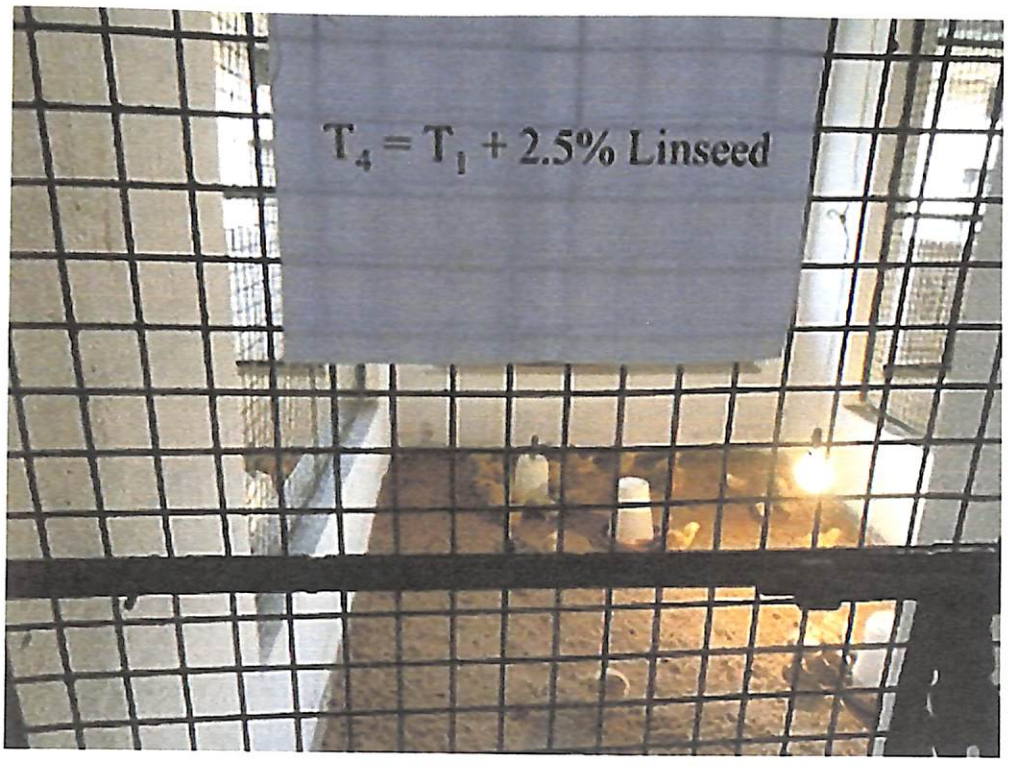
India have a wide range of medicinal herbs scattered over a large area, due to the favourable climatic condition. All these herbs posses a number of chemical substances for the use in poultry.

Different herbs exhibit a wide range of physiological and pharmacological properties in addition to enhancing the taste and flavour of food. This study was undertaken to investigate these facts considering the objectives like effects of feeding of different dietary supplement on growth performance of broilers, carcass quality of broiler, their lipid profile and cost effectiveness. A 42 days study was conducted in the Department of Animal Nutrition at Bihar Veterinary College, Patna.

Experiment: The study was planned to see the effect of feeding herbs like sugarbeet meal, neem leaf meal, linseed meal and coriander seed meal at 2.5% level in broiler ration on lipid profile of broilers. To attain this 150 a-day old chick (Vanaraja strain) was procured from supplier.

Duration of experiment: The experiment was conducted for the period of 42 days. All the standard managemental practices were followed during experimental period including vaccination schedule.

Housing: Chicks were reared on deep litter system. Bedding material used was saw dust. Litter was kept 3-4" thick. The litter was raked weekly to prevent any cake formation in rearing pens. Chicks were served clean drinking water ad lib. through fountain system. The chicks were reared under uniform condition of housing including brooding, feeding, watering, lighting and other managements. During early periods of growth chicks were provided with artificial light.



Chicks were reared under standard management practices

Broilers were reared under uniform condition of housing

Hygienic measures: The cages, feeding and watering troughs were cleaned and disinfected. Fresh water bath with phenol solution, which was changed every morning, was maintained at the entrance of the experiment room throughout the experimental period as one of the hygienic measures.

Feed used during the experiment: Feed ingredients were procured in one lot for whole experiment and its proximate principles were determined as per AOAC (2000) before compounding experimental rations (Table-1). Different ingredients used in experiment were yellow maize, soya bean meal, fish meal, mineral mixture and different dietary supplement like sugar beet, neem leaf meal, linseed and coriander seed.

Fresh sugar beets were procured from market and properly washed, than cut into thin and small pieces, thereafter sundried. Dried pieces than milled in a hammer mill to produce fine sugar beet powder and stored at room temperature (20 + 2°C) in opaque screw – top jars. Powdered sugar beet was used as supplement into test animal diet.

Fresh matured neem leaves were harvested in and around the Bihar veterinary college, Patna. The leaves were spread evenly and sun-dried for four days until they become crispy while still retaining the greenish coloration. They were then milled, using a hammer mill with 2mm sieve, to produce neem leaf meal (NLM).

Dried linseeds were procured from market and used in diet of test animal after converting it to powder. Powder was stored at room temperature (20 ± 2°C) in opaque screw – top jars.

Dried coriander seeds were obtained from the market. Seeds were homogenized to a fine powder and stored at room temperature (20 ±

2°C) in opaque screw – top jars. Powdered coriander was used for incorporation into test animal diet.

Feed formulation: Feed ingredients used in the experiment were purchased from local market and three samples of each ingredient were taken randomly for analysis of protein content before diet formulation. The feed formulation was done as per BIS (1991) having 23% CP and ME 2800 k cal./kg for starter (Table-2) and CP 20% and ME 2900 k cal./kg feed for finisher (Table-3). Each different dietary supplement like sugar beet, NLM, LSM and CSM were mixed in feed @ 2.5% for each treatment.

Table-1: Percentage chemical composition and metabolizable energy of feed used in experiment (on D. M. basis)

Ingredients	DM	CP	CF	EE	Ca	P	ME kcal/kg*
Yellow Maize	90	8.40	2.40	2.82	0.04	0.26	3340
soyabean Meal	92	42.50	5.90	1.11	0.23	0.58	2300
Fish Meal	91	43.10	1.70	5.60	5.20	2.10	2400

* Reddy, D.V. (2007).

Table-2: Percentage composition of experimental diet for starter:

Ingredients (%)	T1	T2	T3	T4	T5
Yellow Maize	52.75	50.25	50.25	50.25	50.25
Soya bean Meal	35.00	35.00	35.00	35.00	35.00
Fish Meal	10.00	10.00	10.00	10.00	10.00
Mineral Mixture	1.75	1.75	1.75	1.75	1.75
Salt	0.50	0.50	0.50	0.50	0.50
Feed Supplement	-	2.50	2.50	2.50	2.50

Calculated value

CP%	23.61	23.40	23.40	23.40	23.40
ME	2806.85	2723.35	2723.35	2723.35	2723.35
Ca	1.222	1.222	1.222	1.222	1.222
P	0.556	0.554	0.554	0.554	0.554

Table-3: Percentage Chemical composition of experimental diet for finisher.

Ingredients	T1	T2	T3	T4	T5
Yellow Maize	60.00	60.00	60.00	60.0	60.00
soya bean Meal	27.75	25.25	25.25	25.25	25.25
Fish Meal	10.00	10.00	10.00	10.00	10.00
Mineral Mixture	1.75	1.75	1.75	1.75	1.75
Salt	0.50	0.50	0.50	0.50	0.50
Feed supplement	-	2.50	2.50	2.50	2.50

Calculated value

CP%	**21.14**	**20.08**	**20.08**	**20.08**	**20.08**
ME	2882.25	2824.75	2824.75	2824.75	2824.75
Ca	1.108	1.101	1.101	1.101	1.101
P	0.548	0.544	0.544	0.544	0.544

Composition of Agrimin forte, Glaxo

Vitamin A (7,00,000 I.U.), Vitamin D_3 (70,000 I.U.), Vitamin E (250 mg.), Nicotinamide (1000 mg.), Cobalt (150 mg.), Copper (1200 mg.), Iodine (325 mg.), Iron (1500 mg.), Potassium (100 mg.), Magnesium (6000mg.),Manganese(1500mg.), Selenium (10 mg.), Sodium (5.9 mg.), Sulphur (0.72%), Zinc (9600 mg.), Calcium (25.5%), Phosphorus (12.75%).

Experimental design: All the day-old chicks were individually weighed at the start of the experiment. Experimental chicks were given only crushed maize initially. On 4th day 150 chicks were wing banded, weighed and randomly distributed into five groups having thirty birds in each. Each group were further subdivided into triplicates having 10 birds in each. First group (T_1) served as control and rest groups T_2, T_3, T_4 and T_5 as treatment groups.

Dietary treatment: Birds in T_1 group which served as control were fed only as broiler ration. Birds in T_2 group were fed broiler ration mixed with 2.5% Sugar beet meal(SBM); T_3 group were fed broiler ration with 2.5% Neem leaf meal(NLM); Birds in T_4 were fed broiler ration with 2.5% of Linseed meal(LSM) and T_5 were fed broiler ration with coriander seed meal(CSM).

T1 : control ration.

T2 : control ration + (2.5% sugar beet meal).

T3 : control ration + (2.5% neem leaf meal).

T4 : control ration + (2.5% linseed meal).

T5 : control ration + (2.5% coriander seed meal).

PARAMETERS OBSERVED DURING THE EXPERIMENT:

(A) GROWTH PARAMETERS:

(i) Feed consumption:

Feed consumption is the amount of feed consumed every week. It was calculated for each treatment group at weekly basis. At the end of the week, the residual amount of feed was weighed and subtracted

from the weight of feed offered at the beginning of week. Difference in weight was divided by the total number of birds.

(ii) Body weight and Body Weight Gain:

During the initial phase of the experiment body weight of individual chicks were recorded. Thereafter, body weight change was observed at weekly interval up to 6 weeks. Live weight gain was calculated by subtracting the live weight at the beginning of the week from the live body weight of the next week and whole body weight gain at the end of 6^{th} week from the initial body weight.

(iii) Feed Conversion Ratio (FCR) and Performance Index (PI):

Feed conversion ratio (FCR) was calculated every week as the amount of feed consumption per unit of body gain (average weekly feed consumption (g)/ average weekly gain (g)). Performance index was also calculated weekly.

FCR was calculated by using the formula -

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

PI was calculated by using the formula (Bird, 1955) -

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

(B) Balance Study of Nutrients

After end of the experimental, a five-day, metabolic trial was conducted to observe the balance of protein, energy, calcium and phosphorus.

In each trial four birds from each group were randomly selected and transferred to metabolic cages. Preliminary feeding was given for adaptation of broilers to the new system of housing. Polythene sheets of appropriate size were spread over the dropping trays for the collection of mixed excreta. The chicks were offered a weighed amount of experimental ration at a fixed morning hour everyday during the trial period. The mixed dropping were also quantitavely collected at the end of 24 hrs. at fixed hours and pooled to know the total amount of excreta voided for five days. Daily feed intake was collected after deducting weight of feed residue left from the feed offered. Representative feed samples were drawn from the bulk, finely ground and stored in bottles for dry matter percentage and chemical analysis. Aliquots from dropping after thorough mixing with the help of spatula was drawn for dry matter and follow up analysis and nitrogen estimation. Aliquots of five days were pooled together for nutrient analysis.

(C) Carcass Study:

For ascertaining meat quality and fat percentage carcass examination was conducted after 6^{th} week of experiment. Six birds from each dietary treatment group were slaughtered by using standard slaughter method. The birds to be slaughted were kept under fasting condition for 24 hrs. and only water was offered ad lib. Each bird was weighed immediately before slaughter. The birds were bled by giving incision to jugular vein. It was allowed to bled completely. Blood loss was calculated by initial weight before slaughter minus final weight after bleeding. The birds were immersed in hot water (70°C) for 30 second (hard scalding). Body feathers from scalded birds were removed by deducting feather loss weight from blood loss weight. The head was removed by severing the cervical vertebrae at the base of the occipital bone and feet and shanks

were cut at the tibio-tarsal joint. Wing tips were removed and dressed weight of carcass was recorded, to calculate dressing percentage.

$$\text{Dressing \%} = \frac{\text{Dressed Weight}}{\text{Pre slaughtered Weight}} \times 100$$

After recording the dressed weight, various visceral organs like liver, heart, gizzard were separated. Individual weight of various organs were taken to record eviscerated weight. Giblet weight calculated by adding weight of liver, heart & gizzard, to calculate giblet percentage.

$$\text{Giblet \%} = \frac{\text{Weight of Giblet}}{\text{Dressed Weight}} \times 100$$

Weight of byproduct was calculated by adding weight of feather, feet & Intestine, to calculate percentage of byproduct.

$$\text{Byproduct \%} = \frac{\text{Weight of Byproduct}}{\text{Pre slaughtered Weight}} \times 100$$

Collection of blood and muscles samples:

At the end of the experiment blood samples were collected from two broiler bird per replicate, making six samples per treatment. Blood was collected in two set of vial, one with without anticoagulant and other with anticoagulant EDTA, from the wing vein using insulin syringes.

Blood without anticoagulant allowed to clot, and centrifuged for 15 min at 1500 rpm to separate the sera. The sera sample were stored at -20^0 C for the analysis of Serum for cholesterol, triglyceride HDL,VLDL ,LDL, Total Protein and Glucose.

Blood samples with EDTA used immediately for haematological tests such as Packed Cells Volume (PCV) and Haemoglobin (Hb).

Pieces of breast muscles, thigh muscle & liver were taken from slaughtered animal of each group with the help of scissor and knife. The muscle pieces were freshly analyzed.

(D) Serum biochemical analysis:

(I) Lipid Profile of Serum:

Total cholesterol, HDL cholesterol and Triglyceride were estimated by using commercial test kit (AUTOSPAN liquid gold, Cogent) at 505nm wavelength in spectrophotometer 106.

$$\text{(i) Total cholesterol (mg/dl)} = \frac{\text{Absorbance of Test}}{\text{Absorbance of standard}} \times 200$$

$$\text{(ii) HDL Cholesterol (mg/dl)} = \frac{\text{Absorbance of Test}}{\text{Absorbance of standard}} \times 50 \times 2^{*}$$

*(2=Dilution factor, as Sample was diluted 1:1)

$$\text{(iii) Triglycerides (mg/dl)} = \frac{\text{Absorbance of Test}}{\text{Absorbance of standard}} \times 200$$

$$\text{(iv) LDL Cholesterol} = \text{Total Cholesterol} - \frac{\text{Triglyceride}}{5} - \text{HDL cholesterol}$$

$$\text{(v) VLDL Cholesterol} = \frac{\text{Triglyceride}}{5}$$

(II)Total protein of serum:

The collected samples of serum from each group were examined for total protein by AUTOSPAN liquid gold, Cogent (Protein)

test kit by Biuret method at 578nm wavelength using spectrophotometer 106.

$$\text{Total protein (g/dl)} = \frac{\text{Absorbance of Test}}{\text{Absorbance of Standard}} \times 6.5$$

(III) Glucose of serum:

The collected samples of serum from each group were examined for Glucose by AUTOSPAN liquid gold (Glucose) test kit at 505nm using spectrophotometer 106.

$$\text{Total Glucose (mg/dl)} = \frac{\text{Absorbance of Test}}{\text{Absorbance of Standard}} \times 100$$

(E) Blood analysis:

(I) Haemoglobin in blood:

Hb was estimated as per cyanmethemoglobin (Drabkin, 1932) method. In this method hemoglobin is oxidized to methaemoglobin by potassium ferri-cyanide; methaemoglobin in turn combines with potassium cyanide to form cyanmethaemoglobin.

The standard absorbance was read before the start of the procedure. 0.02ml of the test sample was added to 4.0ml of Drabkin's solution. The diluted sample was allowed to stand for 10 minutes, it was then transferred to a cuvette and the optical density was determined at 540nm against a blank of Drabkin's solution.

The result was calculated from formula given below.

Calculation:

$$\text{Hemoglobin (g/dl)} = \frac{\text{Absorbance of sample}}{\text{Absorbance of standard}} \times \text{concentration of standard}$$

(II) PCV in blood:

Packed cell volume (PCV) was estimated by micro haematocrit method (Campbell, 1995). Packed cell volume (PCV) was measured as microhaematocrit with 75 x 16mm capillary tubes. Capillary tube was filled with two-thirds to three-quarters full with well-mixed blood. The one end of capillary tube was sealed with sealing wax. Filled capillaries were placed in the microhematocrit centrifuge, with the plugged end away from the center of the centrifuge and centrifuged at 3000 r.p.m. for 5 minutes. PCV reading was taken with the help of PCV reader express as percentage.

(F) Muscle cholesterol analysis:

Total Cholesterol estimation in Liver, Brest and thigh muscle:

Extraction of muscle lipids was done as per Folch *et al* (1957) method:

1gm tissue was triturated and homogenized with 20ml of 2:1 chloroform-methanol (v/v) and homogenate was filtered.

Crude extract obtained after filtration was mixed thoroughly with 0.2 volume of water and mixer were allowed to separate into two phases by centrifugation. Upper phase was discarded and 2:1 chloroform-methanol mixture were added to lower phase to make final volume 20ml.

This final extract was used for estimation of cholesterol. The total cholesterol was estimated by Zlatkis *et al.* (1953) method.

Determination of Muscle total cholesterol by Zlatkis *et al.* (1953) method:

10 ml. of the ferric chloride acetic acid reagent was taken in a glass stoppered centrifuge tube and 0.1 ml. of muscle extract was added. Mixed well and kept for 10-15 minutes to precipitate the proteins. Centrifuged for 10 minutes. 5 ml. of the clear supernatant fluid was taken into a glass stoppered tube. For the standard 0.1 ml. of physiological saline and 10 ml. of the cholesterol standard for use was taken and mixed. 5ml from this was taken in to a second stoppered tube. For blank 5 ml. of the ferric chloride acetic acid reagent was taken in third tube. 3 ml. of sulphuric acid was added to all the tubes. Mixed then allowed to stand for 20-30 minutes. Test and standard were read against the blank using at 560mμ wavelength.

