

**COMPARATIVE EFFECTS OF MORINGA LEAF POWDER AND
GREEN CHIRETTA SUPPLEMENTATION ON BLOOD PROFILE AND
GROWTH PERFORMANCE OF BROILER**

**A THESIS
BY**

**EKHTIAR UDDIN MAHMUD
STUDENT ID. 1604100
SESSION: 2022-2023
SEMESTER: JULY-DECEMBER, 2023**

**MASTER OF SCIENCE (MS)
IN
PHARMACOLOGY**



**DEPARTMENT OF PHYSIOLOGY AND PHARMACOLOGY
HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY
UNIVERSITY, DINAJPUR-5200**

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**DEDICATED
TO
MY BELOVED
MOTHER**

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The Author

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ABSTRACT

Moringa (*Moringa oleifera*) leaf powder and green chiretta (*Andrographis paniculata*) extract has antiviral, antibacterial, antimicrobial, antioxidant, immunomodulatory, hepato protective and various other properties without showing any adverse effects. This experiment was conducted to evaluate the comparative efficacy of moringa leaf powder and green chiretta supplementation in feed as a growth promoter of broiler chicken. A total of 120 one-day-old unsexed broiler chicks were distributed over four treatment groups where T₀ kept as a control (basal diet) and others are T₁ treated with moringa leaf powder @ 1gm/1kg of feed, T₂ treated with green chiretta supplementation (Andose) @ 1gm/1kg of feed and T₃ treated with both moringa leaf powder 1gm/1kg of feed and green chiretta supplementation (Andose) @ 1gm/1kg of feed. Weekly observations were recorded for live body weight gain up to 5th weeks and hematological tests were performed at 35th days. Live weight and weight gain of the treatment group were significantly ($p<0.05$) higher than that of the control group. The results body weight gain of T₀, T₁, T₂ and T₃ at the day 35 was 2050 gm, 2090 gm, 2093 gm and 2140 gm respectively. Hematological parameters of experimental birds like TEC of T₀, T₁, T₂ and T₃ were 2.30 million/mm³, 2.45 million/mm³, 2.29 million/mm³ and 2.49 million/mm³, Hb gm% of T₀, T₁, T₂ and T₃ were 7.05%, 9.69%, 6.79% and 8.32%, PCV of T₀, T₁, T₂ and T₃ were 26.59%, 31.71%, 28.56% and 30.85% respectively. It was observed that growth performance like weight gain was increased significantly ($p<0.05$) in treatment groups (T₁, T₂ and T₃) as compared to control group T₀. Hematological parameters like TEC, Hb concentration and PCV were significantly increased ($p<0.05$) in all the treatment groups as compared to control group T₀. Therefore, it may be concluded that combination of moringa leaf powder 1gm/1kg of feed and green chiretta supplementation (Andose) @ 1gm/1kg of feed had better performance in terms of growth performance, cost effectiveness and hematological parameters without showing any detrimental effects in broilers.

Keywords: moringa leaf powder; growth performance; hematological parameters; green chiretta supplementation; broiler.

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LIST OF SYMBOLS AND ABBREVIATION

ADF	Acid detergent fiber
CF	Crude fiber
CP	Crude protein
DLS	Department of Livestock Service
DM	Dry matter
EE	Ether extract
etc.	Etcetera
FCR	Feed Conversion Ratio
Gm	Gram
Hb	Hemoglobin concentration
HDL	High density lipoprotein cholesterol
Kg	Kilogram
L	Liter
LDL	Low density lipoprotein cholesterol
Ltd.	Limited
NDF	Neutral detergent fiber
PCV	Packed Cell Volume
RBC	Red blood cell
RMG	Readymade garments
SE	Standard error
TC	Total cholesterol
TEC	Total Erythrocyte Count
™	Trademark
@	At the rate of
>	Greater than
<	Less than
±	Plus minus
/	Per
®	Registered trade mark

CHAPTER I

INTRODUCTION

Among all the sub-sectors of the livestock sector in Bangladesh, poultry stands as one of the most important ones. According to USDA, the industry had several bottlenecks in the past, but in 2019 it met 36% of the country's demand for meat. Many people in Bangladesh rely on the poultry sector because they can raise chickens at home. In addition, this sector plays a vital role in rural economic growth and women's empowerment. According to the Bangladesh Poultry Industry Central Council (BPICC), Bangladesh's poultry sector currently produces 1.5 to 1.6 percent of the country's GDP. In 2018 Center for Policy Dialogue report, the poultry business is Bangladesh's second most significant contributor to GDP, trailing only the RMG industry. The poultry business employs nearly 2.5 million people and implicitly engages 3.5 million people, having women accounting for 40% of the workforce (Karmoker, 2022).

Poultry farming in Bangladesh is the process of keeping different types of birds for meat, egg, feather or sale. In Bangladesh, poultry birds are widely used for meat and egg. Bangladesh weather is very much friendly for poultry farming. There are various kind of poultry birds that have been domesticated for many years. As of 2017 about 300 billion taka has been invested in the poultry industry. There are an estimated 150,000 poultry farms in Bangladesh. The farms annually produce 570 million tons of meat and 7.34 billion eggs (The Daily Star., 2017).

The poultry sub-sector is an essential avenue for promoting agricultural growth and reducing malnutrition in Bangladesh (Da Silva *et al.*, 2014). Poultry plays one of the most prominent roles in the income-oriented activities of the rural people of Bangladesh (Kabir, 2009). It is a necessary component of Bangladesh's farming system, providing direct and indirect employment opportunities and support services to approximately 6 million people (Ansarey, 2012). There is a tremendous demand of animal protein source that is free from infectious agents (Alkhalif *et al.*, 2010). In Bangladesh, around 9% of total protein for human consumption comes from livestock and Poultry contribute 30% of animal protein (DLS, 2012).

There is a great possibility of growth and expansion of the poultry sector in our country. Broiler's production reveals the fact of maximum return with minimum expenses. Broiler

farming is developed all over the country. It is a means of quick return and it is recognized as a profitable enterprise in our country (Hamid and Uddin, 2001). The fundamental purpose of the worldwide poultry industry is to provide a healthy food supply in order for the global industry to remain viable in the twenty-first century. It must be able to make changes to meet the demands of the consumers. So, the poultry producers are trying very much to find out better alternatives to antibiotic growth promoter for their profit. Several strategies have been suggested to limit the antibiotic usage. Feed additives are used in poultry feed to improve nutritive value and enhance performance. Antibiotics have been extensively used as feed additives and growth promoters in animal feed industry to improve productivity but have negative effects on animal and human health. European Union has banned the application of most of antibiotics in poultry diets. Thus, during the past decade many studies investigated the use of new and promising feed-additives including probiotics, prebiotics, enzymes, and plant extracts in animal feeding (Demir *et al.*, 2003). Phytogenic feed additives have shown promising effects with regard to weight gain, feed efficiency, lowered mortality and increased viability in poultry (Ahmad and Khan, 2008). Aromatic plants and essential oil extracted from them have been used as alternatives to antibiotics. For this reason, these plants are becoming more important due to their growth promoting and antimicrobial effect on animal health (Al-Kassie, 2009).

Moringa (*Moringa oleifera*) leaf powder as feed additives have attracted worldwide due to its vast range of medicinal properties. *Moringa oleifera* is very useful as a feed supplement for animals, as its leaves are highly nutritious. The leaves of *M. oleifera* are the most nutritious part, being a significant source of vitamin B complex, vitamin C, pro-vitamin A as beta-carotene, vitamin K, manganese, and protein among other essential nutrients (Leone *et al.*, 2015). *Moringa oleifera* leaves have antimicrobial roles and are rich with fats, proteins, vitamins, and minerals (Kalibbala *et al.*, 2015, Abbas, 2013). The extracts from leaves of *Moringa oleifera* contain low amounts of polyphenols, which might have effects on blood lipid metabolism (Leone *et al.*, 2015, Sreelatha and Padma, 2009). *Moringa oleifera* can be used as a source of micronutrient and as a dietary supplement in poultry (Makkar *et al.*, 2007, Mahajan *et al.*, 2007). Moringa (*Moringa oleifera*) was reported to be an excellent source of vitamins and amino acids that reportedly boost immune systems (Olugbemi *et al.*, 2010). The seed extracts of moringa are rich in polyunsaturated fatty acid (Anwar and Rashid, 2007 and Ogbunugafor, *et al.*,

2011). Moringa (*Moringa oleifera*) exhibits anti-oxidant properties that can suppress formation of reactive oxygen species (ROS) and free radicals (Ogbunugafor *et al.*, 2011, Sofidiya *et al.*, 2006).

Green chiretta (*Andrographis paniculata*) extract has been traditionally used as an antiviral, hepatoprotective, antioxidant, and immune enhancing agent. Roy *et al.* (2010) reported that *Andrographis paniculata* extract also contained antimicrobial activity. Moringa leaf powder and green chiretta supplementation as natural feed additives in poultry nutrition may be of great benefit and value especially for broilers. Hence the present study was carried out to study effects of moringa leaf powder and green chiretta supplementation on growth performance of broilers and considering the above information the research work undertaken to fulfill the following objective:

- To know the effects of moringa leaf powder on growth performance and hematology of broiler chicken.
- To know the effects of green chiretta supplementation on growth performance and hematology of broiler chicken.
- To study the combined effects of moringa leaf powder and green chiretta supplementation on growth performance and hematology of broiler chicken.

