SYNERGISTIC EFFECT OF NEEM LEAF (*Azardirachta indica*) AND SWEET POTATO (*Ipomoea batatas*) ON BROILER PRODUCTION

BY

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CERTIFICATE

*This is to certify that thesis entitled, "**SYNERGISTIC EFFECT OF NEEM LEAF (Azardirachta indica) AND SWEET POTATO (Ipomoea batatas) ON BROILER PRODUCTION**" submitted to the Faculty of Animal Science & Veterinary Medicine, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE (M.S.) in ANIMAL NUTRITION**, embodies the result of a piece of bona-fide research work carried out by **MD. ALAUDDIN, Registration no.19-10111** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

I further certify that such help or source of information, as has been availed of during the course of this investigation has duly been acknowledged.

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Dedicated To

My Beloved Parents

And Respected

Teachers

Whose Prayers,

Efforts And

Wishes Are an

Inspiration

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The Author

LIST OF CONTENTS

LIST OF CONTENTS (Cont'd)

LIST OF CONTENTS (Cont'd)

LIST OF CONTENTS (Cont'd)

LIST OF CONTENTS (Cont'd)

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF APPENDICES

LIST OF ACRONYMS AND ABBREVIATION

ABBREVIATION		FULL MEANING
NLP	=	Neem leaf powder
SPP	=	Sweet potato powder
ANOVA	=	Analysis of variance
Avg.	=	Average
BWG	=	Body weight gain
NLSPP	=	Neem leaf and sweet potato powder
DOC	=	Day old chick
DP	=	Dressing percentage
DSM	=	Diagnostic and statistical manual
e.g.	=	For example
et al.	=	And others/associates
EU	=	European union
FAO	=	Food and Agricultural Organization
FC	=	Feed consumption
FCR	=	Feed conversion ratio
FI	=	Feed intake
g	=	Gram
i.e.	=	That is
K Cal	=	Kilo calorie
Kg	=	Kilogram
L	=	Litre
M.S.	=	Master of science
ME	=	Metabolizable energy
ml	=	Mililitre
mm	=	Milimetre

LIST OF ACRONYMS AND ABBREVIATION (CONT'D)

ABBREVIATION		FULL MEANING
No.	=	Number
NS	=	Non-significant
RH	=	Relative humidity
SAU	=	Sher-e-Bangla Agricultural University
SE	=	Standard Error
SPP	=	Sweet potato powder
SPSS	=	Statistical package for social sciences
Viz.	=	Such as
Vs.	=	Versus
WHO	=	World Health Organization
NLP	=	Neem Leaf powder
*	=	5% level of significance
&	=	And
@	=	At the rate of
℃	=	Degree celcius
$	=	Dollar
>	=	Greater than
<	=	Less than
/	=	Per
%	=	Percentage
±	=	Plus-minus
:	=	Ratio

SYNERGISTIC EFFECTS OF NEEM LEAF (*Azardirachta indica*) AND SWEET POTATO (*Ipomoea batatas*) ON BROILER PRODUCTION

ABSTRACT

A total of 120 day old "Cobb-500" broiler chicks were reared in the poultry farm of Sher-e-Bangla Agricultural University, Dhaka, to evaluate the growth performance of broiler fed diet containing neem leaf powder (NLP) and sweet potato powder (SPP). Chicks were divided randomly into 4 experimental group with 3 replications of each group. Each replication contains 10 chicks. One of the 4 experimental group was fed with antibiotics in basal diet and considered as control group (T_0); the remain three groups were fed diet with (2 g NLP + 2 g SPP)/kg feed (T_1), (2 g NLP + 4 g SPP)/kg feed (T_2), and (2 g NLP + 6 g SPP)/kg feed (T_3). Experiment revealed that the relative final live weight (g) of broiler chicken in T_3 ($1875.4^{a}\pm23.27$) group were significantly ($P<0.05$) higher than other groups. Feed conversion ratio of T_1 ($1.3133^{b}\pm.008$) was significantly ($P<0.05$) better than other groups including control T_0 ($1.3367^{a}\pm0.03$). Feed conversion ratio in T_3($1.3333^{a}\pm0.03$) was also better than control group T_0 ($1.3367^{a}\pm0.03$) without any statistically significant ($P<0.05$) differences. The dressing percentage of broiler were $66.66^{b}\pm0.82\%$, $67.30^{a}\pm2.07$, $67.64^{a}\pm1.3\%$ and $64.68^{c}\pm1.33\%$ in T_1 ,T_2, T_3 and T_0 respectively. All treatment groups were significantly ($P< 0.05$) higher than the control group. The relative weight (g) of liver were $41.0^{a}\pm.57$, $41.0^{a}\pm.57$, $45.6^{ab}\pm5.78$ and $54.3^{b}\pm2.02$ in T_0, T_1 ,T_2 and T_3 respectively; the relative weight of heart were $9.817\pm.14$, $10.167\pm.35$, $10.100\pm.56$ and $10.933\pm.31$ in T_0, T_1 ,T_2 and T_3 respectively; the relative weight of gizzard $37.167\pm.52$, 38.033 ± 1.92), 39.000 ± 1.41 and $40.400\pm.15$ in T_0, T_1 ,T_2 and T_3 respectively. The weight of liver, heart and gizzard in T_3 were significantly ($P<0.05$) higher than the other groups including control. The feed consumption; body weight gains (g); survivability rate; carcass weight; weight of intestine; immune organ (spleen) and flock uniformity of broiler chicken were no significant ($P>0.05$) difference among the treatment and control groups. The profit per bird were $57.7367^{a}\pm.09$, $57.9233^{a}\pm1.33$, $56.0067^{a}\pm1.36$ and $62.3933^{b}\pm1.33$ in T_0, T_1 ,T_2 and T_3 respectively. T_3 was significantly ($P< 0.05$) higher than all groups including control group. The experiment recommended that neem leaf powder and sweet potato powder can be use at the concentration of (2 g NLP + 6 g SPP)/kg feed in broiler production.

CHAPTER I
INTRODUCTION

1.1 General Background

Bangladesh is a country in Southern Asia and is located on the Bay of Bengal bordered by India all sides except for a small boarder with Myanmar. In terms of land mass, Bangladesh ranks 92nd, spanning 147,570 sq. kilometers (56,980 sq. miles). It is the eight most populous country in the world, with a population exceeding 161 million people, making it one of the most densely populated countries in the world. Bangladesh is an agricultural country. About 80% of people live in this country based on agriculture. Poultry farming has emerged as one of the fastest growing agribusiness industries in the world, even in Bangladesh. Research on meat production globally indicates poultry as the fastest growing livestock sector especially in developing countries. Poultry plays a vital role in the income generating framework of the rural people of Bangladesh. Poultry such as chicken is one the main sources of animal protein for Bangladeshi people (Kamal and Shafiullah, 2016).

In our country, the growth of population is increasing day by day. Demand of protein of this booming population is a great threat for us. There are so many sources of protein. Broiler can be an alternative potential source to fulfill this demand. Because the duration of broiler rearing is very short and within 28-36 days it is ready for marketing and suitable for human consumption. It also brings very short time return to farmer. Broilers meat is popular to all and there is no religious restriction to consume broiler meat. Improving profitability, reducing environmental impact and enhancing animal welfare are key priorities for the agriculture sector. The major constrain of broiler production is cost of feed that accounts for up to 70% of the total production cost. And the other major challenges this industry faces is the spreading of diseases among the poultry population due to bacterial pathogens which results in serious economic losses (Huque *et al*., 2011). It has triggered the discovery and widespread use of a number of ‘feed additives’. The term feed additive is applied in a broad sense, to all products other than those commonly called feedstuffs, which could be added to the ration with the purpose of obtaining some special effects. The main objective of adding feed additives is to boost animal performance by increasing their growth rate, better-feed conversion efficiency, greater livability and lowered mortality in poultry

birds. These feed additives are termed as “growth promoters” and often called as non-nutrient feed additives (Ilango, 2013) as a result, the use of antimicrobial agents and growth promoters is substantially increasing in the poultry industry to prevent diseases and to promote faster growth (Islam *et al.,* 2016).

In poultry industry, antibiotic growth promotors (AGP) have been used as a feed additive to enhance gut health and control sub-clinical diseases. Synthetic growth enhancers and supplements in poultry nutrition are expensive, usually unavailable and possess adverse effects in bird and human. Sub-therapeutic levels of antibiotics given to poultry as growth enhancer may result to the development of antibiotic-resistant bacteria, which are hazardous to animal and human health (Sarica *et al.,* 2005). However, the use of antibiotics as feed additives is under severe criticism. Growth stimulating antibiotics, by the spread of antibiotic resistant bacteria, are a threat to human health (Wray and Davies, 2000; Turnidge, 2004). Sub-therapeutic levels of antibiotics are mixing in feed ingredient during processing of feed or mixing in drinking water also increasing the cost of feed.

1.2 State of the Problems

The use of antibiotics as feed additives is under severe criticism. Growth stimulating antibiotics, by the spread of antibiotic resistant bacteria, are a threat to human health (Wray and Davies, 2000). Concerns were raised that the use of antibiotics as therapeutics and for growth promotion could lead to a problem of increasing resistance in bacteria of human and animal origin (Jensen, 1998), particularly regarding resistance in gram-negative bacteria (*Salmonella* spp. and *Escherichia coli*). In addition they also will have effect on gut flora composition, specifically in regard to increased excretion of food-borne pathogens (Neu, 1992). The poultry industry is currently moving towards a reduction in use of synthetic antibiotics due to this reason (Barton, 1998).

Because of the growing concern over the transmission and proliferation of resistant bacteria via the food chain, the European Union (EU) banned antibiotic growth promoters to be used as additives in animal nutrition (Cardozo *et al.,* 2004).

Alternative feed additives for farm animals are referred to as Natural Growth Promoters (NGP) or non-antibiotic growth promoters (Steiner, 2006) which include acidifiers, probiotics, prebiotics, phytobiotics, feed enzymes, immune stimulants and antioxidants are gaining the attention. The NGPs, particularly some natural herbs have

been used for medical treatment since prehistoric time. There are some important bioactive components such as alkaloids, bitters, flavonoids, glycosides, mucilage, saponins, tannins (Vandergrift, 1998) phenols, phenolic acids, guinones, coumarins, terpenoids, essential oils, lectins and polypeptides in the structures of nearly all the plants. The use of various plant materials as dietary supplements may positively affect poultry health and productivity.

The large number of active compounds in these supplements may therefore present a more acceptable defense against bacterial attack than synthetic antimicrobials. There is evidence to suggest that herbs, spices and various plant extracts have appetizing and digestion- stimulating properties and antimicrobial effects (Madrid *et al.*, 2003) which stimulate the growth of beneficial bacteria and minimize pathogenic bacterial activity in the gastrointestinal tract of poultry (Wenk, 2000). On the other hand, supplementing the diet with plant material that is rich in active substances with beneficial effects for the immune system can be used as an alternative to antibiotic growth promoters.

Beneficial effects of herbal extracts or active substances in animal nutrition may include the stimulation of appetite and feed intake, the improvement of endogenous digestive enzyme secretion, activation of immune response, antibacterial, anti-viral, anti-oxidant and anti-helminthic actions.

Generally, plant extracts have no problem of resistance (Tipu *et al.*, 2006) and broilers fed on herbal feed additives were accepted well by the consumers. Poultry are the cheapest source of animal protein, contributing significantly to supply the growing demand for animal food products around the world (Farrell, 2013). The consumption and trade in poultry products are increasing rapidly as the human population increases, making it the second largest source of meat after pork (FAO, 2014). The biggest challenge of commercial poultry production is the availability of quality feed on sustainable basis at stable prices.

Neem (*A. indica*) is one of those trees in the world which is currently under discussion on a large scale has been found that different parts of the Neem tree contain chemicals such as azadiractin, nimbin, nimbindin and quercetin and others. The rapid growth of the tree which is evergreen and has medicinal and nutritional effectiveness of chicken meat. Neem in the wa`ter led to an increase in the effectiveness of the feed conversion

and an increase in weight. So present study aims to investigate the determination of impact of Neem powder added to the diet in broiler chickens to evaluating growth performance & immune response of commercial broiler.

1.3 Justification of the study

The production of healthy birds with quality meat and eggs without harmful residues, within a short time interval is the major concern to modern poultry farmers (Neu, 1992).

Neem, a tropical ever green tree is native to the Asian sub-continent. Neem dry leaves fed to broilers have been reported to significantly enhance the antibody titers against new castle diseases (Bakr, 2013). Biologically active ingredients isolated from different parts of the plants include; azadirachtin, meliacin, gedunin, salanin, nimbin, valassinetc (Chari, 1996). Neem has attracted worldwide prominence due to its vast range of medicinal properties like antibacterial, antiviral, antifungal, antiprotozoal, hepatoprotective and various other properties without showing any adverse effects (Kale *et.al*., 2003). Also, neem promotes growth and feed efficiency of birds because of its antibacterial and hepatoprotective properties (Padalwar, 1994). Sweet potato can substitute cereal grains as a carbohydrate source in diets of poultry in tropical countries (Ravindran *et al.* 1995).

The potential of sweet potato in food security and global wellbeing has been well recognized with studies performed on its various properties such as processing, utilization and health importance in humans (Waramboi *et al*. 2011). Its roots are rich in carbohydrates and vitamin A and its leaves are rich in proteins. It can produce more edible energy per hectare per day than wheat, rice or cassava (Lebot 2009). Sweet potato has high productive efficiency and is a reliable source of energy due to its high starch content and digestibility, but its use as a feed ingredient is limited. The limited use of this crop in poultry diets is associated with its high moisture content, associated high drying cost during processing and its low protein content (Avigen 2015). The low protein, sulphur amino acids and lysine content can be overcome by inclusion of protein concentrates, while the high cost of drying can be overcome by presenting it to birds as a boiled mash as well as use of low-cost appropriate drying techniques (Glatz *et al.,* 2007). However, for sweet potato to meet its potential in the feed ingredient market place, studies are required to determine the opportunities and

limitations of its inclusion in poultry diets in order to maximize productive responses in broiler chickens.

Sweet potato has been used in the diets of fish, pigs and poultry (Pandi 2006) to replace grain in developing countries. Recent work by Beckford and Bartlett (2015) with Cornish Rock broiler chickens used discarded sweet potato roots at inclusion rates of 100, 200 and 300 g/kg in the starter, grower and finisher feeds respectively and showed no significant differences in the total feed intake and final live weights of these birds. Feed conversion ratios (FCR) of birds fed with all these sweet potato diets had better FCRs than birds fed with a maize diet indicating that sweet potato roots can be fed to broilers to improve profit margins for farmers (Beckford and Bartlett 2015). These results were similar to those reported by (Glatz, 2013).

1.4 Objectives

With this background, the work was planned to explore the possibilities of Neem Leaf and Sweet Potato in broiler chicken feeds as a replacement for the antibiotic growth promoters, with the following specific objectives:

i. To evaluate the growth performance of broiler by using neem leaf powder and sweet potato powder based diet and comparison with antibiotic added basal diet;
ii. To produce safe broiler meet by naturally grown product;
iii. To evaluate different carcass characteristics of broiler.

CHAPTER II
REVIEW OF LITERATURE

A total about 110 literature were reviewed to identify the background, drawbacks and prospects of research, understand previous findings and to answer the research status. Among them 22 were full article and 60 abstracts, 18 were only titles and some were miscellaneous. A brief account is given below depending on five main headlines viz, antibiotic impacts on poultry, Antibiotic growth promoters (AGPs), Antimicrobial resistance, Alternatives to antibiotic growth promoters and Neem Leaf. Mentioning the references in a traditional way or sequence is avoided. A very critical enquires was made of each article and significant information was collected and arranged according to specific title. It is expected to be pioneering efforts in Bangladesh for higher research review attempts.

