Chapter 1: Introduction

Broiler farming is popular in Bangladesh due to having less initial cost and quick financial return. The broiler farming in developing countries is continuously facing some challenges such as high feed cost and prevailing diseases (Abbas, 2013).
Therefore, the farmers are always seeking some growth promoters to boost-up growth beyond the feed cost. Numerous efforts have been made to overcome these challenges, and one of which is the use of antibiotics in feed. Antibiotics have been used as growth promoters and to prevent outbreak of diseases (Thomke and Elwinger, 1998; Phillips et al., 2004). However, due to high cost of antibiotics, addition of them increase feed cost that limits the profit margins. In addition, the use antibiotics as growth promoter has recently been criticizing due to having residual effects in developing resistant microorganisms for both livestock and human being.

An overflow of studies has been conducted during the last decade to discover suitable alternatives to antibiotics. In consequence, natural products have been considered as an effective alternative to feed antibiotics, mainly to diminish or decrease the residual effects in meat, egg and milk. In addition to reduce residual effects, the farmers are also looking for growth promoters to enhance growth and performance of broiler. Since the commercially available growth promotes are expensive to use, farmers are therefore now looking for locally available ingredients.

Unconventional feed ingredients often contain unknown growth factors (UNGF) making them subject to evaluation for potential growth promoter in animal feed (Lin and Mon, 2020). Among the unconventional feed ingredients available in Bangladesh, various tree leaves are popularly used as ruminant feed particularly for goat and cattle. Due to having monogastric digestive system, grasses and tree leaves are not suitable feed ingredients in chicken. However, UNGF in the soluble fractions of grasses or leaves can be available in the monogastric digestive system. Therefore, numerous efforts have been made to evaluate various tree leaves such as neem, mindi and olive leaves as dietary supplements for growth promotion in broiler (Moghadamtousi et al., 2013).

Medicinal plants and their products containing plant extracts or essential oils are known candidates for use in broiler diets, where they have beneficial effects as phytogenic feed additives has been proven (Veríssimo et al., 1995; Bolukbasi and Erhan, 2007; Soltan and El-katcha, 2008). Several studies have demonstrated that phytobiotics, the plant derived compounds, in the diets of farm animals improved feed intake, gut integrity, nutrient absorption, antioxidant activity and immunity. Alternative growth promoter from herbal plants and their bioactive compound more important because of their antimicrobial effects and digestion-enhancing capacities. In recent years, extensive research has been performed on the use of phytochemicals such as bitter leaf meal and moringa leaf meal as alternative to antibiotic growth promoters in poultry diets. Phytochemical screening of bitter leaf and moringa leaf meals revealed the presence of phenolic acids, flavonoids, tannins, cardiac glycosides, saponin and glucosinolates. These compounds are of great value in preventing the onset or progression of many human and animal diseases. The leaves of Cashew nut (*Anacardium occidentale*) have astringent, antidiarrheal, antioxidant, and antimicrobial properties, due to the presence of polyphenols (mainly tannins) and coumarins (Okpashi and Obi-Abang, 2014). Its use in poultry diets improves the growth performance and quality of eggs and decreases the incidence of diarrhea.

Swietenia is the genus of chinaberry family (Meliaceae). It was brought into Asian countries form the native Caribbean, Mexico and Southern to Central America. Among three different species, S. Mahogany is used as medicinal pant in India, Indonesia, and Africa (Patel et al., 2012). This plant also a source of numerous phytochemicals used through a variety of herbal remedies and foodstuffs with curative properties. Mahogany has been used in Asia and many other countries to treat diverse ailments based on its antimicrobial, anti-inflammatory, antioxidant effects, antimutagenic, anticancer, antitumor and antidiabetic activities. Almost all parts of the plant are used in traditional medicine for the treatment of various human ailments. The fruit of mahogany has been used commercially in health care products for the improvement of blood circulation and skin condition. The seeds have many uses such as in the treatment of hypertension, against chest pain, insect repellent, relieve constipation and menstrual pain, lessen the cholesterol level, increase appetite, fight free radical, prevent colon cancer, boost the immune system and against leishmaniasis. It also contains many natural nutrients that

can sustain a healthy body and increase the overall energy of the human body such as protein, minerals, vitamins, fiber, carbohydrates, folic acid, essential fatty acid and so on (Das et al., 2009). The leaf of mahogany contains a sizeable amount of total phenolic, tannins and flavonoid contents. The leaves are anti-diabetic, anti-bacterial, anti-oxidant, anti-microbial, anti-fungal, antidiarrheal, anti-malarial and anti-inflammatory (Tan et al., 2009).

The *Dillenia indica,* commonly known as chalta, is an ethno-medicinally important plant used for the treatment of several diseases like cancer and diarrhea. It is an important medicinal plant in ayurvedic medicine for curing a plethora disease such as digestive, respiratory and central nervous system disorders. In addition, different parts of chalta are used for the relief of indigestion, asthma, influenza, dysentery, jaundice, weakness and rheumatic pain. Major chemical compounds the betulin (pentacyclic triterpenoid) and betulinic acid show wide spectrum of pharmacological activities like anti-HIV, anti-inflammatory, anti-cancer, anti-malarial etc. (Kumar et al., 2010; Chauhan, 2014). The plant is a rich source of triterpenoids, flavonoids and tannins (Gandhi and Mehta, 2013). The leaves of chalta are rich source of flavonoids and triterpenoids exhibited anti-inflammatory activity (Vaidya, 2013). Researchers demonstrated that the leaf extract of chalta has anti-inflammatory, antimicrobial, antidiabetic, hypolipidemic and antidiarrheal properties (Sb et al., 2009; Apu et al., 2010; Kumar, Kumar and Prakash, 2011). Antinoceptive and antioxidant activities were demonstrated for the methanolic extract of *D. indica* bark (Alam et al., 2010), and anti-leucemic, anti-diarrheal and anti-inflammatory actions were demonstrated for the extracts from the fruit of *D. indica* (Kumar and Prakash, 2011).

Considering the above significant health benefits of mahogany and chalta, we hypothesized that incorporation of these two plants in diet will enhance growth performance of broiler. Therefore, this study was designed to judge the effect of dietary supplementation of mahogany and chalta leaves on growth performance, carcass characteristics, meat quality and serum biochemical parameters in broiler. A comparative cost-benefit analysis was also performed to ensure that supplementation of mahogany and chalta leaves in broiler diet is economically viable.

Objectives

1. To observe the effect of dietary supplementation of mahogany and chalta leaves on growth performance, serum biochemical parameters, oxidative stability of meat, meat composition and carcass characteristics of broiler chicken.
2. To perform a cost-benefit analysis to ensure economic viability of mahogany and chalta leaves inclusion in broiler diet.

Chapter 2: Review of Literature

2.1 Mahogany

Mahogany is a tree belongs the genus Swietenia which is under chinaberry family (Meliaceae). It was brought into Asian countries form the native Caribbean, Mexico and Southern to Central America. The three species of Swietenia genus which are *S. macrophylla*, *S. humilis* and *S. mahagoni* were introduced into several Asian countries such as West India, Malaysia and Southern China (Moghadamtousi *et al.*, 2013). Among three different species, *S. mahagoni* is used as medicinal pant in India, Indonesia, and Africa (Patel, 2012). *S. mahagoni*, commonly known as American mahogany, Cuban mahogany, small-leaved mahogany, and West Indian mahogany. Mahogany is used commonly for high-quality furniture, joinery, musical instruments, etc. It is very much expensive for its timber quality, color, firmness and durability. Mahogany is used primarily as wood for its rapid growth and excellent timber quality though often used as a shade tree (Hossain, 2015). The bark is considered as astringent and is taken orally as a decoction for diarrhea, as a source of vitamins and iron, and as a medicine to induce hemorrhage. When the bark is soaked to red liquor, it is taken to purify the blood, increase appetite, and restore strength in case of tuberculosis (Hossain, 2015). Mostafa *et al.*,(2011) found that *S. mahogany* seed oil which has bitter taste, moderate drying oil and high content on unsaturated fatty acid, considered as useful source for soap and dying industries. Due to having high amount of natural tannin the barks used to use for tanning the leathers (Falah *et al.*, 2008).

