EFFECTS OF MORINGA LEAF (*Moringa oleifera*) AND *SPIRULINA* (*Spirulina platensis*) ON THE GROWTH PERFORMANCE OF BROILER

A Thesis

By

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MASTER OF SCIENCE IN ANIMAL NUTRITION

DEPARTMENT OF ANIMAL NUTRITION, GENETICS AND BREEDING

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*This is to certify that the thesis entitled "**EFFECTS OF MORINGA LEAF (Moringa oleifera) AND SPIRULINA (Spirulina platensis) ON THE GROWTH PERFORMANCE OF BROILER**" submitted to the Department of Animal Nutrition, Genetics and Breeding, Faculty of Animal Science & Veterinary Medicine, Sher-e-Bangla Agricultural University, Dhaka-1207, as partial fulfillment for the requirements of the degree of Master of Science (MS) in Animal Nutrition, embodies the result of a piece of bona fide research work carried out by **ABU NASER**, Registration No.: 18-09207, Semester: **JANUARY- JUNE/2020** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

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

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DEDICATED TO MY BELOVED PARENTS

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LIST OF ACRONYMS AND ABBREVIATION

ABBREVIATION	FULL WORD
ADG	Average daily gain
ADF	Acidic detergent fiber
AGPs	Antibiotic growth promoter
ANOVA	Analysis of variance
Avg	Average
BWG	Body weight gain
CFU	Colony forming unit
Cm^2	Square centimeter
CP	Crude protein
DOC	Day old chick
DP	Dressing percentage
e.g.	For example
et al	And others/Associates
EU	European union
FAO	Food and agricultural organization
FC	Feed consumption
FCR	Feed conversion ratio
FDA	Food and drug administration
FI	Feed intake
G	Gram
GFI	Global food initiative
GIT	Gastro intestinal tract
i.e.	That is
IB	Infectious bronchitis
K Cal	Kilo calorie
Kg	Kilogram
L	Liter
LSD	Least significant difference
MLP	Moringa leaf powder
M.S.	Master of Science

LIST OF ACRONYMS AND ABBREVIATION

ABBREVIATION	FULL WORD
Ml	Mililiter
Mm	Milimetre
MT	Metric ton
NDF	Neutral detergent fiber
No.	Number
NS	Non-significance
RH	Relative humidity
SAU	Sher-e-Bangla Agricultural University
SE	Statistical error
SP	*Spirulina* powder
SPSS	Statistical package for social science
TM	Trade mark
Viz	Such as
Vs.	Versus
WHO	World health organization
Wks	Weeks

LIST OF SYMBOLES

SYMBOLES	FULL MEANING
^{0}C	Degree celsius
^{0}F	Degree fahrenheit
@	At the rate of
:	Ratio
<	Less than
>	Greater than
*	5% level of significance
&	And
/	Per
±	Plus-minus
%	Percentage

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BY

ABU NASER

ABSTRACT

The study was planned to determine the comparative and combined efficacy of Moringa leaf (*Moringa oleifera*) and *Spirulina* (*Spirulina platensis*) on the productive performance of commercial broilers. A total of 120 day-old Lohmann Meat (Indian River) broiler chicks were reared for 28 days at Sher-e-Bangla Agricultural University Poultry Farm, Dhaka. Chicks were divided randomly into 4 experimental groups of 3 replicates (10 chicks with each replication). Among the four treatment groups, one group fed with basal diet as control (T_0) and the other groups with same diet supplemented by 2% Moringa leaf powder (T_1), 1% *Spirulina* powder (T_2) & 1% Moringa leaf powder+0.5% *Spirulina* powder (T_3) were treatment groups. Results of the experiment showed that addition of Moringa leaf and *Spirulina* combinedly improved broilers growth performance and the impact started from the third and fourth week of the feeding trial. Feed conversion ratio (FCR) was comparatively better ($P>0.05$) and dressing percentage was increased ($P<0.05$) in birds fed diets supplemented with *Spirulina* and both Moringa and *Spirulina*. Survivability was higher (non significantly, $P>0.05$) in combined (T_3) and MLP (T_1) feeding group compared to other treated group T_0 and T_2. The relative weight of liver, heart, and intestine were significantly higher ($P<0.05$) in T_3 group than other group T_0, T_1 and T_2. On the other hand, gizzard and spleen were non significantly higher ($P>0.05$) in T_3 group than other treated groups. In case of cost benefit analysis, net profit was highest in MLP (T_1) treated group than the other groups. The study therefore concluded that, combined supplementation of Moringa leaf and *Spirulina* proved to be beneficial for increasing the growth performance of broiler chickens. However, Moringa treated group is more cost effective and profitable than other treated groups.