CHAPTER II

REVIEW OF LITERATURE

Feed additives are added in poultry feed to improve nutritive value of ingredients and enhance broiler performance by increasing growth rate and improving feed conversion ratio for cost effective broiler production. Chemical feed additives e.g., Antibiotic growth promoters, have been intensively used in broiler's ration to improve productivity. However, they are notorious for bacterial resistance and their negative impacts on the public health (Rehman *et al.*, 2018). Thus, use of Antibiotic growth promoters has been banned in poultry industry. Now, nutritionists are shifting from chemical growth promoter to phytogetic growth promoters. Thus, it is important to explore the potential of innate feed additives to replace the chemical ones. Herbs could be expected to serve as feed additives due to their suitability and preference, lower cost of production, reduced risk of toxicity, minimum health hazards and environment friendliness (Devegowda, 1996). Recent research works on phytogetic feed additives have shown promising results as regards weight gain, feed efficiency, lowered mortality and increased livability in poultry birds (Kumar, 1991).

For obtaining an overview and key information the review of literature pertaining the research title "Effects of moringa leaf powder and green chiretta supplementation on blood profile and growth performance of broiler chicken." has been stated following:

Moringa oleifera is a widely grown crop in India, Ethiopia, the Philippines, and Sudan. The tree is being grown in West, East, and South Africa and in tropical Asia, Latin America, the Caribbean, Florida, and the Pacific Islands. Many researchers have noticed its nutritional and medicinal benefits (Abbas, 2013).

Moringa oleifera leaves incorporated into maize meal poultry feed led to better growth performance of the chicks and a significant increase in the serum level of biochemical minerals compared to the maize meal feed alone. Several studies have reported that the use of *Moringa oleifera* leaves as feed supplements in livestock, the optimal concentration of *Moringa oleifera* leaves as a nutritional supplement has not yet been determined and there are only limited reports on the bioactive constituents of *Moringa oleifera* leaves and their impact on meat antioxidant status (Hassan *et al.*, 2016).

2.1 Effects of Moringa leaf powder on growth performance and blood profile of broiler

2.1.1 Nutritional properties of *Moringa oleifera*

M. oleifera is also very popular for its nutritional values. It is reported as a good source of six major nutrients: Carbohydrate, especially dietary fibers; proteins; vitamins; minerals; lipids; and water. The unique features of *M. oleifera* are its richness in proteins, carbohydrates, and fibers with low fat. The leaves have been reported to enclose a range of essential amino acids and are a good source of alpha linoleic acid (Moyo B. *et al.*, 2011). *M. oleifera* leaves have been seen to exhibit high contents of vitamin A, C, and E (Hekmat, S. *et al.*, 2015). The relative bioavailability of folate originated from *M. oleifera* leaves were about 82% in a rat model, which confirmed the fact that *M. oleifera* leaves exhibit rich source of dietary folate (Saini, R.K. *et al.*, 2016)

The nutritional composition of *M. oleifera* leaves (dry matter basic) showed dry matter (DM) about 93.63% to 95.0%, crude protein (CP) 17.01% to 22.23%, carbohydrate 63.11% to 69.40%, crude fiber (CF) 6.77% to 21.09%, crude fat (EE) 2.11% to 6.41%, ash (total mineral) 7.96% to 8.40%, gross energy 14.790 (MJ/kg), and fatty acid 1.69% to 2.31%. In addition, estimated calcium (Ca) was 1.91%; potassium (K) was 0.97%; sodium (Na) was 192.95, iron was (Fe) 107.48, manganese (Mn) was 81.65, Zinc (Zn) was 60.06, and phosphorus (P) was 30.15 parts per million (ppm) (Ogbe, A.O.; John, P.A. 2012) Magnesium (Mg) was 0.38%, and copper (Cu) was 6.1%, tannins 21.19%, phytates 2.57%, trypsin inhibitors 3.0%, saponins 1.60%, oxalates 0.45%, and cyanide 0.1% was also reported by Ogbe and John (Ogbe, A.O.; John, P.A. 2012). The leaves of the plant are enriched with methionine, phosphorus, calcium, and iron (Gupta *et al.* 2018). It is believed that the leaves of *M. oleifera* contain more calcium and twice as much protein than milk, higher vitamin C than oranges, higher potassium and iron than bananas, and higher vitamin A than carrots (Gopalakrishnan, 2016 and Thurber and Fahey, 2009), and thus the plant is considered unique in nature (Razis *al.*, 2014). Niaziridin, an active component that was identified from *M. oleifera*, can improve the absorption of different vitamins, minerals, and other micro nutrients in gastrointestinal tract of the host (Stohs, S.J.; Hartman, M.J. 2015). The nutritional composition of *M. oleifera* leaves are presented in Table 1 and Table 2.

Table 1. Chemical compositions of *Moringa oleifera* leaves

Nutrient Component	Fresh Leaves	Dry Leaves	Leaves Powder
Calories (cal)	92	329	205
Protein (g)	6.7–17.1	29.4–40.0	25.4–27.1
Fat (g)	1.7–2.11	5.2–6.5	2.3
Carbohydrate (g)	6.3–12.5	38.0–41.2	34.3–38.2
Fiber (g)	0.9–7.09	12.5–21.09	19.2
Vitamin A	0.9–11.05	16.3–18.90	-
Vitamin B1 (mg)	0.06	2.02–2.60	2.64
Vitamin B2 (mg)	0.05	19.82–21.3	20.5
Vitamin B3 (mg)	0.8	7.6–8.3	8.2
Vitamin C (mg)	220	15.8–17.3	17.3
Vitamin E (mg)	448	10.8–77.0	113
Calcium (mg)	440	2185–3050	2003
Magnesium (mg)	42–82	86–448	368
Phosphorus (mg)	30.15–70	204–252	204
Potassium (mg)	259	1236–1384	1324
Copper (mg)	0.07	0.08–0.49	0.57
Iron (mg)	0.85–10.7	25.6–490	28.2
Sulphur (mg)	-	363–630	870
Zinc (mg)	6.7	3.25–13.03	-
Manganese (mg)	81.6	86.8–91.2	-

- All values are in 100 g per plant material. **References:** (Gopalakrishnan, L. *et al.*, 2016; Moyo, B. *et al.*, 2011; Olagbemide, P.T.; Alikwe, P.C. 2014).

Table 2. Amino acid contents in *Moringa oleifera* leaves

Amino Acid	Fresh Leaves (mg g ⁻¹ DM)	Extracted Leaves (mg g ⁻¹ DM)
Lysine	13.25–26.77	14.06–18.09
Leucine	20.52–42.89	17.5–21.84
Isoleucine	11.91–22.53	8.08–11.30
Methionine	3.5–8.96	1.13–4.97
Cystine	3.8–5.18	1.0–3.39
Phenylalanine	16.31–27.14	8.9–15.51
Tyrosine	18.88	9.71
Valine	10.62–27.58	7.25–14.26
Histidine	5.17–13.57	7.16–7.50
Threonine	13.5–21.97	7.90–11.70
Serine	10.87–20.79	9.40–10.34
Glutamic acid	28.42–50.85	17.10–25.65
Aspartic acid	20.52–46.11	14.3–22.16
Proline	14.3–25.75	12.41–13.63
Glycine	15.33–26.62	10.3–13.73
Alanine	28.67–30.33	12.51–18.37
Arginine	18.9–30.28	13.25–15.64
Tryptophan	4.25–9.26	5.27–7.16

- **References:** (Moyo, B. *et al.*, 2016; Moyo B. *et al.*, 2011; Ferreira, P.M.P. *et al.*, 2008; Nouman, W. *et al.*, 2014)

2.1.2 Antimicrobial properties of *Moringa oleifera*

The antimicrobial properties of *M. oleifera* are well established. The extracts derived from *M. oleifera* tree leaves have been reported to be potential antibacterial and antifungal functions against various bacterial and fungal species (Gupta, S. *et al.*, 2018; Chuang, P.H. *et al.*, 2007; Oluduro, A.O. 2012). (Oluduro et al 2010) and (Pandey et al. 2012) have highlighted that *M. oleifera* exhibited 4-(α -L-rhamnopyranosyloxy) benzyl isothiocyanate, methyl N-4-(α -L-rhamnopyranosyloxy) benzyl carbamate, and 4-(α -D-glucopyranosyl-1 $\rightarrow$ 4- α -L-rhamnopyranosyloxy) benzyl thiocarboxamide that were able

to play antimicrobial properties. The antimicrobial activities of the *Moringa oleifera* may be due to presence of lipophilic compounds and different metabolites (carboxylic acid, 2,4-diacetyl phloroglucinol, enzymes, and chitinases) in plant cell walls (Jabeen, R. *et al.*, 2008).