2.1.1 Composition of mahogany

Ali *et al.*, (2011) reported the composition of mahogany seed oil. Physicochemical characteristics of *S. mahogany* oil of seeds contained appreciable level of unsaturated fatty acids. Tri-acyl-glycerols and neutral lipids were found to be most abounded components recorded 87.0 and 89.4%. GLC analysis showed the presence of fatty acids from series C16:0 to C20:0 in which principal fatty acids accounted as linoleic (30.1%) in *S. mahogany* seed oils. Of the major energy producing nutrients, the seed samples contained large amounts of lipid (57.9%), protein (13.0%) and potentially useful amounts of other nutrients in *S. mahagoni*. In *S. mahagoni* common phyto-compounds

are alkaloids, flavonoids, tannins, terpenoids, glycosides, saponins, and volatile oils as major active constituents. Alkaloids, terpenoids and carbohydrates are major compounds in both leaf extract and seed extract. The phytochemical screening of *S. macrophylla* showed that tannin, phenol, flavonoid, terpenoids and alkaloids are present in the leaf extract. Flavonoids and fixed oil are absent in leaf extract. Tannins and glycosides are not found in the seed extract. Tannin is major chemical compound in leaf and central-fruit-axis. Steroids and amino acids are found in all the extracts. The high content of tannins, alkaloids and flavonoids was found in seed extract whereas high phenols were found in leaf extract (Balamuniappan *et al.*, 2016). (Mostafa *et al.*, 2011) found that *S. mahagoni* seed oil, which has bitter taste, contains and high amount of unsaturated fatty acid, considered as useful source for soap and dying industries. (Moghadamtousi *et al.*, 2013) reviewed the isolated phytochemicals content from seed, bark, twig, leaves and stem of *S. macrophylla* and summarized the contents as: limonoids (81.91%), polyphenolics (4.26%), steroids (4.26%), essential oils (6.38%), fatty acids (1.06%), coumarin (1.06%) and lignan (1.06%). The quantitative estimation of phytochemicals revealed that the various phytochemical constituents present in the leaf extract. In the leaf extract of *S. macrophylla*, the alkaloid, flavonoids and phenol contents were 9, 12.4, 6.4 and 8.6%, respectively (Neji and Muhammad, 2018).

2.1.2 Medicinal uses of mahogany

S. mahagoni found to show insignificant toxic effects in animal models (Nijveldt *et al.*, 2001). The saponins are naturally occurring surface-active glycosides, which have been shown immunostimulant, hypocholesterolaemic and anticarcinogenic potency in both *in-vitro* and *in-vivo* models (Rajendran *et al.*, 2007). About 80% of the world population depend on the use of traditional medicine, which is mainly based on plant material. Scientific studies on a good number of medicinal plants indicate that promising phytochemicals can be used for many health problems (Vhuiyan *et al.*, 2008). Presence of significant amount of all the above class of phytochemicals in the leaf reflects the pharmacological value as evidenced by previous studies. Minerals are naturally occurring element in the body, to help and perform certain bio-chemical reactions. For most of the enzymatic reaction's minerals such as Zn, Fe, Co acts as co-enzymes and also, they form an integral part of functionally important organic compounds such as

iron (Fe) in hemoglobin and cytochrome or zinc (Zn) in insulin (Devlin, 2010). The elements such as K, Ca, Na are required to maintain osmolarity, nerve conduction and even in the absorption of certain nutrients. Calcium, potassium and magnesium are required for repair of worn-out cells, strong bones and teeth in humans, building of red blood cells and other mechanisms in the body of organisms (Yp and Urooj, 2015).

The results of various antioxidant assays indicate mahogany extracts exhibit electron donating and free radical scavenging property thus it can be extrapolated that the mahogany treatment/supplementation in disorders/diseases involving oxidative stress can ameliorate the oxidative stress and thus the consequent results of oxidative stress (Yp and Urooj, 2015).

S. macrophylla has been widely used in successfully by the common folks' communities around the world especially in Asia and many other countries to treat diverse ailments based on its antimicrobial, anti-inflammatory, antioxidant, antimutagenic, anticancer, antitumor and antidiabetic activities. Every part of this plant has many uses and it is beneficial to humans and animals either as a medicine or other purposes. The fruit, commonly called sky fruit which has been used commercially in healthcare products to improve blood circulation and skin condition. In Malaysia, the seeds are used traditionally to treat hypertension, diabetes and for the relieve of pain (Goh and Kadir, 2011). The seeds of *S. macrophylla* have been reported to have anti-inflammatory, antimutagenicity and antitumor activity (Guevara *et al.*, 1996).

2.1.3 Anti-ulcer activity

S. mahagoni leaf extract showed marked gastric protection along with reduction of edema and leucocytes infiltration of the submucosal layer and higher dose of plant extract at 5 gm/kg did not reveal any toxicological signs in rats. These findings suggest that *S. mahagoni* ethanol leaf extract exhibit an anti-ulcer activity against ethanol-induced gastric ulcer in experimental animals (Al-Radahe *et al.*, 2012). The flavonoids of mahogany leaves had displayed anti-secretory and cytoprotective properties in different experimental models of gastric ulcers (Zayachkivska *et al.*, 2018). Flavonoids

have also anti-oxidant properties as well as strengthening the mucosal defense system by stimulation of gastric mucus secretion (Martín *et al.*, 1994).

2.1.4 Antibacterial activity

Mahogany have been found to have an antibacterial activity. The zone of inhibition on culture and sensitivity (CS) test elucidated that the alkaloid fraction of seeds and leaves is active against four pathogenic bacteria: the Gram-positive: *Staphylococcus aureus* ATCC1026, Gram-negative *Escherichia coli* ATCC10536, *Pseudomonas aeruginosa* ATCC15442 and *Salmonella typhimurium* ATCC14038 (Suliman *et al.*, 2014). For antibacterial testing, two concentrations, 50 and 100 mg/mL of seeds and leaves extracts were prepared and tested by disc diffusion method and result showed that the plant parts contain various levels of alkaloids, and with appreciable level of antibacterial activity against all tested microorganisms.

2.1.5 Anti-inflammatory activity

S. macrophylla also have an anti-inflammatory activity. The seed extract of *S. macrophylla* inhibits carrageen an induce paw edema by 7.35% at a dose of 50 mg/kg, higher dose of 100 mg/kg produce 47.06% that is comparable to the 54.4% inhibition produce by the standard drug ibuprofen. It is well known that there is a close relationship between inflammation and cancer (Eid *et al.*, 2013).

2.1.6 Anti-fungal activity

S. macrophylla seed extract containing triterpenoidal compounds are known to be effective against plant pathogenic fungi. The limonoids of the *S. macrophylla* were examined for anti-fungal activities against the groundnuts rust *Puccinia arachidis* and these results showed an effective reduction of the number of rust pustules on detached ground nuts leaves due to the presence of limonoids content in *S. macrophylla* (Govindachari *et al.*, 1999).