Poultry farming has emerged as one of the fastest growing agribusiness industries in the world. Research on meat production globally indicates poultry as the fastest growing livestock sector especially in developing countries. It has triggered the discovery and widespread use of a number of "feed additives". Further, disease surveillance, monitoring and control will also decide the fate of this sector. Unlike livestock farming, poultry farming is always intensive and hence the birds are more subjected to stressful conditions. Stress is an important factor that renders the birds vulnerable to potentially pathogenic microorganisms. These pathogenic microflorae's in the small intestine compete with the host for nutrients and also reduce the digestion of fat and fat soluble vitamins due to deconjugating effects of bile acids (Engberg*et al.*, 2000). This ultimately leads depressed growth performance and increase incidence of disease.

2.1 Neem

Mahady (2002) found that feeding of *Andrographis paniculatis*to broiler chickens resulted in improved feed conversion ratio, increased live weight and decreased mortality rate and opined that the plant feeding could be an alternative to chlortetracycline in the broiler diet.

In the past two decades a number of ayurvedic preparations have been extensively used in poultry industry in India. Preparations like Livol® and Zeestress® have been found to possess hepatoprotective and immunopotentiative actions in vaccinated birds

and reduced the stress in intensively housed chickens during summer (Parida *et al.,* 1995).

2.1.1 Chemical composition of neem leaves

Neem leaves are chemically composed of proteins, fibers, ether, ash and other compounds, (Okpanyi *et al.,* 1996) showed that neem leaves contain Crude protein 15.8%, Crude fiber 14.6%, Ether extract 8.5%, Ash 4.5%, Moisture 13.0% and NFE 56.6%, These percentages vary from one place to another due to variations in nutrient composition of the soil where the neem plant is grown.

2.1.2 Mechanism of action on neem

Neem (*Azadirachta indica*), a member of the Meliaceae family, has therapeutics implication in the diseases prevention and treatment. But the exact molecular mechanism in the prevention of pathogenesis is not understood entirely. It is considered that *Azadirachta indica* shows therapeutic role due to the rich source of antioxidant and other valuable active compounds such as azadirachtin, nimbolinin, nimbin, nimbidin, nimbidol, salannin, and quercetin. Possible mechanism of action of *Azadirachta indica* is presented as follows:

Neem (*Azadirachta indica*) plants parts shows antimicrobial role through inhibitory effect on microbial growth/potentiality of cell wall breakdown.
Azadirachtin, a complex tetra nor triter phenolic limuloid present in seeds, is the key constituent responsible for both anti-oxidant and toxic effects in insects (MordueLuntz, 2000) Results suggest that the ethanol extract of neem leaves showed *in vitro* antibacterial activity

1. Neem plays role as free radical scavenging properties due to rich source of antioxidant. Azadirachtin and nimbolide showed concentration-dependent antiradical scavenging activity and reductive potential in the following order: nimbolide>azadirachtin>ascorbate. (Hossain *et al*,.2013)
2. Neem ingredient shows effective role in the management of cancer through the regulation of cell signaling pathways. Neem modulates the activity of various tumor suppressor genes (e.g., p53, pTEN), angiogenesis (VEGF), transcription factors (e.g., NF-κB), and apoptosis (e.g., bcl2, bax).

3. Neem also plays role as anti-inflammatory via regulation of proinflammatory enzyme activities including cyclooxygenase (COX), and lipoxygenase (LOX) enzyme.

2.1.3 Antioxidant properties of neem:

Antioxidants are the chemicals that reduce the rate of particular oxidation reaction. They help to protect the body from damage of cell by free radicals. Free radicals are chemical species possessing an unpaired electron that can be considered as fragment of molecules and which are generally very reactive. There is a report that the more the toxic metals in our body, the higher the free radical activity. Thus toxic metals are a cause of free radicals. They cause to oxidative damage of protein, DNA and other essential molecules and cause cancer, cardiovascular diseases and heart disease, and oxidative stress. Free radical or reactive oxygen species are one of the main culprits in the genesis of various diseases. However, neutralization of free radical activity is one of the important steps in the diseases prevention. Antioxidants stabilize/deactivate free radicals, often before they attack targets in biological cells (Nunes P. X. 2012) and also play role in the activation of antioxidative enzyme that plays role in the control of damage caused by free radicals/reactive oxygen species. Medicinal plants have been reported to have antioxidant activity (Rahmani, 2015). Plants fruits, seeds, oil, leaves, bark, and roots show an important role in diseases prevention due to the rich source of antioxidant. Leaf and bark extracts of *A. indica* have been studied for their antioxidant activity and results of the study clearly indicated that all the tested leaf and bark extracts/fractions of neem grown in the foothills have significant antioxidant properties (Ghimeray A. K. 2009). Another important study was performed based on leaves, fruits, flowers, and stem bark extracts from the Siamese neem tree to assess the antioxidant activity and results suggest that extracts from leaf, flower, and stem bark have strong antioxidant potential (Sithisarn, 2005). A valuable study was carried out to evaluate *in vitro* antioxidant activity in different crude extracts of the leaves of *Azadirachta indica* (neem) and antioxidant capacity of different crude extracts was as follows: chloroform >butanol> ethyl acetate extract > hexane extract > methanol extract. Result of the current finding suggested that the chloroform crude extracts of neem could be used as a natural antioxidant (Hossain, 2013). Other results revealed that azadirachtin and nimbolide showed concentration-dependent antiradical scavenging activity and reductive potential in the following

order: nimbolide>azadirachtin>ascorbate. Furthermore, administration of azadirachtin and nimbolide inhibited the development of DMBA-induced HBP carcinomas through prevention of procarcinogen activation and oxidative DNA damage and upregulation of antioxidant and carcinogen detoxification enzymes (Priyadarsini, 2009).

2.1.4 Effect of neem on internal organs

Medicinal plants and their ingredients play a pivotal role as hepatoprotective without any adverse complications. A study was performed to investigate the hepatoprotective role of azadirachtin-A in carbon tetrachloride (CCl_4) induced hepatotoxicity in rats and histology and ultrastructure results confirmed that pretreatment with azadirachtin-A dose-dependently reduced hepatocellular necrosis (Baligar, 2014). Further results of the study show that pretreatment with azadirachtin-A at the higher dose levels moderately restores the rat liver to normal.

Another study was carried out to evaluate the protective effect of active constituent of neem such as nimbolide against carbon tetrachloride (CCl_4) induced liver toxicity in rats and results suggest that nimbolide possesses hepatoprotective effect against CCl_4 induced liver damage with efficiency similar to that of silymarin standard (Baligar, 2014) and another study finding revealed that leaf extract was found to have protection against paracetamol-induced liver necrosis in rats (Bhanwra, 2000).

A study assesses the hepatoprotective activity of *Azadirachta indica* leaf extract on antitubercular drugs-induced hepatotoxicity and results confirmed aqueous leaf extract significantly prevented changes in the serum levels of bilirubin, protein, alanine aminotransferase, aspartate aminotransferase, and alkaline phosphatase and significantly prevented the histological changes as compared to the group receiving antitubercular drugs (Kale, 2003). Additionally, other results showed that ethanoic and aqueous leaf extracts of *A. indica* exhibited moderate activity over carbon tetrachloride treated animals (Kalaivani, 2009). Hepatoprotective effect of methanol and aqueous extracts of *Azadirachta indica* leaves was evaluated in rats and study result established that the plant has good potential to act as hepatoprotective agent.

An experiment was made to investigate the protective effect of neem extract on ethanol- induced gastric mucosal lesions in rats and results showed that pretreatment with neem extract showed protection against ethanol-induced gastric mucosal

damage. A study was performed to investigate the neuroprotective effects of *Azadirachta indica* leaves against cisplatin- (CP-) induced neurotoxicity and results showed that morphological findings of neem before and after CP injection implied a well-preserved brain tissue. No changes, in biochemical parameters, were observed with neem treated groups.

2.1.5 Effect of neem on immune organs

Plants or their isolated derivatives are in the practice to treat/act as anti-inflammatory agents. A study result has confirmed that extract of *A. indica* leaves at a dose of 200 mg/kg, showed significant anti-inflammatory activity in cotton pellet granuloma assay in rats. Other study results revealed that neem leaf extract showed significant anti-inflammatory effect but it is less efficacious than that of dexamethasone (Mosaddek, 2008) and study results suggest that nimbidin suppresses the functions of macrophages and neutrophils relevant to inflammation (Kaur, 2004).

Earlier finding showed immune-modulator and anti-inflammatory effect of bark and leave extracts and antipyretic and anti-inflammatory activities of oil seeds. Experimentation was made to evaluate the analgesic activity of neem seed oil (Arora, 2011) on albino rats and results of the study showed that neem seed oil showed significant analgesic effect in the dose of 1 and 2 mL/kg and oil has dose-dependent analgesic activity (Kumar, 2012). Another study was made to investigate the anti-inflammatory effect of neem seed oil (NSO) on albino rats using carrageenan-induced hind paw edema and results revealed that NSO showed increased inhibition of paw edema with the progressive increase in dose from 0.25 mL to 2 mL/kg body weight. At the dose of 2 mL/kg body weight, NSO showed maximum (53.14%) inhibition of edema at 4th hour of carrageenan injection (Naik M. R 2014). Results of the study concluded that the treated animals with 100 mg kg−1 dose of carbon tetrachloride extract (CTCE) of *Azadirachta indica* fruit skin and isolated ingredient azadiradione showed significant antiseptic and anti-inflammatory activities (Ilango, 2013).

2.1.6 Effect of neem on microbial activity

Neem and its ingredients play role in the inhibition of growth of numerous microbes such as viruses, bacteria, and pathogenic fungi. The role of neem in the prevention of microbial growth is described individually as follows

2.1.6.1 Antibacterial activity

A study was performed to evaluate antimicrobial efficacy of herbal alternatives as endodontic irritants and compared with the standard irritant sodium hypochlorite and finding confirmed that leaf extracts and grape seed extracts showed zones of inhibition suggesting that they had antimicrobial properties. Furthermore, leaf extracts showed significantly greater zones of inhibition than 3% sodium hypochlorite (Ghonmode, 2013).

The antibacterial activity of guava and neem extracts against 21 strains of foodborne pathogens was evaluated and result of the study suggested that guava and neem extracts possess compounds containing antibacterial properties that can potentially be useful to control foodborne pathogens and spoilage organisms (Hoque, 2011). Another experiment was made to evaluate the antibacterial activity of the bark, leaf, seed, and fruit extracts of *Azadirachta indica* (neem) on bacteria isolated from adult mouth and results revealed that bark and leaf extracts showed antibacterial activity against all the test bacteria used. Furthermore, seed and fruit extracts showed antibacterial activity only at higher concentrations (Yerima, 2012).

2.1.6.2 Antiviral activity

Results showed that neem bark (NBE) extract significantly blocked HSV-1 entry into cells at concentrations ranging from 50 to 100 μg/mL. Furthermore, blocking activity of NBE was noticed when the extract was preincubated with the virus but not with the target cells suggesting a direct anti-HSV-1 property of the neem bark (Tiwari, 2010). Leaves extract of neem has shown virucidal activity against coxsackievirus virus B-4 as suggested via virus inactivation and yield reduction assay besides interfering at an early event of its replication cycle (Badam, 1999).

2.1.6.3 Antifungal activity

Experiment was made to evaluate the efficacy of various extracts of neem leaf on seed borne fungi *Aspergillus* and *Rhizopus* and results confirmed that growth of both the fungal species was significantly inhibited and controlled with both alcoholic and water extract. Furthermore, alcoholic extract of neem leaf was most effective as compared to aqueous extract for retarding the growth of both fungal species. Another finding showed the antimicrobial role of aqueous extracts of neem cake in the

inhibition of spore germination against three sporulating fungi such as *C. lunata*, *H. pennisetti*, and *C. gloeosporioides*f. sp. *Mangiferae* (Anjali, 2013) and results of the study revealed that methanol and ethanol extract of *Azadirachta indica* showed growth inhibition against *Aspergillus flavus*, *Alternaria solani*, and *Cladosporium* (Shrivastava, 2014).

2.1.7 Effect of neem on biochemical (safety, toxicity, LD50 value) properties

The measurement of toxicities of natural compound is crucial before their application in health management. Various studies based on animal model and clinical trials confirmed the neem is safe at certain dose and on the other side neem and its ingredients showed toxic/adverse effect. Several studies reported, in children, neem oil poisoning causing vomiting, hepatic toxicity, metabolic acidosis, and encephalopathy (Sundaravalli, 1982) and another study based on rat model showed that administration of leaf sap caused an antianxiety effect at low doses, whereas high doses did not show such types of effect. An important study based on rat's model showed that azadirachtin did not show toxicity even at 5 g/kg bw. A study based on rabbit was performed to check the toxicological analysis and results of the study showed there was progressive increase in body weight in both the test and control animals, and during the entire duration of the administration of the neem extract, there was no observed sign of toxicity in both groups (Sarker *et al.*, 2011).

A study result showed that, in the acute toxicity test, the LD50 values of neem oil were found to be 31.95 g/kg. Another study was performed to evaluate the toxicity in chicken and finding showed that acute toxicity study of neem leaf aqueous extract revealed an intraperitoneal LD50 of 4800 mg/kg, and clinical signs were dose dependent (Biu, 2011).

A study reported that lethal median doses (LD50) recorded for neem leaf and stem bark extracts were 31.62 and 489.90 mg/kg body weight, respectively (Akin-Osanaiya, 2013). The LD50 of water extract of *A. indica* leaves and seeds were 6.2, 9.4 mL kg^{-1}, respectively (Bakr, 2013). Lethal dose values were calculated with probiotic analysis and LD50 and LD90 values were found to be 8.4 and 169.8 μg/fly of neem extract, respectively (Khan and Ahmed, 2000). A test for acute oral toxicity in mice revealed that LD50 value of approximately 13 g/kg body weight (Okpanyi and Ezeukwu, 1996).

2.1.8 Effect of neem on blood parameter

Angiogenesis is complex process that supplies blood to the tissue and that is essential for growth and metastasis of tumor. Angiogenesis is regulated by activators as well as inhibitors. The development of antiangiogenic agents to block new blood vessel growth is crucial step in the inhibition/prevention of tumor growth. Medicinal plants and their ingredients play role in prevention of tumor growth due to their antiangiogenic activity.

An important study revealed that ethanoic fraction of neem leaf (EFNL) treatment effectively inhibited the expression of proangiogenic genes, vascular endothelial growth factors A, and angiopoietin, indicating the antiangiogenic potential of EFNL. Furthermore, inhibition of angiogenesis by ethanoic fraction of neem leaf (EFNL) could be a reason for reduction in mammary tumor volume and for blocked development of new tumor as observed in current studies (Arumugam et al., 2014).

