EFFECT OF SUPPLEMENTATION OF NEEM (*Azadirachta indica*) LEAF POWDER ON GROWTH PERFORMANCE AND CARCASS QUALITY OF BROILER

by

Miss. Pallavi Dattatray Mali
(Reg. No.017/117)

DEPARTMENT OF ANIMAL HUSBANDRY AND DAIRY SCIENCE

POST GRADUATE INSTITUTE

MAHATMA PHULE KRISHI VIDYAPEETH
RAHURI-413722, DIST.AHMEDNAGAR
MAHARASHTRA, INDIA

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A Thesis submitted to the

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MAHARASHTRA, INDIA.**

In partial fulfilment of the requirements for the degree

of

MASTER OF SCIENCE (AGRICULTURE)

in

ANIMAL HUSBANDRY

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2019

CANDIDATE'S DECLARATION

I hereby declare that this thesis or part
thereof has not been submitted
by me or other person to any
other University or Institute
for a Degree or
Diploma

Place: MPKV, Rahuri (P. D. Mali)

Date: / /2019

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Place: MPKV, Rahuri
Date: / / 2019 **(Pallavi Dattatray Mali)**

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF ABBREVIATIONS

%	:	Per cent
/	:	Per
@	:	At the rate of
^{0}C	:	Degree Celsius
AFBW	:	Average Final Body Weight
ADG	:	Average Daily Gain
ADFI	:	Average Daily Feed Intake
A.I.	:	Artificial Insemination
ALE	:	*Azadirachta indica* leaf extract
AZD	:	*Azadirachta indica* decoction
b	:	Bird
CD	:	Critical difference
CRD	:	Completely Randomized Design
d	:	Days
d.f.	:	Degrees of freedom
DM	:	Dry matter
ENSC	:	Expeller neem seed cake
et.al.	:	And others
^{0}F	:	Degrees of farad
FCR	:	Feed conversion ratio
Fig.	:	Figure
g	:	Gram
GM	:	Garlic meal
GP	:	Garlic powder

HNSC	:	Hydraulic press neem seed cake
IBD	:	Infectious bursal disease
J.	:	Journal
Kg	:	Kilogram(s)
L	:	Liter
ME	:	Metabolized energy
Ml	:	Milliliter(s)
Mm	:	Millimetre
MPKV	:	Mahatma Phule Krishi Vidyapeeth
NKC	:	Neem kernel cake
NKM	:	Neem kernel meal
NSC	:	Neem seed cake
NLE	:	Neem leaf extract
NLM	:	Neem leaf meal
NLP	:	Neem leaf powder
NO.	:	Number
NS	:	Non significant
RMNS	:	Raw milled neem seed
RVD	:	*Rauvolfiavo mitoria* decoction
SBC	:	Soybean cake
SE	:	Standard error
SNSC	:	Solvent extracted neem seed cake
Sci.	:	Science
viz.,	:	Namely

ABSTRACT

"EFFECT OF SUPPLEMENTATION OF NEEM (*Azadirachta indica*) LEAF POWDER ON GROWTH PERFORMANCE AND CARCASS QUALITY OF BROILER"

By

Miss. Pallavi Dattatray Mali
A Candidate for the degree of
MASTER OF SCIENCE (AGRICULTURE)
in
ANIMAL HUSBANDRY
2019

Research Guide	:	**Dr. Y. G. Fulpagare**
Department	:	**Animal Husbandry and Dairy Science**

The present experiment entitled, "Effect of supplementation of Neem (*Azadirachta indica*) leaf powder on growth performance and carcass quality of broilers" was conducted at Poultry Unit, Veterinary Polyclinic and A.I, Center, Department of Animal Husbandry and Dairy Science, Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra.

Major objective was to study the growth and carcass quality of broilers by feeding neem leaf powder. The feeding trial of six weeks in broiler chicks (n=160) was conducted with four treatments and designated as treatment T_0, T_1, T_2 and T_3 respectively.

All the broiler chicks were fed with standard starter ration up to 21 days and finisher ration from 22 to 42 days of age as per BIS (1992) specification. The chicks fed with basal diet in control group (T_0), while chicks in treatment group T_1, T_2 and T_3 were fed with Neem leaf powder @ 0.5, 1.0 and 1.5% respectively. All the birds were given isocaloric and isonitrogenous diets throughout the experimental period. The data were analysed using General Linear Model procedure of statistical package for social sciences (SPSS) 15th version and means were compared using Duncan's multiple range test (1955) while significance level was considered at 5% ($p<0.05$).

The weekly body weight changes of chicks indicated no significant difference among various treatment groups during the first two weeks of the experiment. There was significant ($p<0.05$) difference among the treatments from third weeks onwards. However, at the end of the sixth week, significantly ($p<0.05$) higher body weight gain in the T_2 group was recorded. The treatment T_1 and T_3 were at par to each other.

The overall feed intake of the birds showed non-significant differences in all the treatment groups for the entire experimental period.

All treatments were non-significant up to second week's period. Statistically the significant ($p<0.05$) was observed in FCR from third to six weeks. Better FCR was recorded in T_2 treatment as compared to other treatments. However, treatment T_1 and T_3 were at par to each other.

The carcass characteristics data indicated no significant difference in the carcass traits (%) among treatment groups. The breast yield was highest in the treatment T_2 group. However, the difference among all the groups was non-significant.

The inclusion of Neem leaf powder in the broiler ration had non-significant effect on moisture, protein, fat and total ash content in breast and thigh tissues. However, a lower protein and higher fat content was observed in the thigh meat as compared to breast meat.

The Statistically no significant difference was noticed between organoleptic evaluation of meat of different treatments for different parameters viz. Appearance and colour, flavour and overall acceptability.

On the basis of results, it was concluded that treatment T_2 which is 1% inclusion of neem leaf powder was significantly superior over other treatments.

1. INTRODUCTION

1.1 Background Information

India has 60% rural population depending on agriculture. Among the many sectors of agriculture, livestock sector is gaining momentum in India and within livestock sector poultry occupies premium position. Today poultry industry is one of the fastest growing segments of the agricultural. The production of eggs and broilers is rising at a rate of 1.5 to 2% per annum while the poultry industry is rising at a rate of 8% per annum.

India has emerged on world's poultry map as 3rd largest egg (74 billion eggs) and 7th largest chicken producer. Organized sectors of Indian poultry industry accounts for nearly 70% and the rest of 30% in unorganized sector to total poultry output in the country. About 3.4 million tons (74 billion) of eggs are produced from 260 million layers and 3.8 million tons of poultry meat is produced from 3000 million broilers per annum in India. Poultry processing has also gone up to 20 per cent of total broiler production.

Today poultry farming is one of the profits making agro based sector since it provides continuous flow of income round the year by sale of egg and meat, which has increased many folds since last few years. With the rise of middle class and increased urbanization, a major population prefers to go for non-vegetarian. Poultry is major source of meat in India. The chicken meat is most commonly consumed meat source in India and the world due to its affordability and perceived health benefits such as low in cholesterol and fat and rich in protein and other micronutrients compared to other meats (Bhalerao *et al*., 2014). India ranks fifth in broiler production and the per capita consumption of meat is 2.4 kg which is far below than the recommended consumption of 11.00 kg (Athale *et al*., 2010). Hence, the Indian poultry industry has large scope to expand broiler sector. Broiler sector in India may attain the maximum growth rate if we encourage the production of quality chicken meat, kipping in mind the health benefits for the consumer and the health of the birds, in addition to improvement of the chicken meat yield with good feed efficiency.

Today 3 million farmers and 15 million agrarian farmers are employed in the poultry industry that are usually growing poultry ingredients for feed and contribute about 26,000 crore to the national income. The domestic broiler meat demand is expected to grow at around 15-18 per cent, while table egg demand is expected to grow at 5-7 per cent in medium to long term. Indian poultry industry is growing at an estimated rate of 8-10 per cent per annum for egg and 15-20 per cent for chicken. India's contribution to world's egg production is 4% and chicken production is 2%, whereas poultry sector contributes 3.0 per cent to national GDP and 10 per cent of total livestock GDP (Saxena, 2009).

The magnificent expansion of industry is also due to the fact that it provides the main source of animal protein through meat and eggs at cheaper rate as compared to other sources of

animal protein, low maintenance cost and minimum space requirements, broilers adapt easily to almost any condition and profits are quite high. In a developing country like India, poultry plays an important role in improving nutritional status of masses, which are mostly suffering from malnutrition due to inadequate and inferior quality protein in their diet and augmenting the income of weaker sections. While meat of chicken is having low cholesterol level; it is the best from health point of view. The whole concept of poultry farming during the last two decades or so has undergone a sea change. The poultry industry has now emerged as a highly structured and market-oriented enterprise. Thus, the major objective of poultry farming is to increase the profit margin in poultry business by improving feed efficiency and growth rate.

1.2 Importance and Need of study

Poultry feed comprises of 70-80% of the total cost of poultry enterprises. Thus, optimizing the utilization of feed is key to sustainable and profitable poultry production. The present trend in broiler production is to offer diets containing number of feed additives and feed supplements. These are used to feed broiler birds for the purpose to increase in body weight gain, improve feed conversion ratio (FCR) and improve immune system and obtain maximum returns in shortest possible time with increased production of quality meat at lower cost is need of the day.

However, some feed additives like hormones, antibiotics and others have residual effect. They leave their residue in meat and egg. Also, these feed additives are most expensive. To avoid the harmful effects of feed additives, growth promoters or antibiotics on human body due to its indiscriminate use, the nutritionist all over the world are trying to find the phytogenic feeds additives for betterment in production. The plant origin compounds incorporation into animal feed to enhance livestock productivity through the improvement of digestibility, nutrient absorption and elimination of pathogens residents in the animal gut (Athanasiadou *et al*., 2007). Phytogenic feed additives include medicinal plants/ herbs, which are non-woody flowering plants know to have medicinal properties; spices which are herbs with intensive smell or taste, commonly added to human food; essential oils, which are aromatic oily liquids derived from plant materials such as flowers, leaves, fruits and roots. The oleoresins, which are extracts derived by non-aqueous solvents from plant material (Jacela *et al*., 2010). The consumption and demand for medicinal plants as phytogenic substances have been adopted in many countries because of low cost, easy availability, affordable, improving performance, growth rate and weight gain in birds (Lewis *et al*., 2003). The scientist and researchers are trying to combat against fatal diseases in poultry through the use of medicinal plants, containing active ingredients to promote growth, weight gain and immune-stimulant. Among all these, herbal feed additives are better for feeding of broilers to improve weight gain, feed efficiency and feed intake. These feed additives having several types of flavor which can be added to feed to enhance or mask the

natural flavor characteristics of feed and thus improve the palatability. These herbal feed additives have no side effects on the health of birds.

Many plants have beneficial multifunctional aspects which are derived from their specific bio-active components (Kamel 2000). The evergreen *Azadirachta indica* is commonly known as Neem. It is non-leguminous multipurpose tree belongs to family Meliaceae and widely distributed in Asia, Africa and other tropical parts of the world (Sombatsiri *et al*., 1995). All the parts of neem tree are used. The mature tree of neem plant can produce 350 kg of leaves a year, which may be used for feeding cattle during famines. Neem leaves are chemically composed of proteins, fiber, ether, ash and other compounds. Neem leaves contain crude protein 15.8%, crude fiber 14.6 %, Ether Extract 8.5%, Ash 4.5%, Moisture 13.0%, NFE 56.6% (Bonsu *et al.,* 2012). These percentage vary from one place to another. More than one hundred and thirty-five bio-active compounds have been isolated from different parts of neem trees including azadichtin, meliacin, gedunin, salanin, nimbin, valassin, sodium nimbolide, cyclic trisulphides etc. The neem leaf exhibits a wide range of pharmacological activities *viz*., anti-inflammatory, anti-hyperglycaemic, anti-ulcer, anti-malarial, anti-fungal, anti-bacterial, anti-viral, anti-oxidant, anti-mutagenic, immunomodulatory and various others properties without showing any adverse effects (Supriya and Nagini 2005). Therefore, traditionally neem was used by Indians for treatment of a number of health conditions such as parasitic infections and reduction of plasma cholesterol levels. After the oil has been pressed out from the seeds of neem, the cake is used as feed. Upto 10% neem cake may be included in concentrates for cattle and up to 5% for poultry (Kudke *et al*., 1999).

Research has shown that neem will boost the immune system by stimulating the production of T-cells when challenged with infections (Upadhyay, 1990). The role of medicinal plants in disease prevention or control has been attributed to antioxidant properties of their constituents, usually associated to a wide range of amphipathic molecules, broadly termed polyphenolic compounds. Neem leaves contain appreciable amounts of proteins, minerals, carotene and adequate amount of trace minerals (Ogbuewu *et al*., 2010).

Phytogenic feed additives are useful as growth promoters, improve the nutrient digestibility and helps the birds to fight stress arising due to various factors. Ban or time bound decline in use of antibiotic growth promoters provides good scope for other growth promoters including herbal preparations for their use. The growth promotion activity of phytogenic feed additives in poultry production is due to their effects of improving the digestibility of nutrients, improving the gut microbiota, antioxidation property contributing to reducing the oxidative stress, immunomodulation, improvements in body weight, body weight gain, feed intake, feed conversion ratio and carcass characteristics. These phyto feed additives are either applied in solid powder, granulated or in liquid forms. Solid PFAs are usually incorporated in premixtures or

complete feed. Liquid PFAs are suitable for drinking water as well as for spray application to hydro-thermally processed feed, such as pelleted or extruded diets.

There are various herbs known for their effect on gut health. They have a complex mode of action on various organs or systems due to active ingredients present in them. They are supposed to have greater impact on different factors which promote growth and health, by improving physiological and immunological functions of body. Thus, they can be considered as more sustained and long-term solutions.

Herbal growth promoters due to their multidirectional actions are also useful in controlling pathogenic bacteria without possibility of development of resistance and are also safe for animals and humans. In such manner they can work as herbal antimicrobial agents with other advantages like more economical, free from possibility of resistance, maintaining normal functions, improving production performance in broilers, improving egg size, lymphocyte percentage and egg weight in layers (Reddy *et al*., 2002 and Shon *et al*., 2002). Herbal feed additive is economical, without side effect, while other additives may produce adverse effects like stress, toxicity, reduction in growth rate and finally immune suppression. Hence, herbal products can be safely used in poultry rearing.

Poultry meat is rich source of animal protein. Due to ever increasing demand of meat in India, poultry industry growth is at accelerating speed. This results in continuous stress on birds. Thus, the herbal growth promoters for poultry can create optimum condition for normal vigorous growth by acting in various ways. The successful use of herbal growth promoter will fetch more profit to poultry farmers by efficient conversion of feed consumed to body constituents. The dietary use of herbal growth promoter increases the performance of broiler by increasing live weight gain, Feed conversion ratio (Prasad and Sen, 1993 and Samarth *et al*., 2002). The potential efficiency of PFAs to improve overall meat quality attributes such as carcass yield, dressing percentage, fillet and tender yield, organoleptic cooked meat parameters and the overall palatability and acceptability of meat is another area of scientific researcher. Beneficial effects of dietary supplementation with PFAs on meat quality traits are mainly attributed to the anti-oxidative properties of phytogenic compounds. Breast meat is more tender and thigh meat is juicier as compared to the control and Antibiotic Growth Promoters groups (Hong *et al*., 2012). Phytogenic additives also use as colouring in laying hens to affect the egg yolk colour.

In recent years phytogenic feed additives widely used as feed additives for enhancing growth, reducing feed cost by improving feed efficiency and for building better immunity. They also influenced the secretion of digestive juices and enzymes, changes the internal morphology, improvements in nutrient utilization and consequently a higher level of performance. Neem tree has wide range of medical traits like bacterial, antivirus, hepatoprotective, antifungal, antiprotozoal and different others traits without side effects (Kale *et al*., 2003). Neem dry leaves

powder as medical herbs could be beneficial in immunosuppressant disease of poultry. Then poultry feeding neem leaves acts as an effective immune modulator by rising the cellular and humoral immune responses (Sadekar *et al*., 1998). Low dose of neem leaves powder has an inhibitory action on wide spectrum of microorganisms (Talwar *et al*., 1997) and immunomodulator actions that induce cellular immune reaction (Devakumar and Suktt, 1993). Neem leaf and their components have antiviral properties (Mahejabin *et al*., 2015). The medicinal plants could be used as an alternative to antibiotics as growth promoters, neem leaf powder has the potential effectively to improve the growth of broiler (Alam *et al*., 2015).