2.1.3 Anti-oxidant activity of *Moringa oleifera*

Moringa oleifera tree leaves possess various phytochemicals that have antioxidant properties and roles in controlling a wide range of diseases, like diarrhea, asthma, and various cancers. The leaves of *M. oleifera* have also been reported to hold extensive amounts of total phenols, proteins, calcium, potassium, magnesium, iron, manganese, and copper (Hekmat, S. *et al.*, 2015). They also contain rich sources of different phytonutrients, such as carotenoids, tocopherols, and ascorbic acid, which are good sources of dietary antioxidants (Qwele, K. *et al.*, 2013; Saini, R.K. *et al.*, 2014). In addition, leaves extract from *M. oleifera* could improve the superoxide dismutase (SOD), catalase, glutathione, and peroxidase levels and reduce lipid peroxidation in albino mice. Furthermore, total phenolic, flavonoid, and flavonol content in leaf extracts was found to be 120 mg/g of gallic acid equivalents (GAE), 40 mg/g of GAE, and 12.12 mg/g of GAE, respectively (Jaiswal, D. *et al.*, 2013; Luqman, S. *et al.*, 2012).

2.1.4 Effects of *Moringa oleifera* on immune system

The immune functions of *M. oleifera* are also established by several in vitro studies (Gupta, S. *et al.*, 2018). Various biochemical ingredients, like quercetin, different glycosides, various isothiocyanate, kaempferol glucosides, that possess anti-inflammatory properties have been demonstrated from the extract of various parts of *M. oleifera* (Maheshwari, K. *et al.*, 2014; Stohs, S.J.; Hartman, M.J. 2015). Different protein and various peptides' (isothiocyanates, glycoside cyanides etc.) presences in *M. oleifera* leaf extracts were able to modify the immune response positively (Gupta, A. *et al.*, 2010; Rachmawati, I.; Rifai, M. 2014). An investigation was carried out to detect the immunomodulatory activity of *M. oleifera* on mice model. Chronic administration of *M. oleifera* significantly increased white blood cell (WBC) count and percent of neutrophils in experimental mice (Gupta, A. *et al.*, 2010). The exact mechanism of action of moringa leaves on stimulating the humoral and cellular immunity is not clear yet (Gupta, A. *et al.*, 2010)

2.1.5 Effects of Moringa leaf powder on broiler growth performance

The major findings on the role of *Moringa oleifera* on performance in broilers are summarized in Table 3. (Alabi, O. *et al.*, 2017) applied aqueous *M. oleifera* leaf extracts on the performance in broiler chickens. This study demonstrates that average daily body weight gain and final body weight were higher in 120 mL/L extract-supplemented groups than the control. Feed intake was highest in birds on positive control (having antibiotics) and lowest in birds that consumed 90 mL/liter of leaf extracts. Feed conversion ratio (FCR) was lower in birds on 90 mL/L and 120 mL/L of leaf extracts fed groups. Collectively, the authors suggested that moringa leaf extracts can be added up to 90 mL/L in broiler chickens for optimum performance. The higher body weight and lower FCR in this study might be related to the presence of different bioactive components in moringa leaf extracts that may play a role in improved nutrient utilization in supplemented birds. Similarly, higher body weight was also recorded by (Khan, I. *et al.*, 2017) who used moringa leaf powder as dietary supplement with 1.2% levels in broilers. (Abdulsalam, S. *et al.*, 2015) conducted an experiment with moringa leaf meal in broilers and found that supplemented diets could enhance the growth performance at finisher period. The authors finally stated that moringa leaf meal can be applied as a natural source of protein in broiler diets. Similarly, inclusion of *Moringa oleifera* leaves at higher levels (15% and 20%) in broiler diets resulted in a higher growth rate and better health status in broilers (Alnidawi, A. *et al.*, 2016). In addition, dietary supplementation of *M. oleifera* leaves at 5% to 20% level showed higher growth performance in broilers (Moreki, J.C.; Gabanakgosi, K. 2014).

Table 3. Role of *Moringa oleifera* on growth performance in broilers

Types	Study design	Main findings	Reference
<i>Moringa oleifera</i> leaf powder	broilers (Hubbard) from 1–35 days, dose: 6,9,12, and 15 g/kg (supplementation type)	•higher pH of breast muscle •higher weight and diameter of breast muscle fibers •higher water holding capacity of breast muscle •higher weight length index of tibia bone •higher ash percentage of tibia bone •no effects on alkaline phosphatase in tibia bone	(Rehman, H. <i>et al.</i> , 2018)
<i>Moringa oleifera</i> leaf powder	broilers (Hubbard) from 1–35 days, dose: 0, 0.6%, 0.9%, 0.12%, 0.15% (supplementation type)	•no effects on feed intake, FCR and bursa weight •higher final body weight •higher length of small intestine •higher empty weight of small intestine and ceca •higher villus height (duodenum, jejunum, ileum) •higher villus height/crypt depth (ileum) •higher goblet cell number (total) in duodenum •higher acidic mucin number in duodenum, jejunum and ileum	(Khan, I. <i>et al.</i> , 2017)
<i>Moringa oleifera</i> leaf extract	broilers (Hubbard)from 1–42 days, dose: 0, 60, 90, 120, 150 mL/L	•higher body weight gain •lower FCR •no effects on weight of inner organs •no effects on dressing percentage	(Alabi, O. <i>et al.</i> , 2017)

<i>Moringa oleifera</i> leaf meal	broilers from 0–42 days, dose: 0, 5%, 10% 15%, 20%, (inclusion type)	●higher body weight ●higher hemoglobin percent, and RBC number ●lower TC, LDL	(Alnidawi, A. <i>et al.</i> , 2016)
<i>Moringa oleifera</i> seed powder	broilers from 1–42 days, dose: 0, 0.5%, 0.1%, and 2% (inclusion type)	●no effects on live weight and weight gain ●no effects on FCR ●no effects on dressing percentage, liver weight and heart weight	(Ochi, E. <i>et al.</i> , 2015)
<i>Moringa oleifera</i> leaf meal	broilers (ANIK 2000 strain) from 0–49 days, dose: 0, 5%, 7.5%, 10 % (inclusion type)	●higher dressing weight in 7.5% and 10% level ●higher weight of liver, spleen, and gizzard ●no significant effects on body weight gain, feed intake and FCR	(Onunkwo, D.N.; George, O.S. 2015)
<i>Moringa oleifera</i> leaf meal	broilers (Cobb-500) from 1–35 days, dose: starter (1, 3 and 5 g/kg); grower (3, 9, and 15 g/kg); and finisher (5, 15, and 25 g/kg) (inclusion type)	●higher body weight and weight gain at grower period ●lower FCR ●no effects on feed intake ●higher Ca and P content in tibia bone ●no effects on tibia weight, tibia length, and weight-length index of tibia bone ●no effects on ash content in tibia, and bone breaking strength	(Nkukwana, T.T. <i>et al.</i> , 2014)
<i>Moringa oleifera</i> leaf meal	broilers (Cobb-500) from 1–35 days, dose: starter (1, 3, and 5 g/kg), grower (3, 9, and	●higher body weight at starter and finisher period ●lower FCR ●no effects on feed intake	(Nkukwana, T.T. <i>et al.</i> , 2014)

	15 g/kg) and finisher (5, 15, and 25 g/kg) (inclusion type)	•higher dressing percentage, thigh muscle weight and bursa weight •no effects on CP, CF, DM, EE, ash, NDF, ADF digestibility	
<i>Moringa oleifera</i> leaf meal	broilers (Cobb-500) from 1–35 days, dose: 1%, 3%, and 5% (inclusion type)	•higher body weight and weight gain at starter period •lower FCR •no effects on feed intake •higher thiobarbituric acid reactive values in breast muscle during storage •higher fatty acid profile (C18:0, C15:0, C20:0, C20:3n6 and C22:6n3) levels •no effects on thrombogenic index and atherogenic index in breast muscle	(Nkukwana, T.T. <i>et al.</i> , 2014)
<i>Moringa oleifera</i> leaf meal	broilers (Ross) from 1–49 days, dose: 0, 3%, 5%, and 7% (inclusion type)	•higher final body weight and weight gain •lower FCR •higher feed intake •higher dressing percentage •higher meat tenderness and juiciness score	(Safa, M.A.; Tazi, E. 2014)
<i>Moringa oleifera</i> leaf meal	broilers from 1–42 days, dose: 0, 7.5%, 15%, and 30% (inclusion type)	•lower final body weight and weight gain •higher FCR •lower dry matter digestibility •no effects on crude protein, crude fiber digestibility •no effects on lipid metabolic profile (HDL, TC, LDL)	(Gakuya, D.W. <i>et al.</i> , 2014)

		●higher meat color scores	
<i>Moringa oleifera</i> leaf meal	broilers from 1–35 days, dose: 0, 10%, 15% (inclusion type)	●higher body weight gain ●lower FCR ●higher final body weight ●higher RBC number, PCV number, and HB percent	(Ebenebe, C.L. <i>et al.</i> , 2012)
<i>Moringa oleifera</i> leaf meal	broilers (Habbard) from 0–42 days, dose: 0, 25%, 50%, 75 %, 100% (supplementation type)	●no effects on feed intake ●no effects on weight gain ●lower FCR	(Gadzirayi, C.T. <i>et al.</i> , 2012)
<i>Moringa oleifera</i> leaf powder	broilers from 1–42 days, dose: 0, 0.05%, 0.10% (supplementation type)	●higher body weight gain ●lower FCR ●higher final body weight ●higher dressing percentage	(David, L.S. <i>et al.</i> , 2012)
<i>Moringa oleifera</i> leaf extract	broilers (Cobb)from 1–35 days, dose: 0, 30, 60, 90 mL/L	●higher live weight ●lower FCR ●higher returns to investment ●lower feed intake	(Portugaliza, H.P.; Fernandez, T.J. 2012)
<i>Moringa oleifera</i> leaf meal	broilers (Cobb) from 14–42 days, dose: 0, 5%, 10%, and 15% (inclusion type)	●lower weight gain and final body weight ●higher FCR ●no effects on dressing percentage and carcass weight ●no effects on weight of inner organs ●no effects on CP and EE content in meat ●no effects on total cholesterol, HDL, LDL, total protein, glucose	(Zanu, H.K. <i>et al.</i> , 2012)

(FCR: Feed conversion ratio; HDL: High density lipoprotein cholesterol; TC: Total cholesterol; LDL: Low density lipoprotein cholesterol; RBC: Red blood cell; PCV: Packed cell volume; HB: Hemoglobin; CP: Crude protein; CF: Crude fiber; DM: Dry matter; EE: Ether extract; NDF: Neutral detergent fiber; ADF: Acid detergent fiber).