2.1.7 Anticancer activity

S. macrophylla have been considered for the treatment of various diseases. The anticancer activity of *S. macrophylla* leaves extract and its isolated compound towards

human colorectal cancer cell line. The study showed significant DNA damage and apoptosis after treatment with the hexanic extract of *S. macrophylla*. The isolated compound limonoid L1 showed potent cytotoxicity against cancer cell lines with IC_{50} (Half maximal inhibitory concentration) at 55.87 μg mL^{-1} and not trigger any cell membrane rupture in the mice erythrocytes suggesting no toxicity. This study suggests that limonoid L1 isolated from *S. macrophylla* can be a promising anticancer agent in managing colorectal cancer (Pinto *et al.*, 2021).

2.1.8 Antidiabetic activity

It has been reported that treatment of drug induced (by streptozotocin and nicotinamide) diabetes with methanol extract of *S. macrophylla* seed (300 mg/kg body weight) for 12 consecutive days reduced the fasting blood glucose level by 32.78% (Maiti *et al.*, 2008).The extract at the same dose also significantly reduced the serum total cholesterol (18.56%) and triglyceride (10.41%), and increased the reduced liver glycogen level by 46.27%

2.1.9 Antioxidant activity

The ethanol extract of *S. macrophylla* seeds also showed antioxidant activity in the streptozotocin-induced diabetic rats. It also increased the antioxidant levels plasma, live and kidney in mouse model (Kalpana and Pugalendi, 2011).

2.1.10 Effect of *Swietenia macrophylla* on Rabbits

A study by Abdel-Wareth *et al.*, (2014) observed the effect of 35% and 65% supplementation of African mahogany leaves in rabbit diet. The performance parameters and carcass criteria, including daily body weight gain, final body weight, and the percentage of dressing, were increased in rabbits fed 35% mahogany when compared to the control group (Ketzis *et al.*, 2006; Doha Yetongnon G. *et al.*, 2013). Moreover, kidney and liver weight ratios and their functional capacities were improved.

2.2 Chalta

Chalta (*Dillenia indica*) is an evergreen large shrub or small to medium-sized, an important medicinal plant found in Indian subcontinent. The plant has been blessed

with numerous medicinal properties with the edible constituents. The fruit is the main yield of the plant. The leaf, bark and fruit of the plant are used in the indigenous system of medicine. It has many medicinal properties like relieving pain and regulating the body heat. It is also used as cooling beverage in the treatment of fever. It tones up the nervous system and removes fatigue. Traditionally they are used as laxative and carminative. It also helps in relieving flatulence. Fruit juice is also used as cardio tonic. Barks and leaves of the plant are used as laxative and astringent. Due to its various biological activities including anti-diabetic and anticancer properties the plant is gaining importance as a valuable medicinal plant (Barua, Yasmin and Buragohain, 2018).

Table 2.1 Nutritive components of *Dillenia indica.*

Component	**Amount**
Moisture	82.3 gm
Mineral	0.8 gm
Fiber	2.5 gm
Protein	2.1 gm
Carbohydrate	11.4 gm
Phosphorus	26 gm
Free vitamin C	20.0 gm

Source: Barua et al. (2018).

2.2.1 Effect on growth

The leaves and fruit extracts have betuline, which have activity on growth. In vivo effect of betuline containing extract on weight gain and meat quality of broiler chickens was evaluated. The tendency to increase the weight of edible parts and muscles of poultry compared to diet without additive suggests that the extract containing betuline may be a potential food additive in poultry farming (Ilyina *et al.*, 2014).

2.2.2 Anti-cancer activity

Betulin exerted an anti-cancer effect on different cell line of chicken CAM (Chorioallantoic membrane). However, the underlying mechanisms are only partially elucidated. Betulin also inhibits skin tumor apparition and promotion, proved by

histological results and VEGF (vascular endothelial growth factor) expression correlated to non-invasive measurements (Dehelean *et al.*, 2013).

2.2.3 Anti-diabetic effect

The plant parts are also used for treatment of diabetes and cancer (Murthy *et al.*, 2017). The extract treatment showed enhanced serum insulin level and body weight of diabetic rats as compared to diabetic control group. Furthermore, the extract has a favorable effect on the histopathological changes of the pancreas, liver and kidney in alloxan induced diabetes (Sb *et al.*, 2009).

2.2.4 Antidiarrheal effects

Bark and leaves juices are used for treatment of diarrhea. Bark and leaves are astringent. There is an anti- diarrheal activity exhibited by aqueous and methanolic extracts of *D. indica* leaves (Sb *et al.*, 2009).

2.2.5 Antioxidant activity

The methanol extract of *D. indica* has antioxidant activity as determined by free radical scavenging of DPPH (2, 2-diphenyl-1-picrylhydrazyl) scavenging assay (Saha *et al.*, 2009).

2.2.6 Antimicrobial Activity

Antimicrobial activities were tested against four grams positive and seven-gram negative and three pathogenic fungi. N-hexane and dichloromethane fraction of *D. indica* showed remarkable activities against several grams positive, gram negative and fungi, whereas methanolic crude extract showed highest activity against fungus.

Chapter 3: Materials and Methods

3.1 Study area

The feeding trail was carried out at the experimental poultry shed under the Department of Animal Science and Nutrition. Proximate analysis of meat, serum biochemical analysis, measurements for carcass characteristics and estimation of oxidative rancidity was performed at different laboratories of the Department of Animal Science and Nutrition, Chattogram Veterinary and Animal Sciences University (CVASU), Khulshi, Chattogram.

3.2 Study period

The total length of the research was six months. The actual feeding trial was conducted for a period of five weeks starting from 3 September to 8 October, 2021.

3.3 Experimental birds

The day-old unsexed broiler chicks Ross 308 (DOC) were brought from Nahar Agro Complex Limited, Chattogram, Bangladesh. All the chickens were inspected for the presence of any abnormalities and chicks having no noticeable abnormalities were selected for the study. We also measured the body weight of the chicks for the uniformity in size and a variation of more than 5 grams from the mean weight were excluded from the study. The average body weight of the selected DOCs were around 36 gm.

3.4 Preparation of leaf meal

3.4.1 Collection of leaves

Mahogany and Chalta leaves were collected from different area of Chattogram from 5th August to 15th August 2021. The leaves were then left under a shed at 27-32°C temperature for 4-5 days for drying the leaves.

3.4.2 Grinding of leaves and storage

After drying, the leaves were grinded into a fine powder using an electrical grinder to ensure effective mixing with other feed ingredients. The grinded leaf meal was then kept in airtight container until use.

3.5 Design of the experiment

A total of 96 birds were randomly allotted into 4 groups based on feed composition differed by without (Control: T_0) or with inclusion (Treatments: T_1, T_2 and T_3) of mahogany and chalta leaves. Each group was subdivided into three replications containing 8 birds per replication in a completely randomized design. Dietary treatment groups were T_1 = Inclusion of 0.4% dried mahogany leaves in ration, T_2 = Inclusion of 0.4% dried chalta leaves and T_3 = Inclusion of 0.2% dried mahogany + 0.2% dried chalta leaves. T_0 = Control, represent the birds fed diet without mahogany and chalta leaves in ration. The layout of the experiment is presented in Table 3.1 and ingredient composition of 100 kg diet for control and treatment groups are presented in Table 3.2

Table 3.1 Layout of the experiment

Dietary treatment groups	Replications	No. of birds per replications	No. of birds per treatment
T_0 = Diet without mahogany or chalta leaves	R_1	8	24
	R_2	8	
	R_3	8	
T_1 = Diet containing 0.4% dried mahogany leaves	R_1	8	24
	R_2	8	
	R_3	8	
T_2 = Diet containing 0.4% dried chalta leaves	R_1	8	24
	R_2	8	
	R_3	8	
T_3 = Diet containing 0.2% dried mahogany and 0.2% chalta	R_1	8	24
	R_2	8	
	R_3	8	
Total			96

Table 3.2 Ingredient and chemical composition of basal diet (100 kg).