2.2 Sweet potato

Sweet potato (*Ipomoea batatas* (L.) Lam.) is a plant grown for its tuberous roots in tropical, subtropical and warm-temperate regions. Sweet potato tubers are a staple food or an alternative food in many countries and part of the production is used for animal feeding. Sweet potato meal can be successfully used as a substitute for maize in broiler diets, but in most cases the highest substitution levels decrease performance. The recommended inclusion level is usually 20%. For examp

le 25% sweet potato meal plus 10% molasses could profitably replace maize in growing chick rations (Latif et al., 1975 cited by Devendra, 1988). However, up to 30-40% sweet potato meal in the diet did not alter performance in some experiments (Gerpacio et al., 1978; Agwunobi, 1999; Ravindran et al., 1996), though the general relationship between sweet potato level and performance is generally negative. In some cases, inclusion levels higher than 10% reduced performance (Ayuk et al., 2009; Rosenberg et al., 1952). The effect of thermal treatments was found to be variable. In an experiment where raw starch was already fully digestible (97%), steam pelleting did not augment starch digestibility, feed intake and weight gain (Szylit *et al.*, 1978). In young animals, increasing the drying temperature of the tubers from 40 to 80°C did not result in significant improvements in animal performance, which remained lower than those obtained with maize. Other authors found thermal treatments to be

beneficial. Starch digestibility increased at temperatures higher than 68°C (gelatinization point) (Morimoto et al., 1954). Pelleting had positive effects, especially for young birds (Kwack et al., 1975 cited by Woolfe, 1992). It has been suggested (Woolfe, 1992) that in some cases the improvement resulting from the thermal treatment of raw sweet potato tubers could be due to the reduction in trypsin inhibition activity, which is high in some cultivars (Ravindran *et al*., 1995).

2.2.1 Nutritional attributes of sweet potato

Sweet potato tubers are mainly an energy source due to their high carbohydrate content, which accounts for 80-90% of the dry weight. These carbohydrates consist of starch, sugars and small amounts of pectin, hemicelluloses and cellulose (Lebot, 2009). Starch is the main carbohydrate (about 75% DM) and is very resistant to amylase hydrolysis. Cooking increases the easily hydrolysable starch fraction of sweet potato from 4% to 55%. Sugar content can be extremely variable, usually between 1 and 12% DM, but some USA cultivars contain as much as 38% DM of sugars. The sugar composition of a cultivar, especially the sucrose values, gives a reliable indication of its sweetness (Lebot, 2009). The dry matter content of fresh tubers is about 30% and up to 45% in some varieties (Scott, 1992). Tubers are a poor protein source, as they contain about 4% DM of crude protein, less than half that of maize grain, and are poor in lysine and sulphur-containing amino acids. They have low contents of fiber (7% DM of NDF), fat and ash. Heat treatments and ensiling are very helpful in reducing trypsin inhibitor activity.

2.2.2 Feeding of sweet potato to broiler chickens in PNG

In Papua New Guinea, poultry rations made with different root crops supplemented with concentrate mixes are fed to poultry either as a finisher feed for broilers or as a layer feed for maintaining different laying genotypes (Glatz, 2007; 2013). An assessment of the feeding value of sweet potato roots was conducted to evaluate the form of presentation of these roots to broilers. Sweet potato roots were fed to broiler chickens either as a wet mash or as a dried milled product. Processes involved in the preparation of sweet potato tubers included washing, chopping or grating and boiling. After cooling, the boiled tubers are either used directly a smash or dried and milled before being mixed with matching energy concentrates.

The results showed that bird performance was not affected by the form of presentation and that farmers can process these roots either as freshly cooked wet mash or as a dried milled product (Glatz, 2013). Numerous feeding trials were conducted to assess the growth of broilers fed sweet potato with a concentrate mix. The low energy concentrate mix had a ME content of 9.4MJ/kg and a crude protein content of 418 g/Kg DM. Feeding options tested were the 50 percent sweet potato plus 50 percent low energy concentrate (SP50L) and 70 percent sweet potato plus 30 percent low energy concentrate (SP70L). Average daily feed intakes of birds fed the 50 and the 70 percent sweet potato diets were 126 and 129 g compared to 154 g for the control diet. Birds fed the SP50L diet had the second highest weight compared to the control diet.

These birds had by week 7 significantly higher ($P < 0.01$) gains compared to birds on the other experimental diets (Glatz, 2013). The average feed conversion ratio (FCR) of broilers on the sweet potato diets were significantly different ($P < 0.01$) throughout the experiment. The FCR of these birds improved by week 7 and this improvement may have been due to the delayed adaptation of birds to the experimental diets and supports the findings reported by Panigrahi *et al.*, (1996).

2.2.2.1 Growth performance, relative organ weights and gut morphology

Nutrient intake of poultry is affected by both the nutrient composition of the diet and the amount of feed eaten. Processing of the sweet potato roots and the type of cultivar used are the major factors affecting its utilization in poultry (Panigrahi *et al.*, 1996). Numerous studies have been conducted to assess broiler performance when fed sweet potato root meal (SPRM). SPRM has been fed to broiler chickens at varying inclusion rates of between 10 to 100 percent by a few researchers (Table 3). Inclusion of SPRM at 0, 10, 20 and 30 percent did not affect the average daily intake and FCR of birds (Beckford and Bartlett, 2015). Similar results were reported by (Glatz, 2013).

On the contrary, Panigrahi *et al.* (1996) suggested that tuber utilization appeared to be affected by the different degrees of feed intake which was restricted by the high and variable water absorbing nature of the tuber carbohydrates. This view was also expressed by Afolayanet al. (2012) and Maphosa et al. (2003) when trying to explain the decline in body weight gain and feed intake with increasing levels of sweet potato root meal in broiler diets. Effect of SPR Mon internal organ weights and other carcass components were reported by Beckford and Bartlett (2015), Afolayan et al. (2012)

and Agwunobi (1999). These authors did not observe any significant differences on the relative weight of non-commercial carcass components such as gizzard, hearts, liver and shank due to inclusion of sweet potato roots.

Sweet potato root meal when processed appropriately can be included in the diets of poultry by 30 percent with no adverse effect on intake and FCR (Table 3). Organ weights were not significantly affected with the inclusion of SPRM in finishing broilers. However, mucosal changes such as villi heights and villi and crypt depth or absorption area in the small intestine were not investigated, highlighting the need to investigate if such parameters are enhanced by the inclusion of SPRM with high WINSP content in broiler diets.

2.2.2.2 Dietary fiber levels of sweet potato and implications on gut attributes

Uncooked starch in sweet potato roots is resistant to enzyme hydrolysis; however this is greatly improved by cooking. Cooking of sweet potato roots have been shown to increase the dietary fiber level in boiled and steamed sweet potatoes from 1.4 to 3.46 percent (Bradbury and Holloway, 1988). The NSPs which are often cellulose, hemicellulose and pectin contribute towards the 'dietary fiber' fraction of sweet potato roots (Padmaja, 2009). Dietary fiber fractions are not degraded by endogenous digestive enzymes of chickens and will have an impact on the physiology of the gut due to its physical presence thereby affecting the mucosa along the gastrointestinal tract of birds (Montagne *et al.,* 2003). These effects can either be positive or negative depending on the type of dietary fiber and the level of inclusion in the diets (Montagne *et al.,* 2003) diets. Minute changes to the gut such as slower digesta transit time associated with WSNSP will trigger microscopic changes to the mucosal layer and this will affect nutrient assimilation (Choct, 2009). A high gut viscosity which is triggered by the presence of WSNSP will decrease the rate of diffusion of substrates and digestives enzymes and hinder their effective interaction at the mucosal surface, thereby acting as a physical barrier to the digestion and absorption of nutrients in the gut (Choct, 1997). A high gut viscosity may also trigger villus cell losses leading to villus atrophy (Montagne *et al.,* 2003). Nutrient assimilation is also affected by villi height, thus, a decrease in villi height means less surface area for absorption and lower nutrient uptake (Choct, 2009). This may then ultimately compromise growth, health and welfare of birds. Dietary fibre levels in sweet potato roots seem to be well balanced and are often cellulose, hemicellulose and pectin (Padmaja, 2009). There is

currently limited information available on the effects of sweet potato fibre on gut morphology of broiler chickens.

2.2.2.3 Digestive enzymes

Digestive enzymes determine the amount of nutrients available for absorption and are there by closely associated with nutrient assimilation and absorption in the gut. Regional activity of mucosal enzymes is related to the digestive capacity in the three different regions of the small intestine. The activities of these disaccharides may be affected by the characteristics of the diets and available substrate. There is currently limited data available to date on how these digestive enzyme (maltase and sucrase) activities are influenced by the inclusion of SPRM in broiler diets.

2.2.2.4 Use of exogenous feed enzymes in sweet potato based diets

Regular use of alternative feed ingredients in poultry diets is impeded by high fiber fractions. These fiber fractions are structural carbohydrates which are not digested by the endogenous enzymes in chickens and other mono-gastric livestock. The presence of moderately high levels of WSNSP in the gut will create a viscous environment which slows down the digesta transit time resulting in the proliferation of non-beneficial bacteria. Use of exogenous enzymes aids the hydrolysis of this component of the feed thereby reducing its viscosity in the gut of chickens. To date, the work conducted by Nunes et al. (2012) is the only published data on the use of exogenous feed enzymes with SPRM.

2.2.2.5 Diet, gut microflora composition and possible changes due to sweet potato fiber

The microbial status of the gastrointestinal tract of chickens, is influenced by diet and the internal gut (Apajalahti *et al.*, 2004). The commensal microbial community plays a major role in the health and digestion in chickens (Kleyn, 2013). The chemical composition of the digesta determines the composition of the microbial community in the gastrointestinal tract (Apajalahti et al., 2004). This relationship between digesta composition and gut microflora composition is evident when the numbers of Enterococcus, Lactobacillus, Streptococcus and Escherichia and Lactococcus increased when broilers were fed diets based on different grain types such as sorghum, barley, oat and rye respectively (Apajalahti *et al.*, 2004). Other grains, such

as millet, did not significantly change gut bacterial counts (Baurhoo *et al.,* 2011, Panda *et al.,* 2006). Recent work by (Munck *et al.,* 1984) showed that coarsely ground corn when included at 300-600 g/kg in diets increased numbers of Lactobacillus from 7.2 to 7.8 CFU/g of digesta and Bifidobacteriafrom 7.1 to 7.6 CFU/g of digesta as the counts of *Clostridium* (7.45 to 7.0 CFU/g of digesta), *Campylobacter* (7.4 to 6.5 CFU/g of digesta), and Bacteroides (7.0 to 6.1 CFU/g of digesta decreased with increasing inclusion levels of coarse corn. Currently there is limited information available in the literature on the gut microflora composition of broilers fed sweet potato based diets or sweet potato residue after starch extraction. However, Takamine *et al.,* (2005) reported an increase in Bifidobacteria in the ceca of rats fed with sweet potato dietary fibre. It has also been studied that sweet potato fibre extract could increase Lactobacilli population and prevent diarrhea caused by *Salmonella typhimurium*in healthy children (Lestari et al., 2013; Nurliyani *et al.,* 2015). Yoshimoto *et al.,* (2005) reported that fibre enzymatically extracted from three sweet potato varieties exhibited bacteriostatic activity against the *E. coli* and *S. Typhimurium* using micro calorimetry.

Yoshimoto et al. (2005) suggested that the pectin and hemicellulose content in sweet potato fibre at one percent concentration enhanced the growth of Bifidobacteria. Based on the above information available in the literature on sweet potato fibre we can hypothesize that this crop may have specific features that may favor the proliferation of beneficial strains of the gut microflora. This beneficial gut microflora can improve gut health. However, further experimental trials are necessary to assess if sweet potato diets are able to exact such effects in the gut of broiler birds.

CHAPTER III

MATERIALS AND METHODS

3.1 Statement of the experiment

The research work was conducted at Sher-e-Bangla Agricultural University, Poultry Farm, Dhaka, with 120 number "day-old chick" for a period of 28 days from 11th February to 10th March, 2020 to assess the probability of using neem leaf (*Azardirachta indica*) and sweet potato (*Ipomoea batatas*) in commercial broiler diet on growth performance of broilers. The experiment was performed by applying different concentration levels of neem leaf (*A. indica*) and sweet potato (*I. batatas*).

3.2 Collection of experimental broilers

A total of 120 number day old chicks of "Cobb-500" strain having 45±3g average body weight were obtained from Kazi farm limited hatchery, Gazipur, Dhaka.

3.3 Experimental materials

The collected chicks were carried to the university poultry farm in the morning at 7.30 a.m. They were kept in electric brooders equally for 7 days by maintaining standard brooding protocol. During brooding time only basal diet was given. After 7 days, 90 chicks were selected from brooders and distributed randomly in 3 dietary treatments of NLSPP; remaining 30 chicks were distributed randomly in one treatment for control. For proper handling and data collection, the chicks of each treatment group were divided into three replications and in each replication of dietary treatment, there were 10 birds (Table 1). After 28 days of nursing and feeding, data were collected for the following parameters: feed intake, live weight, body weight gain, feed conversion ratio, carcass characteristics, profit per bird and benefit-cost ratio.

3.4 Experimental treatments

The NLSPP was mixed properly with commercial dietary feed at four different inclusion level. The experimental treatments were followings:

T_0 = Basal diets/ control group (With antibiotics, Doxivet @ 0.5 g/ L water)

T_1 = 2g NLP + 2g SPP/kg feed (Without antibiotics)

T_2 = 2g NLP + 4g SPP/kg feed (Without antibiotics)

T_3 = 2g NLP + 6g SSP/kg feed (Without antibiotics)

Table 1. Layout of the experiment

Treatment group	No. of replication			Total
	R1	R2	R3	
T_0	10	10	10	30
T_1	10	10	10	30
T_2	10	10	10	30
T_3	10	10	10	30
Total	40	40	40	120

Here. R_1 =Replication 1, R_2 =Replication 2, R_3 =Replication 3

3.5 Collection of neem leaf

Dried Neem Leaf powder (DNLP) was used in commercial basal diets. Fresh and disease free Neem Leaf was collected from the several Neem plants in SAU. This Neem leaf was dried by sun heat for 1 day then washed into water to remove external dust. After wash dried again into sun heat for 3 days. Finally the dried Neem Leaf (DNL) was grinded into the grinding machine to formation of Neem Leaf powder (NLP).

3.5.1 Description about neem leaf

Neem Leaf contain chemicals like azadirachtin, meliacin, gedunin, salanin, nimbin, valass in and many other derivatives of these principles. Miliacin forms the bitter principles of its leaves. These compounds belong to natural products called triterpenoids (Limonoids). The active principles are slightly hydrophilic, but freely lipophilic and highly soluble in organic solvents like, hydrocarbon, alcohols, ketones and esters. The nutrient composition of neem leaf is shown in table 2.

Table 2. Nutrient composition of DNLP

Nutrient composition	Amount
Dry matter (%)	90.24
Crude protein (%)	23.40
Ether extract (%)	3.36
Ash (%)	9.90
Crude fiber (%)	7.81
Calcium (g)	1.40
Phosphorus (g)	0.25

3.6 Collection of sweet potato

Fresh sweet potato is collected from the Kawranbazar Whole sell market which is situated near the farmgate area of Dhaka Metro-politon. Those sweet potatoes washed into water to remove dusty and sandy particle from the sweet potato. Then slice the sweet potato and dry the sun heat for 5 days. After complete dry the sweet potato grinded into the grinding machine for the formation of sweet potato powder (SPP).

3.6.1 Description about sweet potato

Sweet potato can be promoted as a major energy source for poultry, especially broilers in the live broiler chicken markets. It is currently being used by the backyard and small-scale broiler producers as the cheaper feeding options to finish off broilers. Greater and regular use of this root crop in broiler diets can be promoted if more in-depth work is done on understanding production parameters, digestive health and food safety issues associated with this crop when utilized in broiler finisher diets. The DM content present in sweet potato is 30%.