2.2 Effects of green chiretta supplementation on growth performance and blood profile of broiler

2.2.1 Antibacterial activity of green chiretta

Andrographolide, the main active component of the herb green chiretta, has been used for many years for antibacterial infections. Andrographolide has an antibacterial effect on a wide variety of bacteria, which is reflected in the inhibition of bacterial pathogenic factors and the regulation of immunity to downregulate infectious inflammation caused by bacteria. In the current climate of frequently occurring antibiotic resistance, Andrographolide might be considered a promising lead for new antibacterial drug development. This review outlines the therapeutic potential of Andrographolide and its analogs in combating various bacterial infections, focusing on the mechanisms of action. The antibacterial pharmacological action of Andrographolide mainly lies in the inhibition of bacterial pathogenic factors and the regulation of the immune system to reduce the inflammatory response (Ma L *et al.*, 2012). Andrographolide can inhibit the formation of bacterial biofilms, the production of virulence factors, the adhesion between bacteria, and the destruction of bacterial integrity in direct bacteriostatic action. Indirect bacteriostasis has a potential immunopotentiator effect on the treatment of bacterial infections by regulating the immune response and maintaining the cytoskeleton of the body. This antimicrobial property of Andrographolide and its analogs also exhibits notable properties in combination with antibiotics. Andrographolide can partially restore antibiotic susceptibility by inhibiting the expression of bacterial efflux pumps and competitively inhibiting antibiotic resistance sites in bacteria. However, there are still some difficulties in the clinical application of Andrographolide. For example, the poor solubility of Andrographolide has become one of the important reasons for limiting its efficacy (Sharma *et al.*, 2017). Therefore, at present, many studies in drug development often modify the structure of Andrographolide to increase water solubility and optimize delivery systems, thereby enhancing pharmacological activity and increasing therapeutic

index (Dai Y *et al.*, 2019). In addition, the potential characteristics of Andrographolide in pharmacological research are the improvement of antibiotic sensitivity in combination with antibiotics, which is an advantage in clinical treatment and represents a promising lead in the development of new antibacterial drugs.

2.2.2 Antiviral activity of green chiretta

Green chiretta supplementation has been widely used throughout the world as an antiviral drug. Its mechanisms of action in inhibiting viral infection can be categorized into several categories, including regulating the viral entry stage, viral gene replication, and the formation of mature functional proteins. In addition, andrographolide suppresses the induction of cytokines and chemokines to prevent inflammation that can damage cells. To achieve entry into the host cell and have a pharmacological effect, andrographolide must have a high bioavailability and be thermodynamically stable. However, andrographolide has several shortcomings, including low bioavailability, solubility, and stability. Green chiretta supplementation and some of its active compounds were reported to possess antiviral activities. For instance, andrographolide protects against deoxyribonucleic acid (DNA) viruses Epstein–Barr (EB) virus and herpes simplex virus 1 (HSV-1)) and ribonucleic acid viruses human immunodeficiency virus (HIV), influenza virus A, hepatitis C, dengue virus, and Japanese encephalitis virus (JEV)) (Gupta *et al.*, 2017). An in-silico study showed that andrographolide possessed potential inhibitors of SARS-CoV-2's main protease (Chao *et al.*, 2010, Wang *et al.*, 2011).

2.2.3 Anti-oxidant activity of green chiretta

Hydro alcoholic extract of green chiretta supplementation prevented isoproterenol induced elevated lipid per oxidation and antioxidant enzymes activity super oxide dismutase, catalase, glutathione peroxidase and the levels of reduced glutathione level in heart. In addition, the extract also prevented leakage of lactate dehydrogenase from heart and salvaged it from isoproterenol induced myocardial ischemic injury. The study indicated the antioxidant, antilipid peroxidative and ant ischemic activity of green chiretta and justified its use in ischemic heart diseases.

2.2.4 Hepatoprotective activity of green chiretta

Green chiretta is extensively used as a hepato-stimulant and hepatoprotective agent in Indian systems of medicine. Green chiretta is also an ingredient in several polyherbal preparations used as hepatoprotections in India, one of which has been reported as efficacious in chronic hepatitis B virus infection. Andrographolide is extensively used as a stimulating agent for liver enzymes and hepatoprotective agent. Very few studies on the effects of crude extracts of green chiretta on liver function are available. Most studies for hepatic effects have been conducted on either andrographolide or other purportedly active principles. Multiple-dose pretreatment with arabinogalactan proteins and andrographolide was protective against ethanol induced hepatotoxicity in mice and was deemed comparable to the efficacy of silymarin (Singha *et al.*, 2003).

2.2.5 Effects of green chiretta supplementation on immune system

Green chiretta acts as an immunomodulator by inhibiting the propagation of pathogens (viruses and bacteria) and by eliciting the right amount of immune response. An important component of the immune system is the cytokines that regulate the immune cells and has many other functions such as anti-viral activity. The immune responses are compromised due to stress, age, and lifestyle choices that render the host vulnerable to infections (Arango *et al.*, 2014). Green chiretta has been widely researched for its immunomodulatory activities in vitro and in vivo including lymphocyte proliferation, promoting cell mediated lytic activity through NK cells, antibody-dependent cellular cytotoxicity, and phagocytic activity (Puri *et al.*, 1993). While there is a plethora of evidence available for immunomodulatory effects of green chiretta supplementation in cell. Herbs and bioactive metabolites are believed to be effective in balancing and proper functionality of immune system through various modules of immune modification involving stimulation and suppression. Probably green chiretta may be effective in increasing the NK cell activity as reported by (Sheeja *et al.*, 2007).

2.2.6 Effects of green chiretta on broiler growth performance

In veterinary medicine, antibiotics are frequently used to treat bacterial diseases and to protect the health of farm animals. Due to the low ability of chicken intestines to absorb many antimicrobials, a huge amount of the drug is excreted in feces unaltered. The widespread use of animal excrement as fertilizer in many nations raises concerns about the negative environmental impacts of antibiotic residues that might contaminate over

wide geographical areas (Hao *et al.*, 2014). WHO states that there are currently serious worries regarding the spread of antibiotic resistance genes in bacteria detected in human patients, probably as a result of veterinary usage of antibiotics (WHO, 2014). Herbal extracts are increasingly used as a safe and effective solution to improve performance and decrease coccidiosis cases. Green chiretta supplementation have been separately reported to improve performance when added in the feed. However, there were no studies of the use of both extracts combined. Feed supplemented with 30% dry green chiretta leaves could reduce FCR. Feed supplemented with aqueous green chiretta supplementation could reduce *E. coli* bacterial infection and beneficial bacteria such as *Lactobacillus spp.* was predominant in small intestine, especially in the ileum. Dietary oregano essential oil supported the intestinal absorptive capacity and antioxidant defense system during *Eimeria* infection; however, it displayed minimal direct activity on the reproductive capacity of *Eimeria*. The content of andrographolide in *Andrographis paniculata* acts to increase immunity. Interferon produced by lymphocytes increased the response of phagocytic activity by macrophage cells to inhibit the replication of *E. tenella* (Dai *et al.*, 2019). Green chiretta have anti-inflammatory activity that can inhibit inflammatory mediators caused by bacterial and parasitic infections such as prostaglandins, interleukins (IL), interferons (IFN) and tumor necrosis factor (TNF), etc. (Dai *et al.*, 2019).

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted to study the effects of moringa leaf powder and green chiretta supplementation on growth performance like weight gain, feed intake, Feed Conversion Ratio (FCR), cost effectiveness and blood profile like Total Erythrocyte Count (TEC), Hemoglobin concentration (Hb%), Packed cell volume (PCV) in broilers.

3.1 Study area and duration

The study was conducted at the Department of Physiology and Pharmacology, Faculty of Veterinary and Animal Sciences, Hajee Mohammad Danesh Science and Technology University during the period from early September 2023 to mid-October 2023. Broilers were reared in well partitioned area in a room under strict hygienic management in the hired poultry shed of Narsingdi district. Laboratory tests were conducted at the Green Life Diagnostic Center, Narsingdi.