Total cholesterol (mg.) per gm of Muscle was calculated by using formula –

$$\frac{\text{O.D of Unknown}}{\text{O.D of Standard}} \times 20$$

Statistical Analysis:

All the data were analysed statistically using Statistical Packages for Social Sciences (SPSS) Software, Version 17.00. One-way analysis of variance (ANOVA) with the post hoc Duncan's multiple comparison tests, means were separated using LSD was used to evaluate statistical significance of differences among the control and experimental groups according to Snedecor and Cochran (1980). The results are given as means, standard error of the mean (SEM) and $P<0.05$ was considered as statistically significant difference.

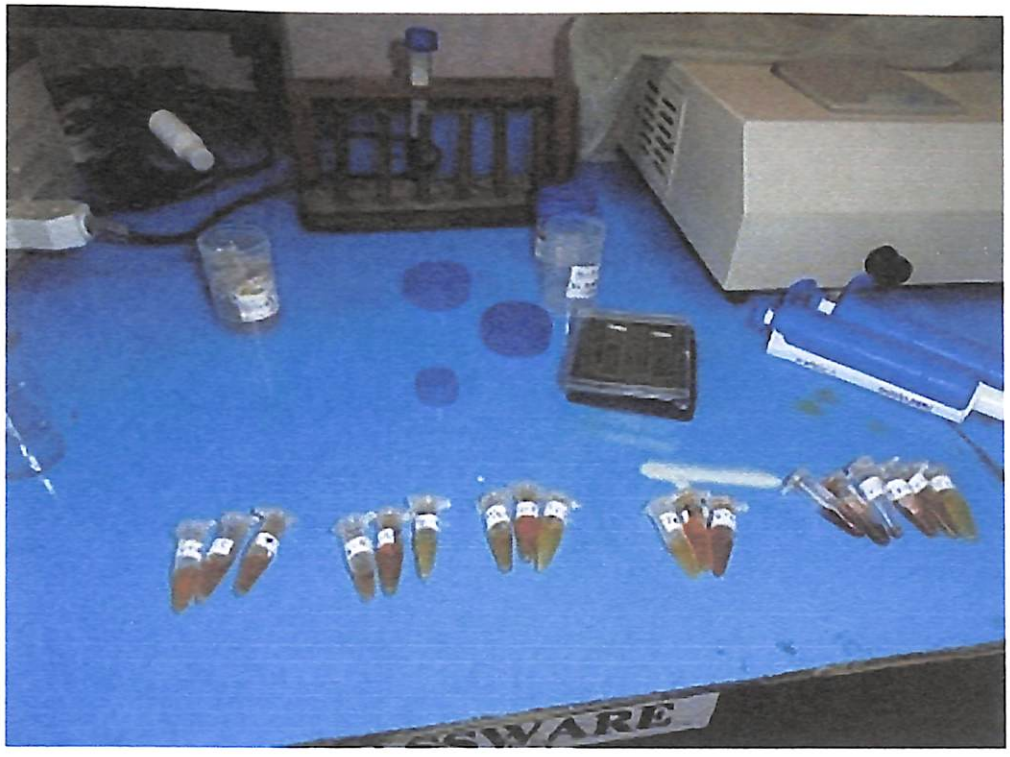
(G) Economics of Production:

The economics of broiler production was calculated on the cost of feed per kg. live weight gain. The economics is thus dependent on the cost of different feed ingredients used in the experiment along with feed efficiency of various treatments. Actual cost of feed was calculated on the basis of rates on which the different feeds ingredients were purchased from the local market.

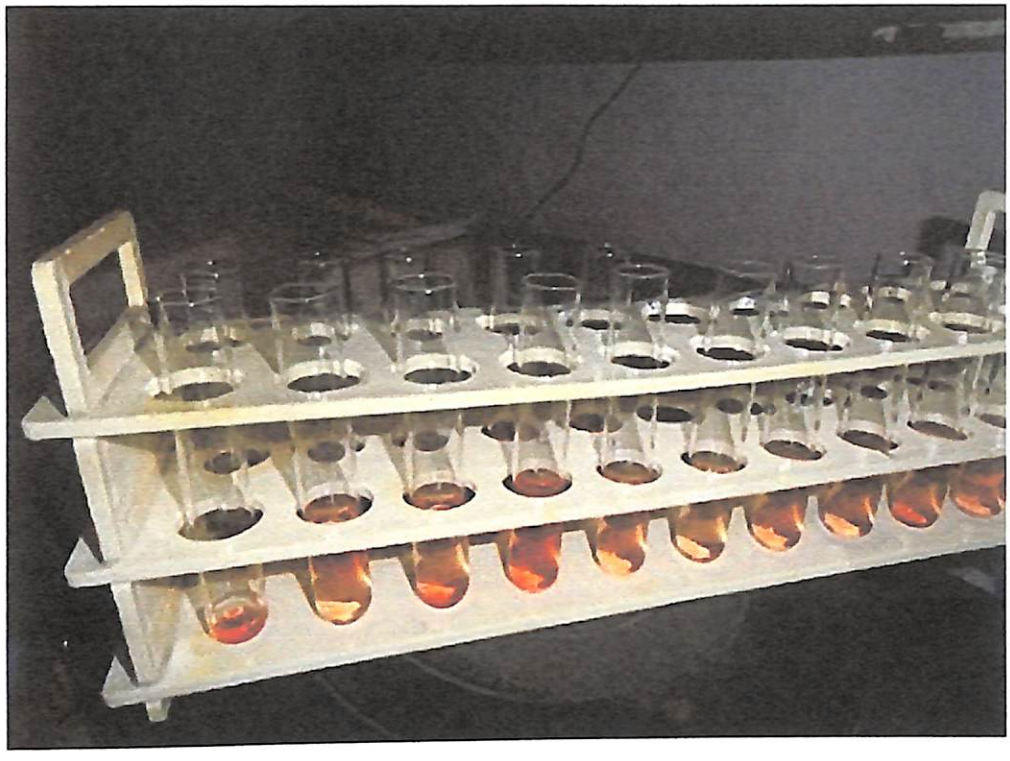
(i) Total output / bird = Total weight of bird (kg) x Sale price / kg

(ii) Total input / bird = Cost of feed + Cost of chicks + Cost of medicines + Vaccines etc.

(iii) Net profit / bird = Total output / bird - Total input / bird.



Collection of serum for biochemical analysis



Estimation of cholesterol from serum

CHAPTER - 4

RESULTS AND DISCUSSION

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Broiler production in our country is facing a serious threat because of the clinical significance of consumption of poultry meat in inducing hypercholesterolemia in adult human population. Cholesterol level in meat can be reduced by dietary intervention. Role of non-pharmacological agents or herbs/spices in reducing the cholesterol in poultry meat is worth investigation. Hence, the present study was undertaken to study the effect of feeding of sugar beet, neem leaf meal, linseed meal and coriander on meat production as well as cholesterol level in broiler chicken. Systematic work in this field is need of the time. In this study different parameter like feed intake, body weight and its gain, feed conversion ratio, performance index, serum and blood parameter, carcass quality, meat quality were observed.

GROWTH PARAMETER

Feed intake:

Result of feed intake at weekly interval and 6th weeks of age in broilers is given in table-4, showed significant effect of inclusion of herbs/spices on feed intake in experimental birds. Average feed intake during the experiment varied from 2742.40g in T_2 to 2894.47g in T_4. Week wise feed intake varied from 193.40 g. in T_5 to 225.17 g. in T_4 at 1st week, whereas it ranged from 242.40 g in T_3 to 250 g in other groups at 2nd week, from 493.63g inT_2 to516.67g in T_4, from 571.23g in T_1 to 587.79g in T_3, from 583g in$T_1$to 602.93g inT_3, from 627.13g in T_2 to 735.97g in T_4 in 3rd, 4th, 5th and 6th week, respectively. A good fluctuation was observed in feed intake in every week among different group.

Analysis of variance for the effect of treatment on feed intake in broilers was found to be significant ($P<0.05$). Average feed intake at

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Analysis of variance for the effect of treatment on feed intake in broilers was found to be significant ($P<0.05$). Average feed intake at

the end of 1st week in T_4 group was found to be the highest (225.17g.) which was significantly ($P<0.05$) more than T_1, T_2, T_3 and T_5 groups. In 2nd week feed intake in T_3 group was found to be significantly ($P<0.05$) lower than T_1, T_2, T_4 and T_5. In 3rd week feed intake in T_2 (493.63g) was found to be significantly ($P<0.05$) lower than T_1, T_3, T_4 and T_5 group. No significant difference was noted among T_3, T_4 and T_5 group.

In 4th week feed intake in T_1 (571.23g) was found to be significantly ($P<0.05$) lower than T_2, T_3, T_4 and T_5 group. Feed intake in T_3 group was found to be highest among group during the week.

In 5th week feed intake in T_1 and T_5 (583g) was found to be significantly ($P<0.05$) lower than T_2, T_3 and T_4 group whereas value of T_3 (602.93g) group was found to be highest among all the group. In 6th week feed intake in T_2 (627.13g) was found to be significantly ($P<0.05$) lower than T_1, T3, T_4 and T_5 group whereas value of T_4 (735.97g) was found to be highest among group.

On the whole after 6th week average feed intake in T_2 (2742.40g) was found to be significantly ($P<0.05$) lower than T_1, T_3, T_4 and T_5 group whereas value of T_4 (2894.47g) group was found to be highest ($P<0.05$) among group.

Feed intake was affected by the addition of different additives herbs/spices during the experiment which was in agreement with the observation of Hikansson *et al.* (1978), Pettersson and Razdan (1993), Saeid and AL-Nasry(2010).

There was a reduced feed intake and growth rate of chickens fed on diets with 2.5% inclusion levels of sugarbeet meal at 3rd, 6th and at the end of six week which may be due to increased satiety due to reduced

gastric emptying caused by distension of the duodenum which was in agreement with Sellers (1977).

Body weight:

Result of body weight at weekly interval in broilers is given in table-5. The average body weight varied from 210±3.22 g in T_1 to 233.20±2.65 g in T_4 at 1st week, whereas it ranged from 347.20±5.27 g in T_1 to 372.73±4.90 g inT_4 at 2nd week. In 3rd week it ranged from 592.29±10.02g inT_1 to 632.48±8.35g inT_4.In 4th week it varied from 844.22±12.45g inT_1 to 917.74±14.38g inT_5.In 5th week it ranged from 1117.80±14.83g in T_1 to 1208.25±18.54g in T_5.It ranged from 1415.20±16.98g inT_1 to 1574.66±24.23g in T_4 at 6th week.

Analysis of variance for the effect of treatment on body weight in broilers was found to be highly significant ($P<0.01$). Average body weight at the end of 1st week in linseed fed group (T_4) was found to be the highest (233.20±2.65g) which was significantly ($P<0.01$) higher than other group. Neem leaf meal addition (T_3 groups) in the feed also gave significantly higher body weight than control, however, result of other groups were comparable with the control (T_1).Similar result was noted during 2nd week. This trend continued till the end of this experiment where it was found that linseed meal has positive effect on body weight.

Body weight gain:

Result of body weight gain at weekly interval and at the end 6th week in broilers is given in table-6. Average body weight gain varied from 110.47±3.07 g in T_1 to 127±2.83 g in T_4 during 1st week. In 2nd, 3rd, 4th ,5th, and 6th week, minimum and maximum change in body weight gain ranged from 135.85g (T_3) to 139.70g(T_5), 245.08g(T_1) to 272.72g(T_5), 251.93g(T_1) to 291.73g(T_3), 273.58g(T_1) to 302.74g(T_3) and 297.40g(T_1)

to 367.26g (T_4),respectively. Final body weight gain at the end of experiment varied between 1315.67g (T_1) and 1468.46g (T_4).

Analysis of variance for the effect of dietary treatment on body weight gain in broilers showed significant ($P<0.05$) effect on change in body weight. Average weight gain at the end of 1st week in T_4 group was found to be the highest (233.20±2.65g) which was significantly ($P<0.05$) more than T_1 groups but no significant difference was noted between control and T_2, T_3 &T_5 group. No effect of dietary inclusion of herbs/spices was noted on body weight gain during 2nd week. In 3rd week body weight gain in T_5 (272.72±10.13g) was found to be significantly ($P<0.05$) higher than other group, however, effect of linseed meal on body weight gain was similar to T_5 and T_3. There was no significant difference between T_1, T_2, T_3 and T_4 group during this period.

Body weight gain in 4th week in T_3 (291.73±10.83g) was found to be the highest but comparable with all the herbs/spices fed group indicating good effect of herbs/spices on body weight change. Similar trend in body weight gain was noted in the 5th week. In 6th week body weight gain in T_4 (367.26±16.01g) was found to be significantly ($P<0.05$) higher than control (T_1) group.

Overall body weight gain in linseed fed group (1468.46±24.24g), i.e., T_4 was found to be the highest which was statistically similar to neem leaf meal fed group (T_3) and coriander seed meal fed group (T_5). Inclusion of sugar beet in diet also gave statistically better result than the control group, indicating effect of herbs/spices on body weight gain.

Body weight gain was affected by the addition of different additives herbs/spices during the experiment which was in agreement with

the observation of Pettersson and Razdan (1993), Arslan and Saatci (2003), Saeid and AL-Nasry(2010) but Esonu et al (2006) did not report any change in body weight gain fed on neem leaf meal.

Feed Conversion Ratio (FCR):

Result of FCR at weekly interval and at the end of 6th week in broilers is given in table-7. The FCR varied from 1.75±0.05 in T_5 to 1.88±0.05 in T_1 at 1st week, whereas it ranged from 1.84±0.05in T_4 to 1.92±0.08 in T_1, from1.96±0.06 in T_5 to 2.15±0.06 in T_1, from 2.07±0.06in T_5 to 2.32±0.06 in T_1, from 2.01±0.06 in T_4 to 2.18±0.06 in T_1, and from 1.97±0.05 in T_2 to 2.21±0.06 inT_1 in 2nd, 3rd, 4th, 5th and 6th week respectively. FCR at the end of 6th week varied from 1.96±0.03 in T_5 to 2.11±0.03 in T_1.

Feeding of Coriander seed meal along with diet exhibited better FCR in this experiment. Statistical difference was noted during 4th and 6th week only showing effect of CSM as superior. Final observation of FCR showed significantly better result with herbs/spices inclusion than the control group indicating significantly better feed utilization in terms of body weight gain of birds. It was poor in control group at both the stages.

FCR was affected by the addition of different additives herbs/spices during the experiment which was in agreement with the observation of Pettersson and Razdan (1993), Saeid and AL-Nasry(2010).

Performance Index (PI):

Result of PI at weekly and at the end 6th week of age in experimental birds are presented in table-8. A trend similar to FCR was noted. PI varied from 61.38±3.35 in (T_1) to 72.66±3.24 in (T_4) at 1st week, whereas it ranged from 76.56±5.27 (T_2) to 80.38±5.21 (T_5), from

120.95±8.67 (T_1) to 149.71±12.77 (T_5), from 113.98±7.12 (T_1) to 150.58±11.09 (T_3), from 131.33±7.51(T_1) to 158.05±12.12 (T_4), from 141.06±8.21(T_1) to 193.37±18.70(T_4) in 2^{nd},3^{rd},4^{th},5^{th} and 6^{th} week respectively and PI at the end of 6^{th} week showed variation from 629.81±16.53(T_1) to 750.89±24.98 (T_4).

It was found that PI in broilers was significantly ($P<0.05$) affected. In 1^{st}, 2^{nd} and 3^{rd} week there was no significant difference between control and treatment group. However numerical value of treatment group was higher than control except in 2^{nd} week where numerical value of T_2 and T_3 was lower than control.

In 4^{th} week PI in T_3 (150.58±11.09) was found to be highest followed by T_2, T_3, T_5 group than T_1 group whereas T4 group was comparable with T_1.

No significant difference between control and treatment group was noted in 5^{th} week. However numerical value of treatment group was higher than control.

In 6th week PI in T_4 (193.37±18.70) was found to be highest and significantly ($P<0.05$) better than T_1 group and T_2, T_3 was comparable with T_1.There was no significant difference between T_1 and T_5.

At the end of the experiment PI in T_2, T_3, T_4, T_5 group was significantly ($P<0.05$) higher than T_1 group whereas T4 group (750.89±24.98) was found to be the highest, numerically.

Table 4:- Effect of dietary supplement on Average Feed intake (g)/bird at weekly interval and 6th week in broilers.

Week	T_1	T_2	T_3	T_4	T_5
1st	203.27^{c}	207.43^{d}	201.50^{b}	225.17^{e}	193.40^{a}
2nd	250^{b}	250^{b}	242.40^{a}	250^{b}	250^{b}
3rd	512.37^{b}	493.63^{a}	516.66^{c}	516.67^{c}	516.66^{c}
4th	571.23^{a}	580.87^{b}	587.79^{e}	583.33^{d}	581.93^{c}
5th	583^{a}	583.33^{b}	602.93^{c}	583.33^{b}	583^{a}
6th	641.97^{c}	627.13^{a}	674.86^{d}	735.97^{e}	629.90^{b}
1 to 6th week	2761.83^{c}	2742.40^{a}	2763.97^{d}	2894.47^{e}	2754.90^{b}

Values with similar superscripts (row wise - a, b, c, d, e) did not differ significantly ($P<0.05$).

Table-5: Effect of dietary supplement on Av. bodyweight (g) at weekly interval in broilers.