Table 3. Nutrient composition of sweet potato root

Nutrient component	Amount (%/kg DM)
Crude protein	5.5
Crude fibre	3.8
Neutral Detergent Fibre (NDF)	11.3
Acid Detergent Fibre (ADF)	5.2
Lignin	1.1
Ether Extract	1.1
Ash	0.6
Starch (Polarimetry) (g/kg DM)	69.3
Total sugars	9.1
Gross energy (MJ/kg DM)	17.4

3.7 Preparation of experimental house

The broiler shed was an open sided natural house. It was a tin shed house with concrete floor. The experimental room was properly cleaned and washed by using tap water. All the equipment of the broiler house was cleaned and disinfected. There was 1ft. side wall around the shed with no ceiling. The floor was above 1ft. from the ground and the top of the roof was above 15ft. from the floor. The house was disinfected by n-alkyl dimethyl benzyl ammonium chloride (Timsen TM) solution before starting the experiment. After proper drying, the house was divided into pens

as per lay-out of the experiment by polythene sheet so that air cannot pass one pen to another. The height of pens was 5 ft. Before placement of chicks the house was fumigated by formalin and potassium permanganate @ 500 ml formalin and 250 g potassium permanganate (i.e. 2:1) for 35 m3 experimental area. Rice husk was used as a litter material to keep free the floor from moisture.

3.8 Experimental diets

Starter Nourish and grower fresh commercial broiler feed were purchased from the local market (Table 4 and Table 5).

Table 4. Name of components present in starter ration

Starter diet	Minimum percentage (%)
Arginine	1.26
Ash	8.0
Cysteine	0.40
Fat	6.0
Fiber	5.0
Lysine	1.20
Methionine	0.49
Protein	21.0
Threonine	0.79
Tryptophan	0.19

Table 5. Name of components present in grower ration

Grower ration	Minimum percentage (%)
Ash	8.0
Cysteine	0.39
Fat	6.0
Fiber	5.0
Lysine	1.10
Grower ration	**Minimum percentage (%)**
Methionine	0.47
Protein	19.0
Threonine	0.75
Tryptophan	0.18
Arginine	1.18

Feed were supplied 4 times daily by following Cobb 500 Management Manual and *ad libitum* drinking water 2 times daily.

3.9 Management procedures

Different aspects of the management of chicks, experimental events and management procedures are described in detail below:

3.9.1 Litter management

High absorbing bedding material was used as litter on floor. Fresh, clean and sun-dried rice husk was used as shallow litter to absorb moisture from fecal discharge of broiler chicken. The shallow litter was 5 cm (2 inch) in depth. About 250 g calcium oxide powder was mixed with rice husk in every pen as disinfectant. At the end of each week the litter was harrowed to prevent accumulation of toxic gases and to reduce moisture and parasitic infection. At 3^{rd} and 4^{th} week of rearing period, droppings were cleaned from the surface level by removing a thin layer of litter and same amount new litter was placed in each pen.

3.9.2 Receiving of day-old chicks

Just after arrival of day-old chicks to the poultry house the initial weight of the chicks were recorded by a digital electronic balance, and distributed them under the hover for brooding. The chicks were supplied glucose water with vitamin-c to drink for the first 3 hours to overcome dehydration and transportation stress. Subsequently small feed particles were supplied on the newspapers to start feeding for the first 24 hours.

3.9.3 Brooding of baby chicks

Electric brooder was used to brood chicks. Due to hot climate brooding temperature was maintained as per requirement. Brooding temperature was adjusted (below 350C) with house temperature. So, when the environmental temperature was above the recommendation, then no extra heat was provided. At day time only an electric bulb was used to stimulate the chicks to eat and drink. In brooding extra heat was not provided at day time except mid night to morning. Electric fans were used as per necessity to save the birds from the heat stress. Partitioning brooding was done due to different experimental treatment. Each brooder had one hover and a round chick guard to protect chicks and four portioning chambers. Sometimes day temperature was 31-37^{0}C. So, at that time there was no need of extra heat to brood the baby chicks, but at night a 100-watt bulb was used in each pen to rise up low temperature according to heat requirement of brooding schedule. The brooding temperature was

checked every 2 hours later by digital thermometer to maintain the temperature of the brooder.

3.9.4 Room temperature and relative humidity

Daily room temperature (^{0}C) and humidity were recorded with a thermometer and a wet and dry bulb thermometer respectively. Daily of room temperature and percent relative humidity for the experimental period were recorded and presented in Appendix 1. Average of room temperature and percent relative humidity for the experimental period was recorded and presented in table 6.

Table 6. Average Temperature and Humidity

Week	Date	Temperature (^{0}C)		Humidity (%)	
		Avg. maximum	Avg. minimum	Avg. maximum	Avg. minimum
1st	11.02.20-18.02.20	36.85	26.175	45.375	27.00
2nd	19.02.20-25.02.20	31.11	21.36	72.03	42.43
3rd	26.02.20-03.03.20	31.96	20.40	74.00	42.14
4th	04.03.20-10.03.20	31.00	20.91	80.43	42.00

3.9.5 Feeding and drinking

Crumble feed was used as starter (0-2 wks.) and pellet feed for grower (3-4 wks.) ration. *Ad libitum* feeding was allowed for rapid growth of broiler chicks up to the end of the four weeks. Fresh clean drinking water was also supplied *Ad libitum*. Feeds were supplied 3 times: morning, noon and night. Water was supplied two times daily: morning and evening. Left over feeds and water were recorded to calculate actual intake. Digital electronic balance and measuring plastic cylinder was used to take record of feed and water. Daily water consumption (ml) and weekly feed consumption (gm)/bird were calculated to find out weekly and total consumption of feed and water. All feeders and drinkers were washed and sun-dried before starting the trial. One plastic made round feeder and one drinker were kept in the experimental pen. Feeder and drinker size were changed according to the age of the birds. Feeders were washed at the end of the week and drinkers once daily.

3.9.6 Lighting

At night there was provision of light in the broiler house to stimulate feed intake and rapid body growth. Four (4) energy lights were provided to ensure 24 hours' light for first 2 weeks. Thereafter 23 hours' light and one-hour dark were scheduled up to marketable age. At night one-hour dark was provided in two times by half an hour.

3.9.7 Ventilation

The broiler shed was south facing and open-sided. Due to wire-net cross ventilation was easy to remove polluted gases from the farm. Besides, on the basis of necessity ventilation was regulated by folding polythene screen. The open space around the farm were favorable for cross ventilation.

3.9.8 Biosecurity measures

Bio-security is a set of management practices that reduce the potential for introduction and spread of diseases causing organisms. To keep disease away from the broiler, farm the following vaccination, medication and sanitation program was undertaken. All groups of broiler chicks were supplied Vitamin B-Complex, Vitamin-A, D, E, K, Vitamin-C, Ca and Vitamin-D enriched medicine and electrolytes.

3.9.9 Vaccination

The vaccines were collected from medicine shop (Ceva Company) and applied to the experimental birds according to the vaccination schedule. One ampoule vaccine was diluted with distilled water according to the recommendation of the manufacturer. The cool chain of vaccine was maintained strictly up to vaccination. The vaccination schedule of broiler is shown in Table 7.

Table 7. Vaccination schedule

Age	Name of disease	Name of vaccine	Route of vaccination
0 day	Infectious Bronchitis + Newcastle Disease (IB+ND)	CEVAC BI L	One drop in eye
09 day	Gumboro (IBD)	CEVAC IBDL	Drinking water
17 day	Gumboro (IBD)	CEVAC IBDL	Drinking water

3.8.10 Medication

Vitamin-B complex, vitamin-A, D3, and E were used against deficiency diseases. Electromin and Vitamin-C also used to save the birds from heat stress. The medication program is presented in the table 8.

Table 8. Medication program

Medicine	Composition	Dose	Period
B-Com-Vit	Vitamin B-complex	2-5ml/1L water	3-5 days (all groups)
Renasol AD3E (Vet)	Vitamin A, D & E	1 ml/5L water	3 -5 days (all groups)
Electromin powder	Electrolytes	1g/2L water	4 -5 days (all groups)
Revit-C	Vitamin-C Premix	1g/5L water	4 -5 days (all groups)
Calplex	Ca, P and Vit-D	10 ml/100 bird	3-5 days (all groups)

3.9.11 Sanitation

Proper hygienic measures were maintained throughout the experimental period. Cleaning and washing of broiler shed and its premises were under a routine sanitation work. Flies and insects were controlled by spraying phenol and lysol to the surroundings of the broiler shed. The attendants used farm dress and shoe. There was a provision of wearing polythene shoe at the entry gate of the broiler shed to prevent any probable contamination of diseases. Strict sanitary measures were followed during the experimental period.

3.10 Recorded parameters

Weekly lives weight, weekly feed consumption and death of chicks to calculate mortality percent were taken during the study. FCR was calculated from final live weight and total feed consumption per bird in each replication. After slaughter carcass weight and gizzard, liver, spleen, bursa, intestine and heart were measured from each broiler chicken. Dressing yield was calculated for each replication to find out dressing percentage. Faecal sample was collected to measure microbial load in the gut.

3.11 Data collection

3.11.1 Live weight

The initial day-old live weight and weekly live weight of each replication was kept to get final live weight record per bird.

3.11.2 Dressing yield

Dressing yield of bird was obtained from live weight subtracting blood, feathers, head, shank and inedible viscera.

3.11.3 Feed consumption

Daily feed consumption record of each replication was kept to get weekly and total feed consumption record per bird.

3.11.4 Survivability of chicks

Daily death record for each replication was counted up to 28 days of age to calculate mortality if occurred that indicated the survivability of the bird.

3.12 Dressing procedures of broiler chicken

Three birds were picked up at random from each replicate at the 28th day of age and sacrificed to estimate dressing percent of broiler chicken. All birds to be slaughtered were weighed and fasted by halal method or overnight (12 hours) but drinking water was provided *ad-libitum* during fasting to facilitate proper bleeding. All the live birds were weighed again prior to slaughter. Birds were slaughtered by severing jugular

vein, carotid artery and the trachea by a single incision with a sharp knife and allowed to complete bleed out at least for 2 minutes. Outer skin was removed by sharp scissor and hand. Then the carcasses were washed manually to remove loose singed feathers and other foreign materials from the surface of the carcass. Afterward the carcasses were eviscerated and dissected according to the methods by Jones (1982). Heart and liver were removed from the remaining viscera by cutting them loose and then the gallbladder was removed from the liver. Cutting it loose in front of the proventiculus and then cutting with both incoming and outgoing tracts removed the gizzard. Giblet were collected after removing the gall bladder. All the carcasses were washed with cold water inside and out to remove traces blood, loosely attached tissue or any foreign materials. Then the eviscerated weight of carcasses was recorded. Thereafter the weight of carcass cuts such as breast, thigh (both), drumstick (both), back, neck, wing (both), heart, liver, gizzard was taken. Dressing yield was found by subtracting blood, feathers, head, shank, liver, heart and digestive system from live weight. Liver, heart, gizzard and neck were considered as giblet. Percent of breast, thigh, drumstick, back, wing, giblet and abdominal fat were found as DP by the following formula-

$$DP = \frac{\text{Dressing yield (g)}}{\text{Live weight (g)}} \times 100$$

Dressing yield = Breast, thigh, drumstick, back, wing, giblet, abdominal fat weight

3.13 Calculations

Each data was collected by the following formulae:

3.13.1 Live weight gain

The average body weight gain of each replication was calculated by deducting initial body weight from the final body weight of the birds.

Body weight gain = Final weight – Initial weight

3.13.2 Feed intake

Feed intake was calculated as the total feed consumption in a replication divided by number of birds in each replication.

Feed intake (g/bird) = Feed intake in replication No. of birds in a replication

3.13.3 Feed conversion ratio

Feed conversion ratio (FCR) was calculated as the total feed consumption divided by weight gain in each replication.

$$FCR = \frac{\text{Feed intake (kg)}}{\text{Weight gain (kg)}}$$

3.13.4 Dressing percentage

Dressing yield was found by subtracting blood, feathers, head, shank and digestive system from live weight. Liver, heart, gizzard and neck were considered as giblet. Dressing percentage of bird was calculated by the following formulae-

$$DP = \frac{\text{Dressing yield (g)}}{\text{Live weight (g)}} \times 100$$

Dressing yield = Breast, thigh, drumstick, back, wing, giblet, abdominal fat weight

3.13.5 Flock uniformity

Flock uniformity is a measure of the variability of bird size in a flock. Uniformity is differentiated between weak and healthy birds. At first individual weight of each bird was taken and then the flock uniformity was calculated by using the following formulae-

$$\text{Flock uniformity} = \frac{\text{Average weight -Total birds (Average weight of birds } \pm 10\%)}{\text{Average weight}} \times 100$$

Here, Average weight of birds = Birds weight/Total birds

3.14. Economic analysis

3.14.1 Profit per bird (PPB)

The benefit cost ratio was analyzed considering stocking density and feeding regime. The capital expenditure, recurring expenditure and depreciation cost were considered to calculate total expenditure. The major expenditure included cost of chick, feed, litter, medicine, vaccine, and labor and electricity bill. The common expenditure per bird was found out from the total expenditure of one batch. The consumption of feed was not same in different replications, so feed expenditure was calculated for every

individual replication. Similarly, due to differences of live weight gain, the sale value of birds was calculated for every individual replication. The sale value of poultry manure and feed bags were also considered to compute income. Number of live birds in each replication considered here to calculate average value. Finally, treatment wise production cost and income was calculated. Net profit per bird was found out by deducting the total expenditure from the total income according to replication under each treatment. PPB= Total income/b − total expenditure/b

3.14.2. Benefit cost ratio (BCR)

The capital expenditure, recurring expenditure and depreciation cost were considered to calculate total expenditure. The major expenditure included cost of chick, feed, litter, medicine, vaccine, labor and electricity charges. The common expenditure per bird was found out from the total expenditure of one batch. The consumption of feed was not same in different replications, so feed expenditure was calculated for every individual replication. Similarly, due to differences of live weight gain, the sale value of birds was calculated for every individual replication. The sale value of poultry manure and feed bags were also considered to compute income. Number of live birds in each replication considered here to calculate average value. Finally, treatment wise production cost and income was calculated. Net profit per m2 was found out by deducting the total expenditure from the total income according to replication under each treatment.

$$\text{BCR} = \frac{\text{Total income}}{\text{Total cost of production}}$$

3.15 Statistical analysis

Total data were complied, tabulated and analyzed in accordance with the objectives of the study. Excel Program was practiced for preliminary data calculation. The collected data was subjected to statistical analysis by applying one-way ANOVA using Statistical Package for Social Sciences (SPSS version 16.0) in accordance with the principles of completely randomized design (CRD). Differences between means were tested using Duncan's multiple comparison test, and significance was set at $P<0.05$.