Hence, considering the vast benefits of the neem the present study entitled as "Effect of supplementation of neem (*Azadirachta indica*) leaf powder on growth performance and carcass quality of broiler with following objectives is undertaken:

1. To study the growth performance of broilers feed with neem leaf powder
2. To assess the feed conversion ratio
3. To study the carcass parameters of broilers

2. REVIEW OF LITERATURE

Neem (*Azadirachta indica*) leaf powder used by many researchers in laboratory animals and human beings to examine its antibacterial, antifungal, antiviral, antioxidant, antiparasitic, antithrombotic, anti-cancerous and vasodilator characteristics. However, as reviewed from the literature, very few workers have conducted experiments to examine its effect on body weight, immune status and carcass characteristics of broilers. Hence, the references related with species other than birds were also included in the reviewed literature on following parameters:

2.1 Body Weight and Weight Gain

2.2 Feed Intake

2.3 Feed Conversion Ratio

2.4 Carcass Quality

2.5 Proximate Composition of Meat

2.1 Body Weight and Body Weight Gain

Esonu *et al*. (2006) conducted feeding trial to evaluate the effects of Neem (*Azadirachta indica*) leaf meal on body weight gain, carcass and organ characteristics and haematological values of laying hens. Neem Leaf Meal did not show any appreciable difference in weight gain between the birds at 0% and those at 5%, 10% dietary levels.

Manwar *et al*. (2007) studied the effect of *Azadirachta indica* leaf powder supplementation on broiler performance. The neem leaves powder was supplemented to broiler chickens to the basal ration @ 1g/kg feed (T_2), 2g/kg feed (T_3), 3g/kg feed (T_4), whereas the T_1 was control. At the end of sixth week, all the treatment groups (T_2 -1583.88 ± 49.36, T_3-1611.73±47.97 and T_4-1567.34±47.97) weighed significantly higher than the control (T_1 -1385.25 ±58.75).

Durrani *et al*. (2008) studied growth promoting and immunomodulatory effects of neem leaves infusion on broilers. 160-day-old chicks were randomly divided into groups A, B, C and D. Birds of group A, B and C were given 4% concentrated neem leaves (*Azadirachta indica*) infusion @ 30 ml, 40 ml and 50 ml per liter of fresh drinking water respectively and group D was kept as control. Resulted group C had significantly ($p<0.05$) higher body weight gain and feed conversion ratio.

Onyimonyi *et al*. (2009) investigated the performance and economic indices of broilers fed varying dietary levels of sun-dried neem leaf meal (NLM). Birds were assigned to five treatment groups in which NLM incorporated at 0, 0.5, 1.0, 1.5 and 2% for treatments 1, 2, 3, 4 and 5 respectively. Results showed that treatment effect on Average Final Body weight (AFBW), Average Daily Gain (ADG), Average Daily Feed Intake (ADFI), and Feed Conversion Ratio

(FCR) were significant ($p<0.05$). Birds on the 0.5% NLM had significantly ($p<0.05$) superior Average final Body weight, Average daily gain and Feed conversion ratio.

Wanker *et al*. (2009) conducted experiment on 120-day old broiler chicks divided into four groups, T_0, T_1, T_2 and T_3 which were supplemented with neem leaf powder @ 0 gm, 1 gm, 2 gm and 3 gm/kg of broiler ration respectively. All the treatment groups T_1 (813.03), T_2 (855.07) and T_3 (834.21) recorded significantly ($P<0.01$) higher means for live body weight than that of control T_0 (768.69) group. All the treatment groups showed non-significant increase in weekly gain in weight, feed consumption and feed efficiency as compared to that of control group.

Landy *et al*. (2011) examined the effect of different levels of neem (*Azadirachta indica*) in comparison with an antibiotic (flavofolipol) on humoral immune response of broiler chicks. 192 one-day-old broiler chicks (Ross 308) were weighed and randomly assigned to the 4 treatment groups. Treatment group 1 as basal diet (control), treatment group 2 basal diet + antibiotic (4.5 mg flavofosfolipol/kg diet), 3 basal diet + neem fruit (7 g/kg diet) and 4 basal diet + neem fruit (12g/kg diet) were fed to broilers. They showed a significant decline in the average of body weight when adding powder neem leaves at a rate of 7g and 12g per kg to broiler diet at age 42 day.

Zanu *et al*. (2011) conducted feeding trial to evaluate the effects of Neem (*Azadirachta indica*) decoction (AZD) and Akakapenpen (*Rauvolfiavo mitoria*) decoction (RVD) on body weight gain, carcass and organ characteristics and haematological values of broiler chickens. The total replacement of antibiotics and coccidiostat resulted in non-significant depression ($P<0.05$) by in final body weight and weight gain in experimental birds. Feed intake was slightly affected ($P<0.05$) by administration of RVD to broilers. There was no significant effect of neem decoctions on water intake, feed conversion efficiency and mortality.

Adeyemo *et al.* (2012) investigated the combined effects of neem and pawpaw leaves supplementation on performance and carcass characteristics of broiler chickens. Broiler chickens were randomly allocated to the diets T_1 (0% leaf meal), T_2 (0.5% NLM), T_3 (2% PLM), T_4 (0.5% NLM + PLM), T_5 (1% NLM + PLM) and T_6 (2% NLM + PLM). Resulted body weight gain and feed conversion ratio of the broiler chickens improved in treatments fed diets supplemented with leaf meal and there were no significant ($p>0.05$) differences.

Ansari *et al*. (2012) evaluated three different levels of *Azadirachta indica* dried leaf meal, using diets supplemented with 0 (negative control), 1.25 g antibiotic/kg (positive control) 1.25, 2.5 and 5.0 g leaf meal per kg of feed. At both 28 and 42 day, birds fed diets supplemented with 2.5 g per kg of leaf meal had significantly higher Body Weight and better Feed Conversion Ratio. There was no significant ($P>0.05$) difference between Body Weight and Feed Conversion

Ratio when birds fed diets 1.25, 5.0 g per kg of leaf meal and antibiotic (positive control) at any age. There was no significant (P>0.05) effect on mortality at any time during the study.

Khatun *et al*. (2013) studied the efficiency of Tulsi (*Ocimum sactum*) and Neem (*Azadirachta indica*) leaves extract as a growth promoter in broilers. A total of 40-day-old broiler chicks were randomly divided into four groups A, B, C and D. Group A served control without any supplements while group B, C and D were supplemented with combination of tulsi and neem extract @ 1 ml, 2 ml and 3 ml per litre of drinking water. Concluded that supplementation 1-3 ml of tulsi and neem leave extract per kg poultry increase in live body weight and improvement in weekly gain in weight and feed efficiency as compared to that control group of poultry.

Olabode *et al*. (2013) studied the influence of supplemental neem leaf meal on the performance of laying birds. Feeding trial reported reduced live body weight (1.853-2.000 kg) in birds fed NLM diets at 2.0, 4.0, 6.0 and 8.0% compared to the control value (2.103 kg) fed 0% NLM.

Ozung *et al*. (2013) studied the effect of utilization of neem leaf on growth, carcass characteristics and internal organs of broilers fed in diets. They observed reduced (P<0.05) Feed Intake and daily weight gain in broilers fed 10 and 15% NLM diets.

Nnenna *et al*. (2013) studied the toxicity and effects of aqueous *Azadirachta indica* leaf extract (ALE) on the performance, haematology and serum biochemistry parameters of broiler chicks. 144-seven-day old broiler chicks were randomly assigned to 4 treatments which contained 0, 20, 40 and 60 ml ALE per litre of water representing T_1, T_2, T_3 and T_4 respectively. There was no significant (P>0.05) difference in weight gain, feed and water intake, feed conversion and protein efficiency ratios among the treatment groups. Also, no significant (P>0.05) effect was observed in the survival of birds treated with ALE and the control.

Kharde *et al*. (2014) conducted an experiment to study the effect of supplementation of garlic and neem leaf powder (NLP) on growth performance and carcass yields in broilers. Supplementation of garlic powder (GP) and NLP in broiler diets have significant (P<0.05) influence on body weight gains from 1^{st} to 6^{th} weeks of age. No Significant (P>0.05) influence was observed in carcass parameters like dressing yield and giblet yield (heart, gizzard and liver) in all treatment groups.

Sarkar *et al*. (2014a) studied the comparative growth promoting efficiency and haematological parameters in growing broilers fed with probiotics, neem leaves and vitamin AD_3E in normal broiler ration observed that probiotic, neem and vitamin AD_3E preparation enhanced the growth broilers. The body weight was significantly increased (p<0.01) in the treated groups in comparison with that of control group.

Sarkar *et al*. (2014b) studied the efficiency of aqueous extract of Neem leaves against Colibacillosis and as a growth promoter in broilers. Results showed that Broilers supplemented with 1% Neem leaves extract (group B, C and D) gained the significantly higher ($P<0.001$) live weight (2165.0 + -97.2, 2190 + -73.8 and 1978.1 + -104.8 g respectively) compared to untreated control regardless of colibacillosis induction.

Alam *et al*. (2015) studied effect of neem (*Azadirachta indica*) leaf powder supplementation on growth in broilers. The supplementation of neem leaf powder (1-3 gm/kg) in I_1, I_2 and I_3 groups of broilers significantly ($P<0.01$) increase mean live body weights as compared to control (I_0) group. The weekly weight gain, feed consumption and feed efficiency of all treated groups were non-significant compared to that of control group.

Ayoola *et al*. (2015) feeding trial was conducted to investigate the effect of neem (*Azadirachta indica*) leaf meal on the growth performance and carcass traits of broiler chickens. The experimental birds were randomly distributed into 4 treatments. Birds in treatment first as control group while other 0.1, 0.2 and 0.3% levels of inclusion. There was a significant ($p<0.05$) effects of varying dietary inclusion of NLM on average weight gain among the birds at starter phase. Groups fed 0.3% NLM recorded the highest average weight gain. Neem leaf meal had no significant ($p>0.05$) effect on broiler performance at the finisher phase across the treatment groups.

Mahmud *et al*. (2015) studied the growing performance of Japanese quails fed graded levels of Neem (*Azadirachta indica*) leaf meal. One hundred and twenty Japanese quails (*Coturnix coturnix Japonica*) were randomly allotted into four dietary treatments. Sun-dried neem (*Azadirachta indica*) leaf was used at 0, 5, 10 and 15 percentage respectively. There were no significant ($p>0.05$) difference in the body weight gain and other carcass traits.

Mahejabin *et al*. (2015) conducted trial to determine the efficacy of mixture of neem, turmeric and papaya leaf extract on growth performance of broilers. Broiler in group A reared as control while group B was supplemented with 2% neem, turmeric and papaya leaf extract @ 1 ml per litre of drinking water. Reported the use of neem leaves led to an increase in the rate of body weight and feed conversion efficiency.

Rahman *et al*. (2015) study was conducted to determine the effects of neem leaf and ginger extracts as a growth promoter of broiler. A total of 40-day-old broiler chicks were divided into 4 groups *viz*., I_0, I_1, I_2 and I_3 which were supplemented with a mixture of extracts from neem leaf and ginger @ 0 ml, 1 ml, 2 ml and 3 ml per litre of drinking water respectively. Study revealed that the maximum weight gain was observed in group I_3 where birds were treated with 3 ml of combined herbal extract per litre drinking water.

Bwana *et al*. (2016) studied the role of aqueous suspensions of Neem (*Azadirachta indica*) and Stinging Nettle (*Urica dioca*) powders fed in drinking water on the growth

performance of indigenous chicken. Birds were randomly allocated into three groups. Group 1 and 2 were treated with aqueous suspensions of Neem and Stinging Nettle powders respectively in drinking water while group 3 served as control. The neem and stinging nettle powders were reconstituted at a rate of 10g per litre of water, boiled, filtered and fed in their crude forms. The birds fed with neem group recorded highest weight gain (510.75 g) as compared to Stinging Nettle (483.25 g) and Control groups (383.5 g). Also, the neem group had the highest weekly weight gains (64 g/week) compared to the Control (47.9 g/week) and Stinging Nettle (60.4 g/week) groups.

Ibrahim *et al*. (2016) conducted experimental to explore the effect of different levels of Neem (*Azadirachta indica*) Seeds powder and aqueous extract on performance of production of the Broiler chickens. Birds were divided to seven treatment groups. Treatment T_1 as control without any addition, T_2, T_3, T_4 supplemented with powdered seeds of the neem to diet at 1.5, 2 and 2.5g/kg of diet respectively. Treatments T_5, T_6 and T_7 supplemented extract of the seeds neem to drinking water by 20, 30 and 40 ml/liter of water respectively. The resulted that to add different levels of powder and extract the seeds of neem leaf to feed or drinking water were not significant affect the rate of live body weight.

Nodu *et al*. (2016) evaluated the effect of neem leaf extract on growth, haematology and biochemical profiles and organs weight of broiler chickens to justify its inclusion in the diet of growing broiler chickens. 120-day-old chicks divided into 4 treatment groups T_1, T_2, T_3 and T_4, thirty birds each were administered clean drinking water with 0 g, 3 g, 4 g and 5 g neem extract respectively. Suggested Neem extract favoured significantly different final body weight range between 2447 and 2620 g, total weight gain and weekly weight gain. T_2 with 3 g of Neem extract in their drinking water organ weights out performed birds in other treatments with the best values for final weight (2620±0.67 g), weight gain (1900±0.13 g), weight gain per week (475±0.10 g) lowest total Feed Intake (700 g in total), best Feed Conversion Ratio (3.68) and Feed Consumption efficiency (27%). Organ weight showed no deviation from standard values for healthy broiler birds. Bird on 3 g of neem extract in their drinking water out performed birds in other treatments in assessed growth rate indices

Unigwe *et al*. (2016) conducted experiment to study the effect of neem (*Azadirachta indica)* leaf meal on growth performance and haematology on rabbits. A twenty-four (24) weaner rabbits (Chinchilla x New Zealand White) aged 8 to 9 weeks were randomly allocated to four treatment diets of T_1 (Control), T_2 (5% NLM), T_3 (10% NLM) and T_4 (15% NLM) in completely randomized design. The results showed that the average total body weight gains were 739.60 g (T_1), 717.85 g (T_2), 740.18 g (T_3) and 729.45 g (T_4). There was no significant difference ($p>0.05$) when T_1 and T_3 as well as T_2 and T_4 were compared but significant ($p<0.05$) when T_1 and T_2 as well as T_3 and T_4 were compared.

Sobayo *et al*. (2016) investigated the effects of feeding diets containing neem leaf meal (NLM) and garlic meal (GM) and their combination (NLM + GM) on growth performance and carcass yield of finishing broiler. Broiler chickens fed diet contained NLM, GM and NLM + GM at four levels of inclusion (0 mg/kg, 500 mg/kg, 1000 mg/kg and 1500 mg/kg). Resulted final live weight, weight gain, daily weight gain and feed conversion ratio were improved ($p<0.05$) at 1500 mg/kg levels of inclusion of NLM + GM.

Ihsan *et al*. (2017) experiment was conducted to study the impact of supplementation neem powder (*Azadirachta indica*) to diet broiler in immunological, physiological and productive traits of broiler. Birds distributed in treatments, treatment T_1 was control received basal diet, treatments T_2, T_3, and T_4 received 1 g, 2 g and 3 g neem powder per kg to diet. Results showed there were significant differences in body weight among treatments. Results showed broiler fed neem leaf powder 2 g per kg was highly significant ($p<0.05$).

Beg *et al*. (2018) work aimed at studying growth performance, carcass traits and health status in broiler chicken fed on dietary Neem (*Azadirachta indica*) leaf meal (NLM) over a period of 4 weeks, Day old broiler chicks (180) were randomly assigned to six treatment groups, the last treatment was designed as control (T_6) in which contain antibiotic supplement with feed, while in treatments T_1, T_2 and T_3, T_4 NLP was provided as 1%, 1.5%, 2.0% and 2.5% of feed respectively. The results revealed a significant ($P<0.05$) decrease in feed intake (2101 g and 2104 g) at 4 weeks in T_3 and T_4 group bird, but produced live weight (1708 g and 1712 g) which had no significant ($P>0.05$) difference with birds consumed highest amount of feed. Neem treated groups showed significantly ($P<0.05$) higher live weight (43.67 to 46.67 g) than antibiotic group (31.0 g).

Dhumal *et al*. (2018) evaluated the performance of broiler, meat quality and immune status by supplementation of essential oils. Observed birds receiving diet supplemented with neem essential oil at different dose levels did not show any improvement in the growth. The non-significant influence on body weight gain of broilers supplementation with neem oil. Cumulative feed consumption revealed decreasing trend for garlic and neem essential oil supplemented treatment groups.

Ubau *et al*. (2019) evaluated the effect of dietary inclusion of neem leaf meal (NLM) on growth performance and carcass characteristics of broiler chickens. The birds were randomly allotted to four dietary treatments T_1, T_2, T_3 and T_4 fed diet containing NLM at inclusion levels 0, 2.5, 5 and 7.5%. Resulted at the starter phase, average final weight and total weight gain were not significantly ($p>0.05$) affected by dietary treatments. At the finisher phase, the average total weight gain and daily weight gain were significantly ($p<0.05$) influenced by dietary treatments.