CHAPTER I

INTRODUCTION

Poultry industry is one of the most profitable business of agriculture provides nutritious meats and eggs for human consumption within the shortest possible time (Basak *et al.,* 2002). Poultry production plays a major role in bringing the protein gap in developing countries where average daily consumption is far below recommended standards (Onyimonyi *et al*., 2009). The most important sources of animal protein in the world is poultry meat. Poultry meat contributes significantly in maintaining the health status of the people, especially in developing countries like Bangladesh. Poultry meat alone contributes 37% of the total meat production in Bangladesh (Hamid *et al*., 2017). Overall poultry contributes about 22-27% of the total animal protein supply in the country (DLS, 2015). However, the first augment in human population of the country is demanding more efforts to increase meat production for food security. Besides the risk of ever-increasing population, expand of diseases, high feed price and non-availability of quality ingredients for balanced feed formulation are some of the factors, which limit the production performance of broilers. However, availability of quality feed at a reasonable cost is a key to successful poultry operation. In broiler industry, feed costs considered a one of the greatest challenges especially in developing countries. It constitutes about 60-80% of the total cost of poultry meat production (Teguia and Beynen, 2005). The high cost and increasing demand of traditional energy source and protein source such as fish meal and soybean meal have encouraged the search for alternative feeds (Gaia, 2005) not only for economy but also to reduce the direct competition between human being and the animals for the available traditional feedstuffs (Muriu *et al*., 2002). One such resource is a group of feed additives termed as phytogenic products or phytobiotics, which include whole plants or their parts (Khan *et al*., 2017). One such plant, *Moringa oleifera*, belongs to the family of Moringaceae and is considered indigenous in south Asia including Bangladesh (Zvinorova *et al*., 2015). The dried, ground leaves of *M. oleifera* contain 25.1% crude proteins, 5.4% lipids, 11.5% ash, 21.9% NDF (neutral detergent fibre) and 11.4% ADF (acidic detergent fibre), 44.4% carbohydrates (Teixeira *et al*., 2014). *Moringa oleifera* is one of the plants whose leaves are used in poultry diets because; it contains good source of nutrients (Makkar and Becker, 1997). *Moringa oleifera* leaves are good source of proteins, vitamin A, B and C and minerals such as calcium and iron (Deschepper, 1995).

Ramachandran *et al*. (1980) and Loren (2007) reported that, Moringa leaves have a calcium content equal to 4 glasses of milk, iron 3 times that of spinach, vitamin A 4 times that of carrot, protein 2 times that of milk, potassium 3 times that of banana, vitamin C 7 times that of orange and heavy metals are absent from the leaves; so it was integrated safely in poultry diet (Foidl *et al*., 2001; Donkor *et al*., 2013). The protein content of *Moringa oleifera* leaf ranged between 20% to 23% on dry weight basis and is of high quality. The protein content of *Moringa oleifera* leaf is of high digestibility and of high quality and have significant amount of all the essential amino acids. Moringa plant known as "Miracle tree" has been reported to have many medicinal uses as it possesses hypo-cholesterolemic properties (Olugbemi *et al*., 2010).

Another unconventional feed named *Spirulina* (*Spirulina platensis)* which may be a good candidate as a growth promoter for broilers. These microalgae have high contents of protein, essential amino acids, vitamins, minerals, essential fatty acids and pigments (Holman and Malau-Aduli, 2013). *Spirulina*, the blue green algae has been used as human food supplement for over 20 years. Use of *Spirulina* as high-quality natural feed additive in animal and poultry nutrition is relatively recent (Belay *et al*., 1996). *Spirulina* contains higher amounts of protein (55-60%) and all essential amino acids, vitamins and minerals (Doreau *et al*., 2010). Also, it is a rich source of carotenoids and fatty acids, especially gamma-linolenic acid (GLA) which infers health benefits (Guroy *et al*., 2012) and has been used throughout the world as a feed component in broiler and layer diets to enhance yolk colour, flesh and egg fertility (Ross and Dominy, 1990). It also improves both, cell mediated and mononuclear phagocytic system potential in chickens allowing them to resist diseases. The higher carotenoid content of *Spirulina* helps in supplementation of vitamin A, provides antioxidant activity and enhance immunity (Qureshi *et al*., 1996) helps in hormonal regulation and plays additional roles in growth, reproduction and maturation (Nikodemusz *et al*., 2010). *Spirulina* is also rich in polysaccharides, which may function as prebiotics (Beheshtipour *et al.*, 2013; de Jesus Raposo *et al.*, 2016).

Several studies have demonstrated the growth-promoting effects of *Spirulina* on broiler chickens showed that feeding 2, 4, or 8 g of *Spirulina* /kg feed increased and decreased the body weight and feed conversion ratio (FCR) of broiler chickens, respectively (Jamil *et al.*, 2015). Similar results were found when feeding 1% of *Spirulina* to broiler chicks (Shanmugapriya *et al.*, 2015). These authors revealed that such treatment resulted in increased villi height, and hence improved absorption capacity of broiler intestines.

It was clear that both Moringa leaf and *Spirulina* were good source of proteins and other essential nutrients which could act as a magnificent growth promoter in broiler. There have been several studies on individual Moringa leaf and *Spirulina* to observe their effect on broiler growth. However, still no research was found on combined effect of moringa leaf and *Spirulina* on growth and FCR on broilers.

With this background, the work was planned to explore the possibilities of Moringa leaf and *Spirulina* in broiler chicken feeds as growth promoters with the following specific objectives:

1. To evaluate the individual effects of Moringa leaf and *Spirulina* on the growth performance and FCR of broiler chickens.
2. To assess the combined effects of Moringa leaf and *Spirulina* on the growth performance and FCR of broiler chickens.
3. To study the effect of Moringa leaf and *Spirulina on the* carcass characteristics of broiler chickens.

CHAPTER II

REVIEW OF LITERATURE

Source of literature

(i) Book and journals in different libraries as mentioned below-

- Sher-e-Bangla Agricultural University (SAU) Library, Dhaka
- Bangladesh Livestock Research Institute (BLRI) Library, Savar, Dhaka.
- Bangladesh National Scientific and Technical Documentation Centre (BANSDOC) Library, Dhaka.
- Bangladesh Agricultural Research Council (BARC) Library, Farmgate, Dhaka.

(ii) Abstract searching at BARC, Farmgate, Dhaka, BANSDOC, Agargoan and Dhaka.