Some photographic view during the experimental period

Plate 1: Preparation of farm

Plate 2: Chick management

Plate 3: Taking advice from honorable supervisor and different test during experimental period

Plate 4: Preparation of neem leaf powder

Plate 5: Preparation of sweet powder powder

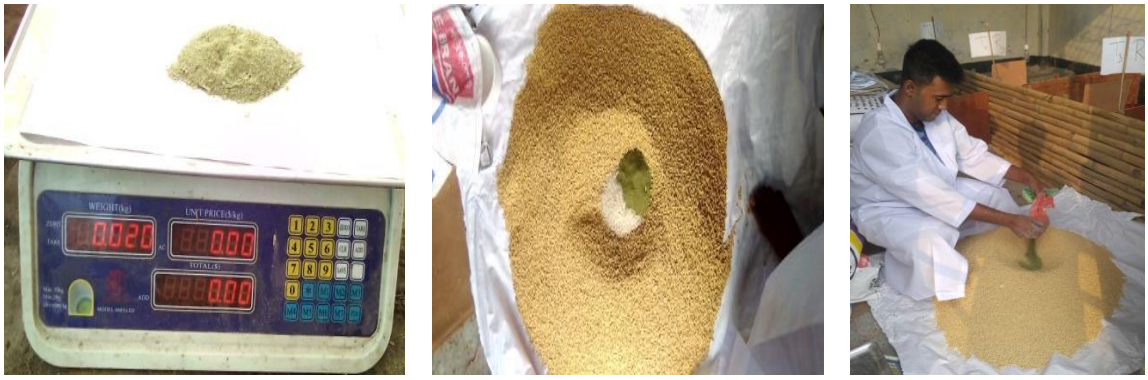


Plate 6: Measuring of neem leaf and sweet potato powder and mixing with diet

Plate 7: Cleaning the utensils and feeding the bird

Plate 8: Post-mortem of dead bird

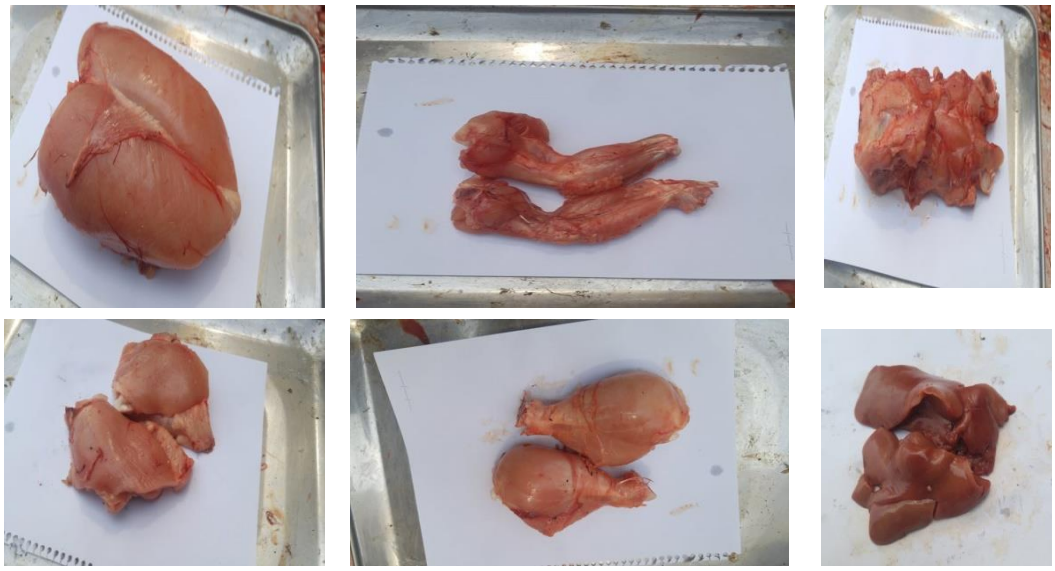


Plate 9: Measuring different carcass characteristics

CHAPTER IV

RESULTS AND DISCUSSION

Results obtained from the present study have been presented and discussed in this chapter with a view to study the effect of neem leaf and sweet potato powder in broiler production. The data are given in different tables and figures. The results have been discussed, and possible interpretations are given under the following headings.

4.1 Production performances of broiler chicken

The health promoting effect of neem leaf powder inhibit the growth of pathogenic bacteria because of its content act as a natural antibiotic and sweet potato powder acts as energy source that helps the body growth of broiler chicken. The chicks were randomly divided into four experimental treatment groups. The four groups were T_1 (2g NLP+ 2g SPP), T_2 (2g NLP+ 4g SPP), T_3 (2g NLP+ 6g SPP) and T_0 (control). The performance traits *viz*. final live weight, body weight gain, feed consumption, FCR, dressed bird weight, relative giblet weight, survivability and flock uniformity were discussed in this chapter.

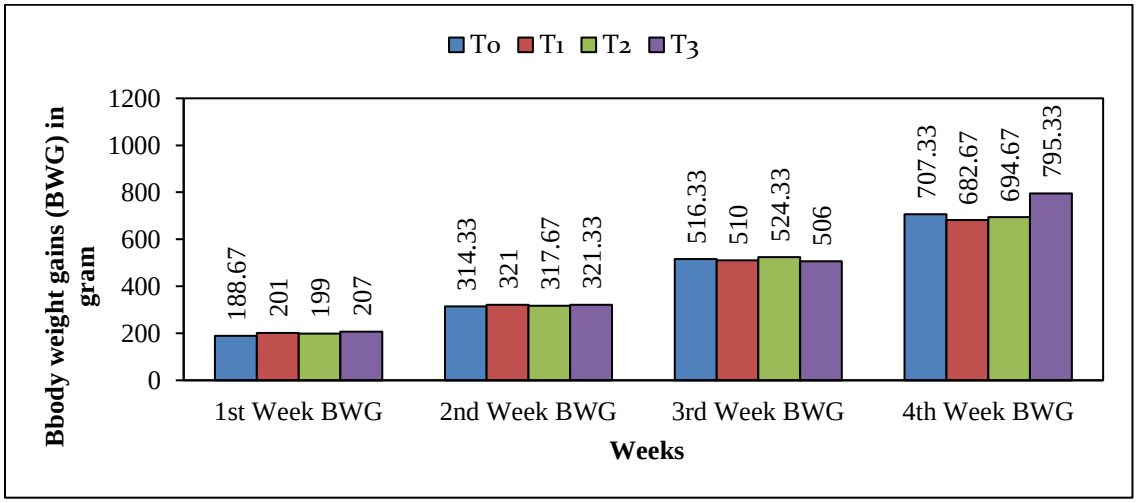
4.1.1 Final live weight

Data submitted in Table 9 expressed that the effect of treatments on final live weight (gram per broiler chicken) was significantly ($P<0.05$) difference. The relative final live weight (g) of broiler chickens in the different groups T_0, T_1, T_2 and T_3 were $1772.2^{b}\pm3.96$, $1771.7^{b}\pm12.07$, $1780.9^{b}\pm20.86$ and $1875.4^{a}\pm23.27$, respectively. The highest result was found in T_3 treatment and lowest result was found in T_1. T_3 group were significantly ($P< 0.05$) higher than other groups. The higher body weight in T_3 group might be due to the positive effect of neem leaf and sweet potato at optimum proportion. Similarly, Kale *et al.* (2003), Bishnu *et al.* (2009) and Sarker *et al.* (2014) also reported that birds supplemented with neem leaf extract had higher body weight and weekly gain in weight.

4.1.2 Weekly body weight gains (BWG)

Body weight gains of broiler chicken at different weeks presented in Figure 1. The body weight gains (g) of broiler chicks in different groups T_0, T_1, T_2 and T_3 at 1^{st} week were

188.67±1.20, 201.00±5.29, 199.00±10.78 and 207.00±10.50 respectively; at 2nd week were 314.33±1.20, 321.00±3.78, 317.67±6.43 and 321.33±6.69 respectively; at 3rd week were 682.67[a]±7.21, 516.33±2.60, 510.00±2.08, 524.33±34.14 and 506.00±7.81 respectively; at 4rth week were 707.33[a]±5.20, 694.67[a]±10.72 and795.33[b]±32.97 respectively. There was no significant (P>0.05) difference among the treatment groups at different ages. These results are slightly similarity with (Yakubu, 2014) founded that growth rate is hampered in later stage of broiler due to anti-nutritional factor of sweet potato.



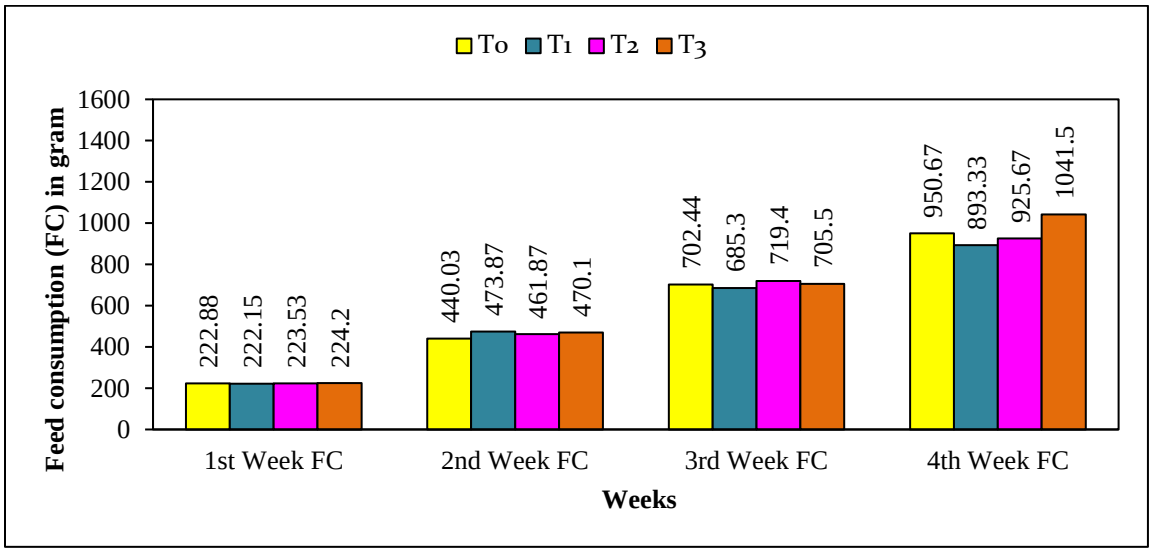
Here, T_1 = (2g neem leaf powder + 2g sweet potato powder)/kg feed, T_2 = (2g neem leaf powder + 4g sweet potato powder)/kg feed, T_3 = (2g neem leaf powder + 6g sweet potato powder)/kg feed, and T_0 = (control)

Fig. 1. Effects of neem leaf powder and sweet potato powder on body weight gain (BWG) (g/bird) of broiler in different weeks

4.1.3 Weekly feed consumption (FC)

Feed consumption (g) of broiler chicken at different weeks presented in Figure 2. The feed consumption (g) of broiler chicks in different groups T_0, T_1, T_2 and T_3 at 1st week were 222.88±.80, 222.15±.87, 223.53±1.01 and 224.20±.83, respectively; at 2nd week were 440.03± 4.36, 473.87±10.33, 461.87±19.50 and 470.10±4.10, respectively; at 3rd week were 702.44±5.31, 685.30±15.11, 719.40±9.77 and 705.50±7.07 respectively; at 4rth week were 950.67[a]±11.25, 893.33[a]±4.09, 925.67[a]±7.12 and 1041.5[b]±56.50

respectively. There was no significant (P>0.05) difference among the treatment groups at different ages. These results are in harmony with Beckford and Bartlett (2015) found in a study that used increasing substitutions of sweet potato meal in the diets of broiler chickens.



Here, T_1 = (2g neem leaf powder + 2g sweet potato powder)/kg feed, T_2 = (2g neem leaf powder + 4g sweet potato powder)/kg feed, T_3 = (2g neem leaf powder + 6g sweet potato powder)/kg feed, and T_0 = (control)

Fig. 2. Effects of neem leaf and sweet potato on feed consumption (g/bird) of broiler in different weeks

4.1.4 Feed conversion ratio (FCR)

The feed conversion ratio (FCR) of broilers under different treatment groups have been shown in Table 9. The FCR of T_1, T_2, T_3 and T_0, groups were 1.3133^{b}±.008, 1.3367^{a}±.003, 1.3333^{a}±.003 and 1.3367^{a}±0.03 respectively. Feed conversion ratio of T_1 was significantly (P<0.05) better than other groups including control. These results are in harmony with those of previous researchers Beckford and Bartlett (2015).

4.1.5 Survivability

The survivability rate showed on Table 9. Survivability rate was statistically (P>0.05) insignificant compared to treatment group and control group. The survivability rate of different group like T_0, T_1, T_2 and T_3 are 96.6667±3.33,96.6667±3.33, 96.6667±3.33 and

93.3333±3.33. The overall survivability (0-4 weeks) during the experimental period was lower in T_3. There was no significant (P>0.05) difference among the treatment groups at different ages. The variation in mortality among the different might be due to the seasonal influence of summer season. The mortality observed in the present study agreed with the report of Apata, (2009) who reported that lower and different mortality rate for (3.5%) is due to environmental factor in Ross 308 commercial broilers.

4.1.6 Dressing percentage (DP)

The dressing percentage showed on Table 9. The dressing percentage of broiler of different group like T_1, T_2, T_3 and T_0 were66.66^{b}±0.82%, 67.30^{a}±2.07%, 67.64^{a}±1.3% and 64.68^{c}±1.33% respectively. All treatment groups were significantly (P< 0.05) higher than the control group. The result might be due to the positive influence of sweet potato powder and neem leaf powder resulting in more energy available for production.

4.1.7 Carcass characteristics

Carcass characteristics of the birds shown in Table 10. The weight of breast in T_0, T_1, T_2 and T_3 were 419.67±3.28419.67±10.17, 416.67±14.40, 443.33±3.93, 424.83±5.08, respectively; The weight of thigh in T_0, T_1, T_2 and T_3 were 147.67^{b}±2.60, 144.33^{b}±2.72, 132.67^{a}±3.84, 147.00^{b}±4.50 respectively; The weight of wing in T_0, T_1, T_2 and T_3 were 76.00^{a}±3.21, 79.67^{a}±7.26, 75.67^{a}±2.02 and 99.33^{b}±1.85respectively; The weight of back in T_0, T_1, T_2 and T_3 were 122.33^{a}±2.33, 139.00^{b}±6.42, 135.67^{ab}±2.60 and 147.67^{b}±4.25respectively; The weight of drumstick in T_0, T_1, T_2 and T_3 were 185.33^{ab}±7.05, 189.00^{ab}±4.73, 173.33^{a}±4.17 and 193.67^{b}±4.05respectively; The weight of neck in T_0, T_1, T_2 and T_3 were 40.33^{b}±.882, 41.00b±.577, 36.67^{a}±1.453 and 40.00^{ab}±.005respectively. The weight of breast, thigh, wing, back, drumstick and neck was no significant (P>0.05) difference among the treatment groups. The findings corroborate with Panda *et al.* (2001) did not found statistically significant difference in carcass characteristics in birds of neem leaf supplemented group and control.

4.2 Relative giblet weight (liver, heart, proventriculus and gizzard)

The relative weight of giblet in different groups were presented in Table 11. The relative weight (g) of liver of broiler chicken in different group T_0, T_1, T_2 and T_3 were

41.0^{a}±.57,44.0^{ab}±2.64, 45.6^{ab}±5.78 and 54.3^{b}±2.02 respectively; the relative weight of heart of broiler chicken in different group T_0, T_1, T_2 and T_3 were 9.817±.14, 10.167±.35, 10.100±.56 and 10.933±.31 respectively; the relative weight (g) of gizzard in different group T0, T1, T2 and T3 were 37.167±.52, 38.033±1.92, 39.000±1.41 and 40.400±.15. The highest results were obtained in T_3 and lowest in T_0 group. The weight of liver, heart and gizzard in T_3 were significantly (P<0.05) higher than the other groups including control. The present finding was in agreement with Kabir *et al.* (2004) reported that the weight of heart was increased (P<0.01) in the neem leaf supplemented group compared with that of the control group and other treatment groups. Another researcher Abdel-Raheem *et al.* (2011) found that there was no significant (P>0.05) difference observed in the carcass traits with respect to carcass percentage, liver weight and gizzard weight in Cobb broilers under study.