Week	T_1	T_2	T_3	T_4	T_5
1st	210.00^{a} ±3.22	216.62^{ab} ±3.02	220.19^{b} ±3.20	233.20^{c} ±2.65	216.38^{ab} ±2.66
2nd	347.20^{a} ±5.27	352.73^{a} ±5.28	356.04^{a} ±6.48	372.73^{b} ±4.90	356.08^{a} ±4.92
3rd	592.29^{a} ±10.02	599.15^{a} ±8.62	613.11^{ab} ±9.39	632.48^{b} ±8.35	628.80^{b} ±10.79
4th	844.22^{a} ±12.45	881.15^{ab} ±13.54	904.84^{b} ±14.65	908.89^{b} ±11.22	917.74^{b} ±14.38
5th	1117.80^{a} ±14.83	1175.67^{b} ±13.18	1207.58^{b} ±15.66	1207.40^{b} ±16.99	1208.25^{b} ±18.54
6th	1415.20^{a} ±16.98	1500.78^{b} ±17.63	1546.44^{bc} ±19.89	1574.66^{c} ±24.23	1513.55^{b} ±19.91

Values with similar superscripts (row wise - a, b, c, d) did not differ significantly($P<0.05$).

Fig.1-Effect of dietary supplement on Average Feed intake(g)/bird at weekly interval and 6th week in broilers.

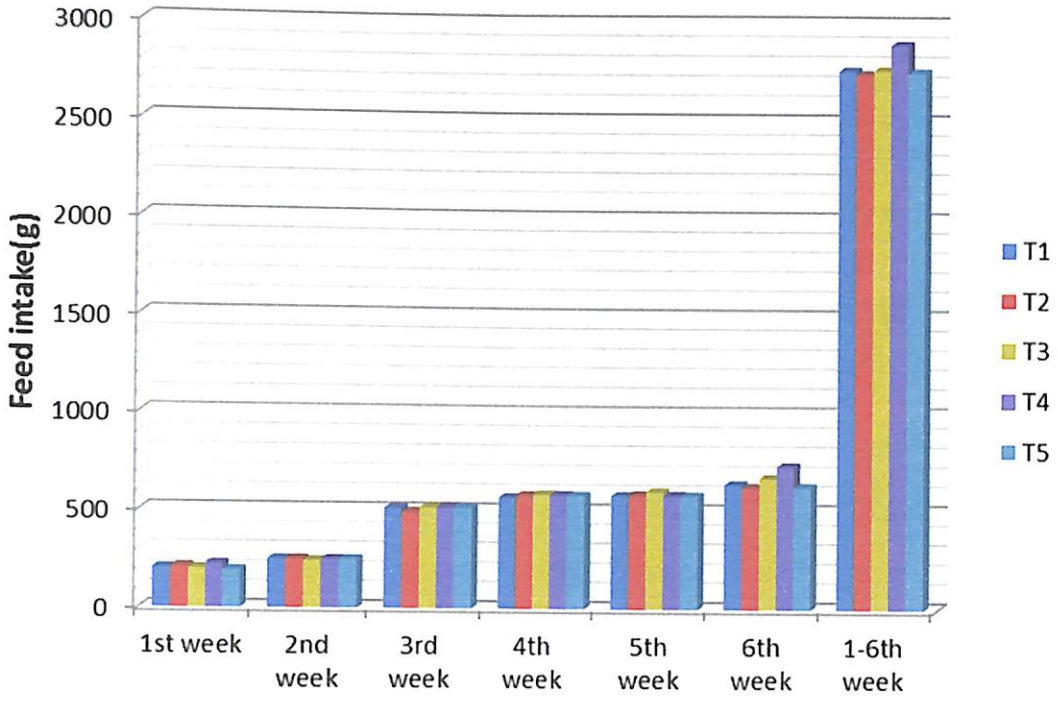


Fig. 2-Effect of dietary supplement on Av.body weight(g) at weekly interval in broilers.

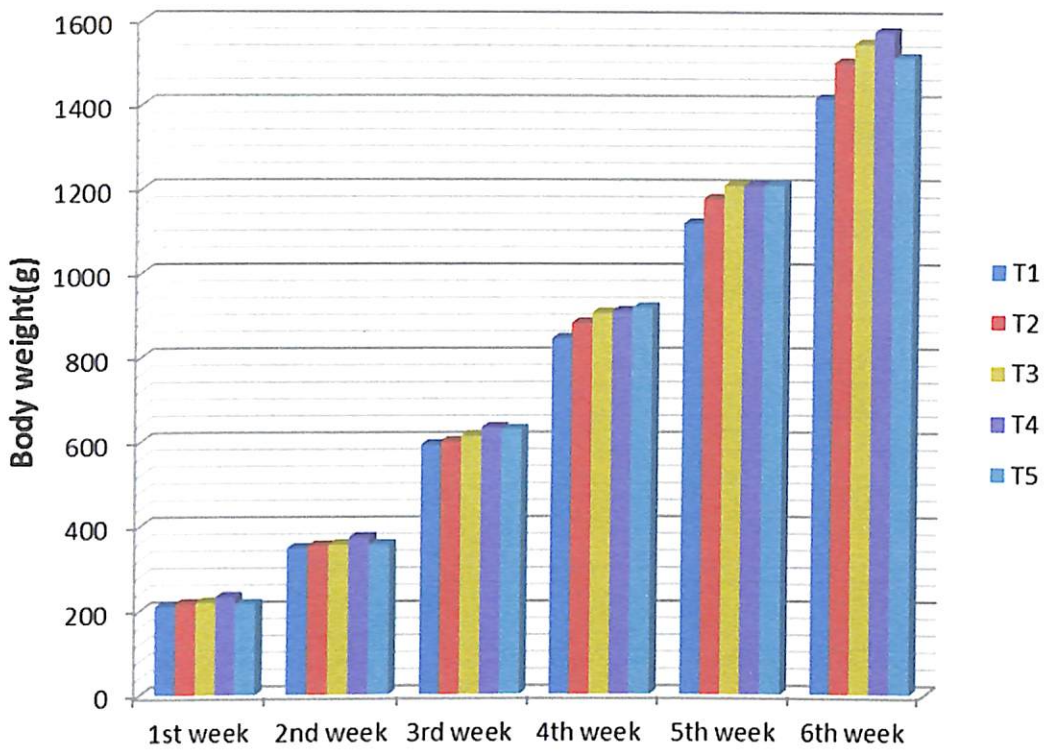


Table-6: Effect of dietary supplement on Av. bodyweight gain (g) at weekly interval and 6th week in broilers.

Week	T_1	T_2	T_3	T_4	T_5
1st	110.47^{a} ±3.07	114.69^{a} ±3.54	114.79^{a} ±3.67	127.00^{b} ±2.83	113.18^{a} ±3.04
2nd	137.20 ±5.69	136.11 ±4.61	135.85 ±4.83	139.53 ±4.18	139.70 ±4.47
3rd	245.08^{a} ±8.10	246.41^{a} ±7.98	257.07^{ab} ± 8.31	259.75^{ab} ±7.71	272.72^{b} ±10.13
4th	251.93^{a} ±7.52	281.99^{b} ±9.79	291.73^{b} ±10.83	276.42^{ab} ±8.01	288.94^{b} ±9.05
5th	273.58^{a} ±7.7	294.52^{ab} ±9.52	302.74^{b} ±9.60	298.51^{ab} ±10.32	290.51^{ab} ±9.28
6th	297.40^{a} ±8.53	325.11^{ab} ±9.66	338.86^{bc} ±12.03	367.26^{c} ±16.01	305.29^{ab} ±10.04
1-6th	1315.67^{a} ±17.07	1398.84^{b} ±17.3	1441.04^{bc} ±19.94	1468.46^{c} ±24.24	1410.35^{bc} ±20.02

Values with similar superscripts (row wise - a, b, c, d) did not differ significantly($P<0.05$).

Table-7: Effect of dietary supplement on FCR at weekly interval and 6th week in broilers.

Week	T_1	T_2	T_3	T_4	T_5
1st	1.88 ±0.05	1.86 ±0.06	1.81 ±0.06	1.80 ±0.04	1.75 ±0.05
2nd	1.92 ±0.08	1.89 ±0.06	1.844 ±0.06	1.84 ±0.05	1.842 ±0.06
3rd	2.15 ±0.06	2.06 ±0.06	2.07 ±0.07	2.04 ±0.05	1.96 ±0.06
4th	2.32^{b} ±0.06	2.13^{ab} ±0.07	2.09^{a} ±0.08	2.16^{ab} ±0.06	2.07^{a} ±0.06
5th	2.18 ±0.06	2.04 ±0.07	2.05 ±0.06	2.01 ±0.06	2.06 ±0.06
6th	2.21^{b} ±0.06	1.97^{a} ±0.05	2.06^{ab} ±0.07	2.10^{ab} ±0.08	2.12^{ab} ±0.06
1-6th	2.11^{b} ±0.03	1.97^{a} ±0.02	1.97^{a} ±0.03	1.99^{a} ±0.03	1.96^{a} ±0.03

Values with similar superscripts (row wise - a, b, c, d) did not differ significantly($P<0.05$).

Fig.3- Effect of dietary supplement on Av. body weight gain(g) at weekly interval and 6th week in broilers.

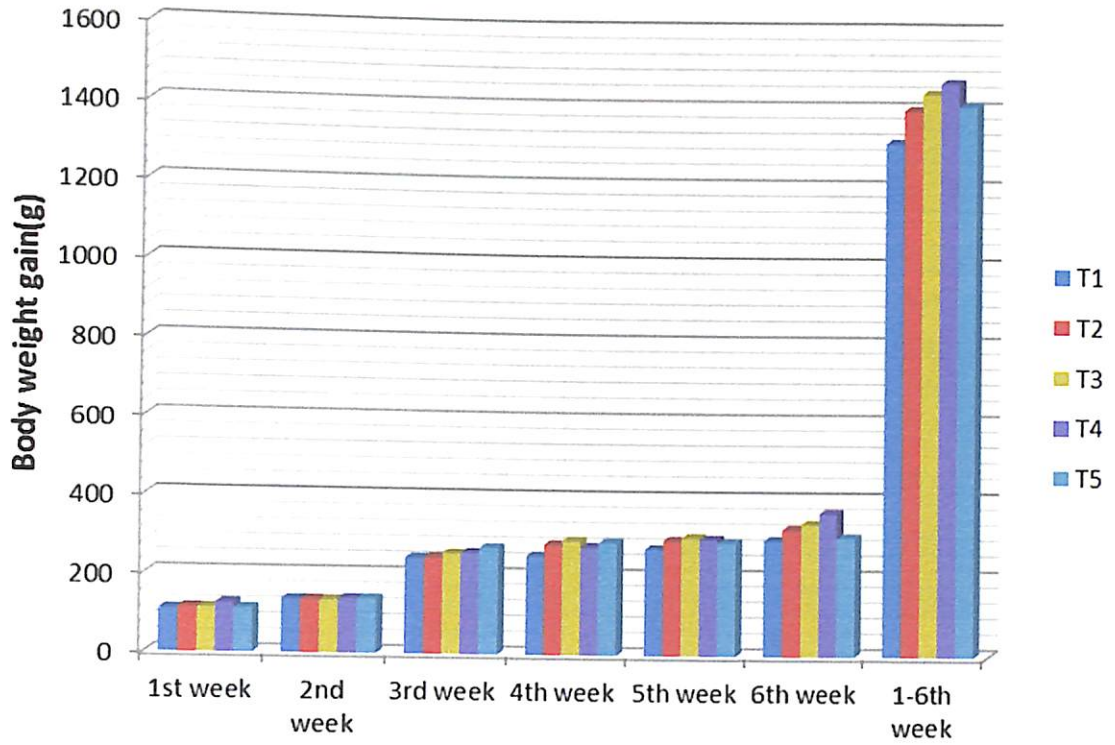


Fig.4- Effect of dietary supplement on FCR at weekly interval and 6th week in broilers.

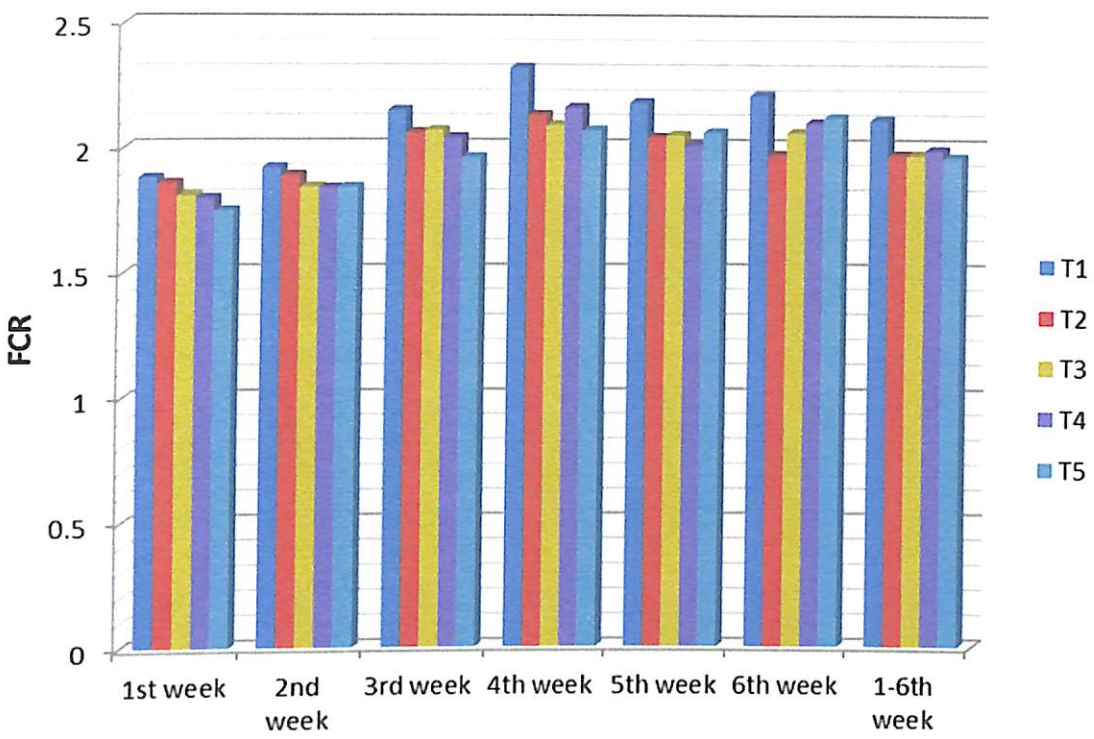
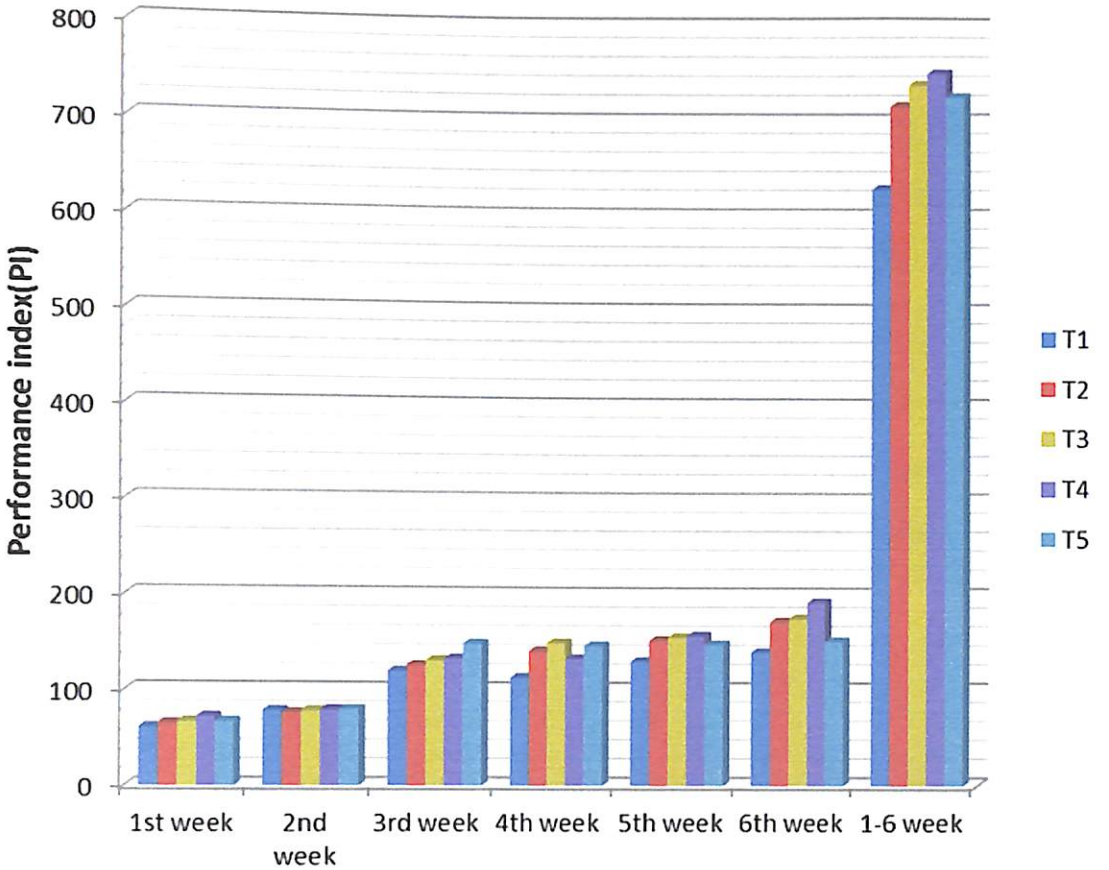


Table-8: Effect of dietary supplement on PI at weekly interval and 6th week in broilers.

Week	T_1	T_2	T_3	T_4	T_5
1st	61.38 ±3.35	65.16 ±4.02	67.34 ±4.12	72.66 ±3.24	67.62 ±3.49
2nd	79.05 ±6.38	76.56 ±5.27	78.93 ±5.86	79.90 ±4.79	80.38 ±5.21
3rd	120.95 ±8.67	126.75 ±8.34	131.78 ±8.57	133.92 ±8.32	149.71 ±12.77
4th	113.98^{a} ±7.12	141.69^{b} ±9.96	150.58^{b} ±11.09	134.18^{ab} ±7.59	147.55^{b} ±9.19
5th	131.33 ±7.51	153.21 ±9.84	156.45 ±10.36	158.05 ±12.12	149.05 ±9.80
6th	141.06^{a} ±8.21	172.86^{ab} ±10.75	176.37^{ab} ±12.90	193.37^{b} ±18.70	152.61^{a} ±10.52
1-6th	629.81^{a} ±16.53	716.69^{b} ±17.64	738.86^{b} ±20.11	750.89^{b} ±24.98	726.23^{b} ±20.77

Values with similar superscripts (row wise - a, b, c, d) did not differ significantly($P<0.05$).