(iii) Internet browsing

About hundred literature were reviewed to identify the drawbacks and prospects of research, background of research, understand previous findings and to answer the research status of this field. Among them twenty were full article and fifty abstracts and some were miscellaneous. A brief account is given below depending on five main headlines viz, unconventional feed impacts on poultry, antibiotic growth promoters (AGPs), alternative to growth promoters such as Moringa and *Spirulina*.

Monitoring the references, a very critical enquires was made of each article and significant information was collected and arranged according to specific title.

In Bangladesh the demand of broiler meat is increased rapidly. Cost of feed accounts up to 80% of the total cost of production. And is very important component in determining the extent of poultry survival and profitability (Olugbemi *et al*., 2010). Feed is a major component affecting net return from the poultry enterprise. Feed supplements and additives are being used to ensure more net return and to minimize expenditure of feed. Economical broiler production depends on optimum utilization of feed. Chemical feed additives and growth promoters have criticism have adverse effects on consumers. Now a day's demand for organic meat and egg is increasing.

Herbal and plant derivatives would be a valuable alternative to promote growth and health in poultry as there is no residual toxicity (Agashe *et al*., 2017).

2.1 Phytogenics

Phytogenic feed additives (PFAs), also referred as phytobiotics or botanicals, are natural bioactive compounds that are derived from plants and incorporated into animal feed to enhance productivity (Windisch *et al*., 2008). Phytogenic additives influence improvement of consumption and conversion of food, digestibility and gain of broiler chickens (Peric *et al*., 2009). The addition of herbs, oils, botanicals and spices in feed additives increases the secretion of digestive fluids and improves the immune system of broilers (Tollba, 2010). Despite the improved health, a better nutrient digestibility, reduced frequency of digestive disorders and also increased performance of broilers is ensured (Botlhoko, 2009). A wide range of plants and their products fall under this category and, based on their origin (part of the plant), they can be broadly classified as herbs (flowering, nonwoody, non-persistent plants from which leaves and flowers are used) or spices (non-leaf parts of plants, including seeds, fruits, bark or root with intensive taste or smell) (Windisch *et al*., 2008). Phytogenic feed additives include medicinal plants/herbs, which are non-woody flowering plants known to have medicinal properties; spices, which are herbs with intensive smell or taste, commonly added to human food; essential oils, which are aromatic oily liquids derived from plant materials such as flowers, leaves, fruits and roots; and oleoresins, which are extracts derived by non-aqueous solvents from plant material (Jacela *et al*., 2010). Phytogenic feed additives include medicinal plants/herbs, which are non-woody flowering plants known to have medicinal properties; spices, which are herbs with intensive smell or taste, commonly added to human food; essential oils, which are aromatic oily liquids derived from plant materials such as flowers, leaves, fruits and roots; and oleoresins, which are extracts derived by non-aqueous solvents from plant material (Jacela *et al*., 2010).

A wide variety of herbs and spices (e.g., thyme, oregano, rosemary, marjoram, yarrow, garlic, ginger, green tea, black cumin, coriander, and cinnamon) have been used in poultry for their potential application as AGP alternatives. Guo *et al*. (2004) showed a significant increase in body weight gain and improvement in feed efficiency when broilers were given diets supplemented with a mixture of 14 herbs. Various plant extracts used as PFAs were also shown to improve the performance of broilers. Research trials conducted with the inclusion of sugar cane extract, aniseed extract (Durrani *et al.*, 2007), chestnut wood extract, forsythia suspensa

extract, and *Portulaca oleracea* extract (Zhao *et al.,* 2013) showed a significant increase in body weight gain and a lower FCR.

2.2 Information about Moringa (*Moringa oleifera*)

Moringa oleifera is a well-known cultivated species in the genus Moringa, (family Moringaceae) under the order Brassicales. The moringa leaves have a broad use in food industry (Fahey, 2005). The common name of Moringa include moringa, drumstick tree, bean oil tree, horse radish tree or miracle tree (Arora *et al*., 2013). It is popular for its seeds, flowers and leaves in human food and as herbal medicine (Oyeyinka, 2018). The various parts of Moringa tree are used as a good source of human nutrition and in traditional diets in different countries (Olugbemi *et al.,* 2010; Onunkwo and George, 2015). The *Moringa oleifera* leaves are rich with fats, vitamins, minerals and protein and have antimicrobial roles (Abbas, 2013). *Moringa oleifera* can be used as a dietary supplementation in poultry and a source of micronutrient (Mahajan, 2007).

2.2.1 Antioxidant properties of Moringa (*Moringa oleifera*)

Moringa oleifera leaves are reported to have potential prebiotic effects and potentially antioxidant phytochemicals, such as chlorogenic acid and caffeic acid (Siddhuraju and Becker, 2003). *Moringa oleifera* leaf meal, widely available in many tropical countries, is also a good source of antioxidant compounds such as ascorbic acid, flavonoids, phenolics and carotenoids (Teixeira *et al*., 2014). *M. 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. They also contain rich sources of different phytonutrients, such as carotenoids, tocopherols, and ascorbic acid, which are good sources of dietary antioxidants. The leaves of the tree have been reported to have an antioxidant activity due to the higher number of polyphenols (Moyo *et al*., 2011; Sreelatha and Padma, 2009). The HPLC analysis indicated the presence of phenolic acids (gallic, chlorogenic, ellagic and ferulic acid) and flavonoids (kaempferol, quercetin and rutin) in moringa. *Moringa oleifera* leaf meal may be a promising source of natural antioxidants for broiler meat. The leaves of moringa tree have been reported to have an antioxidant activity due to the higher number of polyphenols (Moyo *et al*., 2011; Sreelatha and Padma, 2009).