Ingredients	Control (T_0)		Treatment (T_1)		Treatment (T_2)		Treatment (T_3)	
	Starter (kg)	**Grower (kg)**	**Starter (kg)**	**Grower (kg)**	**Starter (kg)**	**Grower (kg)**	**Starter (kg)**	**Grower (kg)**
Corn	52.00	52.83	52.00	52.83	52.00	52.83	52.00	52.83
Wheat	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Rice polish	2.50	3.20	**2.10**	**2.80**	**2.10**	**2.80**	**2.10**	**2.80**
Soybean meal	32.00	29.20	32.00	29.20	32.00	29.20	32.00	29.20
Fishmeal	4.00	3.50	4.00	3.50	4.00	3.50	4.00	3.50
Palm oil	3.50	5.00	3.50	5.00	3.50	5.00	3.50	5.00
DCP	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79
Limestone	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15
NaCl	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Choline chloride	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Vitamin min premix	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
L-lysine	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
DL- methionine	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
Toxin binder	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Enzymes	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Mahogany	-	-	**0.4**	**0.4**	-	-	**0.2**	**0.2**
Chalta	-	-			**0.4**	**0.4**	**0.2**	**0.2**
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Calculated composition								
ME (kcal/kg)	3000	3100	2990	3088	2990	3088	2990	3088
CP(%)	22.09	20.70	22.05	20.65	22.05	20.65	22.05	20.65
Ca%	1.28	1.26	1.30	1.26	1.30	1.26	1.30	1.26
P%	0.71	0.70	0.72	0.69	0.72	0.69	0.72	0.69
CF%	3.76	3.67	3.71	3.62	3.71	3.62	3.71	3.62
EE%	3.67	3.67	3.62	3.62	3.62	3.62	3.62	3.62

We considered starter period from day 01 to 14 and grower period from day 15 to 35. For inclusion of dried mahogany and/or chalta leaves in treatment groups, we have replaced rice polish because of very similar chemical composition.

3.6 Management

3.6.1 Housing

During the dietary trail experiments including the brooding period the birds were housed in well ventilated iron made multi-storey cases. Each replication (consisting of 8 birds) was housed in separate randomly selected compartment of the case. The size of each compartment was 3.5 feet (Length) × 1.63 feet (Width) × 4 feet (Height). Therefore, floor space was 0.71 square feet per bird though out the trial period. Every compartment was equipped with one drinker and one feeder to ensure *ad-libitum* feed and water supply during the experiment.

3.6.2 Cleaning and sanitation

Before housing the birds, the shed and cases were thoroughly washed and disinfected. After removing the visible dirt by sweepers, the floor was washed with tap water followed by water containing caustic soda (sodium hydroxide). Brushes and scrapers were used to remove adhesive dirt. Finally, the floor was thoroughly washed with tap water ensuring no residual caustic soda remaining on the floor surface. For disinfection, phenyl solution (1% v/v) was sprayed and washes every surface of the house including all cages, brooding boxes, corners, ceiling, feed storing racks and fans. The shed was then fumigated using formalin and potassium permanganate and locked for 24 hours. Then the house was rest for one week to ensure proper drying. Powdered lime was spread on the surface of the floor around the shed. A footbath at the entrance of the shed containing 1% potassium permanganate solution was kept throughout the trail period which was changed every 3-days-interval. To maintain strict biosecurity, all feeder and drinkers was cleaned and disinfected everyday by using water and 1% potassium permanganate solution.

3.6.3 Brooding

The chicks were brooded in individual brooding cages replication wise. Birds were placed in a wired battery rearing cage (3.50 ft × 1.63 ft) for 8 birds and the floor space in cages for each bird was 0.57 ft^2. During brooding period, newspapers were given on the floor of brooder cages as bedding materials and these were changed every day to

avoid extreme wet floor with the urine of birds. The brooding temperature was 95º F, 90º F, 85º F and 80º F at 1st, 2nd, 3rd and 4th weeks, respectively. After 4 weeks to end of broiler rearing, 80º F temperature was maintained. The temperature was maintained by adjusting the numbers of 100 and 60 watts-powered electrical bulb. Continuous lighting was provided and temperature was recorded by using a room thermometer. Every brooding cage was provided feeder and drinker to ensure feed ad libitum and free access of water.

3.6.4 Feeding and watering

All feed ingredients were purchased from Pahartali, Chattogram and ration was prepared by mixing different ingredients according to the ration composition (Table 3.2). The feed and water were supplied to the birds ad libitum basis. Total 24 number of feeder (one for each compartment containing 8 birds) and drinker (one for each compartment including 8 birds) was used. Same amount of feed and water was supplied to each replication to avoid feeding bias. Two types of feeders were provided: round type (1-7 days) and linier type (8-35 days). The drinker was round type with capacity of 1.5 liters during the entire period of rearing. Two different types of diets were supplied at different stages of rearing i.e. starter feed from day 1 to 14 and grower feed from day 14 to day 35.

3.6.5 Vaccination

The birds were vaccinated against only two highly prevalent viral diseases: The New Castle Disease (ND) and Infectious Bursal Disease (IBD). Vaccination was performed according to recommended vaccination schedule (Table 3.3).

Table 3.3 The vaccination performed during feeding trail

Age of birds	Name of disease	Name of vaccine and producer	Date	Route of administration
4th day	ND	BCRDV, Livestock Research Institute, Mohakhali, Dhaka	7-09-2021	One drop in one eye
12th day	IBD	Gumboro, Livestock Research Institute, Mohakhali, Dhaka	15-09-2021	One drop in one eye
17th day	ND	BCRDV, Livestock Research Institute, Mohakhali, Dhaka	20-09-2021	One drop in one eye
19th day	IBD	Gumboro, Livestock Research Institute, Mohakhali, Dhaka	22-09-2021	One drop in one eye

3.7 Data collection

All data related to experimental trail was recorded in a well-organized record book. After measuring the initial body weight of chicks on the 1st day of experiment, all other data were recorded daily or weekly basis.

3.7.1 Feed intake

Feed intake was determined by subtracting the residual feed collected every morning from the total supplied feed in a day. The mean daily feed intake in each bird of the respective replication was calculated using the formula:

$$\text{Average daily feed intake} = \frac{\text{Weight of supplied feed} - \text{Weight of residual feed}}{\text{Number of birds}}$$

3.7.2 Determination of growth performance

The body weight was recorded on weekly basis from the initial day to the final day of the experiment. In addition, the feed consumption for each replication was determined by deducting the feed residual from supplied feed. Feed conversion was calculated by dividing the body weight gain with feed consumed.

3.7.3 Live weight gain

The live weight was measured by an electrical weighing balance. The live weight gain for a particular week was calculated by subtracting the live weight of bird at the beginning of a week from live weight at the end of a week. The weight gain per day was calculated using following formula:

$$\text{Average daily weight gain} = \frac{\text{(Weight at the end – Weight at the beginning) of a week}}{\text{7 (Number of days in a week)}}$$

3.7.4 Feed conversion ratio (FCR)

Feed conversion ratio was calculated on daily basis. The feed conversion ratio was determined as average daily feed intake divided by average daily weight gain.