Fig.5-Effect of dietary supplement on PI at weekly interval and 6th week in broilers.



BALANCE OF NUTRIENTS

Nitrogen Retention:

Nitrogen retention percentage in broilers at 6th week of age is given in table-9. Nitrogen retention percentage ranged from 53.05±0.16 in T_3 group to 56.13±0.69 in T_5 group. Analysis of variance for the effect of treatment on nitrogen retention in broilers was found to be highly significant ($P<0.05$). Average nitrogen retention percentage in coriander seed meal fed (T_5) group was highest (56.13±0.69) and lowest in neem leaf meal fed group (T_3). The nitrogen retention percentage in T_1, T_2, and T_4 were found to be as 55.32±0.59, 54.30±0.46, and 54.41±0.36, respectively.

Energy Metabolizability:

Result of average energy metabolizability of experimental birds during balance study are presented in table-8. The analysis of variance for the effect of treatment was found to be highly significant ($P<0.05$). It ranged from 71.74±0.37 in T_1 group to 74.57±1.04 in T_2 group. Energy metabolizability in T_2 group was found to be the highest followed by groups T_4, T_5, T_3 and T_1. Result showed that except NLM all the herbs/spices added in the diet had similar effect on energy Metabolizability.

Calcium and Phosphorus Retention:

Results of calcium and phosphorus retention percentage at 6th week of age are presented in table-9. Calcium retention percentage ranged from 54.11±0.59 in T_3 group to 57.09±0.77 in T_5 group. Calcium retention percentage was highest in T_5 group. It can be inferred from the result NLM had some depressing effect, otherwise effect of all the feed on calcium retention percentage was statistically similar.

As presented in the same table phosphorus retention percentage ranged from 62.54±0.42 in T_3 group to 64.23±0.65 in T_1 group. Result showed that the phosphorus retention was numerically higher in T_1 group (64.23±0.65) and lowest in T_3 group (62.54±0.42).There was no significant difference between control and treatment group, indicating no effect of herbs on phosphate metabolism.

Balance study of nutrient in this experimental study showed that all the herbs/spices had significant ($P<0.05$) effect on nutrient utilization in the broilers. It might be concluded from the result that herbs have modulatory effect on nutrient utilization. Further research in this field is required because parameters like body weight gain and FCR were also showing positive effect in this study.

CARCASS CHARACTERISTICS

In order to observe the effect of feeding of herbs on carcass characteristic like dressing %, giblet% and byproduct percentage were also studied.

Dressing percentage: Dressing percentage of broilers fed with different herbs/spices in the present study is given in the table-10. Dressing percentage of different treatment groups ranged between 71.88±0.76 in T_1 group and 73.58±0.74 in T_2 group. Average dressing percentage was found to be highest in T_2 group (73.58±0.74). No effect of herbs was noted on dressing percentage during the experiment.

Dressing percentage was also affected but not significantly by the addition of different additives herbs/spices during the experiment which was in agreement with the observation of Esonu et al (2006), Saeid and AL-Nasry(2010).

Giblet percentage: Giblet percentage of broilers of different groups in the present study are given in the table-10. Giblet percentage of different treatment groups ranged between 6.40±0.21 in T_1 group and 7.70±0.20 in T_3 group. Average giblet percentage was found to be highest in T_3 group (7.70±0.20) and was statistically comparable with T_2 group, whereas T_4 group was comparable with control. T_2 and T_3 group was significantly ($P<0.05$) higher than T_4 and T_5 group.

Giblet percentage was affected by the addition of different additives herbs/spices during the experiment which was in agreement with the observation of Esonu et al (2006).

Byproduct percentage: Byproduct percentage of broilers in the present study is given in the table-10. Byproduct percentage of different treatment groups ranged between 30.82±0.31 in T_5 group and 33.52±0.26 in T_4 group. Average byproduct percentage was found to be highest in T_4 group (33.52±0.26). There was no significant difference among T_1, T_2 and T_5 groups, and T_3 and T_4 groups were statistically similar in byproduct percentage.

Table-9: Effect of dietary supplement on Nitrogen retention percentage, energy metabolizability percentage, calcium retention percentage and phosphorus retention percentage at 6th week in broilers.

Parameter	T_1	T_2	T_3	T_4	T_5
Nitrogen retention%	55.32^{bc} ±0.59	54.31^{ab} ±0.46	53.05^{a} ±0.16	54.41^{ab} ±0.36	56.13^{c} ±0.69
Energy metabolizability%	71.75^{a} ±0.37	74.57^{c} ±1.04	72.29^{ab} ±0.56	74.23^{bc} ±0.45	73.73^{bc} ±0.44
Calcium retention%	56.56^{b} ±0.46	56.54^{b} ±0.61	54.11^{a} ±0.59	56.60^{b} ±0.62	57.09^{b} ±0.77
Phosphorus retention%	64.23 ±0.65	64.00 ±0.55	62.54 ±0.42	64.13 ±0.75	63.72 ±0.36

Values with similar superscripts (row wise - a, b, c, d) did not differ significantly ($P<0.05$).

Table-10: Effect of dietary supplement on carcass quality at 6th week in broiler.

Parameter	T_1	T_2	T_3	T_4	T_5
Dressing%	71.88 ±0.76	73.58 ±0.74	72.39 ±0.90	73.47 ±0.73	73.31 ±0.66
Giblet%	6.40^{a} ±0.21	7.52^{c} ±0.12	7.70^{c} ±0.20	6.57^{ab} ±0.18	6.99^{b} ±0.06
Byproduct%	31.41^{a} ±0.41	31.06^{a} ±0.39	33.30^{b} ±0.41	33.52^{b} ±0.26	30.82^{a} ±0.31

Values with similar superscripts (row wise - a, b, c, d) did not differ significantly ($P<0.05$).

Fig.6-Effect of dietary supplement on Nitrogen retention %,energy metabolizability%,calcium retention%,phosphorous retention% at 6th week in broilers.

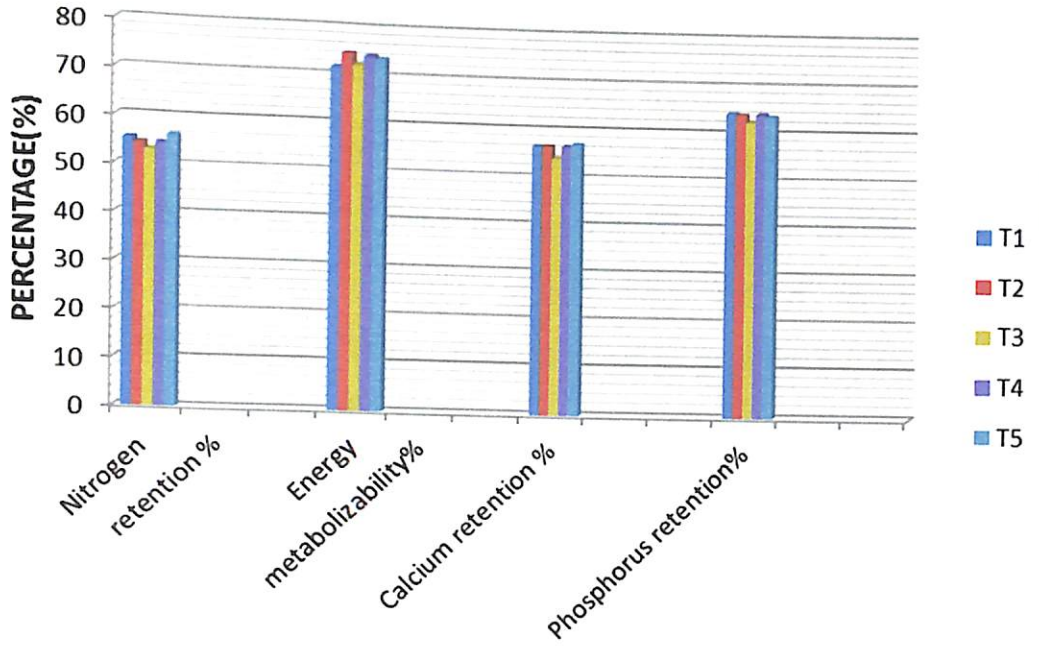
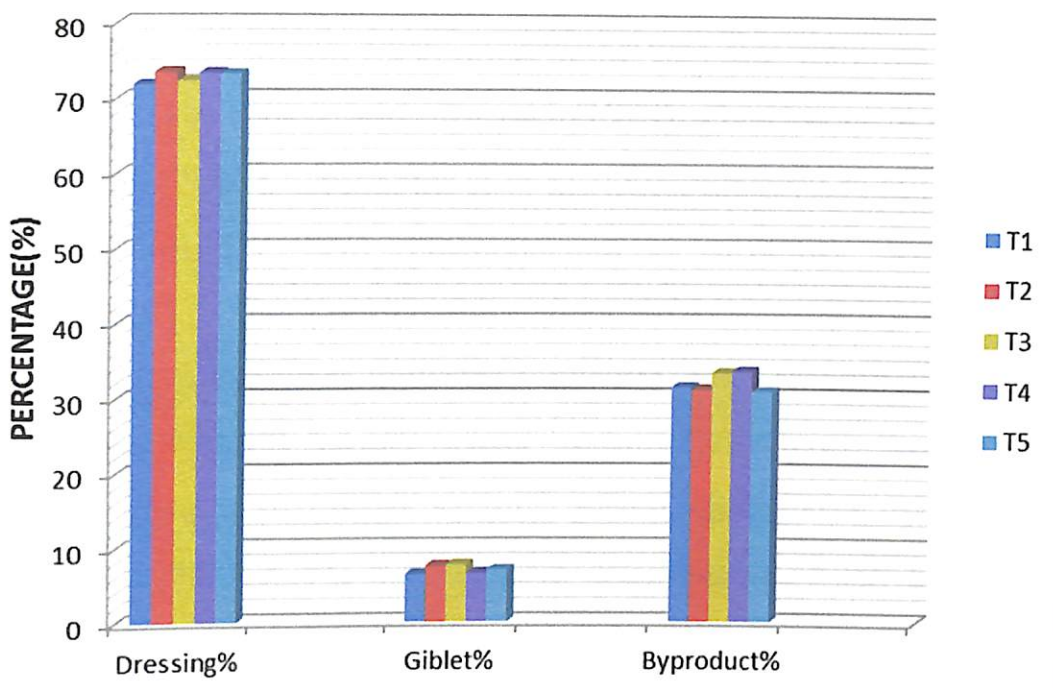


Fig.7-Effect of dietary supplement on carcass quality at 6th week in broilers.



BIOCHEMICAL PARAMETER:

Total cholesterol in serum: Result of total cholesterol at 6th week of age in broilers is presented in table-11. Total cholesterol among different groups was found to range from 131.69±4.01 mg/dl in T_4 group fed with linseed meal to 149.72±4.62 mg/dl in T_1 group, which was control. Statistical analysis for the effect of feeding herbs / spices on total cholesterol level was found to be significant ($P<0.05$). Average total cholesterol level in control group was found to be the highest (149.72±4.62 mg/dl). Level of cholesterol in groups T_2, T_3, T_4 and T_5 were 142.74±5.17mg/dl, 132.06±2.33mg/dl, 131.69±4.01and 139.08±4.42 mg/dl, respectively. It was apparent from result that all the herbs/spices helped in lowering the serum cholesterol level. T_3 and T_4 group was significantly ($P<0.05$) lower than control whereas T_2 and T_5 group was comparable with control. It was seen that feeding of sugar beet, neem leaf meal, linseed, & coriander affected the levels of cholesterol in broilers.

It was interesting to observe that cholesterol level was reduced significantly by the addition of different additives herbs/spices during the experiment. Such observation was also reported by Aritsuka et al.(1989), Pettersson and Razdan (1993), Overton et al (1994), Arslan and Saatci (2003), Obikaonu et al (2012), Ogbuewu et al (2010). Chithra and Leelamma (1997), Dhanapakiam et al(2008), Saeid and AL-Nasry(2010), Joshi (2012). Entrapment of bile acids by soluble dietary fibres and consequent inhibition of bile acid resorption (Ebihara & Schneeman ,1989) would lower serum cholesterol levels and could account for the reduction in total serum cholesterol concentrations in chickens fed on 2.5% inclusion of sugarbeet powder. Soluble dietary fibres such as pectins have been shown to decrease the rate of diffusion of glucose in gut sections *in vitro as per* Johnson & Gee, (1981)and *in vivo*

in man Flourie *et al.* (1984), and it is likely that lipid micelles also diffuse inefficiently under viscous conditions may result in lower cholesterol level than control.

Triglyceride in serum: Result of Triglyceride level in serum at 6^{th} week of age in broilers is presented in table-11. Average triglyceride level ranged between 138.72±2.33 mg/dl in T_5 group and 156.93±4.44 mg/dl in T_1 group. Statistical analysis for the effect of treatment on triglyceride level was found to be highly significant ($P<0.05$). Average triglyceride level was found to be highest in T_1 group (156.93±4.44 mg/dl) and lowest in T_5 group (138.72±2.33 mg/dl). The average triglyceride level in other groups, i.e. T_2, T_3 and T_4 were 139.31±9.78mg/dl, 140.11±3.00 mg/dl and 139.81±5.93 mg/dl respectively. Serum triglyceride in all treatment group was found to be significantly ($P<0.05$) lower than control.

Results indicated that Triglyceride lowered significantly which was in agreement with Joshi et al (2012), Saeid and AL-Nasry(2010).

High density lipoprotein (HDL) in serum: As per table-11, average of HDL level was found to range from 80.24±2.05 mg/dl in T_4 to 88.08±3.58 mg/dl in T_2 group. Average HDL level was found to be highest in sugar beet fed group T2 (88.08±3.58 mg/dl) and was comparable with neem leaf meal and coriander seed meal fed group by significantly ($P<0.05$) higher than linseed meal group. The level of HDL in other groups, i.e. T_1, T_3, T_4, and T_5 were 81.93±1.68 mg/dl, 87.76±1.04 mg/dl, 80.24±2.05 mg/dl and 87.72±1.09 respectively.

It was obsorbed that level of HDL increases which was aiso reported by Dhanapakiam et al (2008), Joshi et al (2012).

Low density lipoprotein (LDL) in serum: Result of LDL level in serum at 6th week of age in broiler is presented in table-11. Average LDL level in serum ranged from 16.28±1.59 mg/dl in T_3 group to 36.41±4.36 mg/dl in T_1 group. LDL level was found to be highest in T_1 group (36.41±4.36 mg/dl) and lowest in T_3 group (16.28±1.59 mg/dl) fed with neem leaf meal. Average levels of LDL in T_2, T_4 and T_5 groups were 26.79±5.45 mg/dl, 23.49±3.71 mg/dl and 23.62±4.34 mg/dl, respectively. Level of LDL in T3 was found to be significantly ($P<0.05$) lower than control whereas T2, T4, T5 group was comparable with control.

This fraction of lipid to be bad lipid. During the experiment their level were lowered. Dhanapakiam et al (2008), Joshi et al (2012) also obsorbed the same.

Very low density lipoprotein (VLDL) in serum: Result of VLDL level in serum at 6th week of age in broiler is presented in table-11. Average VLDL level ranged between 27.74±0.47 mg/dl in T_5 group and 31.39±0.89 mg/dl in T_1 group. Interestingly all the herbs/spices affected significantly ($P<0.05$) in lowering the serum VLDL and numerically lowest value was noted with coriander seed meal indicating beneficial effect in lowering VLDL.

This fraction of lipid to be bad lipid. During the experiment their level were lowered which was aiso reported by Dhanapakiam et al (2008), Joshi et al (2012).

Total protein in serum: Result of total protein level in serum at 6th week of age in broilers is presented in table-11. Average total protein level ranged between 3.17±0.12 g/dl in T_3 group and 3.59±0.11 g/dl in T_5 group. Average total protein level was found to be highest in T_5 group (3.59±0.11 g/dl) and lowest in T_3 group (3.17±0.12 g/dl). No significant effect was elicited by different herbs/spices on serum protein

level in broilers, however numerical value of T_5 group was more than control.

Protein level was affected by the addition of different additives herbs/spices during the experiment which was also reported by Arslan and Saatci (2003),Ogbuewu et al (2010) ,Saeid and AL-Nasry(2010).

Glucose in serum: As per table-11, average total glucose level ranged between 194.04±9.43 mg/dl in T_5 group and 213.33±4.51 mg/dl in T_4 group. There was no significant difference among various herbs fed groups and also between control and treatment group. However low numerical value of T_2 and T_5 group indicated their glucose lowering property.

Different additives herbs/spices influence glucose level in treatment group during the experiment which was also observed by Obikaonu et al (2012). Saeid and AL-Nasry(2010).

BLOOD PARAMETER:

Under this parameter hemoglobin and PCV in birds were studied.

Blood hemoglobin: Result of hemoglobin level in serum at 6^{th} week of age in broiler is presented in table-12. Average hemoglobin level in serum ranged from 8.16±0.15 g/dl in T_3 group to 9.47±0.41 g/dl in T_5 group. Statistical analysis for the effect of treatment on hemoglobin level in birds was found to be highly significant ($P<0.05$). Highest hemoglobin was estimated in T_5 group (9.47±0.41 g/dl) and lowest in T_3 group (8.16±0.15 g/dl). Average levels of hemoglobin in T_1, T_2 and T_4 groups were 8.74±0.45 g/dl, 8.95±0.56 g/dl and 9.21±0.48 g/dl. Level of hemoglobin in T_5 was found to be significantly ($P<0.05$) higher but comparable with control. There was no significant difference between T_1; T_2 and T_4. Neem leaf meal affected significantly ($P<0.05$) in lowering the

hemoglobin level, indicating role of some depressing agent present in neem leaf meal.