2.2 Feed Intake

Deore *et al*. (2005) study was undertaken to determine the beneficial or toxic effects of neem oil supplementation in broiler rations, with special emphasis on general condition, haematology and biochemical parameters at 0.5, 1.0, 2.0, and 5% levels of feed. Supplementation of neem oil resulted birds exhibited poor performance and lower down the feed consumption and lower the body weights.

Akpan *et al*. (2008) studied the effects of dietary Neem (*Azadirachta indica*) leaf extract on the performance of laying hens. Three white maize-based experimental diets were made such diet 1 (control) contained no NLE while diet 2 and 3 contained 2.5 and 5% NLE respectively. It was observed that average daily feed intakes of birds (101.3 g, 104.8 g and 104.5g) were not affected by treatments ($p>0.05$). The groups on NLE diets lost weight. Feed conversion ratio were not affected by treatments ($p>0.05$). The weight of the internal organs was not affected by the treatments ($p>0.05$) but NLE tended to deplete blood hemoglobin.

Durrani *et al*. (2008) investigated the growth promoting and immunomodulatory effects of neem leaves infusion on broilers. One hundred- and sixty-day-old chicks were randomly divided into groups A, B, C and D. Birds of group A, B and C were given 4% concentrated neem leaves (*Azadirachta indica*) infusion @ 30 ml, 40 ml and 50 ml per litre of fresh drinking water respectively and group D was kept as control. Observed significant decrease in the amount of feed intake and water intake.

Landy *et al*. (2011) experiment was conducted to examine the effect of different levels of neem (*Azadirachta indica*) in comparison with an antibiotic (flavofolipol) on humoral immune response of broiler chicks. Treatment group 1 as basal diet (control), treatment group 2 basal diet + antibiotic (4.5 mg flavofosfolipol/kg diet), 3 basal diet + neem fruit (7 g/kg diet) and 4 basal diet + neem fruit (12g/kg diet) were fed to broilers. They found that there was no significant difference between treatments in feed intake when addition of 7 g and 12 g per kg of neem fruit to broiler diet at age of 42 day.

Khan *et al.* (2014) study was undertaken to ascertain the effect of neem seed cake (NSC) in ration on the growth, carcass and feed efficiency of broilers. Birds were divided into four groups, group A was kept as control (without NSC) and broilers in groups B, C and D were fed on ration with NSC at level of 0.5, 1.0 and 1.5% per kg of feed, of NSC in broiler ration. The results showed that all the parameters were significantly ($p<0.01$) different due to inclusion of NSC in broiler ration. Broiler in group A consumed high feed quantity and it was decreased significantly in group C when birds were fed to 1% level of neem seed cake. Better weight gain (1940 g/bird) and Feed Conversion Ratio (1.94) was recorded group C, fed on ration containing neem seed cake at 1%.

Kumari *et al*. (2014) study was planned to investigate the effect of sugar beet, neem leaf, linseed and coriander on growth performance and carcass characteristics in broiler birds. Result showed broilers supplemented with herbs/spices improvement in growth attribute and carcass characteristics. Broilers fed with herbs at the rate of 2.5% had higher feed intake except sugar beet and coriander seed meal fed group. The body weight and weight gain were also significantly ($p<0.05$) higher than control. Both FCR and performance index were improved in supplemented groups in comparison to control.

Wiryawan *et al*. (2014) evaluated the effects feeding graded levels of Neem (*Azadirachta indica)* leaf meal (NLM) on Feed consumption, weight gain and Feed conversion of broiler. Broiler chickens allotted to dietary treatments P_1 (control), P_2 (supplemented with antibiotics/sulfamix), P_3, P_4, P_5 and P_6 were respectively supplemented with 1, 3, 5 and 7 % Neem leaf meal (NLM). No significant difference ($p>0.05$) in weekly feed consumption and feed conversion ratio. The weekly body weight gains of chickens fed on diet supplemented with 5 and 7 % NLM were significantly lower ($p>0.05$) than those fed on diet supplemented with 3% NLM but not different from control and those fed on diet containing sulfamix.

Singh *et al*. (2014) studied growth pattern and carcass traits in pearl grey fowl fed on dietary Neem (*Azadirachta indica)* leaf powder (NLP). Day old guinea fowl kneets were randomly assigned to four treatment groups. The first treatment was designated as control (T_0) while in treatments T_1, T_2 and T_3 was provided neem leaf powder as 1, 2 and 3 g per kg of feed respectively. The results showed that the supplementation of NLP significantly increased feed intake ($p\leq0.05$) which might be due to the hypoglycaemic activity of Neem. Also, significant increase was found in the feed conversion ratio (FCR) of the treated groups over the control group. Also demonstrated the beneficial effects of supplementing NLP on body weight gain and dressed yield in the treated groups in guinea fowl.

Mahmood *et al*. (2016) the intent of study was to investigate the comparative effect of *Azadirachta indica*, *Moringa oleifera* and *Cichorium intybus* leaf extracts on growth performance, immune response and carcass characteristics of broilers. 120-day old broiler chicks selected and were randomly divided into four experiment groups A, B, C and D. Group A was offered drinking water without any supplementation (control). Whereas groups B, C and D were offered drinking water supplemented with leaf extracts of *Azadirachta indica*, *Moringa oleifera* and *Cichorium intybus* @ 50 ml L^{-1}, 30 ml L^{-1} and 10 ml L^{-1} respectively. Results showed the highest feed consumption and body weight gain was observed in the birds of group B fed with *Azadirachta indica* @ 50 ml L^{-1}.

Obikaonu (2016) evaluated the nutritional value of Neem (*Azadirachta indica*) leaf meal on the performance and economics of deep litter managed finisher broiler production. Neem leaf meal included in the broiler finisher diets at 0, 2.5, 5.0, 7.5 and 10% levels respectively. The

birds were divided into 5 groups. Body weight gain of the treatment birds decreased significantly ($p<0.05$) as the level of neem leaf meal increased. Feed conversion ratio and protein efficiency ratio were also affected by the treatments ($p<0.05$). The average total feed intake increased with increase in the level of leaf meal inclusion with 10% having the highest value. No mortality was recorded in all the treatment during the trial.

Khulbey *et al*. (2016) conducted experiment on 180-day-old broiler chicks to evaluate the effects of neem (*Azadirachta indica*) and kadi (*Murraya koenigii*) leaf powder on the growth performance and nutrient utilization. The six dietary treatments included control (T_1), basal diet supplemented with leaf powder @ 0.2 % neem (T_2), 0.2% kadi (T_3), 0.1% kadi and 0.3% neem (T_4), 0.3 % kadi and 0.1% neem (T_5) and 0.2% kadi and 0.2% neem (T_6). The overall feed intake was found to be higher ($p<0.05$) in kadi (0.2%) and neem (0.2%) leaf powder supplemented groups.

Mahmud *et al*. (2016) evaluated the effects of neem (*Azadirachta indica*) leaf meal on performance of laying quails. Four layers diet were formulated to contain leaf meal at 0%, 5%, 10% and 15% of overall diet. Observed significant ($p<0.05$) difference in feed intake. The higher feed intake recorded by quails on the NLM diet (T_1 (5%), T_2 (10%), T_3 (15%)).

Egbeyale *et al*. (2018) conducted feeding trial to determine the growth performance, nutrient digestibility and carcass characteristics of broiler chicks fed diets containing neem (*Azadirachta indica*) leaf meal at different periods. Birds in treatment 1 were fed control diet throughout the experiment, birds in treatment 2 were fed diet containing 0.5% neem leaf meal, birds in treatment 3 were fed diet containing 0.5% neem leaf meal for 3 d in a were, birds in treatment 4 were fed diet containing 1% neem leaf meal, birds in treatment 5 were fed diet containing 1% neem leaf meal for 3 d in a week. Results showed that at the starter phase, daily feed intake and feed conversion ratio were influenced ($p<0.05$) by the treatments. The feed intake was highest in birds fed diet containing 1.0% NLM throughout the experimental period while the other groups had similar values. The feed intake parameter among all the growth indices was significantly ($p<0.05$) influenced by the treatment was daily feed intake at the finisher phase.

Kyere *et al*. (2018) conducted the experiment to investigate the effect of neem (*Azadirachta indica*) leaf meal on growth performance and blood profile of pearl Guinea fowl. Four experimental diets formulated containing 0%, 3%, 6% and 9% neem leaf meal (NLM) were fed to pearl guinea fowls. Results from study showed that birds fed with 6% NLM gained significant ($p<0.05$) higher body weight, body weight gain, daily weight gain, total feed intake, daily feed intake and superior feed conversion ratio.

Pagrut *et al*. (2018) research was conducted to investigate growth promoting effects of neem leaves infusion on broilers. Birds of group-1, group-2 and group-3 were given 4%

concentrated neem leaves (*Azadirachta indica*) infusion @ 30 ml and 50 ml per litre of fresh drinking water respectively and group-3 kept as control. They reported significantly lower feed intake ($p>0.05$) and lower feed consumption. Group-2 had significantly ($p<0.05$) higher body weight gain.

Sonhafouo *et al*. (2019) study was designed to evaluate graded levels of neem seed oil on growth performance of broiler chickens. Study revealed that there was no significant ($p>0.05$) effect of neem seed oil on feed intake, weight gain and feed conversion ratio, when compared with the positive control ration supplemented with antibiotic Body weight gain markedly ($p<0.05$) reduced with neem oil whatever the dose in the ration.

2.3 Feed Conversion Ratio

Elangovan *et al*. (2000) investigated the feasibility of feeding neem kernel meal (NKM) containing diet to growing Japanese quails, which was incorporated into a standard quail diet at 0, 50, 75 and 100 g per kg in place of soybean meal and deoiled rice bran. Quails fed diets containing NKM irrespective of the level recorded significantly ($p<0.05$) lower body weight. The total feed intake and feed conversion ratio of birds in various dietary groups, however remained insignificantly ($p>0.05$) different from each other.

Sarag *et al*. (2001) studied effect of different levels of Neem (*Azadirachta indica*) oil in the performance of broilers. They use of Neem oil, at concentration of 0.25% in the diet. Chicken gave neem oil showed an increase in the body weight and feed conversion efficiency.

Bawa *et al*. (2007) conducted feeding trial to determine the effects of different methods of processing neem seeds on performance and carcass characteristics of Young Rabbits. Rabbits assigned to dietary treatments, treatment diet 1 (control) was a maize-groundnut cake-based diet without neem seed. Diets 2, 3, 4 and 5 has raw milled neem seed (RMNS), Hydraulic press neem seed cake (HNSC), Solvent extracted neem seed cake (SNSC) and Expeller neem seed cake (ENSC) included at 20% level respectively. Resulted final live body weight, feed intake of rabbits fed the experimental diets significant ($p<0.05$) difference across dietary treatments. Feed conversion ratio of rabbits fed the raw neem seed meal showed significant ($p<0.05$) difference compared to those fed the control diet.

Bonsu *et al*. (2012) studied medicinal response, haematological parameters and meat sensory analysis of broilers to diets containing neem leaf meal (NLM). Four starter diets and finisher diets were formulated to contain the NLM at 0%, 1.5%, 2% and 2.5% dietary levels and were fed ad-libitum in phases 1 and 2 respectively. Results showed that in both phases Body weight gain was significantly ($P<0.05$) depressed in birds fed the NLM when compared with the control which adversely affected the feed conversion efficiency.

Nayakka *et al.* (2013) experiment was conducted to study the efficiency of inclusion of neem, turmeric vitamin E and its combinations on performance and haematological parameters.

In the experiment basal diet was supplemented with *Azadirachta indica* (Neem 8g/kg feed), curcuma longa (Turmeric 2g/kg feed) and vitamin E (0.2 g/kg feed) individually and in combination. Results of study indicated that addition of neem either alone or in combination with turmeric and vitamin E to broiler diets induced significant growth depression in birds as compared to control diet.

Egbeyale *et al*. (2015) conducted feeding trial to evaluate the effects of neem (*Azadirachta indica*) leaf meal on growth performance and haematological parameters of broiler chickens. The neem leaf meal was included in fed at 0, 0.5, 1.0 and 1.5% as a replacement of wheat offal. The inclusion of levels of neem leaf meal reduced ($p<0.05$) growth performance of the birds of during starter phase but 0.5% NLM produced highest ($p<0.05$) final weight at finisher phase. The best values of feed conversion ratio (FCR) and protein efficiency were recorded in the control while other groups had similar values at starter phase. At finisher phase, the highest ($p<0.05$) weight gain was recorded from birds fed 0.5% NLM while the control and 1.0% NLM had similar ($p>0.05$) values. The Feed conversion ratio and protein efficiency were similar.

Trigueros *et al*. (2015) evaluated the productivity and composition of fatty acids in chicks fed diets enriched with neem *Azadirachta indica*, *Azadirachta juss* seed flour. 80 mixed broiler chicks of Arbor Acres stock and levels 0, 1, 2, 3 and 5% neem seed flour added to a commercial diet were evaluated. The greatest weight gain, consumption and best feed conversion were found in the treatment that contains 1% neem seed flour.

Kulbey *et al*. (2016) conducted experiment on 180-day-old broiler chicks to evaluate the effects of neem (*Azadirachta indica*) and kadi (*Murraya koenigii*) leaf powder on the growth performance and nutrient utilization. The six dietary treatments included control (T_1), basal diet supplemented with leaf powder @ 0.2 % neem (T_2), 0.2% kadi (T_3), 0.1% kadi and 0.3% neem (T_4), 0.3 % kadi and 0.1% neem (T_5) and 0.2% kadi and 0.2% neem (T_6). FCR (kg feed consumed/kg gain) improved ($p<0.05$) in all the treatments compared to control. Significantly ($p<0.05$) improved FCR was recorded in group T_6 (0.2% kadi and 0.2% neem).

Unigwe *et al*. (2016) conducted experiment to study effect of neem (*Azadirachta indica)* leaf meal on growth performance and haematology on rabbits. A twenty-four (24) weaner rabbits (Chinchilla x New Zealand White) aged 8 to 9 weeks were randomly allocated to four treatment diets of T_1 (Control), T_2 (5% NLM), T_3 (10% NLM) and T_4 (15% NLM) in completely randomized design. The results showed that the weekly feed intakes were 313.91 g, 313.24 g, 312.48 g and 314.69 g whereas the Feed conversion Ratio (FCR) were equally 4.24, 4.36, 4.22 and 4.31 for T_4, T_2, T_3 and T_4 respectively. The weekly feed intake had significant difference ($p<0.05$) across the treatments and similar to the FCR except between T_1 and T_3 ($p>0.05$).

Thomas *et al.* (2017) an experiment conducted to evaluate the effect of dietary supplementation of neem (*Azadirachta indica)* leaf powder (NLP) through feed on growth performance in Namakkal one Japanese quail for a period of 4 weeks. Neem Leaf Powder was supplemented at 0, 0.2, 0.4 and 0.6 per cent level in the basal quail feed. Result showed neem leaf powder supplemented at the level of 0.6 per cent significantly ($p<0.01$) higher body weight, body weight gain and better feed conversion ratio. Feed consumption showed no significant variation among the groups.

Abujradah *et al*. (2018) experiment was carried out to investigate the growth performance, haematological and serum biochemical response of caged broiler to probiotics, garlic and neem leaf powder. Combined supplements of T_6 with basal diet + probiotic + garlic + neem leaf @ 1 kg per ton of feed gave the best performance ($p<0.05$) in final body weight, weekly gain, weekly feed intake and feed conversion ratio.

Adeyemi *et al*. (2018) studied the effects of sundried neem leaf meal (NLM) on growth performance, shank pigmentation and blood profile of broiler chickens. One hundred- and forty-four-day-old chicks were randomly distributed after 1-week pre-experimental period to four experimental diets which comprised NLM at 0% (control), 5% (5 NLM), 10% (10 NLM) and 15% (15 NLM). Results showed for the starter phase, final weight, total weight gain and Feed Conversion Ratio were significantly influenced by NLM inclusion. Chicks fed control and 5 NLM diets had similar higher values than others. At the finisher phase, total weight gain and Feed Conversion Ratio were not significantly different with inclusion of NLM in the diets.

Egbeyale *et al*. (2018) conducted feeding trial to determine the growth performance, nutrient digestibility and carcass characteristics of broiler chicks fed diets containing neem (*Azadirachta indica*) leaf meal at different periods. Birds in treatment 1 were fed control diet throughout the experiment, birds in treatment 2 were fed diet containing 0.5% neem leaf meal, birds in treatment 3 were fed diet containing 0.5% neem leaf meal for 3 d in a week, birds in treatment 4 were fed diet containing 1% neem leaf meal, birds in treatment 5 were fed diet containing 1% neem leaf meal for 3 d in a week. Results showed that at the starter phase, feed conversion ratio was the influenced ($p<0.05$) by the treatments. The feed conversion ratio was poorest in the birds fed diet containing 1.0% NLM throughout the period while their counterparts on 0.5% NLM for 3 d in a week had the best results which was also similar to the response of birds fed 1.0% NLM for 3 d in a week.