3.2 Experimental design

A total of 120-day-old chicks Efficiency Plus meat broiler chicks were purchased from Paragon Poultry Limited that distributed among four equal groups (n=30). Birds were kept on the floor in isolated pens and fed commercial ration and ad libitum water. Four experimental groups were identified as T₀ (basal diet), T₁ (basal diet supplemented with moringa leaf powder), T₂ (basal diet with green chiretta supplementation), T₃ (basal diet with moringa leaf powder and green chiretta supplementation) during five weeks experimental periods. Groups T₁ treated with moringa leaf powder @ 1gm/1kg of feed, T₂ treated with green chiretta supplementation (Andose) @ 1gm/1kg of feed, T₃ treated with moringa leaf powder @ 1gm/1kg of feed and green chiretta supplementation (Andose) @ 1gm/1kg of feed. Feed intake, weight gain and Feed Conversion Ratio (FCR) were recorded weekly at the experimental period. Then the blood samples from broilers collected to assess Hematological parameters like Total erythrocyte count (TEC), Hemoglobin concentration (Hb gm%) and Packed Cell Volume (PCV).

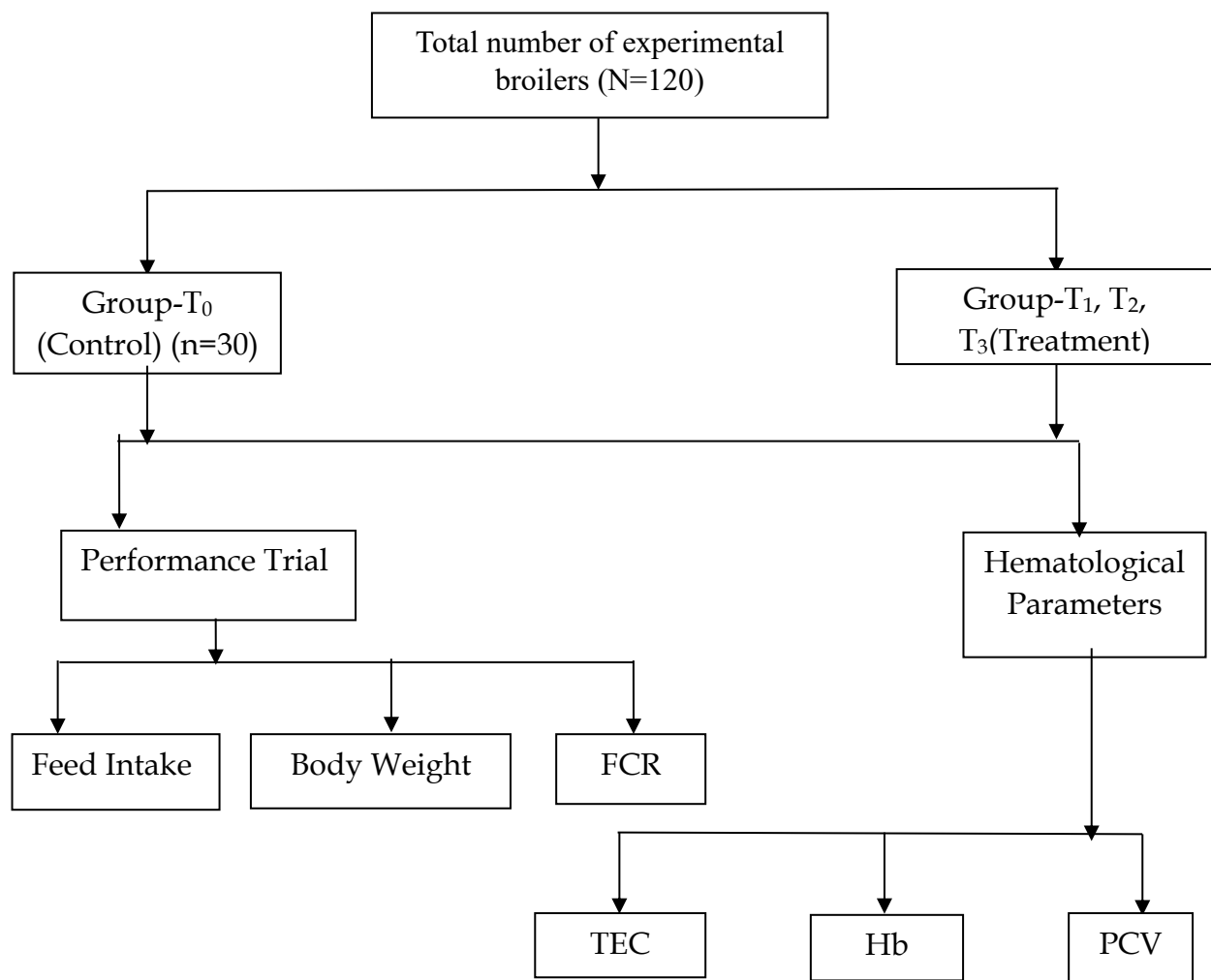


Figure 1: Layout of the experiment

3.3 Preparation of the broiler house

For research purpose an open sided commercial broiler shed was used. Eight pens of equal sizes were made by net with wood. The room was swiped and cleaned properly with fresh water. Then the room was disinfected. All the necessary equipment's like Feeders and waterers were cleaned properly and disinfected thoroughly. For winter season, curtain management maintain properly.

3.4 Experimental broiler

Day old chicks (DOC) of broiler “Efficiency Plus” strain marketed by Paragon Poultry Limited were purchased for this experiment.



Figure 2: Experimental group

3.5 Diet of broiler

The chicks were kept for seven days for acclimatization and were fed commercial broiler starter and grower feed (Paragon Feed Limited, Gazipur as per Table 4) and drinking water. Treatment T₀ control group was fed with commercial broiler ration and fresh drinking water. Treatment T₁ were treated with moringa leaf powder @ 1gm/1kg in commercial broiler ration and fresh drinking water. Group T₂ were treated with green chiretta supplementation (Andose) @ 1gm/1kg in commercial broiler ration and fresh drinking water. Group T₃ were treated with moringa leaf powder and green chiretta supplementation (Andose) @ 1gm/1kg each in commercial broiler ration and fresh drinking water.

Table 4: Ingredients in the basal diet and nutritional analysis (Per 100 kg feed)

Ingredients (kg)	Broiler feed formula	
	Starter	Grower
Maize	52.50	55.00
Soya bean meal	35.00	30.00
Full fat	4.00	5.00
Limestone	1.00	1.00
Protein meal	4.00	4.00
Soya oil	1.50	3.00
Trace minerals	1.00	1.00
Salt	1.00	1.00
Total	100.00	100.00
Nutrient composition		
Moisture (%)	12	12
Crude Protein (Min %)	22.50	21
Crude Fat (Min %)	5.50	6
Ca (Max %)	1	0.95
AvP (Min %)	0.50	0.50
ME (Min Kcal/ kg)	3100	3200

Source: Paragon Feed Limited, Gazipur, Bangladesh.



Figure 3: Broiler starter feed



Figure 4: Broiler grower feed

3.6 Test ingredients

3.6.1 Collection and preparation of moringa leaf powder

Moringa leaf was selected for study was mature and free from disease condition. Moringa leaves were collected from velanagar an area of Narsingdi district. It was identified with the help of botanist. After collection of moringa leaves was washed in running tap water. For the preparation of moringa leaves powder, the leaves were dried in the sun for 10 days. Then it was dried in the oven at 55-60°C for 2 days. The dried leaves were pulverized with a blender. A 25 (unit) mesh diameter sieve was used to obtain the fine dust, after then dust was preserved in air tight plastic container until they were directly used for the experiment.



Figure 5: Moringa (*Moringa oleifera*) leaf powder

3.6.2 Collection of green chiretta supplementation

green chiretta supplementation were collected from the local veterinary medicine corner for the experimental purpose.

Table 5: Description of the ingredients

Name	Description/ Composition	Source/ Company
Moringa leaf powder	Naturally prepared moringa leaf powder	Local Area
Andose	100% <i>Andrographis paniculata</i>	Sabre Agro Pharma

Source: Sabre Agro Pharma, Dhaka, Bangladesh.