These blood parameter were affected by the addition of different additives herbs/spices during the experiment. Role of herbs/spices is helpful to increase haemoglobin except slightly decrease in neem leaf fed group. This was in agreement with the observation of Sadre *et al.*, (1984) and Gowda *et al.*, (1998), Obikaonu et al (2012). Saeid and AL-Nasry(2010). Esonu et al (2006) did not report any change in haemoglobin fed on 5% neem leaf meal. Result showed non aggrement with Ogbuewu et al(2010).

Packed cell volume (PCV): Result of Packed cell volume level in serum at 6^{th} week of age in broiler is presented in table-12. Average PCV level in blood ranged from 23.50±1.48 g/dl in T_3 group to 27.50±0.76 g/dl in T_5 group. Similar to hemoglobin percentage PCV percentage in this experiment was affected and highest ($P<0.05$) level was found in coriander seed meal fed group whereas lowest PCV percentage was obtained in group fed with neem leaf meal.

PCV were affected by the addition of different additives herbs/spices during the experiment. Role of herbs/spices is helpful to increase haemoglobin except slightly decrease in neem leaf fed group. This was in agreement with the observation of Sadre *et al.*, (1984) and Gowda *et al.*, (1998), Obikaonu et al (2012). Saeid and AL-Nasry(2010). Esonu et al (2006) did not report any change in pcv fed on 5% neem leaf meal. Result showed non agreement with Ogbuewu et al(2010).

Table-11: Effect of dietary supplement on serum parameter at 6th week in broilers.

Parameter	T_1	T_2	T_3	T_4	T_5
Cholesterol(mg/dl)	149.72^{b} ±4.62	142.74^{ab} ±5.17	132.06^{a} ±2.33	131.69^{a} ±4.01	139.08^{ab} ±4.42
Triglyceride(mg/dl)	156.93^{b} ±4.44	139.31^{a} ±9.78	140.11^{a} ±3.00	139.81^{a} ±5.93	138.72^{a} ±2.33
HDL cholesterol(mg/dl)	81.93^{ab} ±1.68	88.08^{b} ±3.58	87.76^{b} ±1.04	80.24^{a} ±2.05	87.72^{b} ±1.09
LDL cholesterol(mg/dl)	36.41^{b} ±4.36	26.79^{ab} ±5.45	16.28^{a} ±1.59	23.49^{ab} ±3.71	23.62^{ab} ±4.34
VLDL cholesterol(mg/dl)	31.39^{b} ±0.89	27.86^{a} ±1.95	28.02^{a} ±0.60	27.96^{a} ±1.19	27.74^{a} ±0.47
Protein(g/dl)	3.30 ±0.23	3.24 ±0.19	3.17 ±0.12	3.26 ±0.18	3.59 ±0.11
Glucose(mg/dl)	207.79 ±5.83	197.66 ±5.55	212.30 ±7.60	213.33 ±4.51	194.04 ±9.43

Values with similar superscripts (row wise - a, b, c, d) did not differ significantly($P<0.05$).

Table-12: Effect of dietary supplement on Blood parameter at 6th week in broilers.

Parameter	T_1	T_2	T_3	T_4	T_5
Haemoglobin(g/dl)	8.74^{ab} ±0.45	8.95^{ab} ±0.56	8.16^{a} ±0.15	9.21^{ab} ±0.48	9.47^{b} ±0.41
PCV (%)	24.83^{ab} ±1.68	25.83^{ab} ±1.08	23.50^{a} ±1.48	26.83^{ab} ±0.98	27.50^{b} ±0.76

Values with similar superscripts (row wise - a, b, c, d) did not differ significantly ($P<0.05$).

Fig.8-Effect of dietary supplement on serum parameter at 6th week in broilers.

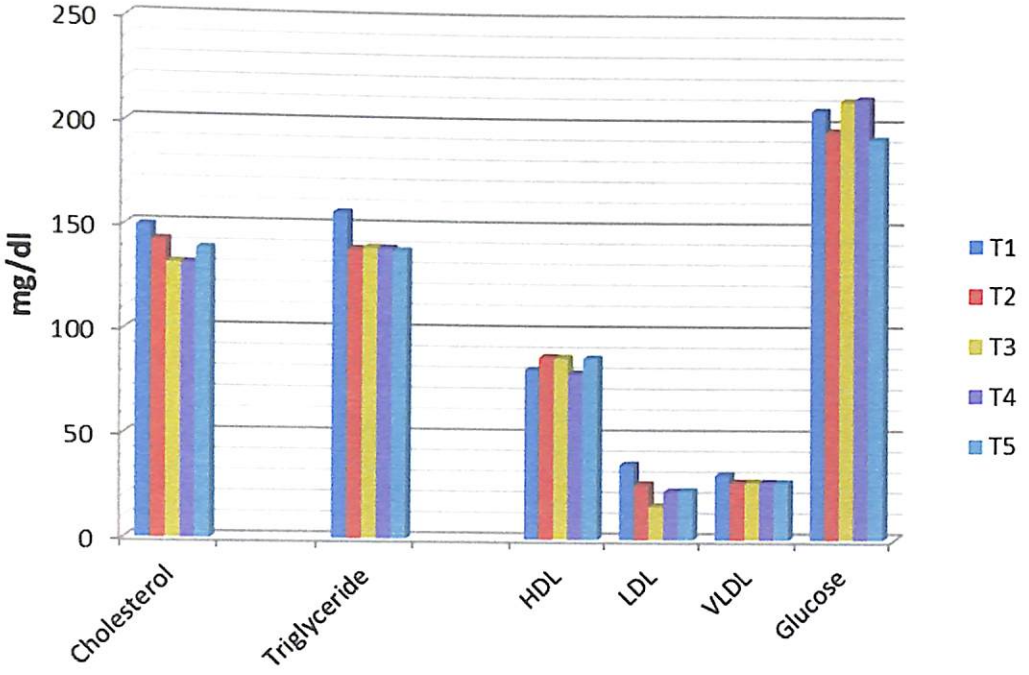


Fig.9-Effect of dietary supplement on Protein and Haemoglobin at 6th week in broilers.

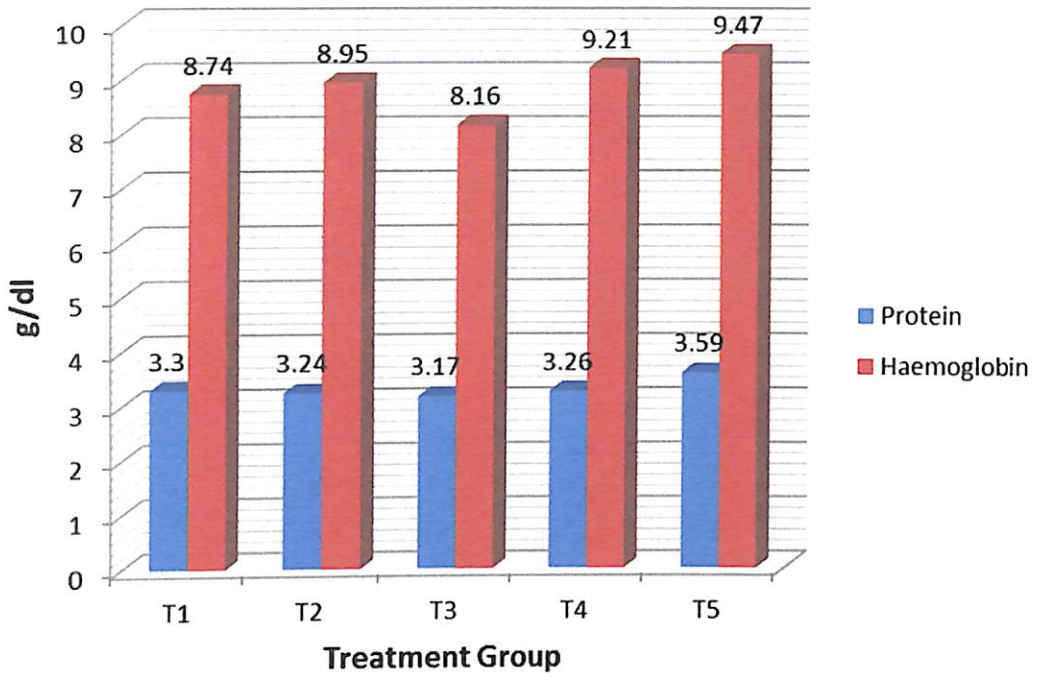
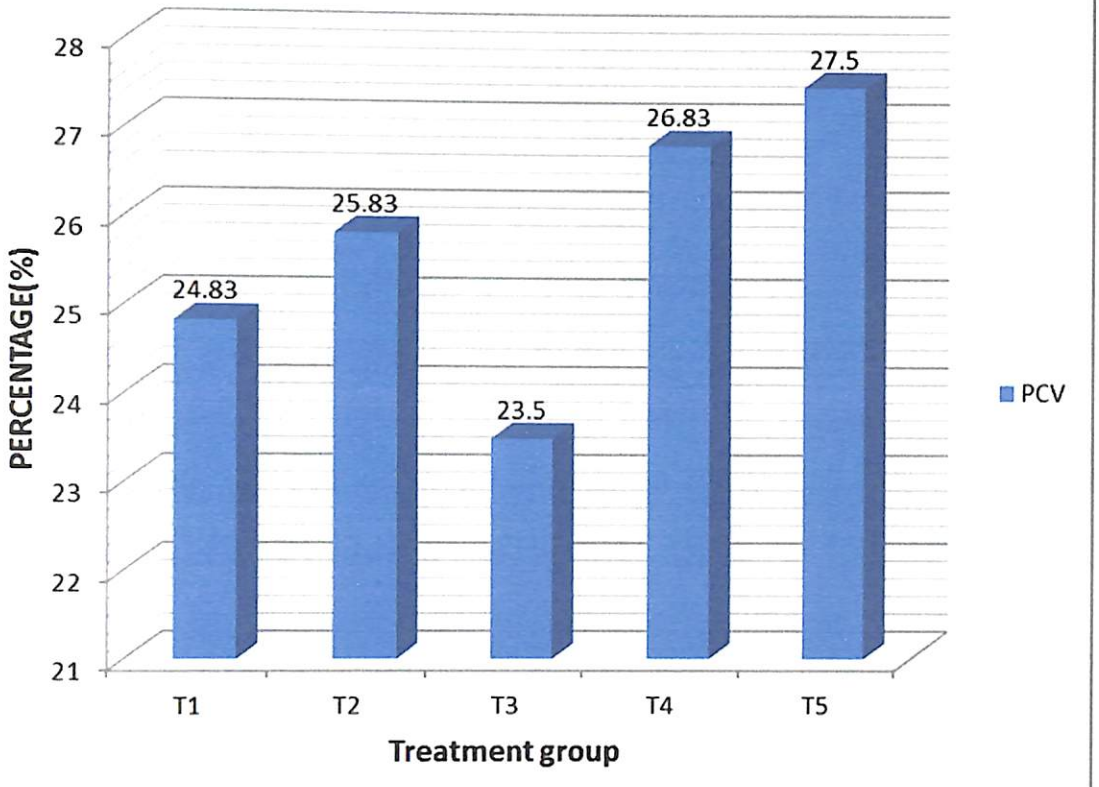


Fig.10- Effect of dietary supplement on PCV at 6th week in broilers.



TOTAL CHOLESTEROL IN MUSCLE:

Cholesterol level in muscle and liver was also evaluated to study the effect of herbs/spices on cholesterol level.

Total cholesterol in Liver muscle:

Results of total cholesterol level in muscle at 6^{th} week of age in broiler are presented in table-13. A very good result was noted about total cholesterol in broilers muscle during this experiment. Average total cholesterol level in liver muscle ranged from 5.86±0.32 mg/g in T_5 group to 7.03±0.17 mg/g in T_1 group. The statistical analysis for the effect of treatment on total cholesterol in liver muscle was found to be highly significant ($P<0.05$). Average cholesterol level was found to be highest in control group T_1 (7.03±0.17 mg/g) and lowest in coriander fed group T_5 (5.86±0.32 mg/g). Average total cholesterol in liver muscle in T_2, T_3, and T_4 were 6.45±0.21 mg/g, 6.04±0.26 mg/g and 6.31±0.26 mg/g respectively. Inclusion of herbs/spices affected the cholesterol level but effect of coriander seed meal and neem leaf meal were noticeable.

Total cholesterol in Thigh muscle:

Average total cholesterol level in thigh muscle ranged from 60.32±3.46 mg/100g in T_4 group to 73.42±1.83 mg/100g in T_1 group. Statistical analysis for the effect of treatment on total cholesterol in thigh muscle showed that all the herbs/spices were equally effective in lowering the cholesterol.

Total cholesterol in Brest muscle:

Average total cholesterol level in Brest muscle ranged from 50.40±2.27 mg/100g in T_3 group to 61.59±2.23 mg/100g in T_1 group.

Almost similar trend was noted as in thigh muscle showing beneficial effect of herbs/spices on cholesterol level.

Table-13: Effect of dietary supplement on muscle cholesterol at 6th week in broilers.

PARAMETER	T_1	T_2	T_3	T_4	T_5
Liver cholesterol(mg/g)	7.03^{b} ±0.17	6.45^{ab} ±0.21	6.04^{a} ±0.26	6.31^{ab} ±0.26	5.86^{a} ±0.32
Thigh muscle cholesterol(mg/100g)	73.42^{b} ±1.83	64.09^{a} ±1.75	63.87^{a} ±2.80	60.32^{a} ±3.46	63.66^{a} ±2.78
Brest muscle cholesterol(mg/100g)	61.59^{b} ±2.23	53.49^{a} ±2.76	50.40^{a} ±2.27	50.46^{a} ±1.56	60.06^{b} ±1.65

Values with similar superscripts (row wise - a, b, c, d) did not differ significantly ($P<0.05$).

Fig.11-Effect of dietary supplement on Liver cholesterol at 6th week in broilers.

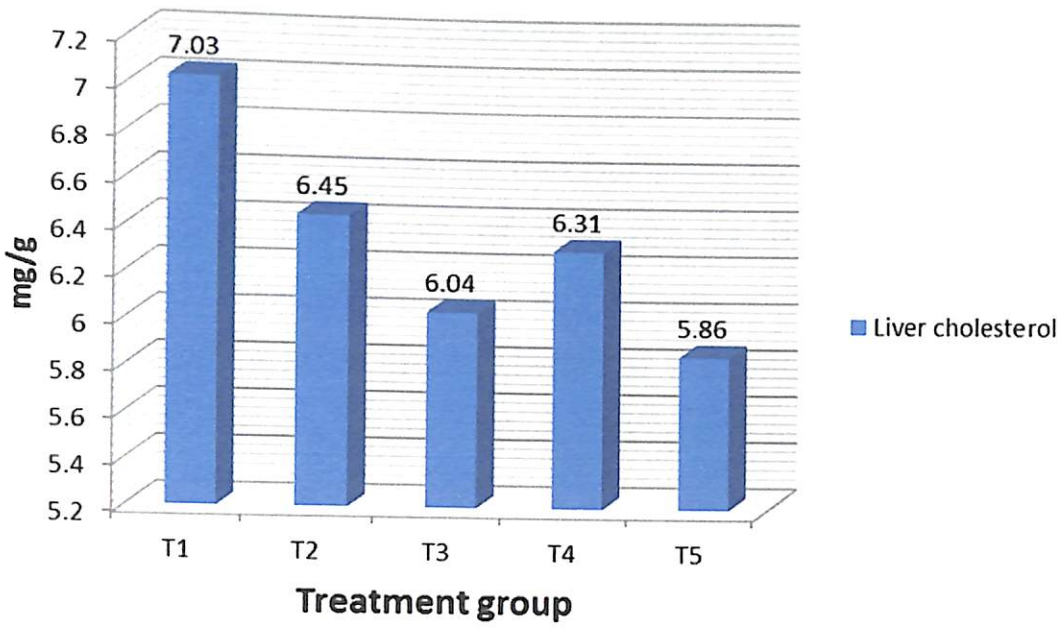
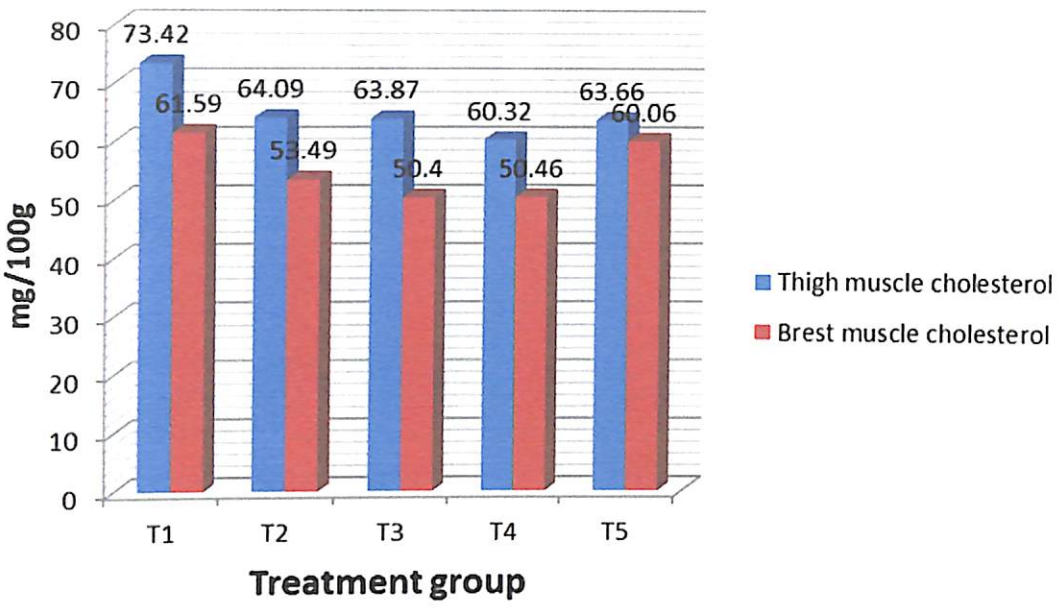


Fig.12-Effect of dietary supplement on muscle cholesterol at 6th week in broilers.