Panday *et al*. (2018) carried out investigation on effects of neem (*Azadirachta indica*) leaves powder supplementation on performance and water intake of broiler chicken. The 200-day-old chicks were divided into four treatment groups, i.e. Group 1, 2, 3 and 4, each group having 50 chicks. These treatment groups were supplemented with neem leaf powder @ 0 g, 1 g, 2 g and 3 g per kg of broiler ration respectively. Average final live weight (kg/bird) and the daily

weight gain (gm/day/bird) were significantly higher in treatment group T_3 fed with 3g/kg neem leaf powder and the lowest FCR was found in groups of T_2 fed with 2g/kg neem leaf powder supplemented with broiler ration.

2.4 Carcass Traits

Elangovan *et al*. (2000) conducted experiment the feasibility of feeding neem kernel meal (NKM) containing diet to growing Japanese quails, which was incorporated into a standard quail diet at 0, 50, 75 and 100 g per kg in place of soybean meal and deoiled rice bran. They reported yield that various carcass traits such as eviscerated carcass, liver, gizzard and heart was almost comparable in all the dietary groups. Also feeding neem kernel meal not affected on acceptability meal of quails.

Esonu *et al*. (2006) conducted 12 weeks feeding trial to evaluate the effects of Neem (*Azadirachta india*) leaf meal on body weight gain, carcass and organ characteristics and haematological values of laying hens. They observed that carcass weight, dressed weight, liver, heart and gizzard weights were significantly ($P<0.05$) increased at 5% dietary level of NLM.

Bawa *et al*. (2007) feeding trial was conducted to determine the effects of different methods of processing neem seeds on performance and carcass characteristics of Young Rabbits. Rabbits assigned to dietary treatments, treatment diet 1 (control) was a maize-groundnut cake-based diet without neem seed. Diets 2, 3, 4 and 5 has raw milled neem seed (RMNS), Hydraulic press neem seed cake (HNSC), Solvent extracted neem seed cake (SNSC) and Expeller neem seed cake (ENSC) included at 20% level respectively. Resulted the difference among dietary treatments was non-significant ($p>0.05$) for the dressing percentage, lungs, liver and head (% yield) and length of small intestine (cm). However significant ($p<0.05$) difference was observed across treatments for pre-slaughter weight, carcass weight, heart, kidney, stomach, intestine, skin, feet, shoulder and thigh (% yield).

Durrani *et al*. (2008) study was conducted to investigate growth promoting and immunomodulatory effects of neem leaves infusion on broilers. One hundred- and sixty-day-old chicks were randomly divided into groups A, B, C and D. Birds of group A, B and C were given 4% concentrated neem leaves (*Azadirachta indica*) infusion @ 30 ml, 40 ml and 50 ml per liter of fresh drinking water respectively and group D was kept as control. Observed dressing percentage was significantly ($p<0.05$) higher in group C (50ml/ L water) than others. Weight of different body organs was not influenced in both treated and untreated groups, except breast weight that was found higher ($p<0.05$) in group C as compared to others. Mean weights of giblet intestine and abdominal fat were also same for all groups.

Lonkar *et al*. (2008) investigated the effect of dietary inclusion of garlic powder and neem seed cake on carcass characteristics, meat protein content and weight of bursa of fabricus of broilers. The experiment was carried out with two levels of GP (0.5 and 1.0%), two levels of

NSC (1.0 and 2.0%) and two levels of GP and NSC combination (0.5% GP + 1.0% NSC and 1.0% GP + 2.0% NSC). Dietary supplementation of GP, NSC and their combination did not influence the per cent dressed yield, eviscerated yield and ready-to-cook yield. Supplementation of combination of 0.5% GP and 1.0% NSC caused a significant ($p<0.05$) reduction in per cent giblet yield. The weight of bursa of fabricus was increased by inclusion of GP, NSC and their combination in broiler ration.

Uko *et al*. (2008) an eight-week trial, water-washed and non-extracted raw, autoclaved or toasted and extracted neem kernels were tested for chemical content and as dietary protein concentrates. Heat treatment of the kernel lasted 10 minutes. Each of them was used at two rates of 15.0 and 22.5% to replace similar rates groundnut cake. The results revealed that the control diet stimulated production of heavier carcass and lighter spleen and kidneys compared to those of chickens fed neem diets, but the differences did not attain significance. However, neem diets significantly ($p<0.05$) increased relative weight of liver, pancreas and small intestine but the pancreatic and intestinal weights of chickens fed low level of raw neem kernel or the intestinal mass of birds offered 15.0% toasted neem diet were comparable to those of control group. Similarly, raw and autoclaved neem diets reduced ($p<0.05$) abdominal fat deposition contrary to the effects of control or extracted neem diets.

Zanu *et al*. (2011) A feeding trial was conducted to evaluate the effects of Neem (RVD) on body weight gain, carcass and organ characteristics and haematological values of broiler chickens. Showed decocation had no significant influence on the dressing percentage. Dressing percentage of the birds fed AID and RVD were not significantly different ($P>0.05$), from those on the control.

Adeyemo *et al.* (2012) investigated the combined effects of neem and pawpaw leaves supplementation on performance and carcass characteristics of broiler chickens. Broiler chickens were randomly allocated to the diets T_1 (0% leaf meal), T_2 (0.5% NLM), T_3 (2% PLM) T_4 (0.5% NLM + PLM), T_5 (1% NLM + PLM) and T_6 (2% NLM + PLM). Study indicated that supplementation of NLM and PLM improved the dressing percentages, the highest values were obtained for birds on T_5 (1% NLM + PLM) and T_6 (2% NLM + PLM) respectively. The eviscerated weight differs significantly across the treatments, birds on T_5 (1% NLM + PLM) and T_6 (2% NLM + PLM) had significantly better ($p<0.05$) results.

Ansari *et al*. (2012) conducted trial to evaluate three different levels of *Azadirachta indica* dried leaf meal, using diets supplemented with 0 (negative control), 1.25g antibiotic/kg (positive control) 1.25, 2.5 and 5.0 g leaf meal/kg of feed. There was no marked variation in dressing percentage between leaf meal supplementation and antibiotic at 28 day of age. However, birds fed diets of 1.25 or 5.0 g/kg of leaf meal had significantly ($P<0.05$) highest dressing percentage than birds fed diets of 1.25 or 5.0 g/kg of leaf meal and control groups at

42day of age. The mean lymphoid organs weight of control birds was significantly lower than the birds fed on diets containing leaf meal and antibiotics.

Bonsu *et al*. (2012) studied medicinal response, haematological parameters and meat sensory analysis of broilers to diets containingneem leaf meal (NLM). Four starter diets and finisher diets were formulated to contain the NLM at 0%, 1.5%, 2% and 2.5% dietary levels and were fed ad-libitum in phases 1 and 2 respectively. Results showed that in both phases Carcass characteristics were not significantly ($P>0.05$) influenced by the NLM although mild bitter taste was sensed in the 2.5% inclusion level when the meat was not salted.

Edch (2013) studied physiological response of broiler birds to oral supplementation with aloe vera and neem leave extracts. Reported that administering NLE at 0.4, 0.8 and 1.2 ml to broiler chicks from 1 to 8 weeks increased carcass, gizzard, lungs and kidney weights. Liver weight of birds fed 0.8 ml NLE and abdominal fat weight of birds fed 0.4, 0.8 and 1.2 ml NLE were reduced, while heart weight of birds fed 0.8ml NLE and liver weight of the birds fed 1.2 ml NLE were increased. Weights of small and large intestine were also increased ($p<0.05$).

Obun *et al*. (2013) studied the effects of feeding graded levels (0, 5, 10, 15 and 20%) of Neem leaf meals (NM) to broiler chicks on live weights, carcass and organ weights and blood constituents was investigated. The results of the live weights and carcass and organ weights decreased with increased NM inclusion in the diets. Haematological constituents were not affected ($p>0.05$) except the packed cell volume while the serum biochemical indices of birds fed 20% NM diets were decreased ($p<0.05$) compared to others. Inclusion of 15% NM in broiler chicks diet had no adverse effects on live, carcass and organ weights and immunity responses.

Ozung *et al*. (2013) studied the effect of utilization of neem leaf on growth, carcass characteristics and internal organs of broilers fed in diets. Reported reduced ($p<0.05$) weights of the carcass, liver, kidney, pancreas and heart in broilers fed 10 and 15% NLM compared to those fed control diets.

Abdulazeez *et al*. (2014) conducted experiment on potential of detoxified neem kernel cake as a protein source in broiler feeding. Reported that 75 and 100% replacement of soybean cake (SBC) with detoxified NKC in broiler diets reduced the weights of the liver, heart, kidney, gizzard and dressed carcass.

Khan *et al.* (2014) ascertained the effect of neem seed cake (NSC) in ration on the growth, carcass and feed efficiency of broilers. Birds were divided into four groups: group A was kept as control (without NSC) and broilers in groups B, C and D were fed on ration with NSC at level of 0.5, 1.0 and 1.5% per kg of feed, of NSC in broiler ration. The results revealed that average dressing percentage was significantly higher (61.5) in broilers group C, fed on ration containing neem seed cake at 1% and lowest recorded from control group. The results regarding the average liver, heart and gizzard weight of broilers were significant ($p<0.01$).

Kharde *et al*. (2014) studied the effect of supplementation of garlic and neem leaf powder (NLP) on growth performance and carcass yields in broilers. No Significant (P>0.05) influence was observed in carcass parameters like dressing yield and giblet yield (heart, gizzard and liver) in all treatment groups.

Kumari *et al.* (2014) study was planned to investigate the effect of sugar beet, neem leaf, linseed and coriander on growth performance and carcass characteristics in broiler birds result showed broilers supplemented with herbs/spices improvement in growth attribute and carcass characteristics. Dressing percentage was not significantly (p>0.05) affected. Average giblet percentage of all supplemented groups were significantly (p<0.05) higher than control & was found to be highest in neem leaf meal fed group.

Ayoola *et al*. (2015) feeding trial was conducted to investigate the effect of neem (*Azadirachta indica*) leaf meal on the growth performance and carcass traits of broiler chickens. The experimental birds were randomly distributed into four treatments. Birds in treatment first as control group while other 0.1, 0.2 and 0.3% levels of inclusion. Observed carcass traits, cut-parts (except neck) and organs showed no influence (p>0.05) of neem leaf meal inclusion.

Mahmood *et al*. (2016) studied comparative effect of *Azadirachta indica*, *Moringa oleifera* and *Cichorium intybus* leaf extracts on growth performance, immune response and carcass characteristics of broilers. 120-day old broiler chicks selected and were randomly divided into four experiment groups A, B, C and D. Group A was offered drinking water without any supplementation (control). Whereas, groups B, C and D were offered drinking water supplemented with leaf extracts of *Azadirachta indica*, *Moringa oleifera* and *Cichorium intybus* @ 50 ml L^{-1}, 30 ml L^{-1} and 10 ml L^{-1} respectively. Results showed supplementation of *Azadirachta indica*, *Moringa oleifera* and *Cichorium intybus* leaf extracts in drinking water showed better effect on dressing percentage, breast means yield and relative weight of gizzard. However, a no marked improvement was observed regarding relative weights of thigh meat, giblets (liver, heart and gizzard) and abdomen fat. The higher dressing percentage may be due to high body weight gain, breast meat yield may be due to move muscle deposition at breast region and high relative liver weight may be due to more feed consumption which might be responsible for increase in size and weight of gizzard.

Maidala *et al*. (2016) experiment was designed to evaluate the effect of some herbal plant extracts additives as alternatives growth promoters for broiler chicks. Results showed that liver weight was significantly higher in broilers fed neem extract (1.88). The abdominal fat was highest in broilers fed neem leaf extract (1.26%) which is an indication of poor meat quality. Gizzard weight was relatively higher in broilers fed neem leaf extract (p<0.05) than those fed control diet and phytogenic leaf extracts.

Ihsan *et al*. (2017) studied the impact of supplementation neem powder (*Azadirachta indica*) to diet broiler inimmunological, physiological and productive traits of broiler. Birds distributed in treatments, treatment T_1 was control received basal diet, treatments T_2, T_3, and T_4 received 1 g, 2 g and 3 g neem powder per kg to diet. Results showed no significant differences in dressing percentage and the relative weight of the viscera internal edible among the treatments. Results showed not significant differences between treatments fed with NLP in the relative weight of the heart and gizzard, liver and spleen compared with control. Broilers fed with 2 g per kg NLP to diet was significantly ($p<0.05$) in carcass weight compared with control. Also, refer presences significant differences of thigh circumference and explained no significant differences were observed among the treatments of chest circumference.

Egbeyale *et al*. (2018) conducted feeding trial to determine the growth performance, nutrient digestibility and carcass characteristics of broiler chicks fed diets containing neem (*Azadirachta indica*) leaf meal at different periods. The head, neck, breast and intestine were influenced ($p<0.05$) by the treatments. The birds fed diet containing 1.0% NLM for 3 d in a week had highest value (2.81%) of head percentage which was similar to the values obtained for the birds fed diet containing 1.0% NLM throughout the period. The highest ($p<0.05$) neck value was recorded in birds on 0.5% NLM for 3 d in a week. The values of breast weight percentage were highest ($p<0.05$) in birds fed diet containing 1.0% NLM throughout the period.

Sonhafouo *et al*. (2019) study was designed to evaluate graded levels of neem seed oil on growth performance of broiler chickens. They observed that neem oil had no significant ($p>0.05$) effect on the carcass yield. Except for the relative weight of liver which significantly ($p<0.05$) increased with 25 g of neem oil per kg, the relative weight of organs was not markedly affected by the dietary treatments.

Ubau *et al*. (2019) evaluated the effect of dietary inclusion of neem leaf meal (NLM) on growth performance and carcass characteristics of broiler chickens. The birds were randomly allotted to four dietary treatments T_1, T_2, T_3 and T_4 fed diet containing NLM at inclusion levels 0, 2.5, 5 and 7.5%. Resulted carcass characteristics, cut-up parts and internal organs of broiler chickens fed neem leaf meal showed no significant ($p>0.05$) differences between treatments.

2.5 Proximate Composition of Meat

Lonkar *et al*. (2008) investigated the effect of dietary inclusion of garlic powder and neem seed cake on carcass characteristics, meat protein content and weight of bursa of fabricus of broilers. The experiment was carried out with two levels of GP (0.5 and 1.0%), two levels of NSC (1.0 and 2.0%) and two levels of GP and NSC combination (0.5% GP+1.0% NSC and 1.0% GP+2.0% NSC). Crude protein content of breast and thigh meat was not influenced by garlic powder, neem seed cake and their combinations.

Ihsan *et al*. (2017) studied the impact of supplementation neem powder (*Azadirachta indica*) to diet broiler in immunological, physiological and productive traits of broiler. Birds distributed in treatments, treatment T_1 was control received basal diet, treatments T_2, T_3 and T_4 received 1 g, 2 g and 3 g neem powder per kg to diet. Reported addition of neem leaf powder in broiler diets significantly ($p<0.05$) higher crude protein value of meat. The Moisture, ether extract and Ash content of the breast and thigh meat of the broiler did not affect by the treatments.

Sirsat *et al.* (2017) studied the effects of dietary supplementation with chistosan, neem leaf meal and their combination at different levels in broiler on fat deposition and intestinal ph and digestive enzymes, amylase and lipase. Birds supplemented combination of 0.025% chistosan and 0.5% neem leaf meal and 0.05% chistosan and 1.0% neem leaf meal both the levels resulted in significant ($p<0.05$) reduction in abdominal fat in comparison to all other treatments and control groups.

Bonsu *et al*. (2012) studied medicinal response, haematological parameters and meat sensory analysis of broilers to diets containing neem leaf meal (NLM). Four starter diets and finisher diets were formulated to contain the NLM at 0%. 1.5%, 2% and 2.5% dietary levels and were fed ad-libitum in phases 1 and 2 respectively. Found that fat isolated from the lower abdomen was significantly ($p<0.05$) higher in the control birds when compared with that of birds fed the NLM at 2 per cent but did not differ significantly ($p>0.05$) from the NLM at 1.5 and 2.5 per cent.

Egbeyale *et al*. (2018) conducted feeding trial to determine the growth performance, nutrient digestibility and carcass characteristics of broiler chicks fed diets containing neem (*Azadirachta indica*) leaf meal at different periods. Birds in treatment 1 were fed control diet throughout the experiment, birds in treatment 2 were fed diet containing 0.5% neem leaf meal, birds in treatment 3 were fed diet containing 0.5% neem leaf meal for 3 d in a were, birds in treatment 4 were fed diet containing 1% neem leaf meal, birds in treatment 5 were fed diet containing 1% neem leaf meal for 3 d in a week. Resulted birds on 0.5% neem leaf meal for 3 d in a week had better ($p<0.05$) nutrient utilization that their counterparts in other groups.