2.2.2 Therapeutic and antimicrobial properties of Moringa

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. The leaves, flowers and pods are used as good sources of vitamins A, B and C, riboflavin, nicotinic acid, folic acid, pyridoxine, ascorbic acid, beta-carotene, calcium, iron, and alpha tocopherol (Dahot, 1988). The pods are considered as an important source of the essential amino acids. A compound, pterygospermin found in the flowers and roots of the Moringa has powerful antibiotic and fungicidal effects (Das *et al*., 1957).

Aqueous leaf extracts are being used to treat hyperthyroidism as they help regulating thyroid hormone (Tahiliani and Kar, 2000). Leaf extracts are also used to treat ulcer (Pal *et al*., 1995). It has been reported that Moringa leaves and pods also have a positive effect in reducing blood cholesterol, and anti-tumor promoting activity (Ghasi *et al*., 2000). Nevertheless, it is an important source of the glucosinolate precursors of the isothiocyanate group of chemopreventives (Daxenbichler *et al*., 1991) that can inhibit carcinogenesis. Moringa is a potential plant that could be used to enhance immune responses and to improve intestinal health of broiler chicken. Yang *et al*. (2009) reported that the dehydrated leaves of *M. oleifera* in the diets of broiler chicken significantly enhanced immune responses and reduced *E. coli* and increased *Lactobacillus* counts in ileum.

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 (Chuang *et al.*, 2007; Oluduro, 2012).

Moringa oleifera is one of the plants that can be utilized in the preparation of poultry feeds. The plant apart from being a good source of vitamins and amino acids, it has medicinal uses (Makkar and Bekker, 1999; Francis *et al*., 2005). *Moringa oleifera*, otherwise regarded as a "miracle tree" has been used in the treatment of numerous diseases (Pal *et al*, 1995; Makomen *et al*, 1997; Ghasi *et al*, 2000 and Matthew *et al*, 2001) including heart disease and obesity due to its hypocholesterolemic property (Ghasi *et al*, 2001; Olugbemi *et al.*, 2010) also reported this quality. *Moringa oleifera* leaves have the calcium equivalent of 4 glasses of milk, 3 times

the iron of spinach, 4 times the amount of vit A in carrot, and 2 times protein in milk (Loren, 2007).

The leaves of Moringa are good source of protein, vitamins A, B and C and minerals such as calcium and iron (Dahot, 1988). The leaves of Moringa has high protein content which is between 20 – 33% on a dry weight basis, the protein is of high quality having significant qualities of all the essential amino acid. Moringa leaves contain a high level of vitamins A, B, C and calciuim. *Moringa oleifera* can be used as a source of micronutrient and as a dietary supplement in poultry (Mahajan *et al*., 2007). In most of the feeding experiments in poultry, the fresh, green, and undamaged mature M. *oleifera* leaves were properly air-dried, and then the dried leaves were ground to a fine powder in a hammer mill and considered as moringa leaf powder or leaf meal. Similarly, fresh mature moringa seeds were air-dried and ground and considered as moringa seed meal.

2.2.3 Effects of Moringa (*Moringa oleifera*) on broiler performance

Moringa oleifera can be used as a source of micronutrient and as a dietary supplement in poultry (Mahajan *et al*., 2007). In most of the feeding experiments in poultry, the fresh, green, and undamaged mature *M. oleifera* leaves were properly air-dried, and then the dried leaves were ground to a fine powder in a hammer mill and considered as moringa leaf powder or leaf meal. Similarly, fresh mature moringa seeds were air-dried and ground and considered as moringa seed meal. In some experiments, the ground particles were then soaked into distilled water for 24 h, and the filtered aqueous solution was considered as moringa extract. Due to the rich nutrient content, especially the high amount of crude protein (CP), vitamins, and minerals, *M. oleifera* leaves can be used as a useful resource of dietary supplementation for livestock as well as poultry (Nouman *et al*., 2014; Moreki *et al.,* 2014; Abou Sekken, 2015).

In addition, moringa leaves can be applied as a dietary supplement in layers and broilers due to high production performance and improved eggs quality. However, still there are many debates on the chicken's performance with different doses of *M. oleifera* in the previous studies. There are also many variables on doses and part of plant used, such as leaves, extract, sods, or seeds. Finally, many scientists agreed that *M. oleifera* plant might have a positive role in improving the production performance and health status in chickens. Further studies are still needed to detect the actual doses of application for optimum performance in chickens.

Similarly, feeding with moringa leaf meal in broilers led to a lower feed intake with higher FCR, as reported by Gakuya *et al.* (2014); Olugbemi *et al.* (2010) stated that average daily growth rate was lower with *Moringa oleifera* leaf meal at the inclusion level below 5% in diets, and the authors suggested to use maximum level of 5% without any harmful effects on growth performance and FCR in broilers. Abdulsalam *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.

2.3 Information about *Spirulina*

Spirulina, also named Arthrospira, is a microscopic and filamentous cyanobacterium (blue-green alga). It thrives in tropical and subtropical warm lakes with a high pH ranging from 9.4 to 11.0. There are 2 different species of *Spirulina* named, *Spirulina maxima* and *Spirulina platensis*, with varying distribution throughout the world (Oliveira *et al.*, 1999). *S. platensis* is more widely distributed and found mainly in Africa, Asia and South America (Vonshak, 2002). *S. maxima* on the other hand is more confined to areas in Central America.