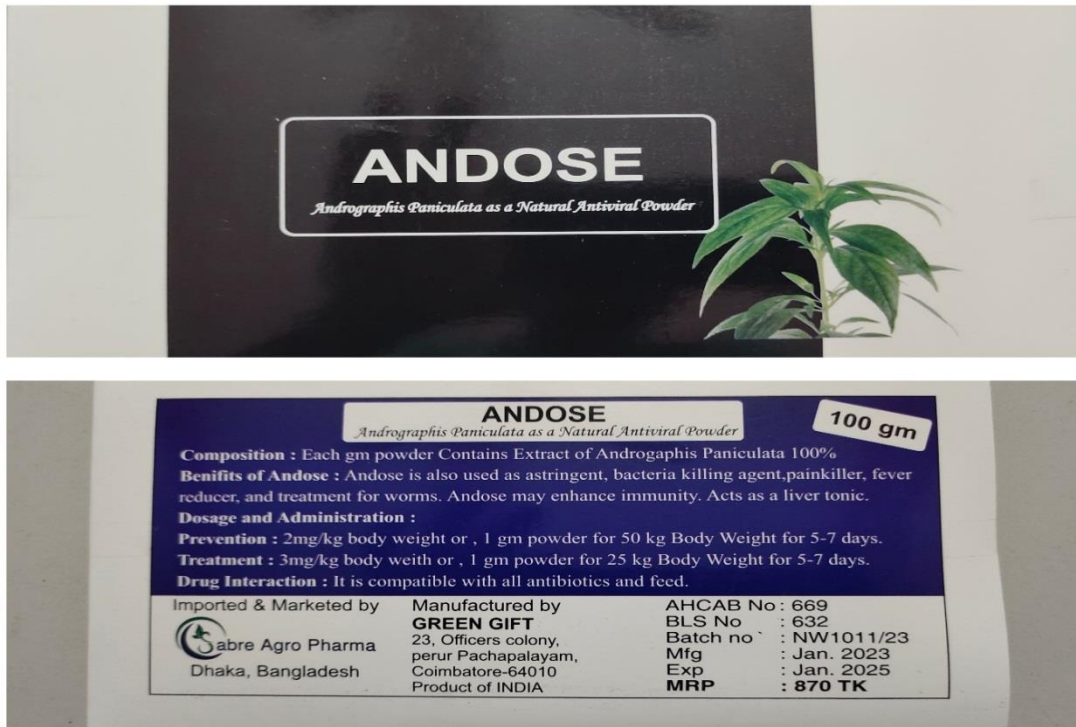


Figure 6: Andose (*Andrographis paniculata* 100%)

3.7 Floor space

The experimental shed was partitioned into eight pens using wire-net. A group of 50 broiler chicks were randomly allocated to each pen. Each pen was 10 ft × 6 ft. Therefore, average floor space allocated for each bird was 1.2 square feet.

3.8 Brooding management

At first week of age brooding temperature was kept at 35⁰ Celsius. From second week of age brooding temperature was decreased gradually 5⁰C/week. Brooding temperature was maintained by electric bulb. Temperature increasing or decreasing was done by birds' behavior. Thermometer is used to measure the brooding temperature.

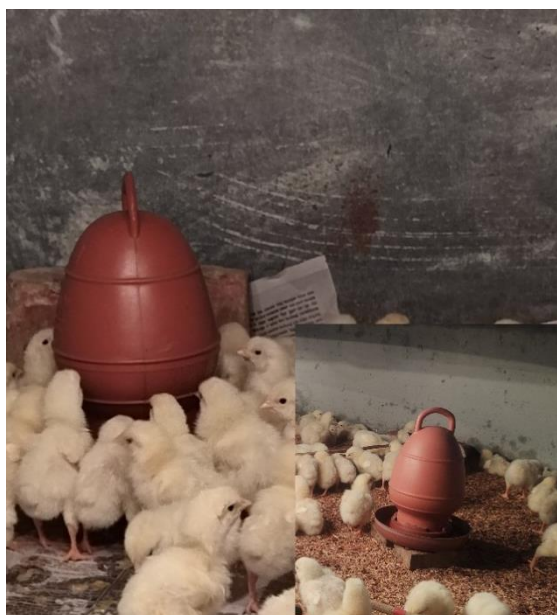


Figure 7: Brooding of chicks

3.9 Lighting management

First seven days the chicks were kept in light in 24 hours due to lower environmental temperature. For this reason, three electric bulbs with 200 watt and one LED bulb were used in case of electricity gone. The birds were regularly exposed to natural lighting at day. Electric bulbs were the source of light at night.

3.10 Litter management

Litter is bedding material of broilers. Rice husk was used as litter. The bedding materials help to absorb moisture, decrease the production of ammonia and various harmful pathogens. The materials used for bedding can also have a significant impact on broilers growth performance. Litter was stirred two times daily to prevent cake formation and minimize dampness. Already used up litter materials were changed regularly with new materials at 15 days interval to prevent birds from various diseases.

3.11 Feeding and drinking

Commercial broiler feed (marketed by Paragon Feed Limited, Bangladesh) was used as broilers diet throughout the experiment. Feed was collected from local market of Narsingdi. Broiler starter feed was given from 1-19 days, Broiler grower feed from 20-35 days. First day feed was given on newspaper. Then gradually tray feeder and round tube feeder were used for supplying feed. Three feeder and drinker were provided in each pen.

First seven days of age feed was given four times and after first week feed was given three times a day. Drinking water was given three times a day.

3.12 Biosecurity measurement

Biosecurity is a set of preventative measures designed to reduce the risks of infectious diseases transmission among birds. It means doing everything to reduce the chances of an infectious disease being carried into farm by people, animals, equipment or vehicles. Strict biosecurity program was maintained in the poultry shed. A footbath was kept outside at the door of the shed where 0.01% KMnO₄ water was used. All the equipment of the farm including feeder, waterer was kept clean. Disinfectant spray was used daily inside and outside the farm. To prevent rat and any other wild animals fencing was done. Inspection was done regularly.

3.13 Vaccination of broiler

During the experimental period birds were vaccinated to prevent the common diseases of broilers. Vaccination was done as per manufacturer's instructions and the following schedule was followed.

Table 6: Vaccination schedule for the experimental broiler

Age (Days)	Vaccine name	Trade name	Company	Method of vaccination
5	IB+ND (Infectious Bronchitis + Newcastle disease)	Nobilis MA5 Clone 30	MSD	Eye drop
12	IBD (Infectious Bursal Disease)	Nobilis Gumboro 228E	MSD	Drinking water
18	IBD (Infectious Bursal Disease)	Nobilis Gumboro 228E	MSD	Drinking water
20	ND (Newcastle Disease)	ND Lasota	Elanco	Drinking water

Sources: Bengal Overseas Limited (Distributor of MSD) & Elanco Bangla Limited.

3.15 Body weight measurement of broiler

Body weight of the experimental birds was measured randomly with help of electric balance. It was measured on 1 day of age and sequentially at 7 days interval up to the age of 35 days. Body weight was measured as gram. All the data were recorded.



Figure 8: Weight measuring

3.16 Blood samples collection

Blood samples were collected from birds for hematological examinations. Blood was collected aseptically from the randomly selected 2 birds from each group at the end of the experiment at 35 days of age. From each bird 3ml blood sample was collected and transferred immediately to a clean and sterile test tube containing anticoagulant (EDTA) @ 1:10 for hematological studies. Test was performed within two hours after collection of blood samples.



Figure 9: Blood collection and sampling

3.17 Hematological parameters

Hematological experiment was conducted at "Green Life Diagnostic Centre" Narsingdi. Total Erythrocyte Count (TEC), Hemoglobin Estimation (Hb) and Packed Cell Volume (PCV) tests were performed as described by Lamberg and Rothstein (1977).

3.18 Data collection, record keeping and analysis

The collected data were entered in the Microsoft Excel work sheet and organized for further analysis. Experimental data on growth performance (e.g., Body weight gain), Hematological parameters (e.g., TEC, Hb concentration, PCV) were collected in structured form. Experimental data were calculated and expressed as Mean $\pm$ SE. For the comparison of data among the various groups one way ANOVA (Analysis of variance) was chosen. The mean difference among the treatments were determined as per Duncan's Multiple Range Test (DMRT). These data were analyzed with the help of computer package SPSS 25.0 software. Distributions of these continuous data were checked by performing univariable descriptive analysis. A P-Value <0.05 was used as a cut off value to assess the level of significance of a particular performance parameter among treatment groups.

CHAPTER IV

RESULTS

The experiment was conducted to study the effects of moringa leaf powder and green chiretta supplementation at same level on growth performance like weight gain, feed intake, Feed Conversion Ratio (FCR) and hematological parameters like Total Erythrocyte Count (TEC million/ mm³ of blood), Hemoglobin concentration (Hb gm/dl of blood) and Packed Cell Volume (PCV%).

4.1 Effects of moringa leaf powder and green chiretta supplementation on live weight gain and growth performance of broiler

The effects of feeding moringa leaf powder and green chiretta supplementation and their combination on body weight gain is shown in Table 6. No mortality occurs within the experimental time.

Table 7: Effects of moringa leaf powder and green chiretta supplementation and their combination on weight gain in different groups of broilers.

Treatment groups	Weight gain in gm (Mean±SE)				
	Day 7	Day 14	Day 21	Day 28	Day 35
T ₀	193.28± 3.17	466.31±2.71	890.55±2.82	1470.45±1.26	2050.62±1.65
T ₁	196.38± 3.21 ^b	469±2.84 ^c	894.12±1.82 ^b	1485.32±4.11 ^c	2090.71±2.98 ^b
T ₂	197.13±2.46 ^a	470.50±2.61 ^b	896.23±1.84 ^a	1478.52±3.32 ^b	2093.85±3.98 ^c
T ₃	200.29±4.13 ^c	473.37±2.01 ^a	900.38±1.95 ^c	1490.11± 2.17 ^a	2140.52±2.41 ^a

Here, T₀=Control, T₁= moringa leaf powder @ 1gm/1kg, T₂= green chiretta supplementation (Andose) @ 1gm/1kg, T₃= moringa leaf powder @ 1gm/1kg and green chiretta supplementation (Andose) @ 1gm/1kg.

^{a,b,c} Values with different superscript letter (s) in the same column differ significantly (p<0.05).