Khulbey *et al*. (2016) conducted experiment on 180-day-old broiler chicks to evaluate the effects of neem (*Azadirachta indica*) and kadi (*Murraya koenigii*) leaf powder on the growth performance and nutrient utilization. The six dietary treatments included control (T_1), basal diet supplemented with leaf powder @ 0.2 % neem (T_2), 0.2% kadi (T_3), 0.1% kadi and 0.3% neem (T_4), 0.3% kadi and 0.1% neem (T_5) and 0.2% kadi and 0.2% neem (T_6). Resulted addition of 0.2% kadi plus 0.2% neem leaf powder improved ($p<0.05$) the digestibility of nutrients.

3. MATERIAL AND METHODS

The present research work entitled as "Effect of supplementation of Neem leaf (*Azadirachta indica*) powder on growth performance and carcass quality of broiler" was carried out at Poultry Unit, Veterinary Polyclinic and A.I. Center, Department of Animal Husbandry and Dairy Science, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra State, India located at 19° 23' 0" N and 74° 39' 0" Eat an attitude of 511 meter. The minimum and maximum ambient temperature range from 10 to 20°C in winter and 30 to 40°C in summer with annual rainfall of 561.6 mm. The experiment was conducted in December 2018-January 2019. The materials used and methodology adopted during the course of experimentation are detailed in this chapter.

3.1 Preparation of Neem Leaf Powder

Mature neem leaves were harvested from experimental site. The neem leaves were sundried for three days on cement floors until they became crispy while still retaining the greenish colouration. The leaves were turned regularly to prevent uneven drying of leaves. The dried leaves were pulverized with a blender. A 25 mm mesh diameter sieve was used to obtain the fine dust; the dust was preserved in air tight plastic container to use as feed supplement while conducting feeding trial on broilers.

3.2 Selection of Experimental Chicks

In the present study, 160-day old broiler chicks (Vencobb 400) were procured from the Venky's Hatcheries Private Limited, Pune, Maharashtra.

On arrival, chicks were weighed and distributed randomly in to four treatment groups *viz.*, T_0, T_1, T_2 and T_3 in each treatment 40 birds as replicates, on equal weight basis (Table 3.1). The chicks were housed in separate compartments. The chicks were fed standard poultry ration with different levels of neem leaf powder as supplementation during the experimental period of six weeks of age. Treatment details are as under

Treatment Details

T_0	Basal diet (Control)
T_1	Basal diet + 5 gm Neem leaf powder / kg of feed
T_2	Basal diet + 10 gm Neem leaf powder / kg of feed
T_3	Basal diet + 15 gm Neem leaf powder/ kg of feed

Table 3.1 Average body weight of day old chicks

Sr. No.	Treatment	Average body weight (g) of chicks
1.	T_0	45.20± 0.25
2.	T_1	45.15± 0.23
3.	T_2	45.15± 0.37
4.	T_3	45.10± 0.39

All the experimental chicks were vaccinated with Marek's disease vaccine on the first day at hatchery and subsequent vaccination schedule was carried out as depicted in Table 3.2.

Table 3.2 Vaccination schedule of experimental birds

Sr. No.	Disease	Vaccine	Age of vaccination	Dose / route
1.	Ranikhet	Lasota vaccine (F1 Strain)	7th day	One drop in eye (intraocular)
2.	Gumboro (IBD)	Gumboro vaccine	14th day	One drop in eye (intraocular)
3.	Gumboro (IBD)	Gumboro vaccine	21th day	Through drinking water
4.	Ranikhet	Booster dose	28th day	Through drinking water

3.3 Housing and Management

Before arrival of broiler chicks, the Pens, Waterer (Drinker), Feeders, Brooders and Floor were cleaned, washed, disinfected and fumigated. All the experimental chicks were reared on deep litter system of rearing on paddy husk as litter material in a well-ventilated house with identical management and environmental conditions. Proper brooding of chicks was done by providing sufficient heat and light by using electric bulbs in each group for first three weeks of age. Afterwards, sufficient artificial light was provided during night hours throughout the experimental period.

The lime stone powder was spread over the floor, to prevent microbial infection. Foot bath containing a disinfectant was provided in front of the door of poultry house. Everyone entering the house was asked to dip their feet's in the foot bath. The shoes or any foot wear was not allowed inside the poultry house as a preventive measure. All the precautionary measure against possible infection of diseases were taken throughout the experimental period. The standard and uniform management practices like brooding, lightning etc. were followed for all the groups. The chicks were provided 23 hours light and one dark hour, 95°F temperature during first week, which was reduced by 5°F during every successive week. The relative humidity of the shed was tried to maintain at 60±5 per cent.

3.4 Feeding and Watering

All the broiler chicks were fed with crumbled maize grains for first two days. For the experiment, a pre-starter (0-1 week), Starter (1-3 weeks) and finisher (4-6 weeks) feed were used during experimental period of 6 weeks. Feeding and watering was done in identical feeders and waterers specified for the deep litter. The birds under all treatment groups had free access to feed and fresh, clean and cool drinking water throughout experimental period.

3.5 Experimental Period

The experiment was conducted from 17 December, 2018 to 30 January, 2019.

3.6 Experimental Details

i. Number of treatments : 4

ii. Number of chicks per treatment : 40

iii. Total number of Chicks : 160

iv. Design of experiment : CRD

3.7 Observations Recorded

Following parameters were recorded during the experimental period.

3.7.1 Body Weight of Chicks

The weight (g) of the experimental birds was recorded individually on electronic weighing balance at weekly interval. The body weight was recorded in morning hours before offering fresh feed and water. Chicks of all groups were weighed individually.

a. Body weight of chick- Day old age
   - 1week age
   - 2 weeks age
   - 3 weeks age
   - 4 weeks age
   - 5 weeks age
   - 6 weeks age

Live weight gain was calculated by subtracting live weight of previous week from that of current week.

3.7.2 Feed Intake

Daily feed intake was calculated from the amount of feed consumed by each group in a day. Average feed intake was calculated from the total feed offered and the feed left over on the next day morning. Weekly feed intake was calculated by adding up the daily average feed intake of the particular week. Cumulative feed intake of particular week was calculated by adding up the weekly average feed intake of the previous weeks with the feed intake of that particular week.

Value for the weekly feed intake per birds were calculated as below,

$$\text{Weekly feed intake (g/bird)} = \frac{\text{Total feed intake by all birds in a treatment during a week}}{\text{No. of live chicks in the treatment during that week}}$$

Similarly, cumulative feed intake was calculated by making sum of all 6 weeks to that week.

3.7.3 Feed Conversion Ratio

Weekly feed conversion ratio was calculated by dividing the weekly feed consumption by weekly weight gain. The weekly cumulative feed conversion ratio was estimated by dividing the cumulative feed consumption or total amount of feed consumed up to that particular week by the body weight gain record upto that week.

Weekly feed conversion ratio was calculated by using following formula-

$$\text{Feed Conversion Ratio (FCR)} = \frac{\text{Feed consumed (g)}}{\text{Body weight gain (g)}}$$

3.7.4 Percentage Mortality (%)

The percent mortality values for each group were calculated as

$$\text{Mortality (\%)} = \frac{\text{No. of dead birds in each group}}{\text{Total no. of birds in each group}} \times 100$$

3.8 Proximate Analysis of Feed and Meat

3.8.1 Moisture Content

Moisture was determined as per AOAC (1990) method gram of sample was transferred to weighed metallic dish which was then transferred to a hot air oven at 100 ± 2^0C and dried till a constant weight was obtained. The dish was kept in desiccator for cooling. After cooling, the loss in weight was determined to calculate moisture content and expressed as %:

$$\text{Moisture (\%)} = \frac{\text{Fresh weight (g)} - \text{Dry weight (g)}}{\text{Fresh weight (g)}} \times 100$$

3.8.2 Determination of Dry Matter (DM)

Representative samples were taken in previously weighed moisture cup/tin trays and kept in hot air oven at 100 ± 2 °C for 24 hrs.

Dry matter was calculated as follows:

$$\text{Dry matter (\%)} = \frac{b}{a} \times 100$$

Where,

a = Fresh weight of sample (g)

b = Dry weight of sample (g)

3.8.3 Determination of Total Ash

Five grams of air-dried samples were taken in a previously weighed silica crucibles. The crucibles along with samples were kept on heater and burnt till smoke disappears from the charred mass of samples. With the help of metal tong, the silica crucibles were kept into Muffle furnace and ignited at 600°C for 4-5 hrs. Allow the muffle furnace to cool down. After 12 hrs silica crucibles containing ash were removed from the furnace and transferred into desiccator, cooled and weighed. Total ash content was expressed on DM basis and calculated as follows:

$$\text{Total ash (\%)} = \frac{a - b}{c} \times 100$$

Where,

a = Weight of silica crucible with ash (g)

b = Weight of empty silica crucible (g)

c = Weight of dry sample taken for ash (g)

3.8.4 Determination of Nitrogen and Crude Protein

Nitrogen and crude protein in samples were estimated by using Kjeldahl method. The representative samples of ration were digested in Kjeldahl flask with commercial sulphuric acid in the presence of digestion mixture ($CuSO_4$: K_2SO_4 1:9). The digested samples were transferred into a volumetric flask to make a suitable volume of 250 ml, cooled and out of which 25 ml sample was subjected to distillation in the semi-automatic Kjeltec distillation assembly. The ammonia released during distillation was collected into 30 ml of 4 per cent boric acid solution containing mixed indicator (0.2 per cent methyl red and 0.1 percent bromocresol green in equal amount in 95 per cent ethyl alcohol). The ammonia collected in boric acid solution was titrated against 0.1 N HCI.

$$\text{Nitrogen (\%)} = \frac{V_1 - V_2 \times 0.0014}{b} \times 100$$

Where,

V_1 = Volume (ml) of 0.1 N HCl used for titration of sample

V_2 = Volume (ml) of 0.1 N HCl used for titration of blank

b = Weight sample taken for digestion on DM basis

0.0014= Molecular weight of nitrogen (g) equivalent to Neutralize 1 ml of 0.1 N HCl.

Crude Protein (%) = N (%) x 6.25

3.8.5 Determination of Ether Extract

Fat and fat soluble components of oven dried feeds and meat samples were estimated by SOCS PLUS Pelican equipment. Solvent extraction in the extraction unit was performed in two steps. One-gram oven dried samples were immersed in the boiling solvent (petroleum ether B.P. 40-60°C) for 20 minutes to dissolve the soluble materials. In the second step, which lasts for 30 minutes the samples were raised above the solvent surface to permit efficient washing with solvent from the condensers.

After the extraction, the condenser valves were closed by lifting the samples to the upper position. After few minutes most of the solvent got collected via the condenser in a collection vessel. At last the residue of the solvent was evaporated when the air pump was started. Ether extract was collected in previously weighed extraction cups and then weighed after cooling in desiccators. The ether extract was calculated as follows:

$$\text{Ether extract (\%)} = \frac{c - a}{b} \times 100$$

Where,

a = Initial weight of extraction cups (g)

b = Weight of samples on DM basis (g)

c = Weight of extraction cups with ether extract (g)

3.8.6 Determination of Crude Fiber

The sample after defating as mentioned above were transferred from thimbles to spoutless beakers of one litter capacity and in each beaker, 200 ml of 1.25 per cent H_2SO_4 was added. It was refluxed for 30 minutes on hot plates after the boiling started and thereafter, filtered through muslin cloth. The residue was washed 5-6 times with hot water until it became acid free. The residual materials on the muslin cloth were again transferred to the respective beakers and in each beaker 200 ml of 1.25 % sodium hydroxide solution (NaOH) was added. It was refluxed for 30 minutes after the boiling started and thereafter filtered through muslin cloth and washed with hot water for 5-6 times until it became free from alkali. Thereafter, total residue was transferred in a clean dry silica crucible and dried in hot air oven at 100 ± 2°C for 24 hrs. and then it was cooled in desiccator and weighed. The residue was then ignited in Muffle furnace at 600°C for 4-5 hrs. After 12 hrs. crucibles containing ash were removed from the furnace and kept into desiccator, cooled and weighed again. Weight loss due to ignition was recorded as the weight of crude fiber:

$$\text{Crude fiber (\%)} = \frac{b}{a} \times 100$$

Where,

a = weight of sample on DM basis (g)

b = weight of crude fiber (g)

3.8.7 Determination of Organic Matter

Organic matter in the feed and meat was calculated by subtracting the ash per cent from 100.

Organic matter = 100 - ash%

3.9 Carcass Traits

Carcass traits were evaluated after slaughtering, dressing and evisceration of birds. Six birds from each treatment were used for carcass traits evaluation. Live weight was recorded prior to slaughter of birds. The birds were slaughtered by standard protocol and allowed to bleed for 180 seconds, in bleeding cones. The birds were then reweighed to record the bleed weight. Scalding was done at 62ºC for 120 seconds and feathers were removed manually. The birds were then reweighed to record the defeathered weight. The birds were then processed by removing the skin, head, shank, feet and preen glands by cutting around vent and removing the viscera. The giblets consisting of heart (without pericardium), liver (without gall bladder) and gizzard were cut open and rinsed of its contents. All of the above components and eviscerated carcass were weighed individually.

The neck was removed from carcass and wings were removed by a cut through the shoulder joint at the proximal end of humorus. The thigh–drumstick portion was obtained by

cutting through the joint between femur and the ilium bone of pelvic girdle. The drumstick was then separated from the thigh by a cut through the joint formed by the femur and fibula and tibia. The breast and the back portions were obtained by cutting on each side of the vertebral column beginning at the midpoint of the sternal ribs until the breast portion completely removed from the back. The cutting procedure resulted in two wings, two drumsticks, two thighs, one breast and one back part. Individual weight of various vital organs like heart, liver, and gizzard were recorded after removal of contents present in gizzard and detachment of gall bladder from liver. The following observations were made on different measurement of carcass and cut-up parts.

3.9.1 Live Weight

Birds were weighted before slaughtering using an electronic balance.

3.9.2 Dressed Weight

After slaughtering, the dressed birds were weighted and dressed weight was recorded to calculate dressing percentage.

$$\text{Dressed weight (\%)} = \frac{\text{Dressed bird weight (g)}}{\text{Live weight of bird (g)}} \times 100$$

3.9.3 Eviscerated Weight

Weight of carcass along with giblets and skin.

$$\text{Eviscerated weight (\%)} = \frac{\text{Eviscerated weight (g)}}{\text{Live weight of bird (g)}} \times 100$$

3.9.4 Edible Weight

Weight of carcass without eviscerated weight.

$$\text{Edible weight (\%)} = \frac{\text{Edible weight (g)}}{\text{Live weight of bird (g)}} \times 100$$

3.9.5 Giblet Weight

Weight of heart, liver and gizzard.

$$\text{Giblet weight (g)} = \frac{\text{Giblet weight (g)}}{\text{Live weight of bird (g)}} \times 100$$

The eviscerated weight with weight to giblet accounts for edible weight while weight of blood, feathers, offal's, head and shank comprise of non-edible weight.

3.9.6 Weight of Carcass Cut Up Parts (g)

Neck, Back, Wing, Breast, Drumstick, Thigh, Head, and Leg weight constitutes carcass cutup parts.

3.10 Organoleptic Evaluation of Samples

The Twelve potential panellists were selected from staff and students of the Department of Animal Husbandry and Dairy Science, MPKV, Rahuri. Panellists were selected on the basis of the following criteria

Not allergic to any foods, interested in and willing to sample meat products, enjoy working in a group and able to participate during training and testing. Some of these panellists had previous sensory training or descriptive analysis experience and had participated in the sensory assessment of meat.

Pressure cooked meat (pooled representative sample from each diet) without salt was subjected to sensory evaluation on modified 9 points hedonic scale for appearance, flavour, juiciness, texture/tenderness, and overall acceptability as given in score sheet. The questionnaire consisted of 9 points hedonic scale where the respondents were to respond to the question of "how much do you like or dislike the sample?" The following scale was used to categorize the respondents (Table 3.3).

Table 3.3 Description of the scale to test sensory qualities of meat

Sr. No.	Scale	Score
1.	Very desirable	9
2.	Desirable	8
3.	Moderately desirable	7
4.	Slightly desirable	6
5.	Neither desirable	5
6.	Slightly undesirable	4
7.	Moderately undesirable	3
8.	Undesirable	2
9.	Very undesirable	1

All meat samples (n = 6/treatment) were coded with randomized 3-digit codes and rotated to prevent bias. Meat samples were lightly-salted and steamed (200°C) in an oven, until a constant internal temperature of 90°C was reached. The cooked breasts were cut into smaller cubes of 2.5 x 2.5 x 2.5 cm to serve to the respondents. Each sample was served in a 30 mL glass bowl, covered with a square of heavy-duty aluminum foil and served at an internal meat temperature of 60–65°C. Twenty-five untrained respondents (n=25) participated in the consumer acceptance evaluation of the breast and thigh meat samples. Tasting of meat samples was performed at room temperature (20–22°C). Each respondent tasted the samples before completing the relevant questionnaire. Tap water at room temperature was provided for rinsing between samples during the taste sessions.