The blue-green algae (*Spirulina platensis*) have been used for hundreds of years as a food source for humans and animals due to the excellent nutritional profile and high carotenoid content. *Spirulina* is relatively high in protein with values ranging between 55-65% and includes all of the essential amino acids (Anusuya Devi *et al*., 1981). The available energy content of *Spirulina* is estimated to be 2.50-3.29 kcal/g and its phosphorous availability is 41% (Yoshida and Hoshii, 1980). In addition, it is rich in nutrients such as vitamins (thiamin, riboflavin, pyridoxine, vitamin-B12, vitamin-C), amino acids, gamma linoleic acid, phycocyanins, tocopherols, chlorophyll and β-carotenes (Abd El-Baky *et al.*, 2003 and Khan *et al*., 2005), carotenoids and minerals especially iron.

It has been reported that *Spirulina* has health benefits in conditions such as diabetes mellitus and arthritis (Parikh *et al*., 2001; Rasool *et al*., 2006). It has also been shown to have immuno-stimulatory effects and to have antiviral activity (Khan *et al*., 2005).

2.3.1 Antioxidant properties of *Spirulina*

Manoj *et al.* (1992) reported that the alcohol extract of *Spirulina* inhibited lipid peroxidation more significantly (65% inhibition) than the chemical antioxidants like α-tocopherol (35%),

BHA (45%) and β-carotene (48%). The water extract of *Spirulina* was also shown to have more antioxidant effect (76%) than gallic acid (54%) and chlorogenic acid (56%).

An interesting aspect of their findings is that the water extract had a signicant antioxidant effect even after the removal of polyphenols. In another study by Zhi-Gang *et al.* (1997) the antioxidant effects of two fractions of a hot water extract of *Spirulina* were studied using three systems that generate superoxide, lipid and hydroxyl radicals. Both fractions showed significant capacity to scavenge hydroxyl radicals (the most highly reactive oxygen radical) but no effect on superoxide radicals. Miranda *et al.* (1998) attributed the antioxidant effect to beta-carotene, tocopherol and phenolic compounds working individually or in synergy.

Beta-carotene concentration of *Spirulina* is ten times higher than that of carrot. Food rich in β-carotene can reduce the risk of cancer (Peto *et al*., 1981). It was found that the natural carotene of *Spirulina* could inhibit, shrink and destroy oral cancer cells. The beta-carotene in algae and leafy green vegetables has greater antioxidant effects than synthetic beta-carotene (Amotz, 1987).

2.3.2 *Spirulina* as nutritional and therapeutic supplement in poultry

2.3.2.1 Effect of *Spirulina* on FCR of poultry

Ross and Dominy, (1990) evaluated the nutritional value of dehydrated *Spirulina* in poultry. Male broiler chicks were fed *Spirulina* in the range of 1.5-12% for 41 days. It was concluded that dehydrated *Spirulina* at a diet content below 12% may be substituted for other protein sources in chick and broiler diets with good feed efficiency. The authors also found similar results with quail. Sugiharto *et al.* (2017) conducted an experiment using 1% of *Spirulina platensis* and they come to a conclusion that the dose of *Spirulina* was 8g/kg and results were body weight was significantly ($P<0.05$) increased in the treatment groups fed with *Spirulina* diet from 7th days to 28th days old. FCR was also significantly ($P<0.05$) decreased among the treatment groups. Kharde *et al*., (2012); Shanmugapriya & Saravana Babu, (2014) reported that dietary *Spirulina* significantly ($P<0.05$) improved feed efficiency of broiler chickens compared with the control groups.

Ross and Dominy, (1990); Venkataraman *et al*. (1994), Qureshi *et al*. (1996), Gongnet *et al*. (2001) and Toyomizu *et al.* (2001) recorded nonsignificant ($P>0.05$) effects of dietary *Spirulina* supplementation on performance parameters. However, Ross and Dominy (1990) and Nikodémusz *et al.* (2010) reported that birds fed dietary *Spirulina* had benefit effects on

productive performance. Also, Sinai hens had significantly ($P<0.05$) a better value of feed conversion ratio than that of Gimmizah hens.

In conclusion, taking the economical aspect into account, *Spirulina* algae could be safely used in laying hen diets with superior effects on their productive and reproductive performance.

2.3.2.2 Effect of *Spirulina* on live weight gain

Ross *et al*. (1994), found that there was no adverse effect of dietary *Spirulina* on final body weight. Kharde *et al.,* 2012; Shanmugapriya and Saravana Babu, (2014) reported that dietary *Spirulina* significantly ($P<0.05$) improved weight gain of chickens compared with the control groups. Ross and Dominy (1990) and Nikodémusz *et al.* (2010) reported that birds fed dietary *Spirulina* had benefit effects on productive performance. In this regard, Raju *et al.* (2005) concluded that dietary inclusion of *Spirulina* at a level of 0.05% can partially offset the adverse effects of aflatoxin on growth rate of broiler chickens.

Effect of the dietary supplementation of *Spirulina* on the growth performance of the Japanese quail (*Coturnix japonica*) at Poultry Research Station, Chennai, India. The results revealed that the dietary supplementation of *Spirulina* in Japanese quails significantly ($P<0.05$) improved the body weight gain. Bonos *et al.* (2016) conducted an experiment and they showed that bodyweight gain (at 21 d and 42 d), differ among the groups. Therefore, *Spirulina* could be a promising functional ingredient in broiler chicken nutrition.