Table 4 shows the live weight gain of different treatment groups and age of broilers. Data were recorded every 7 days interval during the experimental periods. It shows that the

live weight and weight gain of T₁, T₂, T₃ were found to be significantly ($p<0.05$) higher than that of the control group. But, moringa leaf powder and green chiretta supplementation and their combination had no significant effect ($p<0.05$) on the amount of total feed consumption. A distinct fluctuation was observed with the advanced of age of broilers among different groups and always highest in group T₃. The highest live weight recorded in the present findings in group T₃ after 35 days of experiment.

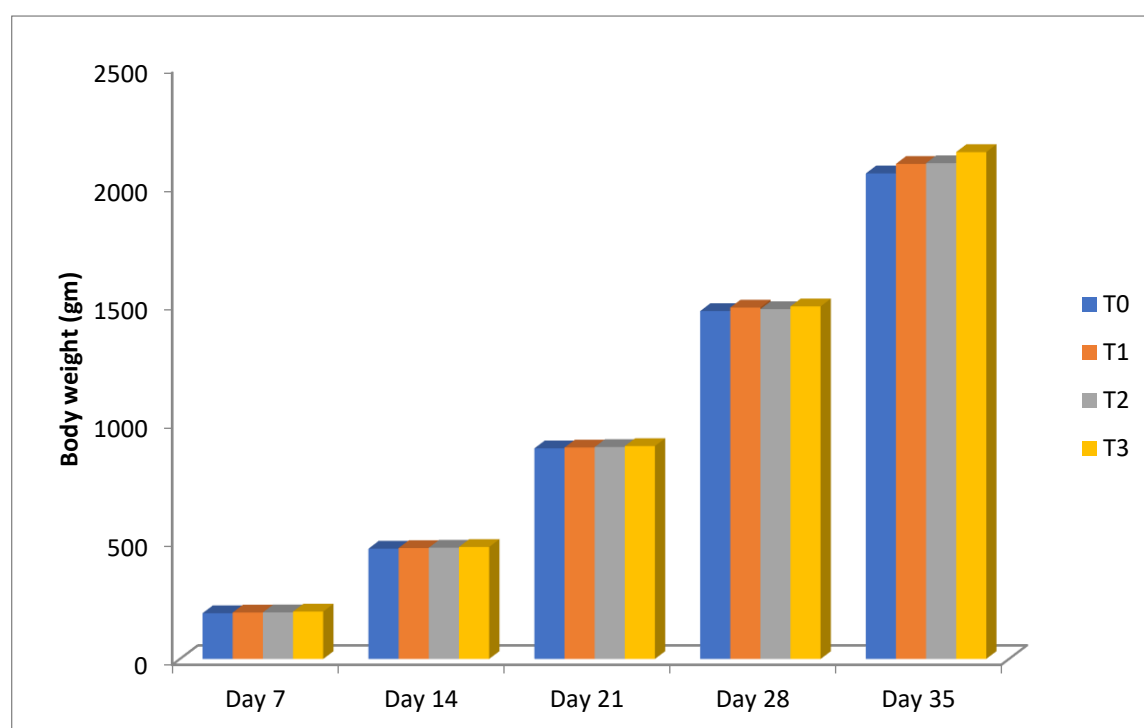


Figure 10: Effects of moringa leaf powder and green chiretta supplementation and their combination on weight gain in different groups of broilers chicken

4.2 Effects of moringa leaf powder and green chiretta supplementation on Feed Conversion Ratio (FCR) of broiler

FCR was calculated at 35th days, the best FCR was in T₃ group at 35th day, followed by T₁, T₂ and lowest was in T₀ group (Table 5).

Table 8: Effects of moringa leaf powder and green chiretta supplementation and their combination on FCR in different groups of broilers.

Parameters	T ₀	T ₁	T ₂	T ₃
Average live weight (gm/bird)	2050.62±1.65	2090.71±2.98 ^b	2093.85±3.98 ^c	2140.52±2.41 ^a
Average feed intake (gm/bird)	2997.10±4.25	3046.16±2.31 ^a	3004.67±3.69 ^b	2992.45±3.84 ^c
FCR (gm/bird)	1.462±0.03	1.457±0.01 ^b	1.435±0.03 ^c	1.398±0.02 ^a

Here, T₀=Control, T₁= moringa leaf powder @ 1gm/1kg, T₂= green chiretta supplementation (Andose) @ 1gm/1kg, T₃= moringa leaf powder @ 1gm/1kg and green chiretta supplementation (Andose) @ 1gm/1kg.

^{a,b,c} Values with different superscript letter(s) in the same row differ significantly (p<0.05).

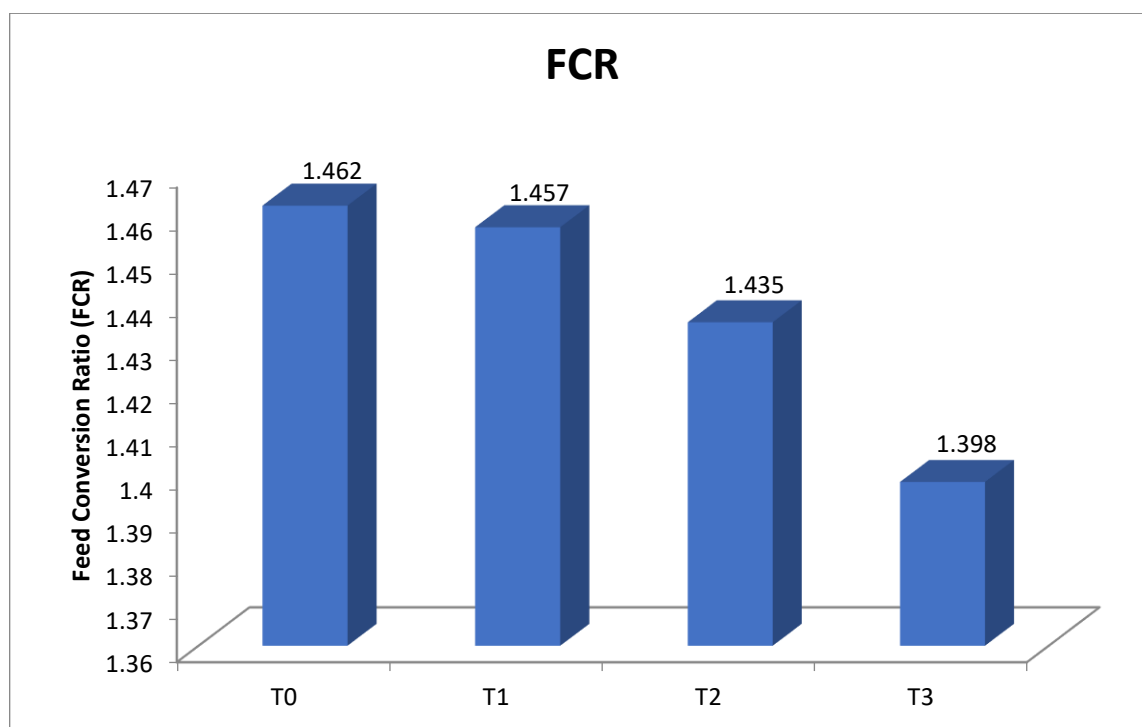


Figure 11: Effects of moringa leaf powder and green chiretta supplementation and their combination on FCR of different groups of broiler chicken

4.3 Effects of moringa leaf powder and green chiretta supplementation on Hematological Parameters of broiler

Hematological parameters of broiler on 35th day.

Table 9: Effects of moringa leaf powder and green chiretta supplementation and their combination in broilers on 35th days.

Parameter	Group of broilers			
	T ₀	T ₁	T ₂	T ₃
TEC (10 ⁶ /mm ³)	2.30±0.01	2.45±0.05 ^b	2.29±0.05 ^a	2.49±0.09 ^c
Hb (g%)	7.05±0.28	9.69±0.28 ^c	6.79±0.19 ^b	8.32±0.16 ^a
PCV (%)	26.59±0.05	31.71±0.02 ^a	28.56±0.04 ^b	30.85±0.03 ^c

Here, T₀=Control, T₁= moringa leaf powder @ 1gm/1kg, T₂= green chiretta supplementation (Andose) @ 1gm/1kg, T₃= moringa leaf powder @ 1gm/1kg and green chiretta supplementation (Andose) @ 1gm/1kg.

^{a,b,c} Values with different superscript letter(s) in the same row differ significantly (p<0.05).