3.7.5 Carcass characteristics

Three birds were randomly selected from each replication at the end of the feed trial period. The weight of each selected bird was recorded. The birds were then slaughtered and ensured complete bleeding. After complete bleeding, skinning, de-feathering and evisceration were performed. After that, the head and feet were removed below the hock joint. The carcass weight excluding the visceral organs, head and feet was then measured and recorded to calculate the dressing percentage. The carcass was then cuts into 10 parts such as breast meat, thigh, drumstick, head, heart, liver, gizzard, spleen, bursa and abdominal fat. The weight of each cutting part, all visceral organs and visceral fats were quantified and recorded to define the carcass characteristics.

3.8 Collection, processing and preservation of meat sample

Fifteen grams of breast meat sample were collected from each slaughtered bird. The collected samples were grinded in a meat grinder kept in polyethylene bags with a zipper lock and stored in freezer at -20ºC for the analysis of proximate components (Figure 3.1).

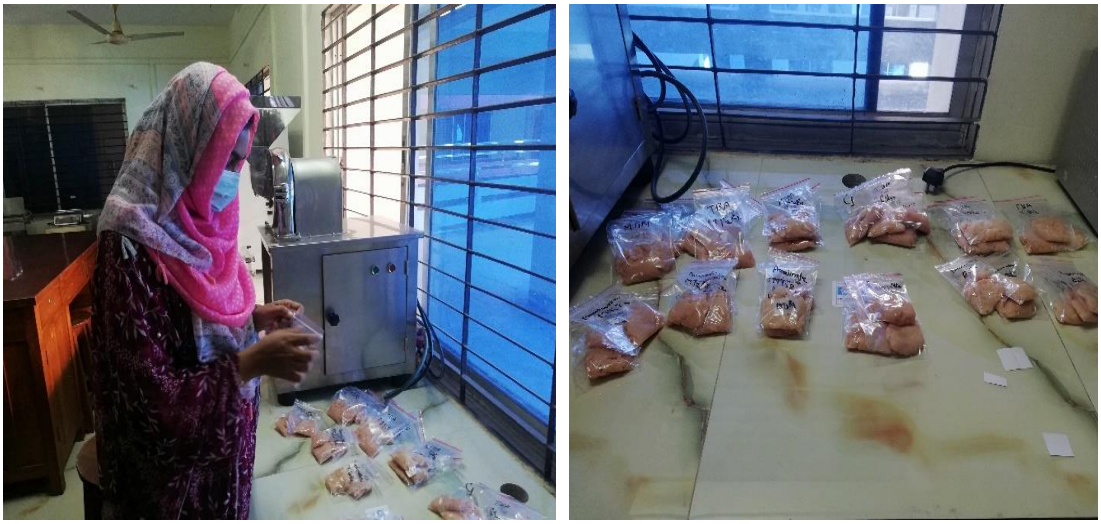

Figure 3.1 Processing and preservation of collected meat sample

3.9 Proximate analysis of meat

Chemical analysis of the meat samples was performed according to the standard method described in Association of Official Agricultural Chemists (AOAC). We determined dry matter, crude protein, crude fiber, Ether extract and total ash from these meat sample. Proximate analysis of these sample was done in the Animal Nutrition Laboratory of the Department of Animal Science and Nutrition, CVASU.

(a) (b) (c)

Figure 3.2 Proximate analysis of meat sample. (a) CF (b) CP and (c) EE

Figure 3.3 Determination of thiobarbituric acid reactive substance (TBRAS) values

3.10 Oxidative rancidity of meat

The oxidative rancidity of the meat was determined based on the amount of thiobarbituric acid reactive substance (TBARS) in meat. The freeze-stored (-20ºC) grinded meat samples were thawed and kept at 4ºC. The TBARS was then measured at day 3, 5 and 7 to estimate rancidity over time. TBARS was also measured just after thawing for comparison as control. TBARS was measured by the method described by (Hossain, 2015b). Briefly, 4 gm of meat sample was taken into a 50-ml centrifuge tube. Then, 10 ml of distilled water and 10 ml of stock solution 1 (402 ml distilled water + 98 ml phosphoric acid + 100 mg trichloroacetic acid) solution was added. The content was blended in homogenizer (VELP Scientificia OV5) followed by filtered through Whatman No .1 filter paper. Two ml of filtered homogenate was taken into a test tube containing 2 ml of stock solution 2 (250 ml distilled water + 0.18 gm dihydroxy-2-mercaptopyridine). After brief mixing, the tube was incubated for 30 minutes at 80ºC into a water bath. After 30 minutes, test tube was removed and kept at room temperature for cool-down. Finally, the absorbance of the solution was measured by a spectrophotometer at 530 nm (UV -2600, UV-VILS Spectrophotometer, Shimadzu). TBARS values are expressed as micromoles of malondialdehyde (MDA) per 100 gm of meat sample.

3.11 Serum biochemical analysis

Blood samples were collected from the brachial vein of two birds from each replicate using a 5 ml sterile syringe and a 23-gauge needle. From each bird, 5 ml blood sample was transferred immediately into a sterile tube without anticoagulant. Clotted blood in

the vacutainer tube was centrifuged at 3000 rpm for 20 minutes and prepared serum was collected into the 1.5-ml microcentrifuge tube using micropipette. The levels of cholesterol, triglyceride, low-density lipoprotein (LDL) and high-density lipoprotein (HDL) were measured from the prepared serum in the post Graduate Laboratory under the department Animal Science and Nutrition, CVASU using standard kits (BioMereux, France) and semi-automatic analyzer (Humalyzer 300, Merck®, Germany) according to the manufacturer's instruction.

3.12 Statistical analysis

Data were compiled in MS Excel. Raw data related to weight gain, feed intake, FCR, carcass characteristics were tested for normality by using normal probability plot and analyzed for ANOVA by using STATA (2017). Means showing significant differences were compared by Duncan's New Multiple Range Test (Duncan, 1955). Statistical significance was accepted when P value was less than 0.05.

Chapter 4: Results

The experiment was carried out to measure the effect of mahogany and chalta leaves on growth performance, carcass characteristics, oxidative stability of meat and serum biochemical parameters in Ross-308 broilers. The results obtained from the study have been described in this chapter.

The dietary effects of mahogany and chalta leaves on growth performance of broiler was measured by live weight, weight gain, feed intake and feed conversion ratio (FCR) from 1^{st} to 5^{th} weeks of growth trial. The performance parameters are also calculated by combining the data from 1^{st} week to 5^{th} week of trial and presented at overall performance (Table 4.1).

4.1. Live weight

Live weight of the experimental broiler was recorded weekly basis throughout the experimental period. Results indicated that the average live weight from 2^{nd} to 5^{th} weeks of age were increased significantly ($P<0.05$) in all treatment groups compared to control group. In overall performance, the highest (1253.75 gm/bird) and lowest (942.08 gm/bird) average live weight was recorded respectively in T_3 and T_0.

4.2. Weight gain

Compared to control (T_0), significant differences ($P<0.01$) were observed in average daily weight gain (ADG) in all treatment groups at 2^{nd}, 3^{rd} weeks of growth trial. The highest (58.51 gm/bird/day) and lowest (48.46 gm/bird/day) ADG were observed respectively in T_3 and T_0 groups in overall performance representing that inclusion of mahogany and chalta mixed leaves performed better than control in terms of weight gain.

4.3. Feed intake

In comparison to control (T_o), the average daily feed intake (ADFI) was increased significantly ($P<0.05$) in all treatment groups at 2^{nd} and 3^{rd} weeks, and groups T_1 and T_3 at 4^{th} weeks of age. The overall ADFI were higher in all treatment ($P<0.001$) groups

compared to control where the highest ADFI was observed in T_2 group (95.33 gm/bird/day).