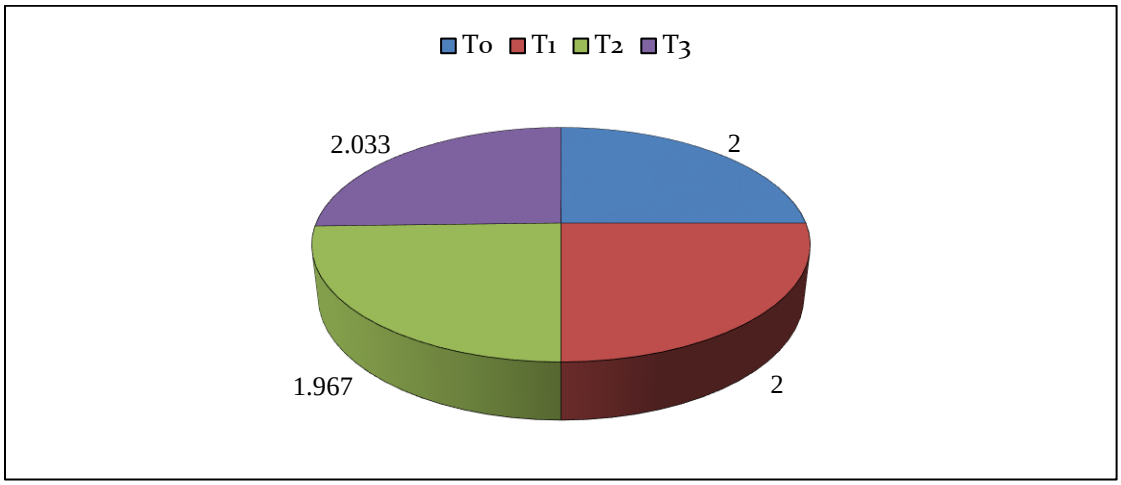
4.3 Weight of intestine

The relative weight of intestine in different groups were presented in Table 11. The relative weight (g) of intestine of broiler chicken in group T_0, T_1, T_2, and T_3 were 127.367±2.73, 127.967±5.72, 120.367±9.48 and 125.933±5.40 respectively. The highest results were obtained in T_1 and lowest in T_2 group. However, there was no significant (P>0.05) difference in the relative weight of intestine between the groups. These results are contradictory with the findings of Partride*et al.* (2003) reported that the weight of small intestine was significantly greater (P<0.05) in the neem leaf powder-supplemented group than that in the control group and other treatment groups. Another researcher Madrid *et al.* (2003) reported that the weight of small intestine and the weight of different cuts (thigh, wing, and back) as percent of live weight accounted non-significant (P>0.05) variations among different groups.

4.4 Immune organs (spleen)

The relative weight of spleen in different groups were presented in Figure 3. The relative weight (g) of spleen of broiler chicken in dietary groups T_0, T_1, T_2 and T_3 were 2.000±.05, 2.000±.11,1.967±.08 and 2.033±.03 respectively. The highest value was T_3 and lowest value was T_1. The relative weight of spleen in different groups showed that there was no significant (P>0.05) difference among the treatment groups including

control. The present finding was in agreement with Apata *et al.* (2009) reported that the absolute and relative weight of spleen tended to be greater (P<0.1) for the sweet potato powder-supplemented group compared with the symbiotic-supplemented groups.



Here, T_1 = (2g neem leaf powder + 2g sweet potato powder)/kg feed, T_2 = (2g neem leaf powder + 4g sweet potato powder)/kg feed, T_3 = (2g neem leaf powder + 6g sweet potato powder)/kg feed, and T_0 = (control)

Fig.3. Effect of neem leaf and sweet potato in spleen weight of broiler.

4.5 Flock uniformity

Flock uniformity of broiler chicken were presented in Table 9. The flock uniformity of broiler chicken in T_0, T_1, T_2 and T_3 were 82.5933±3.75, 75.5567±4.44, 86.2967±3.16 and 75.1867±6.91 respectively. The flock uniformity was no significant (P>0.05) difference among the treatment groups. The uniformity was insignificant due to the environmental effect.

4.6 Economic impact

Profit per bird of broiler chicken were presented in Table 12. The profit per bird of broiler chicken in T_0, T_1, T_2 and T_3 were57.7367^{a}±.09, 57.9233^{a}±1.33, 56.0067^{a}±1.36 and 62.3933^{b}±1.33respectively. T_3 was significantly (P< 0.05) higher than all groups including control group. This is may be the positive effect of sweet potato powder.

Table 9. Effects of neem leaf powder and sweet potato powder on production performances of broiler

Treatment	Final live weight(g/bird)	Average BWG (g/bird)	Total FC (g/bird)	Final FCR (g/bird)	Dressing percentage (%)	Flock Uniformity	Survivability(%)
T_0	1772.2^{a}±3.96	1727.2^{a}±3.96	2316.0^{a}±10.77	1.3367^{a}±0.03	64.68±1.33	82.5933±3.75	96.6667±3.33
T_1	1771.7^{a}±12.07	1726.7^{a}±12.07	2274.7^{a}±8.12	1.3133^{b}±0.08	66.66±0.82	75.5567±4.44	96.6667±3.33
T_2	1780.9^{a}±20.86	1735.9^{a}±20.86	2330.5^{a}±30.45	1.3367^{a}±0.03	67.30±2.07	86.2967±3.16	96.6667±3.33
T_3	1875.4^{b}±23.27	1830.4^{b}±23.27	2447.8^{b}±38.34	1.3333^{a}±0.03	67.64±1.3	75.1867±6.91	93.3333±3.33
Mean ± SE	1800.1±15.00	1755.1±15.00	2342.2±22.20	1.3300±0.003	66.96±0.16	79.9083±2.48	95.8333±1.48

Here, T_1 = (2g neem leaf powder + 2g sweet potato powder), T_2 = (2g neem leaf powder + 4g sweet potato powder), T_3 = (2g neem leaf powder+ 6g sweet potato powder), and T_0 = (control) Values are Mean ± SE (n=10) one- way ANOVA (SPSS, Duncan method), BWG = Body Weight Gain, FCR = Feed Consumption Ratio, FC = Feed Consumption.

- ✓ Mean with different superscripts are significantly different ($P<0.05$)
- ✓ Mean within same superscripts don't differ ($P>0.05$) significantly
- ✓ SE= Standard Error

Table 10. Effects of neem leaf and sweet potato on carcass characteristics of broiler

Treatment	Breast weight(g)	Thigh weight(g)	Wing weight(g)	Back weight(g)	Drumstick weight(g)	Neck weight(g)
T_0	419.67±3.28	147.67^{b}±2.60	76.00^{a}±3.21	122.33^{a}±2.33	185.33^{ab}±7.05	40.33^{b}±.82
T_1	419.67±10.17	144.33^{b}±2.72	79.67^{a}±7.26	139.00^{b}±6.42	189.00^{ab}±4.73	41.00^{b}±.57
T_2	416.67±14.40	132.67^{a}±3.84	75.67^{a}±2.02	135.67^{ab}±2.60	173.33^{a}±4.17	36.67^{a}±1.45
T_3	443.33±3.93	147.00^{b}±4.50	99.33^{b}±1.85	147.67^{b}±4.25	193.67^{b}±4.05	40.00^{ab}±.00
Mean± SE	424.83±5.08	142.92±2.36	82.67±3.44	136.17±3.28	185.33±3.15	39.45±.69

Here, T_1 = (2g neem leaf powder + 2g sweet potato powder), T_2 = (2g neem leaf powder + 4g sweet potato powder), T_3 = (2g neem leaf powder + 6g sweet potato powder), and T_0 = (control) Values are Mean ± SE (n=10) one- way ANOVA (SPSS, Duncan method).

- ✓ Mean with different superscripts are significantly different ($P<0.05$)
- ✓ Mean within same superscripts don't differ ($P>0.05$) significantly
- ✓ SE= Standard Error

Table 11. Effects of neem leaf and sweet potato on giblet, intestine, spleen and bursa of broiler under different treatments Group

Treatment	Liver weight (g)	Heart weight (g)	Gizzard weight (g)	Proventriculus weight (g)	Intestine weight (g)	Spleen weight (g)
T_0	41.0^{a}±.57	9.817±.14	37.167±.52	9.567±.35	127.367±2.73	2.000±.05
T_1	44.0^{ab}±2.64	10.167±.35	38.033±1.92	9.633±.31	127.967±5.72	2.000±.11
T_2	45.6^{ab}±5.78	10.100±.56	39.000±1.41	9.967±.52	120.367±9.48	1.967±.08
T_3	54.3^{b}±2.02	10.933±.31	40.400±.15	10.200±.26	125.933±5.40	2.033±.03
Mean± SE	46.250±2.06	10.254±.38	38.650±.63	9.842±.17	125.408±2.83	2.000±.03

Here, T_1 = (2g neem leaf powder+ 2g sweet potato powder), T_2 = (2g neem leaf powder+ 4g sweet potato powder), T_3 = (2g neem leaf powder+ 6g sweet potato powder), and T_0 = (control) Values are Mean ± SE (n=10) one- way ANOVA (SPSS, Duncan method).

- ✓ Mean with different superscripts are significantly different (P<0.05)
- ✓ Mean within same superscripts don't differ (P>0.05) significantly
- ✓ SE= Standard Error

Table 12. Effects of neem leaf powder and sweet potato powder on economic impact of broiler rearing

Treatment	Feed cost (BDT) per bird	Cost of NL and SP (BDT) per bird	Common expenditure (BDT) per bid	Total production cost (BDT) per bird	Receipt per bird when sold @ 130 TK/Kg live weight	Profit per bird (BDT)	Benefit cost ratio
T_0	104.22^{a}±.48	.00±.00	68.42±.00	172.64^{a}±.48	230.38^{a}±.51	57.7367^{a}±.09	1.33^{b}±.000
T_1	102.36^{a}±.36	1.61±.00	68.42±.00	172.39^{a}±.36	230.31^{a}±1.57	57.9233^{a}±1.33	1.33^{b}±.005
T_2	104.87^{a}±1.36	2.22±.00	68.42±.00	175.51^{a}±1.36	231.52^{a}±2.71	56.0067^{a}±1.36	1.31^{a}±.003
T_3	110.15^{b}±1.72	2.83±.00	68.42±.00	181.40^{b}±1.72	243.79^{b}±3.03	62.3933^{b}±1.33	1.34^{b}±.003
Mean± SE	105.40±.99	1.66±.31	68.42±.00	175.48±1.19	234.00±1.95	58.5150±.86	1.33±.003

Here, T_1 = (2g neem leaf powder + 2g sweet potato powder), T_2 = (2g neem leaf powder + 4g sweet potato powder), T_3 = (2g neem leaf powder + 6g sweet potato powder), and T_0 = (control) Values are Mean ± SE (n=10) one-way ANOVA (SPSS, Duncan method), BDT = Bangladesh Taka

- ✓ Mean with different superscripts are significantly different ($P<0.05$)
- ✓ Mean within same superscripts don't differ ($P>0.05$) significantly
- ✓ SE= Standard Error

CHAPTER V

SUMMARY, CONCLUSION AND RECOMMENDATION

A total of 120 day old "Cobb-500" broiler chicks were reared in poultry farm of Sher-e-Bangla Agricultural University, Dhaka to evaluate the growth performance of broiler fed diet containing neem leaf powder (NLP) and sweet potato powder (SPP). Chicks were divided randomly into 4 experimental group with 3 replications of each group. Each replication contains 10 chicks. One of the 4 experimental group was fed with antibiotics in basal diet and considered as control group (T_0); the remain three groups were fed diet with (2 g NLP + 2 g SPP)/kg feed (T_1), (2 g NLP + 4 g SPP)/kg feed (T_2), and (2 g NLP + 6 g SPP)/kg feed (T_3). The specific objectives of this experiment were i). To evaluate the growth performance of broiler by using neem leaf powder and sweet potato powder based diet and comparison with antibiotic added basal diet; ii). To produce safe broiler meet by naturally grown product; iii). To evaluate different carcass characteristics of broiler. The performance traits *viz.* body weight, weight gain, feed consumption, FCR, dressed bird weight, relative giblet weight, survivability and flock uniformity. Experiment revealed that the relative final live weight (g) in T_0, T_1, T_2 and T_3 groups were 1772.2^{b}±3.96, 1771.7^{b}±12.07, 1780.9^{b}±20.86, 1875.4^{a}±23.27 respectively.T_3 group were significantly ($P< 0.05$) higher than other groups including control group. Feed conversion ratio of T_1 (1.3133^{b}±.008) was significantly ($P<0.05$) better than other groups including control T_0 (1.3367^{a}±0.03). The dressing percentage of broiler in T_0, T_1, T_2 and T_3 groups were 64.68^{c}±1.33%, 66.66^{b}±0.82%, 67.30^{a}±2.07, 67.64^{a}±1.3% respectively. All treatment groups were significantly ($P< 0.05$) higher than the control group. The relative weight (g) of liver of broiler chicken in different group T_0 (41.0^{a}±.57), T_1 (41.0^{a}±.57), T_2 (45.6^{ab}±5.78) and T_3 (54.3^{b}±2.02) wererespectively; the relative weight of heart of broiler chicken in different group T_0 (9.817±.14), T_1 (10.167±.35), T_2 (10.100±.56)and T_3 (10.933±.31) wererespectively; the relative weight of gizzard of broiler chicken in different group T_0 (37.167±.52), T_1 (38.033±1.92), T_2 (39.000±1.41)and T_3 (40.400±.15) wererespectively. The weight of liver, heart and gizzard in T_3 were significantly ($P<0.05$) higher than the other groups including control.

The feed consumption; body weight gains (g); survivability rate; carcass weight (breast, thigh, wing, back, drumstick and neck); weight of intestine; immune organ (spleen) and flock uniformity of broiler chicken were no significant ($P>0.05$) difference among the treatment and control groups.

The profit per bird of broiler chicken in T_0, T_1, T_2 and T_3 groups were $57.7367^{a}\pm.09$, $57.9233^{a}\pm1.33$, $56.0067^{a}\pm1.36$, $62.3933^{b}\pm1.33$ respectively. T_3 was significantly ($P< 0.05$) higher than all groups including control group.

The neem leaf and sweet potato are produce adequate amount in Bangladesh. The result in T_3(2 g NLP+ 6 g SPP)/kg feedwas better than other treatment groups on broiler production. So, the experiment recommended that neem leaf powder and sweet potato powder at the concentration level of (2 g NLP+ 6 g SPP)/kg feed could be used on broiler ration for better performances.

REFERENCES

Abdel-Raheem, S. M., Abd-Allah, S. M., Hassanein, K. M. (2012). The effects of prebiotic, probiotic and synbiotic supplementation on intestinal microbial ecology and histomorphology of broiler chickens. *Int. J. Agron. Vet. Med. Sci.***6**:277-289.

Afolayan, S. B., Dafwang, I. I., Tegbe, T. S. B. and Sekoni, A. (2012). Response of broiler chickens fed on maize-based diets substituted with graded levels of sweet potato meal. *Asian J. Poult. Sci.***6**: 15-22.

Agwunobi, L. N. (1999). Performance of broiler chickens fed sweet potato meal (*Ipomoea batatas* L.) diets. *Trop. Anim. Health Prod*. **31**(6): 383-389.

Akin-Osanaiye, B. C., Nok, A. J. Ibrahim, S. Inuwa, H. M., Onyike, E., Amlabu, E. and Haruna, E. (2013). Antimalarial effect of neem leaf and neem stem bark extracts on plasmodium berghei infected in the pathology and treatment of malaria. *Int. J. Res. Bioche. Biophy*.**3**(1): 7-14.