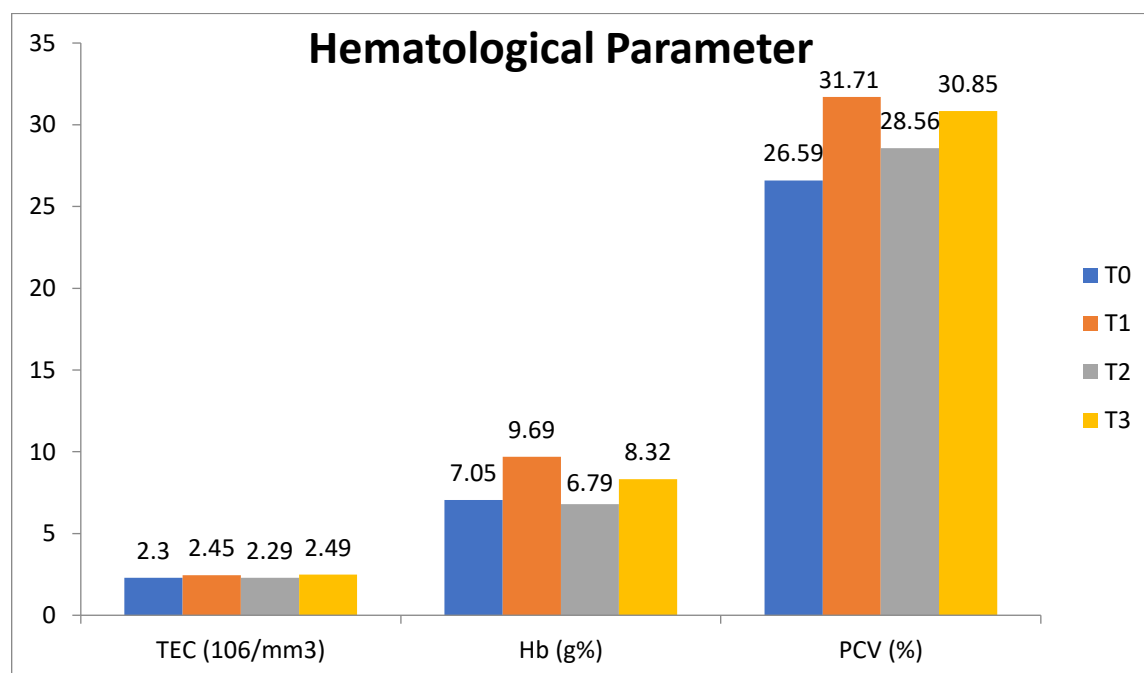


Figure 12: Effects of moringa leaf powder and green chiretta supplementation and their combination on Hematology parameters in different groups of broiler chicken

4.3.1 Effects on Total Erythrocyte Count (TEC)

In the Table 6, the experimental birds of group T₃ was found highest Total Erythrocyte Count (2.49 ± 0.09 million/mm³) followed by T₁ group (2.45 ± 0.05 million/mm³), T₂ group (2.29 ± 0.05 million/mm³), T₀ (Control) group (2.30 ± 0.01 million/mm³) respectively at the end of trial with no significant differences ($p < 0.05$).

4.3.2 Effects on Hemoglobin (Hb) concentration

In the Table 6, the value of Hb were found highest in T₁ group ($9.69 \pm 0.28\%$) followed by T₃ group ($8.32 \pm 0.16\%$), T₂ group ($6.79 \pm 0.19\%$), T₀ (Control) group ($7.05 \pm 0.28\%$) respectively at the end of trial with no significant differences ($p < 0.05$).

4.3.3 Effects on Packed Cell Volume (PCV)

in Table 6 showed that at the end of trial group the value of PCV (%) resulted highest in T₁ group ($31.71 \pm 0.02\%$) followed by T₃ group ($30.85 \pm 0.03\%$), T₂ group ($28.56 \pm 0.04\%$), T₀ (Control) group ($26.59 \pm 0.05\%$) respectively. No significant differences ($p < 0.05$) were observed among the groups.

CHAPTER V

DISCUSSION

Moringa leaf powder and green chiretta supplementation are phytogetic feed additives have shown promising results as weight gain, feed efficiency, lowered mortality and increased livability in poultry. In this experiment, first sixth day, only basal diet was supplied and then the experimental feed was trialed. This study also shows the results from the trial in the broiler chicken in T₁, T₂, T₃ group. From clear demonstration, the control group T₀ was also carried out. Initial data was collected in 7th and final data on 35th day. In the control group (T₀) with fresh water and basal feed supply, live weights were measured and found as initial live weight 193.28 gm, final live weight 2050.62 gm and FCR 1.462. In the treatment group (T₁) basal diet with moringa leaf powder initial live wt 196.38 gm, final live wt 2090.71 gm and FCR 1.457 In the treatment group (T₂) basal diet with green chiretta supplementation (Andose) initial live wt 197.13 gm, final live wt 2093.85 gm and FCR 1.435. In the treatment group (T₃) basal diet with combination of moringa leaf powder and green chiretta supplementation (Andose) initial live wt 200.29 gm, final live wt 2140.52 gm and FCR 1.398. At the end of the experimental period birds of T₁, T₂, T₃ group showed more body weight gain ($p < 0.05$) than the birds of control group T₀. The group supplemented with moringa leaf powder and green chiretta supplementation (T₃) recorded significantly better feed conversion ratio than other treatment and control group. The combination of moringa leaf powder and green chiretta supplementation had provided an environment for better absorption of nutrients and had enhanced the utilization of energy and there by increased the growth rate of chicken. Though feed consumption remains same in all treatment groups, the alteration in feed conversion ratio by the group fed with moringa leaf powder and green chiretta supplementation (T₃) is due to the significant difference in body weight than other treatment groups. These findings are in accordance with (Khan *et al.*, 2017) who observed that supplementation of moringa leaf powder had significantly improved body weight and body weight gain and this may be due to allicin in moringa leaf powder which promotes the performance of the intestinal flora and inhibits the growth of pathogenic bacteria by interfering with bacterial cell metabolism and thus enhances the activity of pancreatic enzymes and decreased growth and colonization of various pathogenic microorganism in the gut resulting in enhanced efficiency of feed utilization. (Malahubban *et al.*, 2013) and (Laing *et al.*, 2013) reported that supplementation of

green chiretta supplementation (*Andrographis paniculata*) to broilers resulted in better body weight and weight gain. Supplementation of green chiretta supplementation causes reduced pH and decreased the intestinal thickness. The present finding was in agreement with earlier report of (Alabi *et al.*, 2017; Malahubban *et al.*, 2013) who had stated that there was no significant difference in feed consumption due to moringa leaf powder and green chiretta supplementation. The combination of moringa leaf powder and green chiretta supplementation had resulted in a positive additive effect on better feed conversion ratio in broilers. In the present study, better livability was observed due to combined effect of moringa leaf powder and green chiretta supplementation. Statistical analysis revealed that no significant difference ($p < 0.05$) was observed in feed consumption between treatment groups throughout the study period. This might be due to iso-caloric and iso-nitrogenous diets fed throughout the experimental period.

The different values of hematological parameters were remained within normal range but statistically no significant ($p < 0.05$) within the comparison of treatment and control group. Hematological test performed on 35th days. In the control group (T_0) with fresh water and basal diet supply: TEC was 2.30 ± 0.01 , Hb (%) was 7.05 ± 0.28 and PCV (%) was 26.59 ± 0.05 . In the treatment group (T_1) basal diet with moringa leaf powder extract, TEC was 2.45 ± 0.05 , Hb (%) was 9.69 ± 0.28 and PCV (%) was 31.71 ± 0.02 . In the treatment group (T_2) basal diet with green chiretta supplementation, TEC was 2.29 ± 0.05 , Hb (%) was 6.79 ± 0.19 and PCV (%) was 28.56 ± 0.04 . In the treatment group (T_3) basal diet with moringa leaf powder and green chiretta supplementation, TEC was 2.49 ± 0.09 , Hb (%) was 8.32 ± 0.16 and PCV (%) was 30.85 ± 0.03 . The increased level of TEC, Hb content and PCV might be due to initiative effects on hematopoietic organs. High PCV, Hb, and RBC indicate improved oxygen carrying capacity of the cells, which translate to better availability of nutrients (Hassan *et al.*, 2016). The hematological parameters of present findings resemble to that of (Cowiesoa *et al.*, 2005) who reported that the number of erythrocyte and other components of blood varied due to influence of nutritional status, environment, exercise and climate. Administration of moringa leaf powder and green chiretta supplementation reduced the platelets in the blood (Hassan *et al.*, 2016) reported that moringa leaf powder could decrease the sensitivity of platelets as aggregating agents. This implies that moringa leaf powder and green chiretta supplementation could improve blood circulation on account of its inhibitory effects on platelet aggregation.

CHAPTER VI

CONCLUSION

Supplementation of moringa leaf powder and green chiretta supplementation is very helpful for improving for weight gain and body weight as an alternative of antibiotics. Animal protein has higher biological value in comparison with plant protein. Initial body weights of each bird were more or less same and kept them into four different treatments. Body weight was recorded every 7 days interval on experimental period and the sampled birds were sacrificed for determining the hematological parameters. It was observed that the effects of supplementation of moringa leaf powder extract at 1gm/1kg and green chiretta supplementation at 1gm/1kg showing the higher body weight gain. The body weight gain in the group T₃ was highest which followed in descending order in groups T₁, T₂ and T₀. The body weight was significant ($P < 0.05$) increased at the terminal day of experimental trial in comparison with that of control group T₀. Blood parameters like Total erythrocyte count, Hb concentration and packed cell volume were significant increased ($p < 0.05$) in all treatment groups than the control group T₀. Among the treatment groups T₃ group showed the better hematological profile. From the results of the present study, it may conclude that feeding moringa leaf powder and green chiretta supplementation mixture diets has definitely proven to give better result than control group. It enhancing the production potential, body weight, body weight gain, maximizes economic returns, survival rate of broilers, feed conversion ratio and cost effectiveness over the control group in whole periods. The combinations of these two Phyto biotics have definitely brought about synergistic effect on the production in broilers. So, it can be effectively used to replace the antibiotic growth promoter in the poultry industry.

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