4.4. Feed conversion ratio

The feed conversion ratio (FCR) showed significant reduction ($P<0.05$) in all dietary groups compared to control at 3rd week of growth trial. The overall FCR also reduced significantly ($P<0.05$) in treatment groups compared to control. In overall values, the lowest (1.88) and highest (2.25) FCR were observed in T_3 and T_0, respectively. These results indicate that the birds fed ration with inclusion of mahogany and chalta leaves were performed better in terms of feed conversion efficiency compared to ration only one type of leaf (Only mahogany, T_1 / only chalta, T_2) or no leaf (T_0).

In summary, the results on growth performance indicates that in all most all cases inclusion of mahogany and chalta leaves in broiler ration performed better than ration containing only one type of leaf (Only mahogany, T_1 / only chalta, T_2) or no leaf (T_0).

Table 4.1 Effects of dietary supplementation of mahogany and chalta leaves on growth performance of broiler

Parameters	Control	Treatments			SEM	P Value
	T_0	T_1	T_2	T_3		
1st week						
Initial weight (gm)	36.84	36.67	36.13	36.63	0.16	0.08
Final weight (gm)	97.92	100.84	98.96	104.96	3.63	0.66
ADG (gm/bird/day)	8.72	9.16	8.98	9.76	0.51	0.65
ADFI (gm/bird/day)	9.70	9.84	10.01	10.35	0.56	0.86
FCR	1.11	1.07	1.12	1.07	0.05	0.001
2nd week						
Initial weight (gm)	97.92	100.84	98.96	104.96	3.63	0.66
Final weight (gm)	188.09^{b}	243.88^{a}	241.75^{a}	259.00^{a}	9.24	0.01
ADG (gm/bird/day)	12.88^{b}	20.44^{a}	20.40^{a}	22.01^{a}	0.96	0.001
ADFI (gm/bird/day)	28.39^{c}	38.96^{b}	40.76^{a}	40.80^{a}	0.22	<0.001
FCR	2.22	1.92	2.00	1.87	0.10	0.02
3rd week						
Initial weight (gm)	188.09^{b}	243.88^{a}	241.75^{a}	259.00^{a}	9.24	0.01
Final weight (gm)	334.42^{b}	501.42^{a}	487.54^{a}	543.21^{a}	16.63	0.001
ADG (gm/bird/day)	20.91^{b}	36.79^{a}	35.11^{a}	40.60^{a}	2.06	0.002
ADFI (gm/bird/day)	59.58^{b}	81.79^{a}	81.67^{a}	81.15^{a}	0.66	<0.001
FCR	2.86^{a}	2.23^{b}	2.35^{b}	2.04^{b}	0.14	0.02
4th week						
Initial weight (gm)	334.42^{b}	501.42^{a}	487.54^{a}	543.21^{a}	16.63	0.001
Final weight (gm)	602.88^{b}	815.00^{a}	789.17^{a}	844.17^{a}	17.38	<0.001
ADG (gm/bird/day)	38.35	44.80	43.09	43.00	1.97	0.02
ADFI (gm/bird/day)	87.68^{b}	95.33^{a}	92.77^{ab}	87.47^{b}	1.35	0.03
FCR	2.29^{a}	2.13^{a}	2.17^{a}	2.06^{a}	0.10	0.02
5th week						
Initial weight (gm)	602.88^{b}	815.00^{a}	789.17^{a}	844.17^{a}	17.38	<0.001
Final weight (gm)	942.08^{b}	1182.92^{a}	1169.57^{a}	1253.75^{a}	30.44	0.002
ADG (gm/bird/day)	48.46	52.56	54.34	58.51	3.48	0.45
ADFI (g/bird/day)	88.25	88.25	89.05	88.25	0.26	0.45
FCR	1.82	1.68	1.66	1.55	0.09	<0.001
1-5th week (Overall)						
Initial weight (g)	36.84^{a}	36.67^{ab}	36.13^{b}	36.63^{ab}	0.16	0.08
Final weight (g)	942.08^{b}	1182.92^{a}	1169.57^{a}	1253.75^{a}	30.44	0.002
ADG (g/bird/day)	25.87^{b}	32.75^{a}	32.38^{a}	34.78^{a}	0.87	0.002
ADFI (g/bird/day)	58.29^{b}	66.40^{a}	67.27^{a}	65.17^{a}	0.45	<.001
FCR	2.25^{a}	2.03^{b}	2.08^{ab}	1.88^{b}	0.06	0.02

The values denoted by superscripts in the same row differ significantly. Data are obtained from the mean value of 3 replications with 8 birds per replication (n = 24). Dietary treatment groups are: T_0 = Control (basal diet), T_1 = 0.4% dried mahogany leaves in ration, T_2 = 0.4% dried chalta leaves in ration and T_3 = 0.2% dried mahogany + 0.2% dried chalta leaves in ration. ADG: Average daily gain; ADFI: Average daily feed intake. SEM: Standard error of means.

4.5 Serum biochemical parameters

Different blood serum biochemical parameters quantified have been presented in (Table 4.2). The blood cholesterol and triglyceride (TG), high density lipoprotein (HDL) and low-density lipoprotein (LDL) contents were quantified and compared between treatment groups with control. According to the obtained results, all the quantified parameters were unchanged upon dietary treatment of mahogany and chalta leaves compared to control except for HDL which was increased significantly ($P < 0.01$). The lowest (47.00 mg/dl) and highest (58.67 mg/dl) concentration of serum HDL were found respectively in T_0 and T_3group.

Table 4.2 Effects of dietary supplementation of mahogany and chalta leaves on serum biochemical parameters in broiler.

Parameters	Control	Treatments			SEM	P value
	T_0	T_1	T_2	T_3		
Cholesterol (mg/dl)	178.73	181.67	199.20	176.90	13.00	0.68
Triglyceride (mg/dl)	71.83	71.83	80.20	93.93	24.18	0.90
HDL (mg/dl)	47.00^{c}	55.67^{ab}	49.33^{bc}	58.67^{a}	1.85	0.01
LDL (mg/dl)	117.37	111.63	133.83	99.45	8.77	0.21

The values denoted by superscripts in the same row differ significantly. Data are obtained from the mean value of 3 replications with 8 birds per replication (n = 24). Dietary treatment groups are: T_0 = Control (basal diet), T_1 = 0.4% dried mahogany leaves in ration, T_2 = 0.4% dried chalta leaves in ration and T_3 = 0.2% dried mahogany + 0.2% dried chalta leaves in ration. SEM: Standard error of means.

4.6. Chemical composition of meat

Dietary effects of mahogany and chalta leaves on proximate composition of broiler meat are represented in (Table 4.3). Result showed dry matter, crude protein and ether extract were significantly differed ($P<0.05$) between control and treatment. Compared to control (24.07%), the dry matter was reduced in the T_1 group (22.57%) whereas it was unchanged in T_2 (23.37%) and T_3 (23.99%). The crude protein was increased in only in T_2 group (22.07%) compared to control (20.66%). In the case of ether extract, it was increased more than 2.35 times (0.73% in control vs. 1.72% in T_3; $P<0.001$) in

treatment T_3 upon dietary supplementation of mahogany and chalta leaves. The total ash was unchanged ($p>0.05$) among the treatment groups with comparison to control groups and it was found highest in T_0 and lowest in T_1 group.