Zahroojian *et al.* (2013) concluded that no significant differences between the treatments with 2.0 and 2.5% of *Spirulina* in case of mean live body weight of six weeks of the experiment and live weight at the end of experiment were found to be significantly ($P<0.05$) higher in *Spirulina* supplemented T_1 and T_2 groups of broilers than that of control (T_0) group. Comparatively better mean weekly weight gain and feed efficiency were also observed in *Spirulina* supplemented groups (T_1 and T_2) with decreased feed consumption as compared to control (T_0) group of broilers. Zahroojian *et al.* (2013) concluded that no significant differences between the treatments with 2.0 and 2.5% of *Spirulina*. In conclusion, this study can suggest use of 2.0~2.5% of *Spirulina* in diet to produce an aesthetically pleasing yolk color. An experimental trial of six weeks was undertaken by Kharde *et al*. (2012) on 90 broiler chicks divided into three groups. Control (T_0) group was fed standard broiler diet and T_1 and T_2 groups were provided same broiler diet supplemented with 300 and 500 mg of *Spirulina* per kg feed, respectively.

CHAPTER III

MATERIALS AND METHODS

3.1 Statement of the experiment

The research was conducted at Sher-e-Bangla Agricultural University poultry farm, Dhaka, with 120-day old commercial broilers (Lohmann meat) for a period of 28 days from 03 November to 01 December 2019 to assess the individual and combined effects of Moringa leaf and *Spirulina* power on the growth performance of broiler chickens.

3.2 Collection of experimental broilers

A total 120-day-old Lohmann broiler chicks were collected from Kazi hatchery distribution point, Savar, Dhaka.

3.3 Experimental materials

The chicks were collected from Kazi hatchery and carried to the university poultry farm early in the morning. Then the chickens were kept in the electric brooders for 7 days by maintaining standard brooding protocol. During brooding time only basal diet was given. After successful brooding the chicks were distributed randomly in four (4) dietary treatments. Each treatment had three (3) replications with 10 birds per replication. The total number of treatments were four (4) and total replications were twelve (12).

3.4 Experimental treatments:

T_0: Basal diets/ control

T_1: 2% Dried Moringa leaf powder (MLP)

T_2: 1% Dried *Spirulina* powder (SP)

T_3: 1% Dried Moringa leaf powder + 0.5% Dried *Spirulina* powder

Table 1: Experiment layout

Treatment Groups	No. of Replications			Total
	R_1	R_2	R_3	
T_0	10	10	10	**30**
T_1	10	10	10	**30**
T_2	10	10	10	**30**
T_3	10	10	10	**30**
Total	**40**	**40**	**40**	**120**

3.5 Preparation of experimental house

The experimental house was properly cleaned and washed by using tap water. Ceiling, walls, floor, feeder and waterer were thoroughly cleaned and disinfected by spraying diluted Iodophor disinfectant solution (3 ml/ liter water). The house was divided into 12 pens of equal size using wood materials after proper drying. A group of 10 birds were randomly shifted to each pen of the 4 treatments. One feeder and one waterer were distributed each pen. The stocking density was 1 m^2/10 birds.

3.6 Experimental diets

Starter and grower commercial Kazi broiler feed were purchased from the market. Starter diet was enriched with minimum: -

Table 2: Name and minimum percentage of nutrients present in starter broiler ration

Nutrients	Amount (%)
Protein	21.0
Fat	6.0
Fiber	5.0
Ash	8.0
Lysine	1.20
Methionine	0.49
Cystine	0.40
Tryptophan	0.19
Threonine	0.79
Arginine	1.26

Table 3: Name and minimum percentage of ingredients present in grower broiler ration

Nutrients	Amount (%)
Protein	19.0
Fat	6.0
Fiber	5.0
Ash	8.0
Lysine	1.10
Methionine	0.47
Cystine	0.39
Tryptophan	0.18
Threonine	0.75
Arginine	1.18

Feed were supplied 4 times daily by following Lohmann manual. *Ad libitum* drinking water were supplied two times daily.

3.7 Collection of Moringa leaves and *Spirulina* powder

The research was conducted at Sher-e-Bangla Agricultural University (SAU) poultry farm, Dhaka. The moringa leaves were harvested from SAU campus. After collection, the moringa leaves were sun dried for 4 days and grinded properly. Dried organic *Spirulina* powder was commercially manufactured by SK+F pharmaceuticals Ltd, Dhaka.

Table 4: Nutritional composition of Moringa leaves

Nutrient component	Amount (%)
Dry Mater	93.78
Crude Protein	22.60
Ash	11.24
Crude fat	13.40
Crude fiber	8.07
Carbohydrate	44.69

Source: Lesten and Emmanuel, 2018

Table 5: Nutritional composition of *S. platensis*

Nutrient Component	Amount
Dry Weight (%)	92.76+0.26
Lipids (%)	30.12+1.19
Proteins (%)	37.55+0.07
Fibers (%)	31.32+7.95
Sugars (%)	24.39+0.99
Energy (kcal)	518.84
Iron (mg/Kg)	256.56+0.01
Manganese (mg/Kg)	23.38+0.00
Copper (mg/Kg)	28.95+0.00
Zinc (mg/Kg)	25.01+0.01
Selenium (mg/Kg)	1.24+0.01
Ash (mg/Kg)	7.93+0.20
Vitamin A (IU/kg)	589
Vitamin E (IU/kg)	207.48
Vitamin B1 (mg/kg)	12.90
Vitamin B2 (mg/kg)	45.50
Vitamin C (mg/kg)	740.00

Source: Moor (2016)

3.8 Management procedures

Feed intake and body weight were recorded every week. Survivability was recorded for each replication up to 28 days of age. The following management procedures were followed during the whole experiment period.