ECONOMICS OF PRODUCTION

Economics as influenced by different dietary treatments is shown in table-14. Total input cost per bird was calculated on the basis of total feed cost and cost of chicks, medicines and other miscellaneous. Supplementation of herbs in the diet increased the cost of experimental ration. However, when cost of feed per kg live weight gain was considered it was found maximum in T_2 groups which was fed with sugar beet and minimum in T_3 group which was fed with neem leaf meal. Net profit per bird was also found highest in T_3 group and lowest in T_2 group. This might be due to higher cost of Sugar beet in comparison to other herbs.

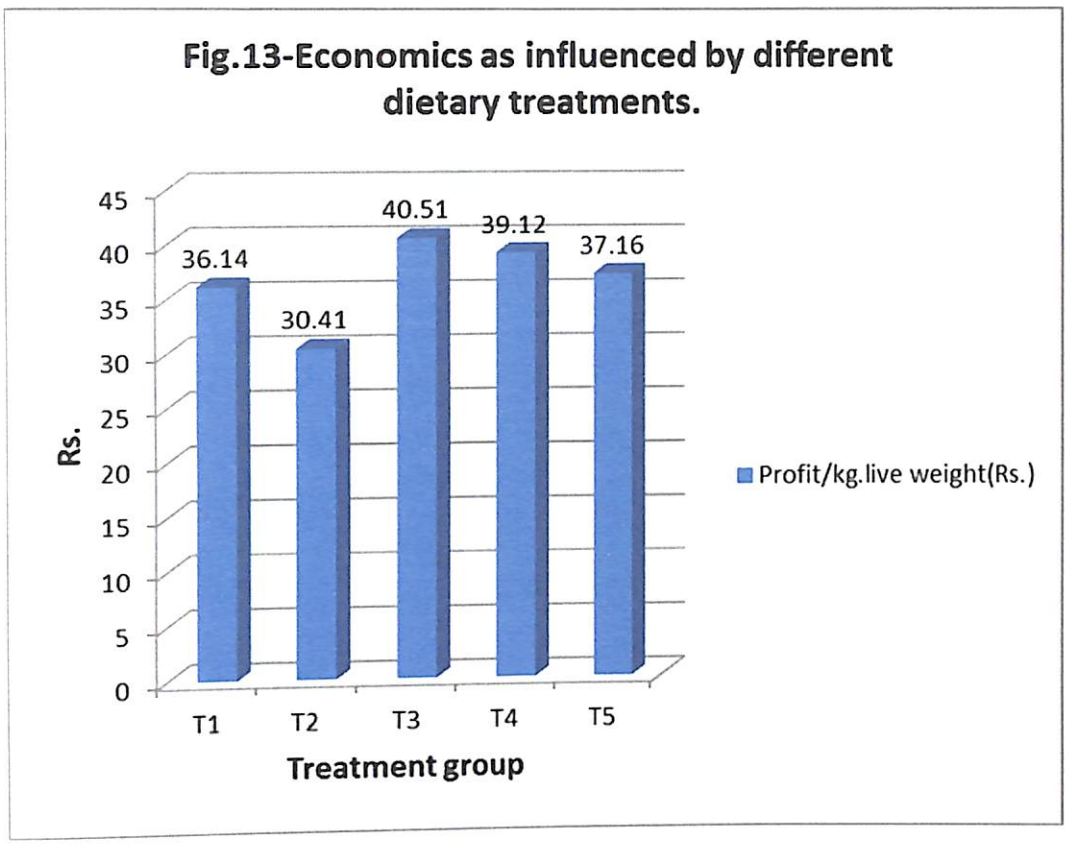


Table-14: Economics as influenced by different dietary treatments.

	T_1	T_2	T_3	T_4	T_5
Feed cost/kg. starter ration (Rs.)	20	25	20.50	21	21.75
Cost of starter ration consumed (Rs.)	30.8	38.25	31.77	32.97	33.49
Feed cost /kg. finisher ration (Rs.)	19	24	19.50	20	20.75
Cost of finisher ration consumed (Rs.)	23.18	29.04	24.96	26.40	25.11
Total feed cost (Rs.)	53.98	67.29	55.73	59.37	58.6
Cost of Chicks + Medicines+ Misc. (Rs.)	30	30	30	30	30
Total cost (Rs.)	83.98	97.29	85.73	89.37	88.6
Av. live weight of chicks (kg.)	1.315	1.398	1.441	1.468	1.410
Market price of bird (Rs.) at the rate of Rs. 100/-	131.50	139.8	144.1	146.8	141
Net profit/bird (Rs.)	47.52	42.51	58.37	57.43	52.4
Profit/kg. live weight (Rs.)	36.14	30.41	40.51	39.12	37.16

CHAPTER - 5

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

Broiler production in India is rapidly increasing to combat the need of animal protein for human population due to high prices and shrinking supply of other animal protein sources. Broilers are one of the most efficient nutrient convertors with respect to economy and nutritional point of view. The trend of non-vegetarian population on the globe is changing towards poultry meat consumption from red meat. Changes in human diet over the past few years particularly in terms of dietary fat intake and its effect on human health have become a major concern in nutritional research. Various evidences have shown a strong relationship among total fat intake and number of diseases including coronary heart diseases, obesity, cancer, etc. Coronary heart disease is believed to have a non-pharmacological remedy by way of physical exercise, low salt intake and cessation of smoking while hyper cholesterolemia is still difficult and costly to be controlled. Thus, the most practical and least expensive way of overcoming the cardiovascular diseases is of resorting to non-pharmacological procedures. Researches, in past, have shown that various herbs reduce the total cholesterol and other lipoproteins in chicks as well as in other animals.

The present study was planned to investigate the effect of sugarbeet meal, neem leaf meal, linseed meal and coriander seed meal on growth performance, balance of nutrients, carcass quality and lipid profile of broilers. The entire study consisted of five treatment groups. T_1 group served as control and other treatment groups, i.e., T_2, T_3, T_4 and T_5 were fed sugarbeet, neem leaf meal, linseed meal and coriander seed meal at the

rate of 2.5% in poultry ration. This experiment was conducted for 42 days on 150 birds.

GROWTH PARAMETER

Feed intake: A good fluctuation was observed in feed intake in every week among different group. On the whole after 6th week average feed intake in T_2 (2742.40g) was found to be significantly ($P<0.05$) lower than T_1, T_3, T_4 and T_5 group whereas value of T_4 (2894.47g) group was found to be highest ($P<0.05$) among group.

Body weight: Average body weight in broilers was found to be highly significant ($P<0.05$). There was no definite trend was observed in body weight of different treatment group but all herbs were increases body weight in treatment group than control. At 6^{th} week linseed fed group had higher body weight.

Body weight gain: The average body weight gain at the end of 1^{st} week of age was highest in T_4 (linseed) group. It was observed that broilers of T_4 fed with herbs at the rate of 2.5% gained significantly ($P<0.05$) higher body weight than control in 1^{st} week but not significantly in T_2, T_3 and T_5 group. The body weight gain in T_5 (coriander) group was found to be the highest (139.70±4.47g) at the end of 2^{nd} week. At this stages, i.e., at the end of 2^{nd} week of age, it was observed that broilers fed with herbs at the rate of 2.5% not gained significantly ($P<0.05$) higher body weight than control. Numerically T_2, T_3 showed lower body weight gain than control. The average body weight gain at the end of 3^{rd} week of age was highest in T_5 group. In 4^{th} week body weight gain was highest for T_3 group. At the end of 5^{th} week body weight gain highest for T_3. Weight gain was highest for T_4 group at 6^{th} weak. During 1-6^{th} week body

weight gain was highest for T_4 group. There was no definite trend was observed in body weight gain of different treatment group.

It might be concluded that herbs had effect on body weight gain. That might be due to effect of herbs on body metabolism.

Feed conversion ratio (FCR): Feed conversion ratio in broilers was found to be highly significant ($P<0.05$) at 4^{th} , 6^{th} and 1-6^{th} week of age. There was no definite trend was observed in FCR of different treatment group but all herbs lower the FCR in treatment group than control. This might be due to better feed utilization in terms of body weight gain of birds.

Performance index (PI): Significantly ($P<0.05$) higher performance index was observed at 4^{th}, 6^{th} and 1-6^{th} week of age. There was no definite trend was observed in PI of different treatment group but all herbs increase the PI in treatment group than control.

BALANCE STUDY

Nitrogen retention percentage: Average nitrogen retention percentage was highest in coriander fed group. The effect of treatment on nitrogen retention in broilers was found to be highly significant ($P<0.05$).

Energy metabolizability percentage: Energy metabolizability was found to be highest in T_2 group, which was fed with sugar beet. The effect of treatment was found to be highly significant ($P<0.05$).

Calcium and Phosphorus retention percentage: Calcium retention percentage was highest in group fed with coriander in diet. On the other hand phosphorus retention percentage was found not significantly different from control.

The balance study showed that all the groups had significant ($P<0.05$) difference except phosphorus retension percentage indicating effect of feeding herbs in broilers.

CARCASS CHARACTERISTIC

Byproduct percentage: Byproduct percentage was numerically lowest in group fed with coriander followed by sugar beet. Treatment group T_3 and T_4 had significantly ($P<0.05$) higher byproduct% than control.

Giblet percentage: Statistical analysis for the effect of feeding herbs on giblet percentage was found to be highly significant ($P<0.05$). giblet percentage was highest in group fed with neem leaf meal followed by sugar beet, coriander and linseed.

Dressing percentage: Dressing percentage was numerically highest in group fed with sugar beet. There was no significant difference among various herbs fed groups and also between control and treatment group.

SERUM BIOCHEMICAL PARAMETER

Total cholesterol in serum: Statistical analysis for the effect of feeding herbs on total cholesterol level was found to be highly significant ($P<0.05$). The average total cholesterol in serum was highest in control and lowest in linseed fed group. It was seen that feeding of sugarbeet meal, neem leaf meal, linseed meal and coriander seed meal effected the levels of cholesterol in broilers.

Triglyceride in serum: Statistical analysis for the effect of feeding herbs on Triglyceride level was found to be highly significant ($P<0.05$). The average Triglyceride in serum was highest in control and

lowest in coriander fed group. There was no significant difference among treatment groups. It was seen that feeding of sugarbeet, neem leaf meal, linseed and coriander effected the levels of cholesterol in broilers.

High density lipoprotein (HDL) in serum: The effect of treatment on HDL level was found to be highly significant ($P<0.05$). Average HDL level was found highest in Sugar beet fed group and lowest in linseed fed group.

Low density lipoprotein (LDL) in serum: LDL level was found to be highest in control and lowest in case of T_3 group, which was neem leaf meal fed. The statistical analysis for the effect of treatment on LDL level was found to be highly significant ($P<0.05$).

Very low density lipoprotein (VLDL) in serum: The statistical analysis for the effect of treatment on VLDL level was also found highly significant ($P<0.05$). The average VLDL level was found to be highest in control and lowest in coriander fed chicks.

Protein in serum: There was no significantly difference between control and treatment group but numerically coriander fed group had higher protein value than control.

Glucose in serum: There was also no significantly difference between control and treatment group but numerically coriander fed group and sugar beet fed group had lower glucose value than control.

BLOOD PARAMETER

Hemoglobin: Coriander followed by linseed and sugar beet fed group had numerically higher hemoglobin value than control. There was no significantly difference between control and sugarbeet, linseed fed

group but in coriander and neem leaf meal fed group value was comparable with control. Neem leaf meal had lower value than control.

Packed cell volume: Coriander followed by linseed and sugar beet fed group had numerically higher PCV value than control. There was also no significantly difference between control and sugarbeet, linseed fed group but in coriander and neem leaf meal fed group value was comparable with control. Neem leaf meal had lower value of PCV than control.

MUSCLE CHOLESTEROL PARAMETER

Total cholesterol in muscle: The effect of treatment on total cholesterol in muscle was found to be highly significant ($P<0.05$). The average cholesterol level in liver was found to be highest in control group and lowest in coriander fed group. The average cholesterol level in Thigh muscle was found to be highest in control group and lowest in linseed fed group. In brest muscle it was highest for control and lowest for neem leaf meal fed group. There was no definite trend obsorbed between different treatment groups. Various herbs reduced the level of total cholesterol in muscle with respect to control.

Economics of production: Supplementation of herbs in the diet increased the cost of experimental ration. Cost of feed per kg. Live weight was found maximum in case of T_2 group which was fed with sugar beet and minimum in T_3 group which was fed with neem leaf meal. This may be attributed to high cost of sugar beet in comparison to other herbs.

CONCLUSION:

(i) A good fluctuation was observed in feed intake in every week among different group. However, birds fed with linseed had

better feed consumption in comparision to other treatment groups.

(ii) Broilers fed with herbs at the rate of 2.5% gained significantly ($P<0.05$) higher body weight than control. Effect of herbs on body weight gain indicated that herbs can effect accretion of body weight. Among different groups, linseed fed group showed highest body weight gain at 6^{th} week of age.

(iii) Both FCR and PI were seen better in supplemented groups in comparision to control. Thus, it can be concluded that growth parameters showed positive inclination towards supplemented groups.

(iv) In study of balance of nutrients, nitrogen and calcium retention percentage was seen highest among coriander fed groups while no significant change in phosphorus retention in treatment group and control. Metabolisable energy was maximum in case of sugar beet fed groups.

(v) Carcass traits like giblet% and dressing percentage also showed better results in herbs supplemented groups with respect to control. Neem leaf meal group showed significantly ($P<0.05$) highest giblet% than control. Among different herbs, sugar beet fed group had highest dressing percentage numerically but not significantly than control. Neem leaf meal fed group and linseed fed group showed significantly ($P<0.05$) highest byproduct % than control.

(vi) Various herbs, like, sugarbeet, Neem leaf meal, Linseed and Coriander affected significantly ($P<0.05$) the levels of total cholesterol and lipoproteins in serum and meat of broilers. Though, all herbs / spices reduced the level of total cholesterol in serum, but no definite trend was shown by different treatment group.

(vii) Lipoproteins like HDL, LDL and VLDL were also affected significantly ($P<0.05$). Highest HDL and lowest LDL was observed in sugarbeet fed group and Neem leaf meal fed group respectively while VLDL was minimum in group supplemented with coriander.

(viii) In case of protein and glucose in serum there was no significantly difference between control and treatment group.

(ix) Highest hemoglobin and lowest hemoglobin was observed in coriander fed group and neem leaf meal fed group respectively while neem leaf meal fed group had lower value than control. Similar trend was observed in PCV also. It may be concluded that feeding of sugarbeet, linseed and coriander in broiler with poultry ration may be helpful in increasing haemoglobin and PCV value in Broiler blood.

(x) In case of total cholesterol in muscle, no definite trend was shown by different treatment group but it may be concluded that feeding of sugarbeet, neem leaf meal, linseed and coriander in broiler with poultry ration may be helpful in production of low cholesterol meat.

(xi) Supplementation of various herbs increased the total feed cost marginally, except, in case of feed supplemented with sugar beet with respect to control. Net profit per bird and profit per kg. live weight was highest in group fed with neem leaf meal.

Thus, it may be concluded that inclusion of Herbs in poultry ration may prove helpful in production of low cholesterol meat.

RECOMMENDATIONS:

1. It is recommended to use as feed supplements sugarbeet meal, neem leaf meal, linseed meal and coriander seed meal to broilers in their starter and finisher diets as 2.5% feed supplement in diet used in this study. However, further research is required to assess present findings.

2. Sex, house conditions and management practices should be investigated in order to shed light on exact effect of herbal plants on the tested parameters.

CHAPTER - 6

BIBLIOGRAPHY

BIBLIOGRAPHY

"Applied Physiology, Nutrition and Metabolism"; Experimental and clinical research findings on the cardiovascular benefits of consuming flaxseed. Bassett CM, et al.; 2009

Adaramonye, O.A.; Nwaneri, V.O.; Anyanwu, K.C. (2005). Possible anti-atherogenic effect of kolaviron (Garcinia kola seed extract) in hypercholesterolemic rats. *Clin. Exp Pharmacol Physiol.*, 32: 40 – 46.

Ahn, D. U., H. H. Sunwoo, F. H. Wolfe and J. S. Sim, 1995. Effects of dietary alpha-linolenic acid and strain of hen on the fatty acid composition, storage stability, and flavor characteristics of chicken eggs. Poultry Sci. 74:1540-1547.

Ajuyah, A. O., K. H. Lee, R. T. Hardin, and J. S. Sim. 1991. Changes in yield and in the fatty acid composition of whole carcass and selected meat portions of broiler chickens fed full-fat oilseeds. Poultry Sci. 70: 2304-2314.

Ajuyah, A. O., D. U. Ahn, R. T. Hardin, and J. S. Sim. 1993. Dietary anti-oxidants and storage affect chemical characteristics of w-3 fatty acid-enriched broiler chicken meats. J. Food Sci. 61: 43-46.

Akpan MJ, Enyenihi GE, Obasi OL, Solomon IP, Udedibie ABI. Effects of dietary neem leaf extract on the performance of laying hens. Proceedings of 33rd Annual Conference

Nigerian Society Animal Production March 20-25, 2008; 396-398.

Al-Kassie, G.A 2009. *Pakistan Vet. J,* 29(4): 169-173.

American Heart Association, (1991). Report of the expert panel on population strategies for blood cholesterol reduction. National Cholesterol Education Program; National Heart, Lung, and Blood Institute; National Institutes of Health, Dallas, TX.

American Heart Association, (2001). Heart and Stroke Statistical Update. American Heart Association, Dallas, TX.

Anderson J. W. (1985) Physiological and metabolic effects of dietary fiber. Fed. Proc. 44:2902–2906.

Anderson, J. W. & Tietyen-Clark, J. (1986). Dietary fiber: hyperlipidemia, hypertension and coronary heart disease. *American Journal of Gastroenterology* 81, 907-9 19.