Anjali K., Ritesh K., Sudarshan M., Jaipal S. C., Kumar S. (2013). Antifungal efficacy of aqueous extracts of neem cake, karanj cake and vermicompost against some phytopathogenic fungi. *The Bioscan*. **8**: 671–674.

Apajalahti, J. H. A., Kettunen, A. and Graham, H. (2004). Characteristics of the gastro-intestinal microbial communities with special reference to the chicken. *World's Poult. Sci. J.* **60**: 223-232.

Apata, D.F. (2009). Antibiotic resistance in poultry. *Int. J. Poult. Sci*. **8**: 404-408

Arora N., Koul A., Bansal M. P. (2011). Chemopreventive activity of *Azadirachtaindica*on two-stage skin carcinogenesis in murine model. *Phytotherapy Res*. **25(**3): 408–416.

Arumugam, A., Agullo, P., Boopalan, T., Nandy, S., Lopez, R., Gutierrez, C., Narayan, M. and Rajkumar, L. (2014). Neem leaf extract inhibits mammary carcinogenesis

by altering cell proliferation, apoptosis, and angiogenesis. *Cancer Biol. Therapy*. **15**(1): 26-34.

Avigen., (2015). Feed ingredients: Consideration of alternatives when facing increased price volatility. Vol. 14th May 2015.

Ayuk, E. A. and Essien, A. (2009). Growth and haematological response of broiler chicks fed graded levels of sweet potato (*Ipomoea batata*) meal as replacement for maize. *Int. J. Poult. Sci*.**8**(5): 485-488

Badam L., Joshi S. P. and Bedekar S. S. (1999). 'In vitro' antiviral activity of neem (*Azadirachtaindica*. A. Juss) leaf extract against group B coxsackieviruses. *J. Comm. Diseases*. **31**(2): 79–90.

Bakr S. A. (2013). Evaluation of acute toxicity of water extract of *Azadirachta indica* leaves and seeds in rats. *Pakistan J. Bio. Sci.* **16**(14): 697–700.

Baligar, N. S., Aladakatti, R. H., Ahmed, M. and Hiremath, M. B. (2014). *Can. J Physiol Pharmacol*. **92**(4): 267-77.

Barton, M. D. (1998). Does the use of antibiotics in animals affect human health? *Australian Vet. J.* **76**: 177–180.

Baurhoo, N., Baurhoo, B., Mustafa, A. and Zhao, X. (2011). Comparison of corn-based andCanadian pearl millet-based diets on performance, digestibility, villus morphology, anddigestive microbial populations in broiler chickens. *Poult. Sci*.**90**: 579-586.

Beckford, R. C. and Bartlett, J. R. (2015). Inclusion levels of sweet potato root meal in the diet of broilers I. Effect on performance, organ weights, and carcass quality. *Poult. Sci*.**94**: 1316-1322.

Bhanwra S, Singh P. and Koshla P. (2000). The effect of Azadirachta indica (Neem) leaf aqueous extract on paracetamol induced liver damage in rats. *Ind. J. Physiol. Pharmacol.***44**: 64-69.

Bishnu, J., Sunil, L. and Anuja, S. (2009). Antibacterial property of different medicinal plants: Azadirachtaindica, Cinnamomumzeylanicum, Xanthoxylumarmatum and Origanummajorana, Kathmandu University. *J. Sci. Eng. Tech*. **5**: 143- 150.

Biu A. A., Yusufu S. D. and Rabo J. S. (2010). Acute toxicity study on neem (*Azadirachtaindica*, Juss) leaf aqueous extract in chicken (*Gallus gallusdomesticus*) *African Scientist*. **11**(4): 241–244.

Bradbury, J. H. and Holloway, W. D. (1988). Chemistry of tropical root crops: Significance for nutrition and agriculture in the Pacific. Australian Centre for International Agricultural Research, Canberra, Australia.

Cardozo, P. W., Calsamiglia, S., Ferret, A. and Kamel, C. (2004). Effects of natural plant extracts on ruminal protein degradation and fermentation profiles in continuous culture. *J. Ani. Sci*. **82**: 3230–3236.

Chari, M. S. (1996). Neem and transfer of technology. In: Neem and environment, Sinh, R.P., Chari, M.S., Raheja, A.K and Kraus (eds). Vol. I. Oxford and IBH publishing Co. Pvt. Ltd: New Delhi, India, pp: 27-38.

Choct, M. (1997). Feed non-starch polysaccharides: Chemical structures and nutritionalsignificance. Feed milling International, June Issue pp.13-26., pp. 13-26.

Choct, M. (2009). Managing gut health through nutrition. *Brit. Poult. Sci*. **50**: 9-15.

Devendra, C. (1988). Non-conventional feed resources and fibrous agricultural residues.Strategies for expanded utilization. Proceedings of a Consultation held in Hisar, India, 21-29 March 1988, IDRC, ICAR.

Engberg, R. M., Hedemann, M. S., Leser, T. D. and Jensen, B. B. (2000). Effect of zinc bacitracin and salinomycin on intestinal microflora and performance of broilers. *Poult. Sci.* **79**: 1311-1319.

FAO (2014). Meat & Meat Products. http://www.fao.org/ag/againfo/themes/en/meat/home.htm.

Farrell, D. (2013). The role of poultry in human nutrition. https:// www. fao. org/ docrep /013/ al709e/al709e00.

Gerpacio, A. L., Pascual, F. Sd., Querubin, L. J., Vergel de Dios, A. F. and Mercado, C. I., 1978. Evaluation of tuber meals as energy sources. 1. Sweet potato and cassava based rations for broilers. *The Philippine Agric.***61**(9/10): 395–410

Ghimeray, A. K., Jin C. W., Ghimire B. K. and Cho D. H. (2009) Antioxidant activity and quantitative estimation of azadirachtin and nimbin in *Azadirachtaindica*A. Juss grown in foothills of Nepal. *African J. Biotec*. **8**(13): 3084–3091.

Ghonmode W. N., Balsaraf O. D., Tambe V. H., Saujanya K. P., Patil A. K., Kakde D. D. (2013). Comparison of the antibacterial efficiency of neem leaf extracts, grape seed extracts and 3% sodium hypochlorite against *E. feacalis*—an in vitro study. *J. Int Oral Health*. **5**(6):61–66..

Glatz, P. (2007). Poultry feeding systems in Papua New Guinea, Australian Centre for International Agricultural Research (ACIAR), Canberra, Australia.

Glatz, P. (2013). Improving the profitability of village broiler production in Papua New Guinea, Australian Centre for International Agricultural Research (ACIAR), Canberra, Australia.

Hossain, M. A., Al-Toubi, W., Weli, A. M., Al-Riyami, Q. and Al-Sabahi, J. N. (2013). Identification and characterization of chemical compounds in different crude extracts from leaves of Omani neem. *J. Taibah Univ. Sci.***7**(4): 181-188.

Huque, K.S., Saleque, M.A. and Khatun, R. (2011). Commercial poultry production in Bangladesh. In: proceedings of the seminar, 7th international Poultry Show and Seminar. World's Poultry Science Association, Bangladesh Branch. pp. 13-19.

Ilango K., Maharajan G. and Narasimhan S. (2013). Anti-nociceptive and anti-inflammatory activities of *Azadirachtaindica*fruit skin extract and its isolated constituent azadiradione. *Nat. Prod. Res*. **27**(16): 1463–1467.

Islam, K. B. M. S., Shiraj-Um-Mahmuda, S. and Hazzaz-Bin-Kabir, M. (2016). "Antibiotic Usage Patterns in selected Broilers Farms of Bangladesh and their Public Health Implications." *J. Public Health in developing Countries.* **2**(3): 276-284.

Jensen, C., Lauridsen, C. and Bertelsen, G. (1998). Dietary vitamin E: Quality and storage stability of pork and poultry. *Trend. Food Sci. Tech.* **9**: 62-72.

Kabir, S.M.L., Rahman, M.M., Rahman, M.B., Rahman, M.M. and Ahmed, S.U. (2004) The dynamics of probiotics on growth performance and immune response in broilers. *Int. J. Poult. Sci*. **3**: 361-364.

Kale, B. P., Kothekar, M. A., Tayade, H. P., Jaju, J. B. and Mateeddin, M. (2003). Effect of aqueous extract of Azadirachtaindica leaves on hepatotoxicity induced by antitubercular drugs in rats. *Ind. J. Pharm.* 35: 177-180.

Kamal, S. M. and Shafiullah, M. (2016). "Bangladesh's poultry sector: Are the chicken's home to roost. *The Financial Express.*

Kaur G., SarwarAlam M., Athar M. (2004). Nimbidin suppresses functions of macrophages and neutrophils: relevance to its anti-inflammatory mechanisms. *Phyt. Res*. **18**(5): 419–424.

Khan, M. F. and Ahmed, S. M. (2000). Toxicity of crude neem leaf extract against housefly Musca domestica L. adults as compared with DDVP, dichlorvos. *Turkish J. Zoology*. **24**: 219-224.

Kleyn, F. J. (2013). Chicken nutrition.A guide for nutritionists and poultry professionals. Context Leicestershire, England.

Kumar S., Agrawal D., Patnaik J., Patnaik S. (2012). Analgesic effect of neem (*Azadirachtaindica*) seed oil on albino rats. *Int. J. Pharma and Bio Sci*. **3**(2): 222–225.

Kwack, C. H. and Ahn, B. H. (1975). Studies on the utilization of sweet potato as a poultry feed. I. Substitution level of pelleted sweet potato for corn in growing chick rations. *Korean J. Anim. Sci*. **18**(3): 261-70

Latif, M. A. and Islam, M. S. (1975). Economic feasibility of replacement of cereal grains by sweet potato in growing chick rations. *Nutr. Abstr. Revs.***45**: 731.

Lebot, V. (2009). Tropical root and tuber crops: cassava, sweet potato, yams and aroids. Crop production science in horticulture (17), CAB books, CABI, Wallingford, UK

Lestari, L. A., Setyabudi, S., Julia, M. and Amalia, L. (2013). Effects of synibiotic yogurt madewith indigenous probiotic Lactobacillus plantarum Mut7 and sweet potato fiber (Impomeabatatas) in healthy children. *Int. Res. Microbiol.***4**: 98-102.

Madrid, J., Hernandez, F., Garcia, V., Orengo, J., Magias, D. and Savilla, V. (2003). Effect of plant extracts on ileal apparent digestibility and carcass yield in broilers

at level of farm 14th European Symp. Poultry Nutrition. August 10-14, Norway. pp. 187-188.

Mahady, G. B. (2005). Medicinal plants for the prevention and treatment of bacterial infections. *Curr. Pharm. Des*. **11**: 2405-2427.

Maiorka, A., Santin, E., Sugeta, S.M., Almeida, J.G. and Macari, M. (2001).Utilizacao de prebioticos, probioticos ousimbioticos emdieta sparafrangos. *Revista Brasileira de Ciencia Avicola*.**3**: 75-82.

Maphosa, T., Gunduza, K. T., Kusina, J. and Mutungamiri, A. (2003). Evaluation of sweet potatotuber (Ipomeabatatas I.) as a feed ingredient in broiler chicken diets, LivestockResearch for Rural Development, Article #3.

Montagne, L., Pluske, J. R. and Hampson, D. J. (2003). A review of interactions between dietary fibre and the intestinal mucosa, and their consequences on digestive health in young non-ruminant animals. *Anim. Feed Sci. Technol*. **108**: 95-117.

Mordue (Luntz) A. J. and Nisbet A. J. (2000). Azadirachtin from the neem tree *Azadirachtaindica*: its action against insects. *Anais da SociedadeEntomológica do Brasil*. **29**(4):615–632.

Morimoto, H.; Yoshida, M., 1954. On the nutritive value of starches. *I. Bull. Nat. Inst. Agric. Sci., Set. G*.**8**: 43-51.

Mosaddek A. S. M., Rashid M. M. U. (2008). A comparative study of the anti-inflammatory effect of aqueous extract of neem leaf and dexamethasone. *Bangladesh J. Pharma*. **3**(1):44–47.

Munck, A., Guyre, P. M. and Holbrook N. J. (1984). Physiological functions of glucocorticoids in stress and their relation to pharmacological actions. *EndocrineRev*. **5**: 25–44.

Naik, M. R., Bhattacharya, A., Behera, R., Agrawal, D., Dehury, S. and Kumar, S. (2014). Study of anti-inflammatory effect of neem seed oil (*Azadirachtaindica*) on infected albino rats. *J. Health Res. Rev.***1**(3):66–69.

Neu, H.C. (1992). The crisis in antibiotic resistance. *Poult. Sci.* **257**: 1064–1073.

Nunes, P. X., Silva S. F., Guedes R. J. and Almeida S. (2012) *Phytochemicals as Nutraceuticals—Global Approaches to Their Role in Nutrition and Health*. Biological oxidations and antioxidant activity of natural products.

Nunes, J. K., Gonçalves, F. M., Dallmann, H. M., Gentilini, F. P., Anciuti, M. A., Rutz, F., Maier, J.C. and Silva, J. G. C. (2011). Development of the digestive tract of broilers fed diets containing sweet potato meal. *Archivos de Zootecnia*. **60**(232): 1105-1114.

Nurliyani, Julia, M., Harmayani, E., Ikawati, M. and Baliarti, E. (2015). Potency of Lactobacillusplantarum Dad-13 and sweet potato (Ipomoea batatas) fiber as immunomodulator in ratsinfected with Salmonella typhimurium. *J. Food Res*. **4**: 1-13.

Okpanyi S. N. and Ezeukwu, G. C. (1996). Anti-inflamatory and antipyretic activities of Azadirachta indica. *Planta Medica.* **41**(1): 34–39.

Padalwar, R.V. (1994). M. V. Sc Thesis, Dr. P. D. K. V, Akola.

Padmaja, G. (2009). Uses and nutritional data of sweetpotato, In: Loebenstein, G., Thottappilly, G. (Eds.), The Sweetpotato, Springer, pp. 189-234.

Panda, A. K., Rama, R. S. V., Raju, M. V. L. N. and Sharma, S. R. (2006). Dietary supplementation of *lactobacillus sporogenes*on performance and serum biochemico-lipid profile of broiler chickens. *J. Poult. Sci.* **43**: 235-240.

Pandi, J. (2006). Influence of insoluble fibre in poultry feeds on energy utilisation and gut parameters in broiler chickens. School of Agriculture, Food and Wine. University of Adelaide, South Australia. (Master's Thesis).

Panigrahi, S., Oguntona, E. B. and Roberts, B. R. (1996). Effects of ovendrying tubers of twohighprotein sweet potato varieties at different temperatures on their feeding value inbroilers. *Brit. Poult.* Sci. **37**: 173-188.

Parente, I. P., Rodrigues, K. F., Vaz, R. G. M. V., Sousa, J. P. L., Santos, N. E.R., Albino, L. F. T., Siqueira, J. C., Paiva, J. A. (2014). Nutritional characteristics and use the residue of sweet potato in slow growth broiler diets. *Revista Brasileira de Saúde e Produção Animal* [online]. **15**(2): 470-483.

Parida, R.N.S., Bisoi, P.C., Sahoo, P.K. and Mohapatra, M. (1995). Protective effect of Livol during experimental aflatoxicosis in chicks: a histomorphological approach. *Indian J. Indg. Med*. **17**: 19-25.

Partridge, G. and Wyatt, C. (1995). More flexibility with new generation of enzymes. *World Poult.***11**: 17-21.