Table 4.3 Effects of dietary supplementation of mahogany and chalta leaves on proximate components of broiler meat

Parameters	Control	Treatments			SEM	P Value
	T_0	T_1	T_2	T_3		
Dry matter (%)	24.07^{a}	22.57^{b}	23.37^{ab}	23.99^{a}	0.24	0.01
Crude protein (%)	20.66^{b}	19.75^{b}	22.07^{a}	20.43^{b}	0.23	0.003
Ether extract (%)	0.73^{b}	0.60^{b}	0.51^{b}	1.72^{a}	0.07	<0.001
Total ash	1.11	1.09	1.14	1.10	0.02	0.71

The values denoted by superscripts in the same row differ significantly. Data are obtained from the mean value of 3 replications with 8 birds per replication (n = 24). Dietary treatment groups are: T_0 = Control (basal diet), T_1 = 0.4% dried mahogany leaves in ration, T_2 = 0.4% dried chalta leaves in ration and T_3 = 0.2% dried mahogany + 0.2% dried chalta leaves. SEM: Standard error of means.

4.7 Carcass characteristics

The carcass characteristics were evaluated by measuring the dressing percentage, weight of major meat cuts of chicken, organs weight and abdominal fat weight both in control and treatment groups (Table 4.4). Most of the carcass characteristic parameters unchanged ($P>0.05$) upon dietary treatments with mahogany and chalta leaves except dressing percentage, drumstick weight and heart weight which were differed significantly ($P<0.05$). Compared to control (55.78%), dressing percentage was increased ($P<0.01$) in T_1 group. Drumstick weight was significantly increased in ($P<0.01$) T_2 group (9.42 gm in T_2 vs. 8.29 gm in control). The heart weight was reduced in T_3 group (0.47 gm in T_3 vs. 0.62 gm in control).

Table 4.4 Effects of dietary supplementation of mahogany and chalta leaves on carcass characteristics of broiler.

Parameters	Control	Treatments			SEM	P Value
	T_0	T_1	T_2	T_3		
Dressing percentage	55.78^b	54.87^b	57.48^a	55.32^b	0.27	0.001
Breast meat weight (gm)	12.34	11.19	11.77	12.31	0.71	0.69
Thigh weight (gm)	10.29	10.45	10.13	9.88	0.37	0.74
Head weight (gm)	2.72	3.03	3.00	2.78	0.09	0.15
Drumstick weight (gm)	8.29^c	8.86^b	9.42^a	8.37^c	0.10	<0.001
Heart weight (gm)	0.62^a	0.51^a	0.63^a	0.47^b	0.02	0.01
Liver weight (gm)	2.09	2.05	2.04	2.42	0.15	0.42
Gizzard weight (gm)	3.61	3.71	3.58	3.23	0.15	0.31
Spleen weight (gm)	0.09	0.08	0.07	0.07	0.01	0.24
Bursa weight (gm)	0.23	1.11	0.25	0.24	0.24	0.46
Abdominal fat weight (gm)	0.93	0.72	0.69	0.72	0.20	0.84

The values denoted by superscripts in the same row differ significantly. Data are obtained from the mean value of 3 replications with 8 birds per replication (n = 24). Dietary treatment groups are: T_0 = Control (basal diet), T_1 = 0.4% dried mahogany leaves in ration, T_2 = 0.4% dried chalta leaves in ration and T_3 = 0.2% dried mahogany + 0.2% dried chalta leaves. SEM: Standard error of means.

4.8 Oxidative stability of meat

The oxidative stability of meat was determined by measuring the TBARS values of meat from different treatment groups after keeping the breast meat of broiler at 4ºC for 3 weeks are shown in (Table 4.5). Insignificant differences in TBARS values were observed in fresh meat among the groups whereas the values in treatments were decreased ($P<0.05$) after keeping for 3 or more days suggesting that dietary treatment with mahogany and chalta leaves protected oxidative rancidity of broiler meat. The meat was more stable in treatment group T_3 in terms of oxidative rancidity.

Table 4.5 Effects of dietary supplementation of mahogany and chalta leaves on thiobarbituric acid reactive substances (µmol MDA/100g of meat)

Parameters	Control	Treatment			SEM	P Value
	T_0	T_1	T_2	T_3		
Fresh	1.66	1.04	0.91	0.81	0.25	0.52
Day 3	3.62^{a}	1.97^{b}	1.35^{b}	0.87^{b}	0.40	0.02
Day 5	4.35^{a}	3.12^{ab}	2.59^{bc}	1.25c	0.41	0.01
Day 7	5.31^{a}	3.78^{ab}	2.33^{b}	1.54^{b}	0.63	0.02
Average	3.73^{a}	2.48^{b}	1.80^{bc}	1.12^{c}	0.30	0.002

The values denoted by superscripts in the same row differ significantly. Data are obtained from the mean value of 3 replications with 8 birds per replication (n = 24). Dietary treatment groups are: T_0 = Control (basal diet), T_1 = 0.4% dried mahogany leaves in ration, T_2 = 0.4% dried chalta leaves in ration and T_3 = 0.2% dried mahogany + 0.2% dried chalta leaves. SEM: Standard error of means.
MDA: malondialdehyde.

4.9. Cost-benefit analysis

In cost-benefit analysis, we considered expenses variable parameters like cost for feed, vaccine and medicine. We also considered selling price of birds are only income source. Since expenses in many sectors such as manpower, housing, electricity, water etc. and earnings from manure are common to all groups, we did not include them in cost-benefit analysis. Therefore, cost -benefit is not an absolute calculation rather is a comparative difference among the dietary groups. We observed that, the net profit was significantly ($P<0.01$) higher is all treatment groups and it was highest in T_3 (Tk. 42.35/ Kg live weight).

Table 4.6 Cost benefit analysis of broiler diets supplemented with dry mahogany and chalta leaves.

Parameters	Control	Treatment			SEM	P Value
	T_0	T_1	T_2	T_3		
Live weight (gm)	942.08[b]	1182.92[a]	1169.57[a]	1253.75[a]	30.44	0.002
Feed intake/bird (gm)	2040.21[b]	2324.13[a]	2354.54[a]	2281.13[a]	38.52	<0.001
Feed cost/bird (Tk)	77.53[b]	88.32[a]	89.47[a]	86.68[a]	1.46	<0.001
Chick, vaccines and medicine cost	60.00	60.00	60.00	60.00	0.00	
Total cost	137.53[b]	148.32[a]	149.47[a]	146.68[a]	1.46	<0.001
Selling price (TK.)	150.73[b]	189.27[a]	187.13[a]	200.60[a]	4.87	0.002
Net profit (Tk.)	13.21[b]	40.95[a]	37.66[a]	53.92[a]	5.16	0.01
Net profit/ kg (Tk.)	14.00[b]	34.50[a]	32.11[a]	42.35[a]	3.51	0.004

The values denoted by superscripts in the same row differ significantly. Data are obtained from the mean value of 3 replications with 8 birds per replication (n = 24). Dietary treatment groups are: T_0 = Control (basal diet), T_1 = 0.4% dried mahogany leaves in ration, T_2 = 0.4% dried chalta leaves in ration and T_3 = 0.2% dried mahogany + 0.2% dried chalta leaves. Feed cost was considered = 38 BDT/kg. Live bird selling price was considered = 160 BDT/kg. SEM: Standard error of means.

Chapter 5: Discussion

In this study, the effect of mahogany and chalta leaves on growth performances such as live weight, weight gain, feed intake and FCR, blood serum parameter, chemical composition and stability of meat and carcass characteristics were investigated. Globally many studies have been conducted using various parts of mahogany and chalta trees. The exclusive use of only leave portion and combining with chalta leaves provide new dimension in this study. Moreover, investigating meat quality and stability of meat are further insights in this study. As fer we explored, the effect of mahogany and chalta leaves on broiler performance have not studied yet in Bangladesh.