3.8.1 Brooding of baby chicks

The experiment was conducted during 3rd November to 1st December, 2019. The average temperature was 28.07^{0}C and the relative humidity was 68% in the poultry house. Common brooding was performed for one week. After one week brooding the chicks were distributed in the pen randomly. There were 10 chicks in each pen and the pen space was 1 m^2. Brooding temperature was maintained as per requirement. Brooding temperature was adjusted (below 35^{0}C) with house temperature by using heat producing electric bulb.

It was beginning the winter season, so night temperature falls dramatically. Extra heat was needed at night. At day time only an electric bulb was used to stimulate the chicks to eat and drink.

3.8.2 Room temperature and relative humidity

Daily maximum and minimum room temperature and humidity were recorded with digital thermometer. Average room temperature and percentages of relative humidity for the experimental period were recorded and presented in Appendix 2.

3.8.3 Litter management

Rice husk was used as litter at a depth of 6cm. Every day litter was stirred to prevent accumulation of harmful gasses and to reduce parasite infestation. After 3 weeks of age droppings on the upper layer of the litter were cleaned and if necessary fresh litter was added.

3.8.4 Feeding and watering

Feed and fresh clean water were offered to the birds *ad libitum.* One feeder and one round drinker were provided in each pen for 10 birds. At the end of each week feeder were cleaned and drinkers were washed daily morning. All mash dry feed was feed to all birds *ad libitum* during the experimental period.

3.8.5 Lighting

Lighting has an important effect in the broiler farm to stimulate feed intake and body growth. 24 hours lighting was given for first 2 weeks. Thereafter 2 hours dark and 22 hours light was given up to 28 days.

3.8.6 Bio security measures

Recommended vaccination, sanitation program was taken in the farm and its premises to disease away from the farm. All chicks were supplied Vitamin-ADEK, Vitamin-C, Vitamin-B Complex, Ca and electrolytes.

3.8.7 Vaccination

Vaccines were collected from medicine shop (HIPRA Company) and applied to the birds according to the schedule. The vaccination schedule is given in Table 6.

Table 6: Vaccination schedule

Age of Birds	Name of Disease	Name of Vaccine	Route of Administration
3 days	IB+ND	HIPRAVIAR B1/H120	One drop in each eye
9 days	Gumboro	HIPRAGUMBORO GM97	Drinking Water
17 days	Gumboro	HIPRAGUMBORO GM97 (booster)	Drinking water

3.8.8 Ventilation

The broiler shed was open sided. Due to having half wall, it was easy to enter fresh air into the farm and remove polluted gas from the farm. Besides ventilation was maintained as per requirement by folding polythene screen.

3.8.9 Sanitation

During the experimental period strict sanitary measures were taken. Disinfectant (Timsen) was used to disinfect the feeders, waterers and house also.

3.9 Study parameters

Weekly feed consumption, live weight and death of chicks were recorded to calculate mortality percentage. FCR was calculated from final live weight and total feed consumption per bird in each replication. After slaughter liver, heart, spleen, gizzard, proventiculus and intestine were measured from each broiler chicken. Dressing yield was calculated for each replication to find out dressing percentage.

3.10 Data collection

3.10.1 Live weight

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

3.10.2 Feed consumption

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

3.10.3 Mortality of chicks

Daily death record for each replication was counted up to 28 days to calculate chick's mortality.

3.10.4 Dressing yield

Live weight – (blood + feathers + shank + head + liver + heart + digestive system)

3.10.5 Dressing procedures of broiler chicken

Three birds were picked up randomly from each replication at the 28^{th} days of age and slaughtered to calculate dressing percentage of broiler chicken. All birds were slaughtered by halal method. All the live birds were weighed prior to slaughter. Birds were slaughtered by severing jugular vein, carotid artery and the trachea by a single incision with a sharp knife and allowed to complete bleed out at least for 2 minutes. Outer skin was removed by sharp scissor and hand. Then the carcasses were washed manually to remove loose feathers and other foreign materials from the surface of the carcass. Then the carcass was eviscerated and dissected according to the methods by Jones (1992). Liver and heart were removed from the remaining viscera by cutting them loose and then the gall bladder was removed from the liver. Afterward the gizzard was removed. Dressing yield was calculated by subtracting feathers, blood, head, shank, heart, liver and digestive system from the weight.

3.11 Calculations

3.11.1 Live weight gain

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

Body weight gain = Final weight – Initial weight

3.11.2 Feed intake

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

$$\text{Feed intake (g/bird)} = \frac{\text{Feed intake in a replication}}{\text{No. of birds in a replication}}$$

3.11.3 Feed conversion ratio

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

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

3.12 Statistical analysis

The data was subjected to statistical analysis by applying one-way ANOVA using statistical package for social sciences (SPSS) version 16. Differences between means were tested using Duncan's multiple comparison test, LSD and significance was set at $P<0.05$.

CHAPTER IV
RESULTS AND DISCUSSION

Production performances of broiler chicken was evaluated by average live weight, average feed consumption (FC), weekly feed consumption, feed conversion ratio (FCR), average body weight gain, weekly body weight gain, survivability and flock uniformity. Carcass characteristics were taken by dressing percentage (DP), carcass weight and relative weight of giblet organs.