Anderson, J. W., Deakins, D. A,, Floore, T. A,, Smith, B. M. & Whitis, S. E. (1990). Dietary fiber and coronary heart disease. *Critical Reviews in Food Science and Nutrition* 29, 95-147.

AOAC (2000). Official Method of Analysis. Association of Analytical Chemists. 16th Edn. Washington, D.C.

Aritsuka T., Tanaka K., Kiriyama S. (1989) Effect of beet fiber on lipid metabolism in rats fed a cholesterol-free diet in comparison with pectin and cellulose. J. Jpn. Soc. Nutr. Food Sci. **42**:295–304.

Arslan,C and Saatci,M (2003) Bulky feeds in the intensive fattening Of goslings *Revue Méd. Vét.,* 154, 10, 633-638.

Aymond, W. M., and M. E. Van Elswyk, 1995. Yolk thiobarbituric acid reactive substances and n-3 fatty acids in response to whole and ground flaxseed. Poultry Sci. 74:1388-1394.

Bakshi MPS, Wadha M, Rana KK. Nutritive value of tree leaves for livestock from a semihilly arid region of India. In: Improving productivity by supplementary feeding of multinutrient blocks, controlling internal parasites and enhancing utilization of alternate feed resources 2006.

Berggren AM, Björck IME, Nyman EM, Eggum BrO. Short-chain fatty acid content and pH in caecum of rats given various sources of carbohydrates. J Sci Food Agric. 1993;63:397–406. Doi : 10.1002 / jsfa.2740630405.

Bird, H.R. (1955). Performance index of growing chickens. Poult. Sci., 34:1163-1164.

BIS, (1991). Bureau of Indian standards. Poultry Feeds Specification, New Delhi, India.

Block, G.; Jensen, C.D.; Norkus, E.P.; Dalvi, T.B.; Wong, L.G.; McManus, J.F. and Hudes, M.L. (2007). Usage patterns, health and nutritional status of long term dietary supplement users: a cross-sectional study. *Nutr. Journal* 6:30.

Bridges S. B., Anderson J. W., Deakins D. A., Dillon D. W., Wood C. L. (1992) Oat bran increases serum acetate of

hypercholesterolemic men. Am. J. Clin. Nutr. **56**:455–459.

Budvari, S. (1996). The Merck Index : An Encyclopedia of Chemicals, drug 12th ed. Whitehouse Station, N. J. Merck & Co, Inc.

Campbell, T.W., 1995. Avian hematology and Cytology. Iowa State University Press, Ames Iowa.

Case, G.L., He, H. MO and C.E. Elson, 1995 Induction of geranyl pyrophosphate pyrophosphatase activity by cholesterol-suppressive isoprenoids. Lipids, 30: 357-359.

Caston, L. and S. Leeson. 1990. Research note: Dietary flaxseed and egg composition. Poultry Sci. 69: 1617-1620.

Chakraborty, T., Verotta, L. and Podder, G. (1989). Evaluation of *A. indica* leaf extract for lypoglycaemic activity in rats. Phytotherapeutic Research, 3: 30 – 32.

Chatterjea, M.N. and Shinde, Rana. Text book of Medical Biochemistry. 3rd Edn. (1998); Medical Publishers (P) Ltd., New Delhi, India. Page : 38-39, 439-504, 717.

Chattopadhyay, R. R. 1996. Possible mechanism of anti-hyperglycemic effects of Neem leaf extracts. Part IV. General Pharmacology 27: 431-434.

Chen W. J., Anderson J. W. (1979) Effects of guar gum and wheat bran on lipid metabolism of rats. J. Nutr. **109**:1028–1034.

Cherian, G., and J. S. Sim, 1991. Effect of feeding full fat flax and canola seeds to laying hens on the fatty acid composition of

eggs, embryos and newly hatched chicks. Poultry Sci. 70:917-922.

Cherian, G., and J. S. Sim, 1993. Net transfer and incorporation of yolk n-3 fatty acids into developing chick embryos. Poultry Sci. 72:98-105.

Chithra V. and Leelamma S. (1997) : Hypolipidemic effect of coriander seeds (*Coriandrum sativum*) : mechanism of action. Plant Foods Hum. Nutr. 51(2), 167-72.

Chithra V. and Leelamma S (1999) : Coriandrum sativum changes the levels of lipid peroxides and activity of antioxidant enzymes in experimental animals. Indian J. Biochem. Biophys. 36(1), 59-61.

Chithra V. and Leelamma S. (2000) : Coriandrum sativum-effect on lipid metabolism in 1, 2-dimethyl hydrazine induced colon cancer. J. Ethnopharmacol. 71(3), 457-63.

Cho W. K., Mennone A., Rydberg S. A., Boyer J. L. (1997) Bombesin stimulates bicarbonate secretion from rat cholangiocytes: implications for neural regulation of bile secretion. Gastroenterology**113**:311–321.

Chowdhury SD, Datta BC, Rahman ABMS and Ahmed SU (2004). Efficacy of neem (*Azadirachta indica*) leaf meal (NLM) used alone or in a combination with a probioticin the diet of broiler chicks. Proc. 11th AAAP Congr. 5-9 Sep., Kualalumpur, Malaysia. P. 244-247.

Chu, T. K., and F. A. Kummerow. 1950. The deposition of linolenic acid in chickens fed linseed oil. Poultry Sci. 29:846-851.

Cintra DEC, Costa AGV, Peluzio MDC, Matta SLP, Silva MTC, Costa NMB. 2006. Lipid profile of rats fed high-fat diets based on flaxseed, peanut, trout, or chicken skin. Nutrition 22: 197-205.

Crowell, P.L.,1999. *J. Nutr.*, 129:775-778.

Cui W, Mazza G, Biliaderis CG. Chemical Structure, Molecular Size Distributions, and Rheological Properties of Flaxseed Gum. J Agric Food Chem. 1994;42:1891–1895. doi: 10.1021/jf00045a012.

Delaquis PJ, Stanich K. and Girard B. (2002). Antimicrobial activity of Individual and mixed fractions of dill, Cilantro, Coriander and eucalyptus essential oils. Int. J. Food Microbiol. 74(1-2) : 101-9.

Dhanapakiam,P., Mini Joseph,J., Ramaswamy,V.K, Moorthi,M., and Senthil Kumar,A.(2008) The cholesterol lowering property of coriander seeds (Coriandrum sativum): Mechanism of action. Journal of Environmental Biology, 29(1) 53-56.

Drabkin, DL. (1932) J. Biol. Chem 98,719.

Ebihara, K. & Schneeman, B. 0. (1989). Interaction of bile acids, phospholipids, cholesterol, and triglyceride with dietary fibres in the small intestine of rats. *Journal of Nutrition* 119, 1100-1 106.

Edenharder, R., P. Kurz, K. John, S. Burgard and K. Seeger (1994) '*In vitro* effect of vegetable and fruit juices on the mutagenicity of 2-amino-3-methylimidazole[4,5-

f]quinoline, 2-amino-3,8-dimethylimide-3-ol[4,5-f]quinoxaline', *Food Chem. Toxicol.*, 32: 443-459.

Edoziem, J.C. and Switzer, B.R. (1977). Effects of dietary protein, fat and energy on blood haemoglobin and haematocrit in rat. J. Nutr, 107: 1016 – 1021.

Ertas, O.N., Guler, T., Ciftci, M., Dalkilic, B. and Yilmaz, O. (2005) : The effect of a dietary supplement coriander seeds on the fatty acid composition of breast muscle in Japanese quail. Revue Med. Vet. 156, 10, 514-518.

Esonu, B.O., Opara, M.N., Okoli, I.C., Obikaonu, H.O., Udedibie, C. and Iheshiulor, O.O.M. (2006). Physiological Response of Laying Birds to Neem (*Azadirachta indica*) Leaf Meal-Based Diets: Body Weight ,Organ Characteristics and Haematology. Online J Health Allied Scs.,2:4,www.ojhas.org/issue 18/2006-2-4.htm.

Farouk M., Geoghegan J. G., Pruthi R. S., Thomson H. J., Pappas T. N., Meyers W. C. (1992) Intracerebroventricular neuropeptide Y stimulates bile secretion via a vagal mechanism. Gut**33**:1562–1565.

Farrell, D. J., 1995. Effects of consuming seven omega-3 fatty acid enriched eggs per week on blood profiles of human volunteers. Poultry Sci. 74:148 (supplement).

Floch, j., Lees,M., and Sloane Staniey,G.H (1957).A simple method for the isolation and purification of total lipids from animal tissue. j .Biol.Chem.,226:497-507.

Fluorie, B., Vidon, N., Florent, C. H. & Bernier, **J.** J. (1984). Effect of pectin on jeujenal glucose absorption and unstirred layer thickness in normal man. *Gut* 25, 93G-941.

Furda, I. (1990). Interaction of dietary fibre with lipids - mechanistic theories and their limitations. In *New Developments in Dietary Fiber,* pp, 67-82 [I. Furda and C. J. Brine, editors]. New York: Plenum Press.

Gallaher, D. D., Locket, P. L. & Gallaher, C. M. (1992). Bile acid metabolism in rats fed two levels of corn oil and brans of oat, rye and barley and sugar beet fiber. *Journal of Nutrition* 122, 473481.

Gebhard R. L., Morley J. E., Prigge W. F., Goodman M. W., Prasad C. (1981) TRH and histidyl-proline diketopiperazine inhibit cholesterol synthesis in dog intestine. Peptides **2**:137–140.

Global Agricultural Information Network (GAIN) Report, (2011) IN1205.

Goh KKT, Pinder DN, Hall CE, Hemar Y. Rheological and Light Scattering Properties of Flaxseed Polysaccharide AqueousSolutions. Biomacromolecules. 2006;7:309 8–3103. doi: 10.1021/bm060577u.

Goodlad R.A., Ratcliffe B., Fordham J.P., Ghatei M.A., Domin J., Bloom S. R., Wright N. A. (1989) Plasma enteroglucagon, gastrin and peptide YY in conventional and germ-free rats refed with a fibre-free or fibre-supplemented diet. Q.□J. Exp. Physiol. **74**:437–442.

Gowda, S. K., Verma, S. V. S., Elangovan, A. V. and Singh, A. D. (1998). Neem (*Azadirachta indica*) kernel meal in the diet of white leghorn layers. *British Poultry Science.* 39, 648-652.

Gray A.M. and Flatt, PR. (1999) Insulin-releasing and insulin-like activity of the traditional anti-diabetic plant coriandrum sativum (coriander). Br. J. Nutr. 81(3) : 203-9.

Gülçin I, Küfrevioğlu K, Oktay M, Büyükokuroğlu M.E (**2004**)..*J. Ethnopharacology* . 90: 205-215..

Gyarfas, I. 1992. Cardiovascular diseases : the world's public health enemy number one. World Health. 42 : 4-5.

Haila, K.M., Lievonon S.M., Heinonen, M.I. (1996) : Effects of lutein, lycopene, annatto, and α-tocopherol on autoxidation of triglyceridos. J. Agric. Food. Chem. 44, 2096-2100.

Henning, B., and Watkins, B.A. (1998). Dietary lipid guidelines for infants and children : considerations for growth and disease risk. Pages 235-251 in lipids in Infant Nutrition. Y.S. Huang and A.J. Sinclair, ed. AOCS Press, Champaign, IL.

Hlkansson, J., Eriksson, S. & Svensson, S. A. (1978). The influence of feed energy level on feed consumption, growth and development of different organs of chicks. *Report 57,* 1-54. Uppsala: Swedish University of Agricultural Sciences.

Hu, S.H.; Liang, Z.C.; Chia, Y.C. (2006). Antihyperlipidemic and antioxidant effects of extracts from *Plenrotus citrinopileatus. J. Agric. Food Chem.*. 22: 2103 – 2110.

Hu, C., Yuan, V., Kitts, D. 2007. Antioxidant activities of the flaxseed lignin secoisolariciresinol diglucoside, its aglycone secoisolariciresinol and the mammalan lignans enterodiol and enterolactone *in vitro*. Food Chem. Toxicol. 45, 2219-2227

Hudson B.J.F. and Ghavami M. (1984) : Phospholipids as antioxidant synergists for tocopherols in the autoxidation of edible oils. Lebensm. Wiss. Technol. 17, 191-194.

ICRA Rating Feature (*2011*). Poultry industry-broiler meat and table egg.1-9. ICRA Limited, Associate of Moody's Investors Service.

Jiang, Z., D. U. Ahn, and J. S. Sim. 1991. Effects of feeding flax and two types of sunflower seeds on fatty acid composition of yolk lipid classes. Poultry Sci. 70: 2467-2475.

Jiang, Z., D. U. Ahn, L. Ladner and J. S. Sim, 1992. Influence of feeding full-fat flax and sunflower seeds on internal and sensory qualities of eggs. Poultry Sci. 71:378-382.

Johnson, I. T. &Gee, J. M. (1981). Effect of gel-forming gums on the intestinal unstirred layer and sugar transport *in vitro*. *Gut* 22, 398403.

Joshi,S.C., Sharma,N. and Sharma,P.(2012) antioxidant and lipid lowering effects of coriandrum sativum in cholesterol

fed rabbits. *Int J Pharm Pharm Sci, Vol 4, Suppl 3, 231-234*

Kapadia, G.J. et al. (1996) *Cancer Letters*, 100: 211-214.

Katan, M.B. (2000). Nutritional interventions : The evidence. Proc. Nutr. Soc. 59 : 417-418.

Kausik B, Ishita C, Ranajit KB, Uday B. Biological activities and medicinal properties of Neem (*Azadirachta indica*). Review article 2008.

Kelsay JL, Behall KM, Prather ES. Effect of fiber from fruits and vegetables on metabolic responses of human subjects I. Bowel transit time, number of defecations, fecal weight, urinary excretions of energy and nitrogen and apparent digestibilities of energy, nitrogen, and fat. Am J Clin Nutr. 1978;31:1149–1153.

Kender, B. (1987). Garlic (Allium sativum) and Onion (allium cepa) a review of their relationship to cardiovascular diseases. Journal of Preventive Medicine. 16:670-75.

Kennedy H. J., Sarson D. L., Bloom S. R., Truelove S. C. (1982) Gut hormone responses in subjects with a permanent ileostomy. Digestion **24**:133–136.

Kiriyama S., Okazaki Y., Yoshida A. (1969) Hypocholesterolemic effect of polysaccharides and polysaccharide-rich foodstuffs in cholesterol-fed rats. J. Nutr. **97**:382–388.

Klasing K.C. (1998) : Comparative avian nutrition. Centre for Agriculture and Biosciences International, Oxford University Press (Edited by K C Klasing) UK.

Klatt, L. 1986. The lure of omega-3-polyunsaturated fatty acids. Food Sci. Newsl. 16:1-4.

Klose, A. A., E. P. Mecchi, G. A. Behman, H. Lineweaver, F. H. Kratzer and D. Williams. 1952. Chemical characteristics of turkey carcass fat as a function of dietary fat. Poultry Sci. 31:354-359.

Kristensen M, Savorani F, Christensen S, Engelsen SB, Bugel S, Toubro S, Tetens I, Astrup A. Flaxseed dietary fibers suppress postprandial lipemia and appetite sensation in young men. Nutr, Metab Cardiov Dis. 2011. Accepted.

Kubo I, Fujita K, Kubo A, Nihei K. and Ogura T. (2004) Antibacterial activity of coriander volatile compounds against Salmonella choleraesuis. J. Agric. Food Chem. 52(11):3329-32.

Kummerow, F. A., J. Hite and S. Kloxin. 1948. Fat rancidity in eviscerated poultry. The effect of variation in diet on the characteristics of the fat extracted from immature turkeys. Poultry Sci. 27:689-694.

Lal, A. A, Kumar T, Murthy PB and Pillai KS (2004) : Hypolipidemic effect of coriandrum sativum L. in triton-induced hyperlipidemic rats. Indian J. Exp. Biol. 2004; 42(9):909-12.

Langhout, P., **2000**. New additives for broiler chickens. *World Poultry*-Elsevier, 16: 22-27.

Lata, S., Saxena, K. Bhasin, V., Saxena, R., Kumar, A. and Srivastava, V. (1991). Beneficial effect of *Allium sativum*, *Allium cepa* and comiphora mukul on experimental hyperlipidemia and atherosclerosis : a comparative evaluation. J. of Postgraduate Medicine. 37:132-35.

Leaf, A., and Kang, J. X. (1998). Omega-3-fatty acids and cardiovascular diseases. Pages 24-37 in the Return of □-3 Fatty Acids into the Food supply. A. P. Simopoulos. ed. S. Karger AG, Basel.

Lee, K.W., Everts, H. and Beyen, A.C. 2003. *Journal of Applied Poultry Research*. 12:394-399.

Leung, A.Y. and Foster, S. (1996) : Encyclopedia of common natural ingredients Drugs, and Cosmetics, 2nd edition (John Wiley, Editor, New York : John Wiley & sons Inc. Press.

Lichtenstein, A.H. (1999). Dietary fat : A history. Nutr. Rev. 57 : 11-14.

Lin Y., Vonk R.J., Slooff M. J., Kuipers F., Smit M. J. (1995) Differences in propionate-induced inhibition of cholesterol and triacylglycerol synthesis between human and rat hepatocytes in primary culture.Br. J. Nutr. **74**:197–207.

Liukkonen-Anttila, J. (2001). Nutritional and genetic adaptation of gallitorns birds: Implications for hand rearings and resticking. Acanic Dissertation, Faculty of Science, University of Oulu, Oulu Yilopisto, Finland. Retrieved September 17, 2007 from http://herkulesoulu.fi/isbn951425990index.html.

Lonkar, V.D., Jalaludeen, A., Narayankutty, K. and Viswnath, A. (2009) : Modulation of cholesterol level in broiler chicken by feeding garlic (*Allium sativum*) powder and neem (*Azadirachta indica*) seed cake. Ind. J. Poult. Sci. (2009) 44(1) : 49-53.