3.11 Chemical Analysis

The chemical analysis of the experimental broiler rations was carried out as per AOAC (2005) for all the proximate principles.

3.12 Statistical Analysis

The data collected during this investigation were subjected to statistical analysis by Snedecor and Cochran (1994) and difference between means by DMRT.

4. RESULTS AND DISCUSSION

Results emerged out of the analysis of collected empirical facts from the present study with relevant discussion thereon has been presented in this chapter. The data obtained from the experiment have been analyzed by taking into account the objectives of study. The details of different parameters studied and result obtained under the investigation are discussed in following major heads.

4.1 Proximate Composition of Experimental Broiler Ration

The proximate composition of experimental broiler starter and finisher rations are presented in Table 4.1. It was observed that experimental broiler rations contained adequate nutrients for growth as per BIS (1992).

4.1.1 Starter Ration

The proximate composition of experimental starter ration is given in Table 4.1. The crude protein and calculated metabolizable energy (ME) of the diet was 23 per cent and 2863.81 kcal/kg, respectively.

4.1.2 Finisher Ration

The proximate composition of finisher ration is given in table 4.1. The crude protein and calculated metabolizable energy (ME) of the diet was 20 per cent and 2939.75 kcal/kg, respectively.

Table 4.1 Per cent proximate composition of experimental broiler ration on 100% dry matter basis

Nutrients	Broiler ration	
	Starter	Finisher
Crude protein	23.0	20.0
Crude fiber	4.60	3.78
Ether extract	4.80	4.3
Total ash	7.20	6.85
Nitrogen free extract	60.40	65.15
Acid insoluble ash	1.25	1.44
ME (kcal/kg)	2863.81	2939.75

4.2 Growth Performance

4.2.1 Body Weight Changes

The body weight changes of broiler chicks at different weekly intervals on inclusion of neem leaf powder in feed has been represented in Table 4.2 and graphically presented in Fig. 1.

The average initial body weight of day old experimental chicks in different treatments i.e. T_0, T_1, T_2 and T_3 were found as 45.20 ± 0.25, 45.15 ± 0.20, 45.18 ± 0.37 and 45.10 ± 0.39 g, respectively.

Table 4.2 Cumulative body weight changes of broiler (g/bird)

Parameters	Treatments				SE(+)	CD @ 5%
	T_0	T_1	T_2	T_3		
Initial	45.20 ±0.25	45.15 ± 0.23	45.18±0.37	45.10±0.39	0.32	NS
1st Week	118.23 ± 0.90	116.65 ± 0.36	117.03± 0.35	116.55± 0.25	0.53	NS
2nd Week	304.03 ± 5.02	298.98 ± 4.78	300.15± 3.53	297.58± 2.94	4.16	NS
3rd Week	573.8 ± 1.95^{a}	587.35 ± 6.57^{bc}	598.15± 3.94^{c}	580.70± 4.59^{ab}	4.57	12.77
4th Week	924.08 ± 9.81^{a}	958.20 ± 11.45^{b}	991.18± 11.75^{c}	960.38± 8.52^{b}	10.46	29.23
5th Week	1359.08 ± 10.52^{a}	1423.33 ± 11.38^{b}	1469.6± 10.04^{c}	1424.13± 10.53^{b}	10.63	29.69
6th Week	1764.65 ± 14.72^{a}	1849.30 ± 13.43^{b}	1928.35± 16.45^{c}	1869.90± 17.72^{b}	15.67	43.76

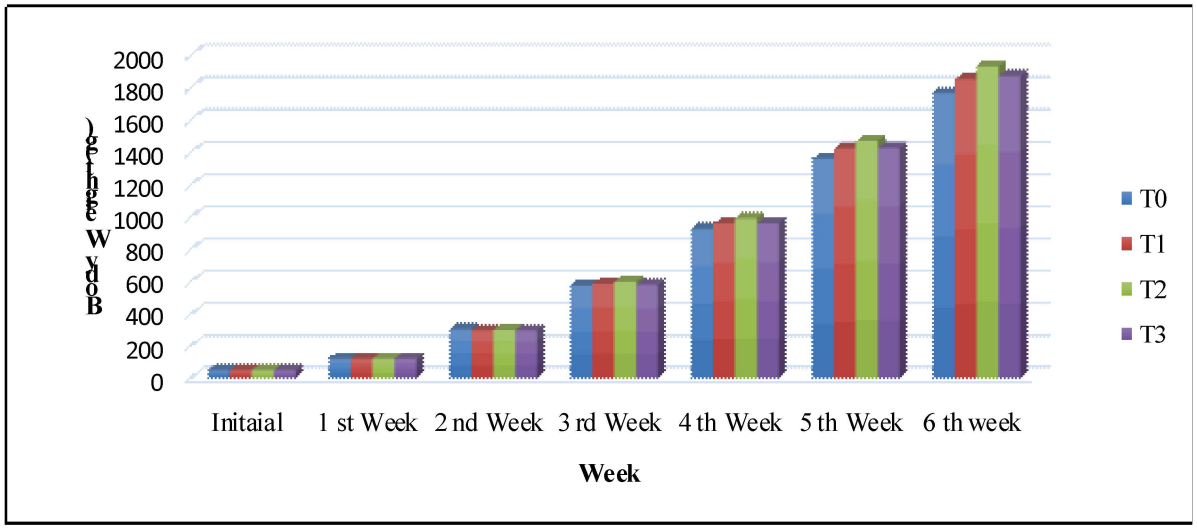

Fig 4.1 Weekly body weight changes of broilers (g/bird) fed with experimental rations

The average body weight of experimental chicks at 6th was 1764.65 ± 14.72, 1849.3 ± 13.43, 1928.35 ± 16.45 and 1869.9 ± 17.72 g, respectively. The weekly body weight changes of chicks indicated no significant difference among treatment groups upto the first two weeks of the experiment. However, a significant ($p<0.05$) difference was observed from third weeks onwards.

In the third week the treatment T_2 was significantly ($p<0.05$) higher than other. However, the treatment T_1, T_2 and T_1, T_3 and treatment T_0, T_3 were at par to each other. The average body weight of birds in fourth weeks in treatment T_2 was higher. However, treatment T_1 and T_3 were at par to each other. The average body weight of birds in the fifth weeks in the treatment T_2 was significantly ($p<0.05\%$) superior than other treatments. However, the treatment T_1 and T_3 were at par to each other. At the end of the sixth week, significantly ($p<0.05\%$) higher body weight gain in the T_2 group was recorded. However, the treatment T_1 and T_3 were at par to each other. Results are in agreement with the Khan *et.al*. (2014) who observed that broilers fed 1% neem seed cake showed significantly ($p< 0.05$) higher body weights at six weeks of age over those of the control group.

Manwar *et al*. (2007) reported significant increase in the live body weight of broilers in neem fed groups when compared with control groups supplemented neem leaf powder @ 1-3 gm/kg feed.

Sarkar *et al*. (2014) observed that probiotic, neem and vitamin AD_3E preparation enhanced the growth broilers. The body weight was significantly increased ($p<0.01$) in the treated groups in comparison with that of control group.

The increase in weight gain in neem leaf powder fed birds might be due to stimulating its appetite and anti-bacterial hepatoprotective properties of neem, which help to reduce the microbial load of birds and improved the feed efficiency of the birds (Wanker *et al*., 2009).

4.2.2 Body Weight Gain

The body weight gain of broiler chicks at different weekly intervals on inclusion of neem leaf powder in feed has been presented in Table 6 and graphically presented in Fig. 4.2.

Table 4.3 Weekly body weight gain of broilers (g/bird) fed with neem leaf powder

Weeks	Treatments				SE(+)	CD @5%
	T_0	T_1	T_2	T_3		
1st Week	73.03 ± 0.90	71.50 ± 0.44	71.83 ± 0.55	71.45 ± 0.48	0.62	NS
2nd Week	185.8 ± 5.02	182.33 ± 4.68	183.13 ± 3.48	181.03 ± 2.88	4.11	NS
3rd Week	269.78 ± 5.08^{a}	288.38 ± 8.85^{b}	298.00 ± 5.39^{b}	283.13 ± 4.9^{ab}	6.27	17.51
4th Week	350.28 ± 9.14^{a}	370.85 ± 12.38^{ab}	393.03 ± 12.81^{b}	379.68 ± 8.99^{ab}	10.97	30.65
5th Week	435 ± 8.50^{a}	465.13 ± 9.83^{b}	478.43 ± 10.39^{b}	463.75 ± 11.40^{b}	10.09	28.17
6th Week	405.58 ± 11.82^{a}	425.98 ± 12.97^{ab}	458.75 ± 14.24^{b}	445.78 ± 17.35^{ab}	14.24	39.79

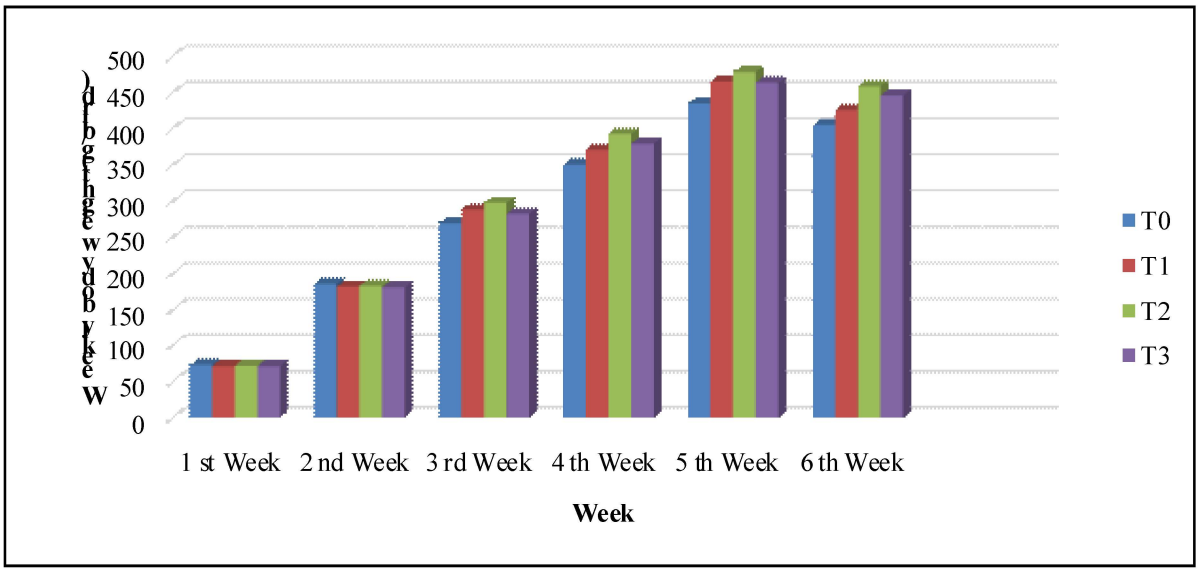

Fig. 4.2 Weekly live body weight gain of broilers (g/bird) fed with experimental rations

The weekly live body weight gain of chicks indicated no significant difference among various treatment groups during the first two weeks of the experiment. There is significant ($p<0.05$) difference among the treatments from third weeks onwards. In third week, highest weight gain observed in treatment T_2. However, treatments T_1, T_2, T_3 and treatments T_0, T_3 were at par to each other. In the fourth and fifth weeks, significantly ($p<0.05\%$) higher body weight gain in the T_2 than other treatment was recorded. In the sixth week, significantly ($p<0.05\%$) higher body weight gain in the T_2 was recorded. However, the treatment T_0, T_1, T_3 and treatment T_1, T_3 were at par to each other. Similar finding was reported by Sarkar *et al*. (2014) they reported broilers supplemented with 1%

neem leaves extract (Group A, C and D) gained the significantly higher ($p<0.001$) live weight compared to untreated control group regardless of calibacillosis induction.

The findings of Bonsu *et al*. (2012) reported significant influence of neem leaf meal on weight gain and final weight of broiler chickens fed diet containing neem meal at different levels (0, 1.5, 2.0 and 2.5%).

Mahejabin *et al*. (2015) reported addition of extract of neem, turmeric rhizome extract and papaya leaf extract improved the weight gain of broilers.

Khatun *et al*. (2013) reported that supplementation 1-3 ml of tulsi and neem leave extract per kg poultry ration increase in live body weight and improvement in weekly gain in weight and feed efficiency as compared to that control group of poultry.

The increase in weight gain in neem leaf powder fed birds might be due to its appetite and digestion stimulating, anti-bacterial and hepatoprotective properties, which help to reduce the microbial load of birds and improved the feed efficiency of the birds (Wanker *et al*., 2009).

4.3 Feed Intake and Feed Efficiency

4.3.1 Feed Intake

The average feed intake of experimental broiler chicks was recorded at weekly interval throughout the experimental period of 6 weeks.

The average weekly feed intake of broiler chicks represented in Table 4.4 and graphically presented in Fig. 4.3.

Table 4.4 Cumulative average feed intake of broilers (g/bird) throughout the experiment

Weeks	Treatments				SE(+)	CD @5%
	T_0	T_1	T_2	T_3		
1	130.3 ± 0.49	129.83 ± 0.43	128.35 ± 0.77	129.7 ± 0.23	0.52	NS
2	456.3 ± 4.3	447.85 ± 5.77	440.58 ± 3.19	445.85 ± 2.75	4.17	NS
3	911.18 ± 2.12	906.05 ± 5.4	894.98 ± 3.92	902.13 ± 6.18	4.67	NS
4	1635.3 ± 4.45	1623.5 ± 8.77	1609.23 ± 7.74	1605.18 ± 11.77	8.59	NS
5	2440.2 ± 6	2435.05 ± 6.45	2420.13 ± 6.8	2425.2 ± 8.95	7.14	NS
6	3400.23 ± 7.1	3387.8 ± 9.05	3366.38 ± 13.92	3375.75 ± 9.68	10.25	NS

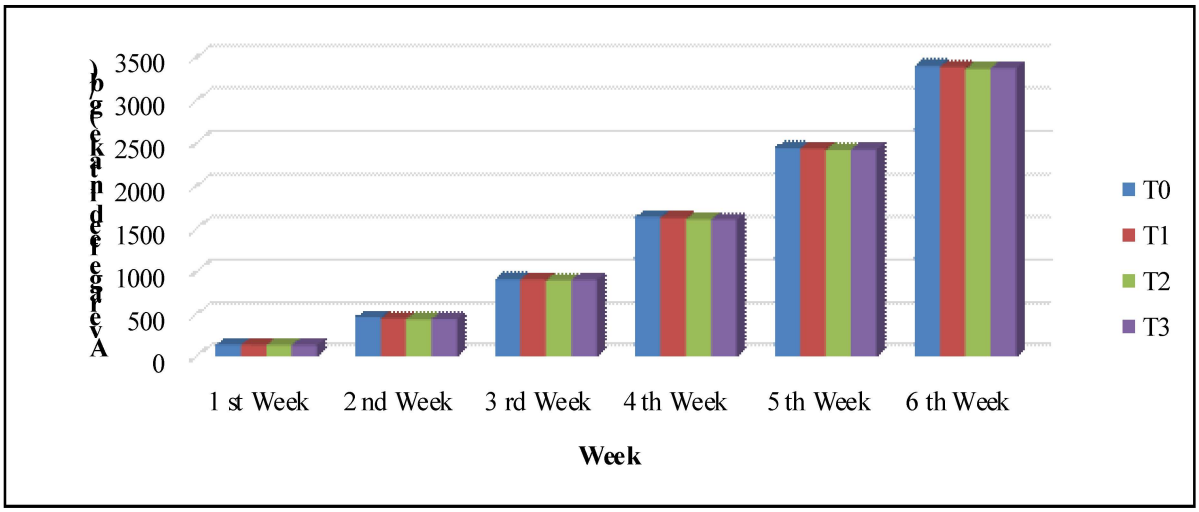

Fig. 4.3 Treatment wise cumulative average feed intake (g/bird) of broilers during experiment

The overall average feed intake of the birds during experiment for treatment T_0, T_1, T_2 and T_3 were 3400.23 ± 7.1, 3387.8 ± 9.05, 3366.38 ± 13.92 and 3375.75 ± 9.68 g, respectively. However, the differences were non-significant for feed consumption in all the treatment groups during experimental period of six weeks. The trend indicated that the decline in feed intake with an increase in the level upto 1.5% of supplementation of neem leaf powder was recorded during the experiment. This might be due to presence of miliacin which forms bitter principles of leaves (National Research Council, 1994). A similar finding is reported by Khan *et al*. (2014) was showed that broiler in control group consumed high feed quantity and it was decreased significantly in group C birds fed to 1% level of neem seed cake.