Priyadarsini R. V., Manikandan P., Kumar G. H. and Nagini S. (2009). The neemlimonoidsazadirachtin and nimbolide inhibit hamster cheek pouch carcinogenesis by modulating xenobiotic-metabolizing enzymes, DNA damage, antioxidants, invasion and angiogenesis. *Free Radical Res.***43**(5): 492–504.

Rahmani A. H. and Aly S. M. (2015). *Nigella sativa* and its active constituents thymoquinone shows pivotal role in the diseases prevention and treatment. *Asian J. Pharma. Cli. Res.***8**(1):48–53.

Ravindran, V., Ravindran, G., Sivakanesan, R. and Rajaguru, S. B. (1995). Biochemical and nutritional assessment of tubers from 16 cultivars of sweet potato (*Ipomoea batatas*L.). *J. Agric. Food Chem.* **43**(10): 2646-2651.

Ravindran, V. and Sivakanesan, R. (1996). Replacement of maize with sweet potato (*Ipomoea batatas*L.) tuber meal in broiler diets. *Br. Poult. Sci.***37**: 95-103.

Sarica, S., Ciftci, A., Demir, E., Kilinc, K. and Yildirim, Y. (2005). Use of an antibiotic growth promoter and two herbal natural feed additives with and without exogenous enzymes in wheat-based broiler diets. *S. Afr. J. Anim. Sci.* **35**: 61–72.

Sarker, S. K., Mostofa, M., Akter, F., Rahman, M. M. and Sultana, M. R. (2014). Effects of aqueous extract of neem(Azadirachtaindica) leaves as growth promoter and anti-colibacillosis in broilers. *Bang. J. Anim. Sci.***43**: 138-141.

Scott, G. J. (1992). Sweet potato as animal feed in developing countries: present patterns and future prospects. In: Roots, tubers, plantains and bananas in animal feeding. Machin, D. and Nyvold, S. eds, Proc. FAO Expert Consultation held in CIAT, Cali, Colombia 21–25 January 1991; FAO Animal Production and Health Paper - 95.

Shrivastava, D. K. and Swarnkar, K. (2014). Antifungal activity of leaf extract of neem (*Azadirachta indica* Linn). *Int. J. Curr. Microb. App. Sci*.**3**(5):305–308.

Sithisarn P., Supabphol R., Gritsanapan W. (2005). Antioxidant activity of Siamese neem tree. *J. Ethnopharma.* **99**(1):109–112.

Steiner, T. (2006). Managing gut health: Natural growth promoters as a key to animal performance. Nottingham University Press, Nottingham, UK.

Sundaravalli N., BhaskarRaju, B. and Krishnamoorthy, K. A. (1982). Neem oil poisoning. *The Indian J. Pediatrics*. **49**(3):357–359.

Svihus, B. (2011). Limitations to wheat starch digestion in growing broiler chickens: a brief review. *Animal Production Sci*. **51**(7): 583-589.

Szylit, O., Durand, M., Borgida, L. P., Atinkpahoun, H., Prieto, F. and Delort-Laval, J. (1978). Raw and steam-pelleted cassava, sweet potato and yam cayenensis as

starch sources for ruminant and chicken diets. *Anim. Feed Sci. Technol*.**3**(1): 73-87.

Takamine, K., Hotta, H., Degawa, Y., Morimura, S., Kida, K. (2005). Effects of dietary fiberprepared from sweet potato pulp on cecal fermentation products and microflora in rats. *J. Appl. Glycosci*. **52**: 1-5.

Tipu, M.A., Akhtar, M.S., Anjum, M.I. and Raja, M.L. (2006). New dimension of medicinal plants as animal feed.*Pakistan Vet. J.* **26**(3): 144-148.

Tiwari V., Darmani N. A., Yue B. Y. J. T., Shukla D. (2010). In vitro antiviral activity of neem (*Azardirachtaindica*L.) bark extract against herpes simplex virus type-1 infection. *Phytotherapy Res*. **24**(8): 1132–1140.

Vandergrift, B. (1998). Biotechnology in the Feed Industry. In: Proc. Altech's 14th Annual Symposium Altech Technical Publications Nottingham University Press. Nicholasville. K.Y. pp: 293-300.

Waramboi, J. G., Dennien, S., Gidley, M. J. and Sopade, P. A. (2011) Characterization of Sweet potato from Papua New Guinea and Australia: Physicochemical, Pasting and Gelatinization Properties. *Food Chemi.* **126**: 1759-1770.

Wenk, C. (2000). Why all the discussion about herbs? In: Proc. *Alltech's 16th Ann. Symp. Biotechnology in the Feed Industry*. (Ed. Lyons, T.P.), Alltech Tech. Publ., Nottingham, University Press, Nicholasville, KY.pp.79-96.

Woolfe, J. A. (1992). Sweet potato: an untapped food resource. Cambridge University Press. pp. 643.

Wray, C. and Davies, R. H. (2000). Competitive exclusion-an alternative to antibiotics. *J. Vet. Sci.* **159**: 107-108.

Yakubu, I. J. (2014). Optimum level of utilization of cooked sweet potatoes meal (ipomeiabatatas LAM) in broiler chicken diets. pp. 45. MSc (Thesis)-

Department of Animal Science, Faculty of Agriculture, Ahmadu Bello University, Zaria, Nigeria. Receipt date: 17/09/2017 Approval date: 18/01/2018.

Yerima, M. B., Jodi, S. M., Oyinbo, K., Maishanu, H. M., Farouq, A. A. and Junaidu, A. U. (2012). Effect of neem extracts (*Azadirachtaindica*) on bacteria isolated from adult mouth. *J. Basic and Applied Sci.* **20**: 64–67.

Yoshimoto, M., Yamakawa, O. and Tanoue, H. (2005). Potential chemopreventive properties andvarietal difference of dietary fiber from sweetpotato (Ipomoea batatasL.) root. *Japan Agric. Res. Quar*.**39**: 37-43.

CHAPTER VII

APPENDICES

Appendix I. Temperature and humidity

Date	Day	Temperature		Humidity	
		Max	Min	Max	Min
11.02.20	0	36.8	22.4	54	21
12.02.20	1st	41.2	27.8	39	17
13.02.20	2nd	38.3	29.9	28	14
14.02.20	3rd	36.9	29.8	40	22
15.02.20	4th	35.2	26.9	52	35
16.02.20	5th	36.8	24.1	50	32
17.02.20	6th	36.4	25.1	48	38
18.02.20	7th	33.2	23.4	52	37
19.02.20	8th	32.0	23.0	67	38
20.02.20	9th	33.4	20.9	73	41
21.02.20	10th	30.6	21.7	62	31
22.02.20	11th	31.0	20.0	72	45
23.02.20	12th	31.8	19.7	78	41
24.02.20	13th	29.8	21.2	67	42
25.02.20	14th	29.2	23.0	85	54
26.02.20	15th	27.8	20.9	84	62
27.02.20	16th	28.1	18.7	82	56
28.02.20	17th	31.9	19.1	78	46
29.02.20	18th	37.5	20.1	65	35
01.03.20	19th	33.3	22.1	63	26
02.03.20	20th	33.2	20.9	68	31
03.03.20	21th	31.9	20.9	78	39
04.03.20	22th	31.5	21.9	76	42
05.03.20	23th	30.9	20.4	79	40
06.03.20	24th	31.9	20.9	78	39
07.03.20	25th	30.8	23.5	90	55
08.03.20	26th	27.4	21.0	86	50
09.03.20	27th	31.8	20.2	82	40
10.03.20	28th	32.7	18.5	72	28

Appendix-II. Feed consumption (FC) (g/bird) of 1st, 2nd, 3rd and 4th week under different group

Treatment	Replication	1st Week FC	2nd Week FC	3rd Week FC	4th Week FC	Total FC
	R1	223.2	434.28	701.28	942	2300.76
T_0	R2	221.35	448.6	693.87	973	2336.82
	R3	224.1	437.2	712.16	937	2310.46
	R1	223.15	482.3	663.9	892	2261.35
T_1	R2	222.9	486	677.5	887	2273.4
	R3	220.4	453.3	714.5	901	2289.2
	R1	225.3	468.4	722.3	912	2328
T_2	R2	221.8	491.9	734.7	936	2384.4
	R3	223.5	425.3	701.2	929	2279
	R1	222.7	471.2	696.3	985	2375.2
T_3	R2	225.6	462.5	719.4	1098	2505.5
	R3	224.3	476.6	700.8	1061	2462.7

Appendix-III. Body Weight Gain (BWG) (g/bird) of 1st, 2nd, 3rd and 4th week under different group

Treatment	Replication	1st Week BWG	2nd Week BWG	3rdWeek BWG	4th Week BWG	Final BWG
	R1	191	312	521	698	1722
T0	R2	188	315	516	716	1735
	R3	187	316	512	708	1723
	R1	193	327	511	697	1728
T1	R2	199	322	513	674	1708
	R3	211	314	506	677	1708
	R1	196	322	529	682	1729
T2	R2	182	326	581	686	1775
	R3	219	305	463	716	1703
	R1	218	327	505	734	1784
T3	R2	186	308	520	847	1861
	R3	217	329	493	805	1844

Appendix-IV. Feed Conversion Ratio (FCR)(g/bird) of 1st, 2nd, 3rd and 4th week under different group

Treatment	Replication	1st Week	2nd Week	3rd Week	4th Week
	R1	1.168	1.39	1.34	1.349
T_0	R2	1.177	1.42	1.34	1.358
	R3	1.198	1.38	1.39	1.32
	R1	1.156	1.47	1.299	1.279
T_1	R2	1.12	1.407	1.32	1.316
	R3	1.044	1.44	1.41	1.33
	R1	1.149	1.45	1.365	1.337
T_2	R2	1.218	1.508	1.26	1.36
	R3	1.02	1.39	1.51	1.297
	R1	1.021	1.44	1.378	1.34
T_3	R2	1.21	1.5	1.38	1.296
	R3	1.03	1.448	1.42	1.318

Appendix-V. Average live weight, Eviscerated weight and Dressing percentage of broiler chicken under different treatment group

Treatment	Replication	Avg. Live Weight G	Eviscerated Weight G	Dressing Percentage %
	R1	1767.77	1142	64.60
T_0	R2	1780.1	1189	66.79
	R3	1768.7	1156	65.35
	R1	1767.4	1201	67.95
T_1	R2	1753.22	1175	67.019
	R3	1794.4	1257	70.05
	R1	1774.1	1216	68.54
T_2	R2	1820	1243	68.29
	R3	1748.7	1117	63.87
	R1	1829.99	1206	65.90
T_3	R2	1906.9	1239	64.97
	R3	1889.4	1242	65.73

Appendix-VI. Production performance of broiler chicken under different treatment group

Treatment	Replication	Final Live WT(g/bird)	Total FC (g/bird)	Total BWG (g/bird)	Final FCR	Survivability (%)
	R1	1812.77	2300.76	1767.77	1.30	90
T_0	R2	1825.1	2336.82	1780.1	1.31	100
	R3	1813.7	2310.46	1768.7	1.30	100
	R1	1812.4	2261.35	1767.4	1.27	100
T_1	R2	1798.22	2273.4	1753.22	1.29	90
	R3	1839.4	2289.2	1794.4	1.27	100
	R1	1819.1	2328	1774.1	1.31	100
T_2	R2	1865	2384.4	1820	1.31	90
	R3	1793.7	2279	1748.7	1.30	100
	R1	1874.99	2375.2	1829.99	1.29	90
T_3	R2	1951.9	2505.5	1906.9	1.3139126	100
	R3	1934.4	2462.7	1889.4	1.3034297	90

Appendix-VII. Weight(g) of Liver, Heart, Neck, Gizzard, Intestine, Proventriculus Spleen

Treatment	Replication	Liver	Heart	Neck	Gizzard	Intestine	Proventriculus	Spleen
	R1	40	10.1	42	38	128.1	10.1	2.1
T_0	R2	42	9.65	39	36.2	131.7	9.7	1.9
	R3	41	9.78	40.1	37.3	122.3	8.9	2
	R1	45	10.3	41.3	40.2	136.5	9.6	2.2
T_1	R2	39	9.5	40	34.2	117.1	9.1	1.87
	R3	48	10.7	42.3	39.7	130.3	10.25	2
	R1	42	9.8	39.7	37.2	112.9	10.1	2
T_2	R2	57	11.2	45.1	41.8	139.2	10.8	2.1
	R3	38	9.3	40.6	38	99.6	9.05	1.8
	R1	51	10.4	43.2	40.3	121.3	10.7	2.1
T_3	R2	58	11.5	46.3	40.7	136.2	10.1	2
	R3	54	10.9	45.4	40.2	119.8	9.85	2

Appendix-VIII. Weight (g) of carcass cut of broiler chicken under different treatment group

Treatment	Replication	Breast	Thigh	Wing	Back	Drumstick
	R1	418	148	75	123	188
T_0	R2	426	143	82	126	196
	R3	415	152	71	118	172
	R1	422	146	78	137	182
T_1	R2	401	139	68	129	187
	R3	436	148	93	151	198
	R1	407	127	72	140	178
T_2	R2	445	140	79	136	165
	R3	398	131	76	131	177
	R1	438	143	98	145	193
T_3	R2	451	156	103	142	201
	R3	441	142	97	138	187

Appendix-IX. Effect of Neem Leaf and Sweet Potato on flock uniformity in chicken

Treatment	Replication	Uniformity (%)	Average Uniformity (%)
T_0	R1	77.77	82.59
	R2	90	
	R3	80	
T_1	R1	80	75.55
	R2	66.67	
	R3	80	
T_2	R1	90	86.29
	R2	88.89	
	R3	80	
T_3	R1	66.67	75.18
	R2	70	
	R3	88.89	

Appendix-X. Production cost of the birds at 28 days of rearing period

Parameters	Amount (BDT)
Day old chicks cost (120 Chicks)	2400
Feed cost	13500
Litter cost	1100
Feeder and Drinker	700
Medicine Cost	500
Vaccine Cost	500
Neem leaf and sweet potato cost	200
Electric Cost	650
Electric bulb Cost	360
Others cost	2000
Total	21910

Appendix-XI. Economic impact of neem leaf powder and sweet potato powder on broiler production

Treatment	Replication	Feed Coast (BDT) Per Bird	Cost of Neem leaf & sweet potato (BDT) Per Bird	Expenditure and other cost (BDT) Per Bird	Total production cost (BDT) per Bird
	R1	103.53	0	68.42	171.95
T_0	R2	105.15	0	68.42	173.57
	R3	103.97	0	68.42	172.39
	R1	101.76	1.61	68.42	171.79
T_1	R2	102.30	1.61	68.42	172.33
	R3	103.01	1.61	68.42	173.04
	R1	104.76	2.22	68.42	175.4
T_2	R2	107.29	2.22	68.42	177.93
	R3	102.55	2.22	68.42	173.19
	R1	106.88	2.83	68.42	178.13
T_3	R2	112.74	2.83	68.42	183.99
	R3	110.82	2.83	68.42	182.07

Appendix-XII.Selling price of the birds under different treatment group

Treatment	Replication	Number of Bird	Live Body Weight (kg)	Selling price (BDT) at 130 tk/kg Live Weight	Total selling price
	R1	9	15.91	2068.3	
T_0	R2	10	17.80	2314.13	
	R3	10	17.68	2299.31	
	R1	10	17.67	2297.62	
T_1	R2	9	15.77	2051.27	
	R3	10	17.94	2332.72	27139.58
	R1	10	17.74	2306.33	
T_2	R2	9	18.2	2366	
	R3	10	17.48	2273.31	
	R1	9	16.46	2140.97	
T_3	R2	10	19.06	2478.97	
	R3	9	17.00	2210.65	