Marshall, A. C., K. S. Kubena, K. R. Hinton, P. S. Hargis and M. E. Van Elswyk, 1994. n-3 Fatty acid enriched table eggs: a survey of consumer acceptability. Poultry Sci. 73:1334-1340.

Mandour, A.A., Ashry, K.M. and Hedaya, S.A. (1998). Biochemical profile of serum constituents of broiler chickens supplemented with different levels of *Nigella sativa* with special references to its effect on hormonal and mineral concentrations. Egypt. Poult. Sci., 18:429-439.

McCance R.A. and E.M. Widdowson (1995) *The Composition of Foods*. 5th Edition. Cambridge, UK: The Royal Society of Chemistry.

Mellor, S., 2000a. Antibiotics are not the only growth promoters. *World Poult.*, 16(1): 14.

Mellor, S., 2000b. *World Poult.*, 16: 30-33.

Mirinova, A.N. (1991) : Chemical and biological properties of coriander fat. Vopr. Pitan. 1, 59-62.

Moundras C., Demigné C., Mazur A., Rémésy C. (1995) The cholesterol lowering effect of steroid sequestrants is modulated by large intestine fermentation. J. Nutr. Biochem. **6**:158–162.

Naran R, Chen G, Carpita NC. Novel Rhamnogalacturonan I and Arabinoxylan Polysaccharides of Flax Seed Mucilage. Plant Physiol. 2008;148:132–141. doi: 10.1104/pp.108.123513.

Nishimura N., Nishikawa H., Kiriyama S. (1993) Ileorectostomy or cecectomy but not colectomy abolishes the plasma cholesterol-lowering effect of dietary beet fiber in rats. J. Nutr. **123**:1260–1269.

Nishina P. M., Freedland R. A. (1990) Effects of propionate on lipid biosynthesis in isolated rat hepatocytes. J. Nutr. **120**:668–673.

Stephen Nottingham (2004), Beetroot, Health and Nutrition, Chapter-6.

Obikaonu,H.O., Okoli,I.C., Opara,M.N., Okoro,V.M.O., Ogbuewu,I.P., Etuk,E.B, and Udedibie,A.B.I.(2012) Haematological and serum biochemical indices of starter broilers fed leaf meal of neem (*Azadirachta indica*). Journal of Agricultural Technology Vol. 8(1): 71-79.

Oforjindu O. The toxicity of graded levels of graded levels of Neem (*Azadirachta indica*) leaf meal. B. Agric. Tech. Project Report, Federal University of Technology, Owerri 2006.

Ogbuewu IP, Okoli IC, Iloeje MU. Serum biochemical evaluation and organ weight characteristics of buck rabbits fed graded levels Neem (*Azadirachta indica*) leaf meal diets. Veton - line - The International Journal of Veterinary Medicine 2008.

Ogbuewu IP, Okoli IC, Iloeje MU. Semen quality characteristics, reaction time, testis weight and seminiferous tubule diameter of buck rabbits fed neem *Azadirachta indica*) leaf meal based diets. Iranian Journal of Reproductive Medicine 2009; 7(1): 23-28.

Ogbuewu, I.P, Okoli, I.C.and Iloeje, M.U. (2010) Evaluation of Toxicological Effects of Leaf Meal of an Ethnomedicinal Plant-Neem on Blood Chemistry of Puberal Chinchilla Rabbit Does. ISSN: 1553-9873, 2010:2(2):29-34.

Ojiako, O.A. and Nwanjo, H.U. (2009) Biochemical studies of the effects of the aqueous extract of Nigerian garlic on lipid profile and artherogenic risk predictor indices. *Australian Journal Basic and Applied Sciences,* 3 (3): 2861 – 2865.

Okuyama, H., Kobayashi, T. and Watanabe, S. (1997). Dietary fatty acids - the n-6/n-3 balance and chronic elderly diseases excess linoleic acid and relative n-3 deficiency syndrome seen in Japan. Prog. Lipid Res. 35:409-457.

Olomu, J. M., and V. E. Baracos, 1991. Influence of dietary flaxseed oil on the performance, muscle protein deposition and fatty acid composition of broiler chicks. Poultry Sci. 70:1403-1411.

Overton P. D., Furlonger N., Beety J. M., Chakraborty J., Tredger J. A., Morgan L. M. (1994) The effects of dietary sugar-beet fibre and guar gum on lipid metabolism in Wistar rats. Br. J. Nutr.**72**:385–395.

Pan A, Yu D, mark-Wahnefried W, Franco OH, Lin X. Meta-analysis of the effects of flaxseed interventions on blood lipids. Am J ClinNutr.2009;90:288–297. doi: 10.3945/ajcn.2009.27469.

Paschos GK, Zampelas A, Panagiotakos DB, Katsiougiannis S, Griffin BA, Vasilios Votteas V, Skopouli FN. 2007. Effects of flaxseed oil supplementation on plasma adiponectin levels in dyslipidemic men. Eur J Nutr 46:315-320.

Pekkanen AN, Punsar S, Karvonen MJ (1992) Short and long term association of serum cholesterol with mortality. Am J Epidemiol 135:1252–1258.

Pellizzon MA, Billheimer JT, Bloedon LT, Szapary PO, Rader DJ. 2007. Flaxseed reduces plasma cholesterol levels in hypercholesterolemic mouse models. J Am Coll Nutr 26: 66-75.

Pettersson,D and Razdan, A(1993) Effects of increasing levels of sugar-beet pulp in broiler chicken diets on nutrient digestion and serum lipids *British Journal of Nutrition*, **70,** 127-137.

Phetteplace, H. W. and B. A. Watkins, 1989. Effects of various n-3 lipid sources on fatty acid composition in chicken tissues. J. Food Compos. Anal. 2:104-117.

Philip, B. and cephas, T.B. (1997). The effect of plant extracts on plasma glucose levels in rats. *Journal of Clinical Chemistry*, 10 (5): 167 – 169.

Platt; B.S. (1962) Table of Representative values of tropical countries,

Medical Research Council, Spec. Rep. Series No. 302, HMSo, London.

Pritchard, K.A. Jrn.; Groscek, L.; Smalley, D.M. (1995). Native low-density lipoprotein increases endothelia cell nutric oxide synthase generation of superoxide amion *Circ. Res.;* 77:510 – 518.

Qureshi, A.A., Abuirmeileh, N., Din, Z. Z., Ahmad, Y. Y., Elson, C.E. and Burger, W.C. (1983b). Suppression of avian hepatic lipid metabolism by solvent extracts of garlic : Impact on serum lipids. J. Nutr., 113:1746-1755.

Rajesha, J., Murthy, K., Kumar, M., Madhusudhan, B., Ravishankar, G. 2006. Antioxidant potentials of flaxseed in vivo model. J. Agr. Food Chem. 54, 3794-3799.

Ramadan M.F. and Morsel J.T. (2004) : Oxidative stability of Black cumin (*Nigella sativa* L.) coriander (*Coriandrum sativum* L.) and niger (*Guizotia abyssinica cass.*) Crude seed oils upon stripping. Eur. J. Lipid Sci. Technol. 106, 35-43.

Reddy, D.V. (2007). *Applied Nutrition (Livestock, Poultry, Human, Pet, Rabbit and Laboratory Animal Nutrition)*. Oxford & IBH Publishing Co. Pvt. Ltd., page-146.

Reische D.W., Lillard D.A., Eitenmiller R.R. (2002) : *Antioxidants in : Food lipids*, Second edition, Eds. Akoh, C.C; Min, D.B. Marcel Dekker, NY (USA) 489-516.

Rigaud D, Ryttig KR, Leeds AR, Bard D, Apfelbaum M. Effects of a moderate dietary fibre supplement on hunger rating, energy input and faecal energy output in young,

healthy volunteers. A randomized, double-blind, cross-over trial. Int J Obes. 1987;11(Suppl 1):73–78.

Rosenberg, H. (1990) 'Cancer chemo(toxico) therapy revisited and alternative ways of healing', http://karlloreen.com/biopsy/book/p14.htm

Sadre, N. L., Deshpande, V. Y., Mendulkar, K.N. and Nandal, D. H. (1984). Male anti-fertility activity of *Azadirachta indica* A. Juss (Neem) in different species. Pp. 473 – 482.

Saeid,J.M and Al-Nasry,A.S.(2010) Effect of Dietary Coriander Seeds Supplementation on Growth PerformanceCarcass Traits and Some Blood Parameters of Broiler Chickens. International Journal of Poultry Science 9 (9): 867-870.

SAS Institute. **2001**. SAS user guide: Statistics. Version 8.2 ed. SAS Institute Inc., Cary, NC

Scheideler, S. E., S. Cuppett, and G. Froning. 1994. Dietary flaxseed for poultry: Production effects, dietary vitamin levels, fatty acid incorporation into eggs and sensory analysis. Proc. 55th Flax Institute, Jan. 26-28, 1994, Fargo, N.D. pp 86-95.

Sellers, A. F. (1977). Genesis and propagation of motor activity in the digestive tract. In ***Duke's Physiology q/Domestic Animals,*** pp. 233-239 [M. J. Swenson, editor]. New York: Ithaca.

Simopoulos, A.P. (1998). Overview of evolutionary aspects of □-3 fatty acids in the diet. pages 1-11 in the return of □ -3 fatty acids into the food supply. A. P. Simopoulos, ed. S. Karger AG, Basel.

Snedecor, G.W. and W.G. Cochran, 1980. Statistical Methods, SXVII. 507. The Iowa State Univ. Press.Ames, USA.

Sokunbi OA, Egbunike GN. The performance of growing rabbits fed diets containing sun cured Neem leaf meal. Proceedings of the 5th Ann. Conf. ASAN., Sept.19-22, Port Harcourt, Nigeria 2000a; 113-116.

Sokunbi OA, Egbunike GN. Physiological response of growing rabbits to Neem leaf based diets. Hematology and Serum Biochemistry. Tropical Animal Production and Investigation 2000b; 3: 81-87.

Theuwissen E, Mensink RP. Water-soluble dietary fibers and cardiovascular disease. Physiol Behav. 2008;94:285–292. doi: 10.1016/j.physbeh.2008.01.001.

Tomotake, H.; Yamanoto, N.; Yanaka, N. (2006). High protein buckwheat flour suppresses hypercholesterolemia in rats and gall stone formation in mice by hyperchotesterolemic diet and body fat in rats because of its low protein digestibility. *Nutr.;* 22: 166 – 173.

USDA (2011). International egg and poultry review. Vol. 14 No. 34, United States Department of Agriculture, Washington, DC.

Visavadiya, N.P. and Narasimhacharya, A.V. (2007). Ameliorative effect of *Chorophytum borivilianum* root on lipid

metabolism in hyperlipaemic rats. *Clin. Exp. Pharmacol. Physiol.*, 34: 244 – 249.

Warrand J, Michaud P, Picton L, Muller G, Courtois B, Ralainirina R, Courtois J. Structural investigations of the neutral polysaccharide of Linum usitatissimum L. seeds mucilage. Int J Biol Macromol. 2005;35:121–125. doi: 10.1016/j.ijbiomac.2004.12.006.

Warrand J, Michaud P, Picton L, Muller G, Courtois B, Ralainirina R, Courtois J. Flax (Linum usitatissimum) seed cake: a potential source of high molecular weight arabinoxylans? J Agric Food Chem. 2005;53:1449–1452. doi: 10.1021/jf048910d.

Younis, T.M., (1987). Effect of feed additives on broiler performance. Ph.D. Thesis. Cited from N. AL-Beitawi and S.S.EL Ghousein (2008). Int. J. of Poult. Sc. 7(7) 715-721.

Zlatkis, A., Zak., B. and Boyle, G.J. (1953). J. Lab. Clin. Med. 41, 486. Cited from Hawk's Physiological Chemistry by Bernard L. Oscr. Pub. TMH. New Delhi Page No.- 1067.

ANNEXURE

ANNEXURE

I. Analysis of variance for the effect of treatment on Feed intake in broilers:

Source of Variance	d.f.	S.S.	M.S.	F
Treatment	4	470151.717	117537.929	2.295**
Period	1	57298.549	57298.549	1.119**
Error	145	0.000	0.000	

** = significant at P<0.05

II. Analysis of variance for the effect of treatment on body weight in broilers:

Source of Variance	d.f.	S.S.	M.S.	F
Treatment	4	437811.265	109452.816	9.219**
Period	1	219633.975	219633.975	18.499**
Error	145	1721516.680	11872.529	

** = significant at P<0.05

III. Analysis of variance for the effect of treatment on body weight gain in broilers:

Source of Variance	d.f.	S.S.	M.S.	F
Treatment	4	400673.024	100168.256	8.444**
Period	1	201205.571	201205.571	16.961**
Error	145	1720076.649	11862.598	

** = significant at P<0.05

IV. Analysis of variance for the effect of treatment on FCR in broilers:

Source of Variance	d.f.	S.S.	M.S.	F
Treatment	4	0.452	0.113	4.787**
Period	1	0.222	0.222	9.403**
Error	145	3.422	0.024	

** = significant at P<0.05

V. Analysis of variance for PI in broilers:

Source of Variance	d.f.	S.S.	M.S.	F
Between Treatment	4	276363.119	69090.780	5.634**
Period	1	154645.851	154645.851	12.611**
Error	145	1778133.882	12262.992	

** = significant at P<0.05

VI. Analysis of variance for Nitrogen retention in broilers:

Source of Variance	d.f.	S.S.	M.S.	F
Between Treatment	4	20.408	5.102	4.100**
Error	15	18.664	1.244	

** = significant at P<0.05

VII. Analysis of variance for Energy metabolisability in broilers:

Source of Variance	d.f.	S.S.	M.S.	F
Between Treatment	4	32.636	8.159	3.843**
Error	15	31.843	2.123	

** = significant at P<0.05

VIII. Analysis of variance for Calcium retention in broilers:

Source of Variance	d.f.	S.S.	M.S.	F
Between Treatment	4	22.590	5.648	3.683**
Error	15	23.003	1.534	

** = significant at P<0.05

IX. Analysis of variance for Phosphorus retention in broilers:

Source of Variance	d.f.	S.S.	M.S.	F
Between Treatment	4	7.583	1.896	1.490NS
Error	15	19.084	1.272	

NS =Non significant

X. Analysis of variance for the effect of treatment on dressing percentage in broilers:

Source of Variance	d.f.	S.S.	M.S.	F
Between Treatment	4	13.420	3.355	0.963^{NS}
Error	25	87.089	3.484	

NS = Non significant

XI. Analysis of variance for the effect of treatment on giblet percentage in broilers:

Source of Variance	d.f.	S.S.	M.S.	F
Between Treatment	4	7.766	1.942	11.931^{**}
Error	25	4.068	0.163	

** = significant at P<0.05

XII. Analysis of variance for the effect of treatment on byproduct percentage in broilers:

Source of Variance	d.f.	S.S.	M.S.	F
Between Treatment	4	39.735	9.934	12.667^{**}
Error	25	19.606	0.784	

** = significant at P<0.05

X111.Analysis of variance for the effect of treatment on Total cholesterol level in serum in broilers:

Source of Variance	d.f.	S.S.	M.S.	F
Between Treatment	4	1383.046	345.762	3.231**
Error	25	2675.632	107.025	

** = significant at P<0.05

XIV. Analysis of variance for the effect of treatment on Triglyceride level of serum in broilers:

Source of Variance	d.f.	S.S.	M.S.	F
Between Treatment	4	1467.923	366.981	1.855**
Error	25	4947.131	197.885	

** = significant at P<0.05

XV. Analysis of variance for the effect of treatment on HDL level of serum in broilers:

Source of Variance	d.f.	S.S.	M.S.	F
Between Treatment	4	338.945	84.736	3.187**
Error	25	664.781	26.591	

** = significant at P<0.05

XVI. Analysis of variance for the effect of treatment on LDL level of serum in broilers:

Source of Variance	d.f.	S.S.	M.S.	F
Between Treatment	4	1278.423	319.606	3.172**
Error	25	2518.741	100.750	

** = significant at P<0.05

XVII .Analysis of variance for the effect of treatment on VLDL level of serum in broilers:

Source of Variance	d.f.	S.S.	M.S.	F
Between Treatment	4	58.717	14.679	1.855**
Error	25	197.885	7.915	

** = significant at P<0.05

XVIII. Analysis of variance for the effect of treatment on Protein level of serum in broilers:

Source of Variance	d.f.	S.S.	M.S.	F
Between Treatment	4	0.611	0.153	0.857NS
Error	25	4.458	0.178	

NS =Non significant

XIX. Analysis of variance for the effect of treatment on Glucose level of serum in broilers:

Source of Variance	d.f.	S.S.	M.S.	F
Between Treatment	4	1825.79	456.447	1.641^{NS}
Error	25	6954.698	278.188	

NS =Non significant

XX. Analysis of variance for the effect of treatment on Hemoglobin level of blood in broilers:

Source of Variance	d.f.	S.S.	M.S.	F
Between Treatment	4	5.964	1.491	1.324^{**}
Error	25	28.163	1.127	

** = significant at P<0.05

XXI. Analysis of variance for the effect of treatment on PCV level of blood in broilers:

Source of Variance	d.f.	S.S.	M.S.	F
Between Treatment	4	60.800	15.200	1.641^{**}
Error	25	231.50	9.260	

** = significant at P<0.05

XXII. Analysis of variance for the effect of treatment on Total cholesterol in liver in broilers:

Source of Variance	d.f.	S.S.	M.S.	F
Between Treatment	4	4.907	1.227	3.284**
Error	25	9.340	0.374	

** = significant at P<0.05

XXIII. Analysis of variance for the effect of treatment on Total cholesterol in thigh muscle in broilers:

Source of Variance	d.f.	S.S.	M.S.	F
Between Treatment	4	579.842	144.961	3.559**
Error	25	1018.151	40.726	

** = significant at P<0.05

XXIV. Analysis of variance for the effect of treatment on Total cholesterol in brest muscle in broilers:

Source of Variance	d.f.	S.S.	M.S.	F
Between Treatment	4	677.551	169.388	6.169**
Error	25	686.429	27.457	

** = significant at P<0.05