Pagrut *et al*. (2018) reported 4% neem leaves infusion @ 30 ml and 50 ml per liter of fresh drinking water significantly lower feed intake ($p>0.05$) and lower feed consumption.

Reduction in feed intake for birds fed the neem leaf powder in diets as a result of reduced palatability from the highly bitter neem taste. Miliacin forms the bitter principles of leaves (National Research Council, 1994).

Table 4.5 Weekly feed intake of broilers (g/bird) during the experiment

Weeks	Treatments				SE(+)	CD @5%
	T_0	T_1	T_2	T_3		
1	130.3 ± 0.49	129.83 ± 0.43	128.35 ± 0.77	129.7 ± 0.23	0.52	NS
2	326 ± 4.3	318.03 ± 5.77	312.23 ± 3.27	316.15 ± 2.72	4.18	NS
3	454.88 ± 4.78	458.2 ± 7.6	454.4 ± 5.16	456.28 ± 6.59	6.14	NS
4	724.13 ± 4.52	717.45 ± 9.22	714.25 ± 9.07	703.05 ± 11.81	9.04	NS
5	804.9 ± 7.58	811.55 ± 9.77	810.9 ± 8.18	820.03 ± 13.33	9.97	NS
6	960.03 ± 9.03	952.75 ± 10.94	946.25 ± 13.77	950.55 ± 12.79	11.77	NS

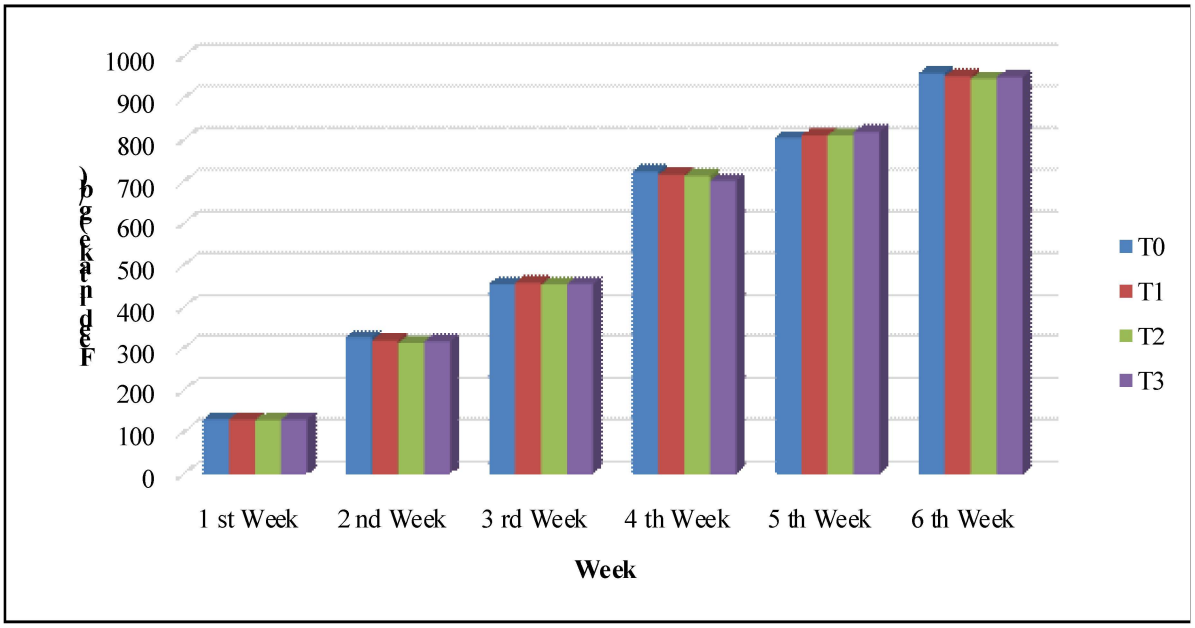

Fig. 4.4 Weekly feed intake (g/bird) of broilers during the experiment

The weekly feed intake of experimental broiler chicks was recorded at weekly interval throughout the experimental period of 6 weeks. The average weekly feed intake of broiler chicks represented in table 4.5.

The average feed intake of the birds at first weeks of age during experiment for treatment T_0, T_1, T_2 and T_3 were 130.3 ± 0.49, 129.83 ± 0.43, 128.35 ± 0.77 and 129.7 ± 0.23 g, respectively. The average feed intake of the birds at six weeks of age during experiment for treatment T_0, T_1, T_2 and T_3 were 960.03 ± 9.03, 952.75 ± 10.94, 946.25 ± 13.77 and 950.55 ± 12.79 g, respectively. However, the difference was non-significant for the feed intake in all the treatment groups for the entire experimental period. During the entire experiment, the T_2 group significantly gained highest body weight with lowest feed consumption.

Durrani *et al*. (2008) observed 4% concentrated neem leaves (*Azadirachta indica*) infusion in drinking water significant decrease in the amount of feed intake and water intake.

4.3.2 Feed Conversion Ratio

The mean weekly feed conversion ratio and their standard error at different weeks of age are presented in Table 4.6 and graphically represented in Fig. 4.5.

Table 4.6 Weekly feed conversion ratio in broilers in different treatments

Weeks	Treatments				SE(+)	CD @5%
	T_0	T_1	T_2	T_3		
1	1.80± 0.02	1.82 ± 0.01	1.79 ± 0.02	1.82 ± 0.01	0.02	NS
2	1.81 ± 0.07	1.77 ± 0.04	1.72 ± 0.02	1.75 ± 0.01	0.04	NS
3	1.70 ± 0.03^{c}	1.65 ± 0.05^{b}	1.53 ± 0.01^{a}	1.62 ± 0.02^{ab}	0.03	0.09
4	2.13 ± 0.06^{b}	1.99 ± 0.05^{ab}	1.92 ± 0.09^{b}	1.88 ± 0.04^{a}	0.07	0.18
5	1.87 ± 0.02^{c}	1.76 ± 0.02^{ab}	1.71 ± 0.02^{a}	1.80 ± 0.04^{bc}	0.03	0.08
6	2.44 ± 0.07^{c}	2.30 ± 0.05^{ab}	2.12 ± 0.05^{a}	2.27 ± 0.10^{ab}	0.07	0.20
Overall	1.96 ± 0.02^{c}	1.88 ± 0.01^{b}	1.80 ± 0.02^{a}	1.86 ± 0.02^{b}	0.02	0.05

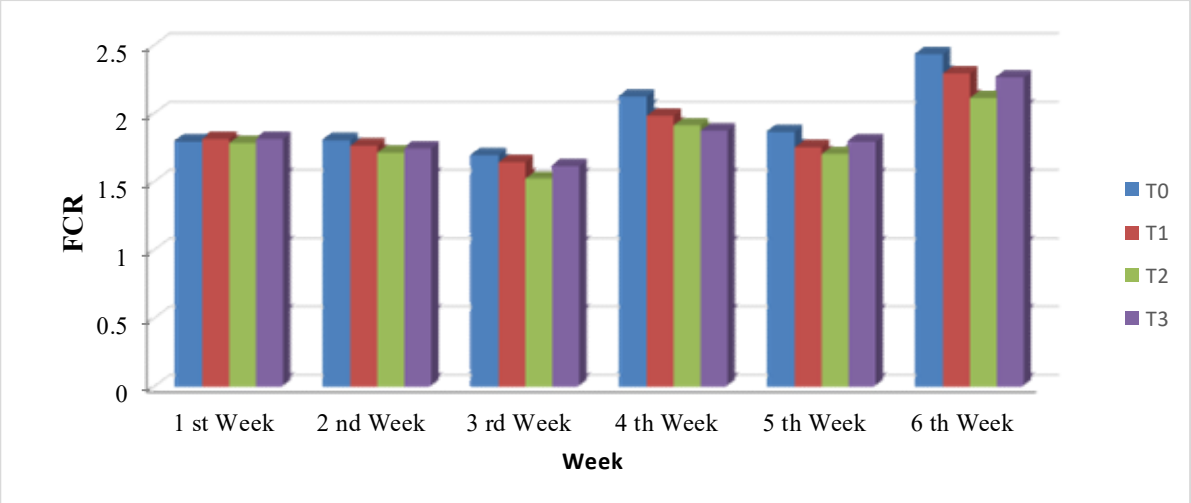

Fig. 4.5 Weekly feed conversion ratio (FCR) in broilers during the experiment

All treatments were non-significant upto second week's period. Statistically the significant ($p<0.05$ %) was observed in FCR from third to six weeks. The feed conversion ratio at six weeks for treatment T_0, T_1, T_2 and T_3 were 2.44 ± 0.07, 2.30 ± 0.05, 2.12 ± 0.05 and 2.27 ± 0.10, respectively. Overall feed conversion ratio for treatments T_0, T_1, T_2 and T_3 were 1.96 ± 0.02, 1.88 ± 0.01, 1.80 ± 0.02 and 1.86 ± 0.02 respectively. Statistically better FCR was recorded in T_2 treatment as compared to other treatments. However, treatments T_1 with T_3 were at par to each other.

Thomas *et al.* (2017) showed neem leaf powder supplemented at the level of 0.6 per cent significantly ($p<0.01$) higher body weight, body weight gain and better feed conversion ratio in Japanese quail.

Abujradah *et al.* (2018) offered basal diet supplemented with probiotic + garlic + neem leaf @ 1 kg per ton of feed to which they get the best performance ($p<0.05$) in final body weight, weekly gain, weekly feed intake and feed conversion ratio.

4.4 Carcass Traits

Table 4.7 represents the data on carcass traits (%) due to different dietary treatments of neem leaf powder during experimental period and graphically represented in Fig. 4.6.

Table 4.7 Effect of supplementation of neem leaf powder on the carcass traits (%) of broiler chicken

Carcass traits (%)	Treatment				SE (+)	CD @5%
	T_0	T_1	T_2	T_3		
Live body weight (g)	1861 ± 19.71	1920.5 ± 21.02	1960.33 ± 31.08	1934.17 ± 34.24	27.24	NS
Dressed weight (g)	1251±23.62	1313.33±18.26	1371.17±43.65	1310.83±18.21	27.96	NS
Dressing (%)	67.22 ± 1.35	68.38 ± 0.28	69.94 ± 0.45	67.77 ± 0.44	0.76	NS
Breast (%)	20.75 ± 0.83	20.97 ± 0.86	21 ± 1.18	20.26 ± 1.13	1.01	NS
Giblet (%)	4.89 ± 0.2	4.75 ± 0.19	4.53 ± 0.23	4.43 ± 0.18	0.20	NS
Drumstick (%)	13.35 ± 0.5	13.68 ± 0.12	13.78 ± 0.61	13.33 ± 0.2	0.41	NS
Thigh (%)	11.88 ± 0.4	12.04 ± 0.58	13.25 ± 0.44	13.17 ± 0.24	0.43	NS
Edible (%)	66.3 ± 0.77	66.02 ± 0.78	68.17 ± 0.73	65.83 ± 1.04	0.84	NS
Non edible (%)	33.7 ± 0.44	33.98 ± 0.59	31.83 ± 0.37	34.17 ± 1.09	0.68	NS

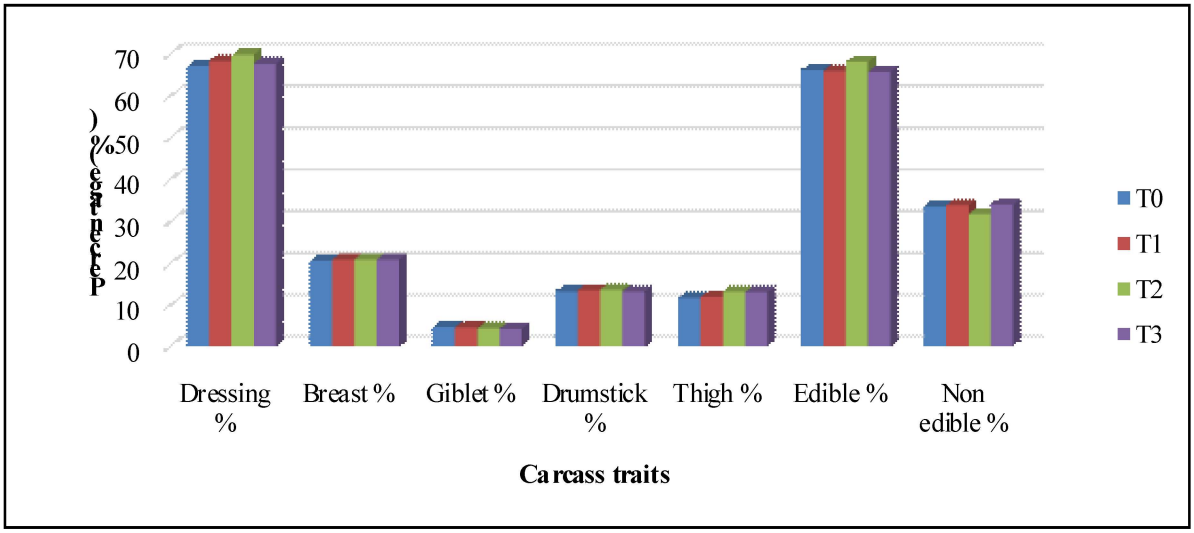

Fig. 4.6 Effect of different levels of Neem leaf powder feeding on carcass traits (%) of broilers

The carcass characteristics data indicated no significant (p<0.05%) difference in the carcass traits (%) among treatment groups. The breast yield was highest in the T_2 group. However, the difference among all the treated groups was non-significant. Although a slight variation was observed in giblet and drum stick per cent of the carcass weight of different treatment groups, it was statistically non-significant. Thigh yield was highest in the T_2 group. However, the difference among all treatments was non-significant.

These results are in agreement with Kharde *et al*. (2014) who observed no significant (p>0.05) influence of supplementation of garlic and neem leaf powder (NLP) on carcass parameters like dressing yield and giblet yield (heart, gizzard and liver) in all treatment groups.

Ozung *et al*. (2013) recorded inclusion of neem leaf meal @ 2.5, 5 and 7.5% in chicken diets no significant (p>0.05) differences across dietary treatments.

Bonsu *et al*. (2012) showed that in both phases' carcass characteristics were not significantly (p>0.05) influenced by the neem leaf meal.

In contrast to this study, Esonu *et al*. (2006) reported carcass weight, dressed weight, liver, heart and gizzard weights were significantly (p<0.05) increased at 5% dietary level of NLM.

4.5 Proximate Composition of Meat

4.5.1 Meat Composition in Breast Muscle

The effect of dietary incorporation of neem leaf powder on meat composition in breast muscle is presented in Table 4.8 and graphically represented in Fig. 4.7.

Table 4.8 Effect of different levels of neem leaf powder feeding on breast muscle composition of broilers

Treatments	Parameter			
	Moisture	Crude protein	Fat	Ash
T_0	71.69 ± 0.30	19.60 ± 0.06	3.40 ± 0.10	1.25 ± 0.02
T_1	71.72 ± 0.16	19.56 ± 0.07	3.38 ± 0.03	1.27 ± 0.01
T_2	71.75 ± 0.16	19.62 ± 0.07	3.22 ± 0.03	1.3 ± 0.02
T_3	71.71 ± 0.17	19.58 ± 0.05	3.32 ± 0.04	1.26 ± 0.02
SE(+)	0.21	0.06	0.06	0.02
CD @ 5%	NS	NS	NS	NS

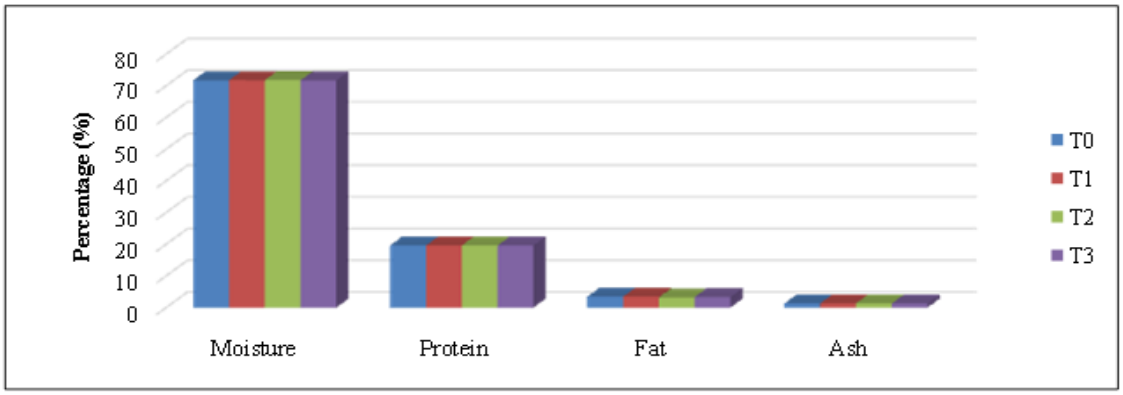

Fig. 4.7 Effect of different levels of neem leaf powder feeding on breast muscle composition of broiler

The data in Table 4.8, envisaged, that 71.69 ± 0.3, 71.72±0.16, 71.75 ± 0.16 and 71.71 ± 0.17 per cent moisture, 19.6 ± 0.06, 19.56 ± 0.07, 19.62 ± 0.07 and 19.58 ± 0.05 per cent protein, 3.4 ± 0.1, 3.38 ± 0.03, 3.22 ± 0.03 and 3.32 ± 0.04 per cent fat, 1.25 ± 0.02, 1.27 ± 0.01, 1.3 ± 0.02 and 1.26 ± 0.02 per cent ash in T_0, T_1, T_2 and T_3 group, respectively were present. Statistically the differences in proximate composition of breast muscle of broiler meat were non-significant, which indicated that though the different levels neem leaf powder in the diet improved feed conversion efficiency but it does not affect the breast meat quality.