5.1 Live weight and weight gain

The average body weight was remarkably increased in treatment groups in comparison to control groups. The highest body weight gain observed at treatment group supplied, mahogany and chalta leaves might be due to having growth boosting properties or their contents. A study by (Abdel-Wareth *et al*., 2014) observed an increase in growth of rabbit by diet supplemented with 35% and 65% of African mahogany (*Khaya senegalensis)*. The performance parameters and carcass characteristics, including daily body weight gain, final body weight, and the percentage of dressing, were increased in rabbits fed 35% (*Khaya senegalensis)* when compared to the control group.

In addition to enhancement of growth and performance, oral administration of ethanolic extract *Khaya senegalensis* at a dose rate of 50 mg/kg body weight showed a significant decrease ($P<0.05$) in blood glucose level, although the extract had no effect on the lipid profile or body weight of rabbits (Essé Agossou, 2015). Daily oral administration of *Dillenia indica* methyl extract (250 and 500 mg/kg body weight) in mice showed beneficial effects on blood glucose level and body weight gain (Sb *et al.*, 2009). The better body weight gain in our research by the inclusion of mahogany leaves could be due to the presence of polyphenolic compounds (tannins, anthocyanins, leuco anthocyanin) of saponins, steroids and anthracene compounds (o-glycosides).

Like mahogany popular leaf of meliaceae family the neem (*Azadirachta indica)* showed enhanced broiler performance when supplemented in feed at a dose rate of 1-3 gm dried leaf powder per kg of ration. The neem leaf fed groups showed a significant increase in live body weight, weekly weight gain and feed efficiency as compared to that of control group (Wanker *et al.*, 2009). The increased performance by supplementing neem leaf could be due to antimicrobial and anti-protozoal properties of neem leaves, which help to reduce the microbial load of birds and improved the feed consumption and feed efficiency of the birds. A study by (Kannan *et al.*, 2019) showed quite relevance with this information where they applied 0, 0.25, 0.5, 0.75 and 1% neem powder added to the basal diet. At the end of the study, dietary supplementation of 0.5% neem leaf powder induced significant improvement in body weight up to fourth weeks of age of Japanese quail.

In the current study result showed that highest overall body weight gain observed in treatment groups fed mahogany and chalta mixed dry leaves powder. It could be due to phytochemicals contents having numerous biological properties including antimicrobial, antioxidant, anti-stress and immune enhancement effects (Hashemi and Davoodi, 2010).

5.2 Feed intake

In present study, the feed intake increase was highly significant ($P<0.001$) among the different dietary treatment groups. (Mahmud *et al.*, 2015) found that an increased feed intake by dietary inclusion of neem leaf meal on Japanese quail. The higher feed intake observed in this research by inclusion of mahogany and chalta might be due to pharmacological effect of these leaves on digestive system by bioactive compound (Obikaonu, 2012).

5.3 Feed conversion ratio

The FCR shows a significant decreased in all dietary group compared to control where lowest FCR value was obtained in group fed on mahogany and chalta mixed dry leaves powder containing ration. It may be due to the presence of phytochemicals. In line with our study, feed efficiency was improved in Japanese quail fed on neem supplemented

ration (Mahmud *et al.*, 2015). The improvement of feed efficiency by mahogany and chalta might be due to having polyphenolic compounds which may increase the activity of digestive enzymes, decreased pathogenic microorganisms and inhibits toxins present in feed (Younan *et al*., 2019).

5.4 Carcass characteristics

The chalta leaf containing ration fed group of broiler birds exhibited a signinificantly increased dressing percentage, drumstick weight and heart weight. Previous study Shafey *et al.*, (2013) based on supplementing ethanoic extract of olive leaf extract in broiler showed a significant difference in carcass characteristics. The increased dressing percentage and some selective organ weight might be due to relative increased body size in chalta leaf fed group.

5.5 Chemical composition of meat

Proximate analysis for meat composition showed that crude protein and ether extract were higher in chalta and, mahogany and chalta mixed leaves treated group compared to control. It may be because of synergistic effects different bioactive compounds and plant phytochemicals.

5.6 Serum biochemical parameters

According to the serum parameters in the study, a significant increase in HDL level were found in all treatment groups. Although it is unclear to us how HDL increased by mahogany and chalta feeding in broiler, phytochemicals present in these plants may contribute in alteration of lipid metabolosm (Nath and Kumar.K, 2021) and there by increase HDL.

5.7 Oxidative stability of meat

In the current study, diet containing dried mahogany and chalta leaves significantly reducced overall TBARS value compared to control in breast meat when stored 4°C for 3 to7 days. Chalta *(Dillinia indica*) and mahogany (*Swietenia mahogany*) leaves are a

good source of antioxidant and also have free redical scanvenging activity (Yp and Urooj, 2015) that might have contributed to these results.

5.8 Cost benefit analysis

A significantly high net profit was obtained from all dietary treatment groups in comparision with control ($P<0.001$). The highest net profit was recorded from group fed with 0.2% dry mahogany and 0.2% chalta mixed leaves. Actually, better profit in traetment groups are due to better body weight gain and improved feed efficiency.

Chapter 6: Conclusion

The study investigated the dietary effects of dry mahogany and chalta leaves supplementation on growth performance, carcass characteristics, biochemical parameter and oxidative stability of meat in broiler. It was revealed that, there was a positive relationship between of dry mahogany and chalta leaves supplementation and growth performance of commercial broiler. Statistically remarkable results were found on growth, FCR, and oxidative rancidity of meat in treatment group supplied dry leaves. The blood HDL level also increased in treatment group whereas LDL level found low compared to control group. In case of nutrient composition of meat, there was a significant increase in crude protein and ether extract contents in treatment group while dry matter increased in control group. A significant reduction of TBARS of meat derived from broiler fed mahogany and chalta leaves was found, suggesting the antioxidant potentials of these leaves. It may be concluded that combination of dry leaf powder of mahogany and chalta can be incorporated as feed additive in broiler diet.

Recommendations and Future Perspectives

The inclusion of mahogany and chalta in broiler diet significantly induced growth and performance, contributed meat and carcass quality, and inhibited the oxidative rancidity. These plants are also good sources of phytochemicals such as flavonoids, saponins, tannins, alkaloids etc. that are potential for maintaining intestinal microflora. Therefore, the leaves from mahogany and chalta could be alternatives for probiotics and antibiotic growth promoters. This study therefore, suggesting that dry mahogany and chalta leaves might be potential feed supplements for broiler as it is grown everywhere in Bangladesh. However, a long-term investigation with larger sample size and multidimensional temporal pattern is suggested for increasing sensitivity and validity of the study under field condition.

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Appendix

1. Proximate analysis of mahogany leaf

Proximate components	**Amount (%)**
Dry matter	97.54
Crude protein	14.56
Crude fibre	27.25
Ash	24.49

2. Proximate analysis of chalta leaf

Proximate components	**Amount (%)**
Dry matter	86.73
Crude protein	18.89
Crude fibre	12.74
Ash	9.03

3. Proximate analysis of mahogany and chalta mixed leaves

Proximate components	**Amount (%)**
Dry matter	88.01
Crude protein	20.75
Crude fibre	12.59
Ash	8.85

Biography

Najia Sharmin Mukta was born in Daulatkhan, Bhola in 1995. She is elder daughter of Abdul Malek Babul and Bibi Rahima. She passed the Secondary School Certificate (SSC) Examination from Daulatkhan Govt Girls High School from Daulatkhan, Bhola and Higher Secondary School Certificate (HSC) Examination from Daulatkhan Abu Abdullah College,Daulatkhan, Bhola. She completed her graduation degree on Animal Husbandry (AH) from Patuakhali Science and Technology University (PSTU), Dumki, Patuakhali. Now she is candidate for the the degree of MS in Animal Science, Department of Animal Science and Nutrition, Faculty of Veterinary Medicine, CVASU.