4.5.2 Meat Composition in Thigh Muscle

The effect of dietary incorporation of neem leaf powder on meat composition in thigh muscle is presented in Table 4.9 and graphically represented in Fig. 4.8.

Table 4.9 Effect of different levels of neem leaf powder feeding on thigh muscle composition of broilers

Treatments	Parameter			
	Moisture	Crude protein	Fat	Ash
T_0	68.28 ± 0.14	18.94 ± 0.17	5.4 ± 0.14	1.27 ± 0.05
T_1	68.23 ± 0.04	19.08 ± 0.11	5.38 ± 0.09	1.3 ± 0.04
T_2	68.34 ± 0.03	19.18 ± 0.12	5.45 ± 0.08	1.35 ± 0.01
T_3	68.29 ± 0.03	19.15 ± 0.12	5.39 ± 0.06	1.31 ± 0.04
SE(+)	0.08	0.13	0.10	0.04
CD @ 5%	NS	NS	NS	NS

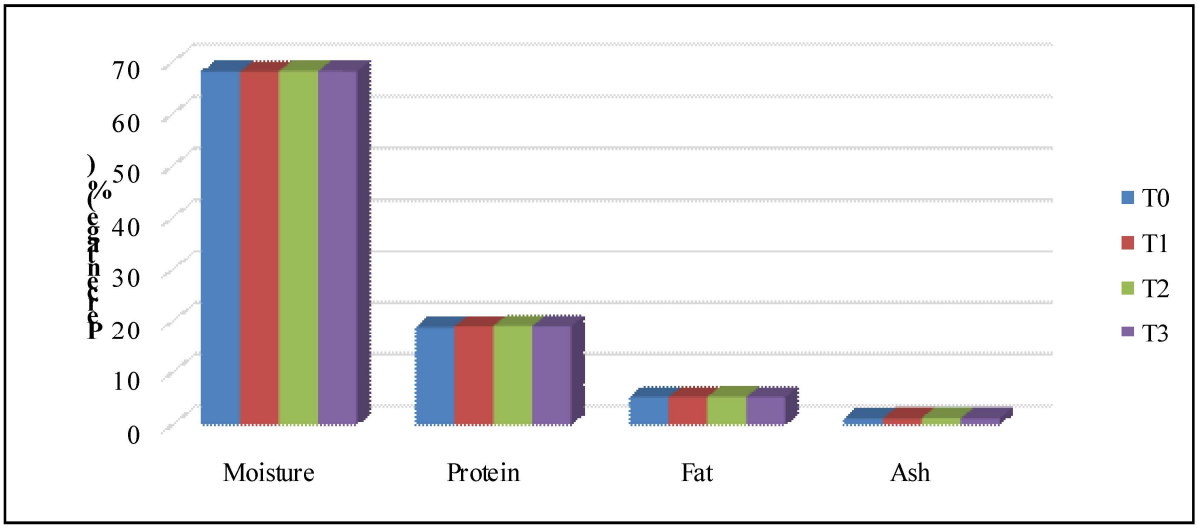

Fig. 4.8 Effect of different levels of neem leaf powder feeding on thigh muscle composition of broiler

The data presented in Table 4.10 indicated that, 68.28 ± 0.14, 68.23 ± 0.04, 68.34 ± 0.03 and 68.29 ± 0.03 per cent moisture, 18.94 ± 0.17, 19.08 ± 0.11, 19.18 ± 0.12 and 19.15 ± 0.12 per cent protein, 5.4 ± 0.14, 5.38 ± 0.09, 5.45 ± 0.08 and 5.39 ± 0.06 per cent fat, 1.27 ± 0.05, 1.3 ± 0.04, 1.35 ± 0.01 and 1.31 ± 0.04 per cent ash in T_0, T_1, T_2 and T_3 group, respectively were present. Statistically the differences in proximate composition in thigh muscle of broilers meat were non-significant. However, different levels of neem leaf powder in the diet did not affect the moisture, protein, fat and ash content of thigh meat samples

From Table 4.8 and 4.9 it indicated that inclusion of neem leaf powder in the broiler diet had non-significant effect on moisture, protein, fat and ash content in breast and thigh tissues. However, a higher fat content was observed in the thigh meat as compared to breast meat.

Ihsan *et al*. (2017) reported addition of neem leaf powder in broiler diets significantly ($p<0.05$) higher crude protein value of meat. The moisture, ether extract and ash content of the breast and thigh meat of the broiler did not affect by the treatments.

4.6 Organoleptic Characteristics of Broiler Meat

Organoleptic evaluation of broiler chicken meat was carried out and the data in Table 4.10 and graphically represented in Fig. 4.9.

Table 4.10 Effect of different levels of neem leaf powder feeding on organoleptic characteristics of broiler chicken

Treatments	Organoleptic characteristics					
	Appearance & colour	Tenderness	Flavour	Juiciness	Texture	Overall acceptability
T_0	7.87 ± 0.14	7.89 ± 0.18	7.56 ± 0.18	7.39 ± 0.20	7.67 ± 0.17	8.11 ± 0.14
T_1	7.94 ± 0.13	8.00± 0.19	7.50± 0.17	7.61 ± 0.14	8.17 ± 0.20	8.22 ± 0.17
T_2	8.11 ± 0.20	8.17 ± 0.20	7.44 ± 0.13	8.00 ± 0.20	8.22 ± 0.21	8.56 ± 0.13
T_3	7.78 ± 0.12	7.83 ± 0.19	7.39 ± 0.14	7.67 ± 0.19	7.83 ± 0.22	8.17 ± 0.14
SE (+)	0.15	0.19	0.15	0.18	0.20	0.15
CD @ 5%	NS	NS	NS	NS	NS	NS

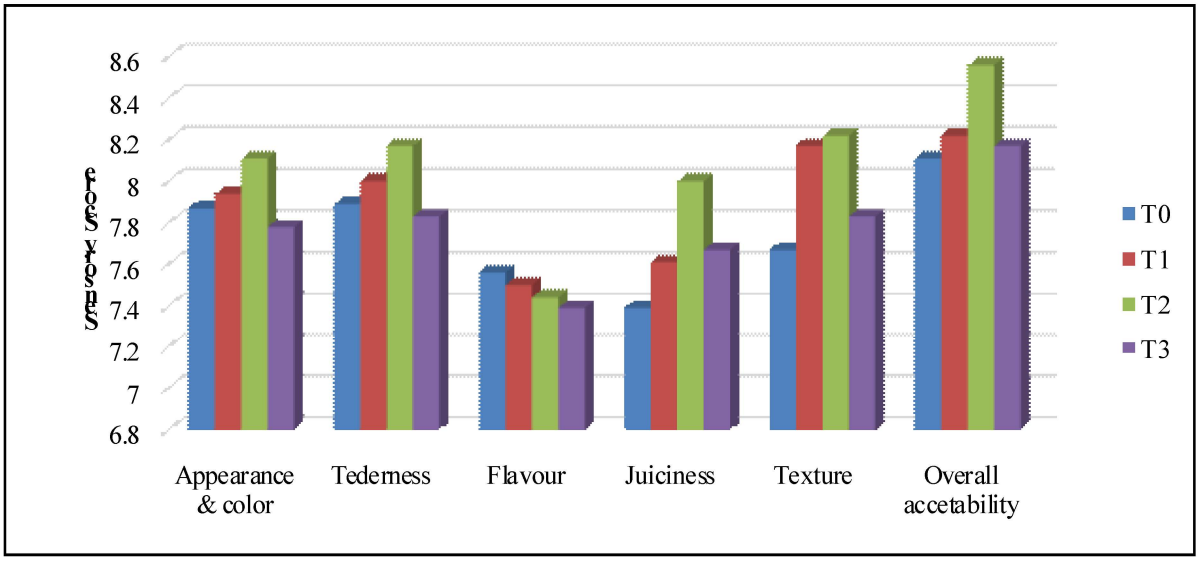

Fig. 4.9 Effect of different levels of neem leaf powder feeding on organoleptic evaluation of broiler meat

Sensory scores for appearance & colour**,** tenderness, juiciness, texture and overall acceptability for the 1% neem leaf powder group were higher than the other group. However, statistically no significant difference was noticed between the treatments for different parameters *viz*., appearance and colour, flavor and overall acceptability.

The trends show that there was no effect for sensory score when broiler birds were fed with different levels of neem leaf powder. The result of sensory quality from this study was in agreement with the results of the study by Bonsu *et al*. (2012) was reported that there was no significant difference in meat colour, aroma, texture and juiciness and acceptability of meat.

5. SUMMARY AND CONCLUSION

An experiment entitled, "Effect of supplementation of Neem (*Azadirachta indica*) Leaf Powder on growth performance and carcass quality of broiler" was conducted at Poultry Unit, Veterinary Polyclinic and A.I. Centre, Department of Animal Husbandry and Dairy Science, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist- Ahmednagar (Maharashtra State). The study was carried out to assess the effect of feeding neem leaf powder (NLP) on body weights, feed consumption, feed conversion ratio (FCR) and carcass parameters of broilers.

The experiment was conducted from December 2018 to January 2019. The study was conducted on broiler chicks in CRD with four treatment groups *viz.*, T_0, T_1, T_2, and T_3 with 40 chicks/hens in each treatment as replicates, on equal weight basis. The details of the feeding treatments were as under.

T_0: Basal diet (Control)

T_1: Basal diet + 5 gm Neem leaf powder/ kg of feed

T_2: Basal diet + 10 gm Neem leaf powder/kg of feed

T_3: Basal diet + 15 gm Neem leaf powder/kg of feed

The experiment was conducted on 160-day old broiler chicks (Vencobb 400) which were obtained from Venky's Hatcheries Private Limited, Pune, Maharashtra. The chicks were reared under uniform feeding and management conditions and were lasted for 42 days. The chicks were housed in separate compartments. The chicks were fed experimental diets with different levels of neem leaf powder supplementation during the experimental period of six weeks of age. The observations on growth performance, feed efficiency, sensory evaluation of meat and proximate composition of meat were recorded.

5.1 Proximate Composition of Experimental Broiler Ration

The broiler diet contained crude protein and calculated metabolizable energy (ME) of the starter diet and Finisher diet was 23 per cent and 2863.81 Kcal/kg, 20 per cent and 2939.75 Kcal/kg respectively.

5.2 Growth Performance

5.2.1 Weekly Body Weight

The average initial body weight of day old chicks in different treatments i.e. T_0, T_1, T_2 and T_3 groups were as 45.20 ± 0.25, 45.15 ± 0.23, 45.18 ± 0.37 and 45.10 ± 0.39 g, respectively. The average body weight of experimental chicks at 6^{th} was 1764.65 ± 14.72, 1849.30 ± 13.43, 1928.35 ± 16.45 and 1869.9 ± 17.72 g, respectively. The weekly body weight changes of chicks indicated no significant difference among various treatment groups during the first two weeks of the experiment. At the end of the sixth week, significantly ($P<0.05$ %) higher body weight gain in the T_2 (1928.35 ± 16.45) group was recorded. However, the treatment T_1 and T_3 were at par to each other.

5.2.2 Body Weight Gain

The weekly live body weight gain of chicks indicated no significant difference among various treatment groups during the first two weeks of the experiment. There is significant ($P<0.05$) difference among the treatments from third weeks onwards. In the sixth week, significantly ($p<0.05\%$) higher body weight gain in the T_2 was recorded. However, the treatment T_0, T_1, T_3 and treatment T_1, T_3 were at par to each other.

5.3 Feed Intake and Feed Efficiency

5.3.1 Feed Intake

The overall average feed intake of the birds during experiment for treatment T_0, T_1, T_2 and T_3 were 3400.23 ± 7.1, 3387.8 ± 9.05, 3366.38 ± 13.92 and 3375.75 ± 9.68 g, respectively. However, the difference was non-significant of the feed consumption in all the treatment groups during experimental period of six weeks.

The average feed intake of the birds at six weeks of age during experiment for treatment T_0, T_1, T_2 and T_3 were 960.03 ± 9.03, 952.75 ± 10.94, 946.25 ± 13.77 and 950.55 ± 12.79 g, respectively. However, the difference was non-significant of the feed intake in all the treatment groups for the entire experimental period.

5.3.2 Feed Conversion Ratio

All treatments were non-significant upto second week's period. Statistically the significant ($P<0.05\%$) was observed in FCR from third to six weeks. The feed conversion ratio at six weeks for treatment T_0, T_1, T_2 and T_3 were 2.44 ± 0.07, 2.30 ± 0.05, 2.12 ± 0.05 and 2.27 ± 0.10, respectively. Overall feed conversion ratio for treatments T_0, T_1, T_2 and T_3 were 1.96 ± 0.02, 1.88 ± 0.01, 1.80 ± 0.02 and 1.86 ± 0.02 respectively. Statistically better FCR was recorded in T_2 treatment as compared to other treatments. However, treatment T_1 with T_3 was at par to each other.

5.4 Carcass Traits

The carcass characteristics data indicated no significant difference in the carcass traits (%) among treatment groups. The breast yield was highest in the T_2 group. However, the difference among all the treated groups was non-significant. Although a slight variation was observed in giblet and drumstick per cent of the carcass weight of different treatment groups, it was statistically non-significant. Thigh yield was highest in the T_2 group. However, the difference among all treatments was non-significant.

5.5 Meat Composition

The per cent proximate principles in breast muscle under each treatment were 71.69 ± 0.3, 71.72 ± 0.16, 71.75 ± 0.16 and 71.71 ± 0.17 per cent moisture, 19.6. ± 0.06,

19.56 ± 0.07, 19.62 ± 0.07 and 19.58 ± 0.05 per cent protein, 3.4 ± 0.1, 3.38 ± 0.03, 3.22 ± 0.03 and 3.32 ± 0.04 per cent fat, 1.25 ± 0.02, 1.27 ± 0.01, 1.3 ± 0.02 and 1.26 ± 0.02 per cent ash in T_0, T_1, T_2 and T_3 group, respectively. Statistically the differences in proximate composition of breast muscle of broiler meat were non-significant, which indicated that though the different levels of neem leaf powder in the diet improved feed conversion efficiency but it does not affect the meat quality.

Similarly, in thigh muscle under each treatment 68.28 ± 0.14, 68.23 ± 0.04, 68.34 ± 0.03 and 68.29 ± 0.03 per cent moisture, 18.94 ± 0.17, 19.08 ± 0.11, 19.18 ± 0.12 and 19.15 ± 0.12 per cent protein, 5.40 ± 0.14, 5.38 ± 0.09, 5.45 ± 0.08 and 5.39 ± 0.06 per cent fat, 1.27± 0.05, 1.30 ± 0.04, 1.35 ± 0.01 and 1.31 ± 0.04 per cent ash in T_0, T_1, T_2 and T_3 group, respectively were present. Statistically the differences in proximate composition in thigh muscle of broilers meat were non-significant. However, different levels of neem leaf powder in the diet of broiler did not affect the moisture, protein, fat and ash content of thigh meat samples

5.6 Organoleptic Characteristics of Broiler Meat

Sensory scores for appearance & colour**,** tenderness, juiciness, texture and overall acceptability for the 1% neem leaf powder group (T_2) were higher than the other group. However, statistically no significant difference was noticed between the treatments for different parameters *viz*., appearance and colour, flavor and overall acceptability. The trends show that there was no effect for sensory score was observed when fed with neem leaf powder.

Conclusions

From the present investigation, the following conclusions were drawn.

1. The effect of feeding of neem leaf powder on growth performance of broiler indicated that 10 gm of neem leaf powder had significantly higher body weight and weekly gain in body weight.
2. Better feed conversion ratio was observed in T_2 (10 gm neem leaf powder), however treatment T_1 (5 gm neem leaf powder) and T_3 (15 gm neem leaf powder) were at par to each other.
3. Dietary treatments did not significantly influence the carcass traits and organoleptic characteristics of broiler meat.

The inclusion of neem leaf powder @ 10 gm in broiler ration as a feed supplement found better in terms of growth performance without affecting meat quality of broilers.

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7. VITAE

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MASTER OF SCIENCE (AGRICULTURE)

IN

ANIMAL HUSBANDRY

2019

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