The analysis of research data is given and discussed below:

4.1 Production performance

4.1.1 Final live weight

The effect of dietary inclusion of Moringa leaf powder (MLF), *Spirulina* powder (SP) and both MLF and SP on production performance of broiler chickens showed no significant (P>0.05) effect, it may be due to no or less effect of Moringa leaf and *Spirulina* on live weight (Table 7). However good fluctuation was observed among the different treatment groups. The relative final live weight (g) of broiler chickens in the dietary group T_0, T_1, T_2 and T_3 were 1873.85±37.25, 1813.50±30.43, 1857.33±48.30 and 1894.57±21.14, respectively. The highest live weight was found in T_3 (1894.57±21.14) and lowest result was in T_1 (1813.50±30.43) group.

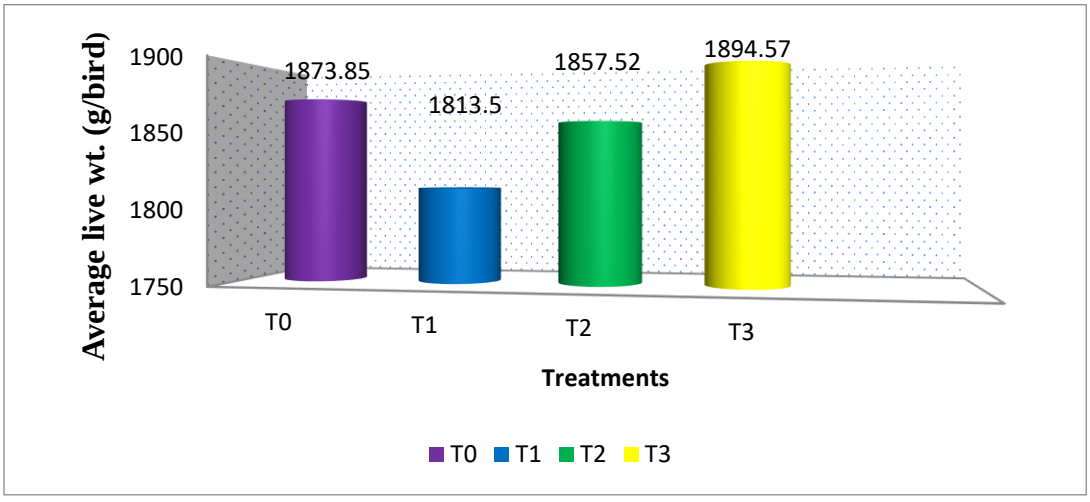

Fig. 1: Average live weight (g/bird)

Live weight in *Spirulina* treated group (1857.33±48.30) is more than Moringa treated group (1857.33±48.30). But highest live weight was found in both MLF and SP treated group.

These results are in agreement with those obtained by Ross *et al*. (1994), who found that there was no adverse effect of dietary *Spirulina* on final body weight. In addition, these results are in contradictory with those of previous researchers (Kharde *et al*., 2012; Shanmugapriya and Saravana Babu, 2014) reported that dietary *Spirulina* significantly (P<0.05) improved weight gain of chickens compared with the control groups. The present findings are in contradictory with Banjo (2012) who also observed significantly higher body weights on diets containing different levels (2%) of *M. oleifera* leaf meal. The reason for the improved weight gain can be attributed to high protein content of Moringa leaf meal as claimed by (Kakengi *et al.,* 2003) and (Olugbemi *et al*., 2010). *M. oleifera* plant was reported to contain various amino acids, a highly potent anti-inflammatory and hepatoprotective properties (Ezeamuzle *et al*., 1996).

There was no previous work found on combined effect of MLP & SP on final live weight on broiler chicken. In this research, there is no significant effect (P>0.05) of MLP & SP on live weight, however, it seems that combined effect of Moringa leaf power and *Spirulina* increased final live weight of broiler chicken.

Table 7: Production performance of broiler chicken with different treatments

Treatment	Av. Live weight±SE	Av. Feed consumption±SE	Av. BWG±SE	FCR±SE	Surviv ability±SE
T_0	1873.85±37.25	2471.46±81.21	1829.85±37.25	1.35±0.02	96.67±3.33
T_1	1813.50±30.43	2383.17±6.66	1769.50±30.43	1.34±0.02	100±0.00
T_2	1857.33±48.30	2397.21±14.55	1813.50±48.19	1.33±0.03	96.67±3.33
T_3	1894.57±21.14	2469.87±28.93	1850.57±21.14	1.33±0.01	100±0.00
Mean±SE	1859.81±17.67	2430.43±22.33	1815.85±17.66	1.34±0.01	98.33±1.12

Here, T_0 = (Control), T_1 = (2% Moringa leaf powder), T_2 = (1% *Spirulina*), T_3 = (1% Moringa leaf powder+0.5% *Spirulina*); Values: Mean ± SE; Applying: One-way ANOVA (SPSS, Duncan method)

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

4.1.2 Weekly body weight gain

Data presented in table 8 and figure 2 showed that the body weight gains (g) of broiler chicks at the end of 1st week in different groups was 169.5±0.00, because 1st week was the common brooding period for all birds. In table 8, body weight gains at the end of 2nd week in different treatment groups were 343.67±16.52 (T_0), 317.50±3.60 (T_1), 326.81±4.88 (T_2), 320.90±8.46 (T_3); 3rd week were 569.81±2.68 (T_0), 553.00±14.57 (T_1), 578.45±17.49 (T_2), 602.27±12.23 (T_3) and at the end of 4th week were 746.87±29.67 (T_0), 729.50±15.68 (T_1), 738.76±35.61 (T_2), 757.90±14.85 (T_3), respectively.

Weekly body weight gain is non-significant (P>0.05) in 1st, 2nd and 4th week however, significant (P<0.05) effect was found at the end of 3rd week.

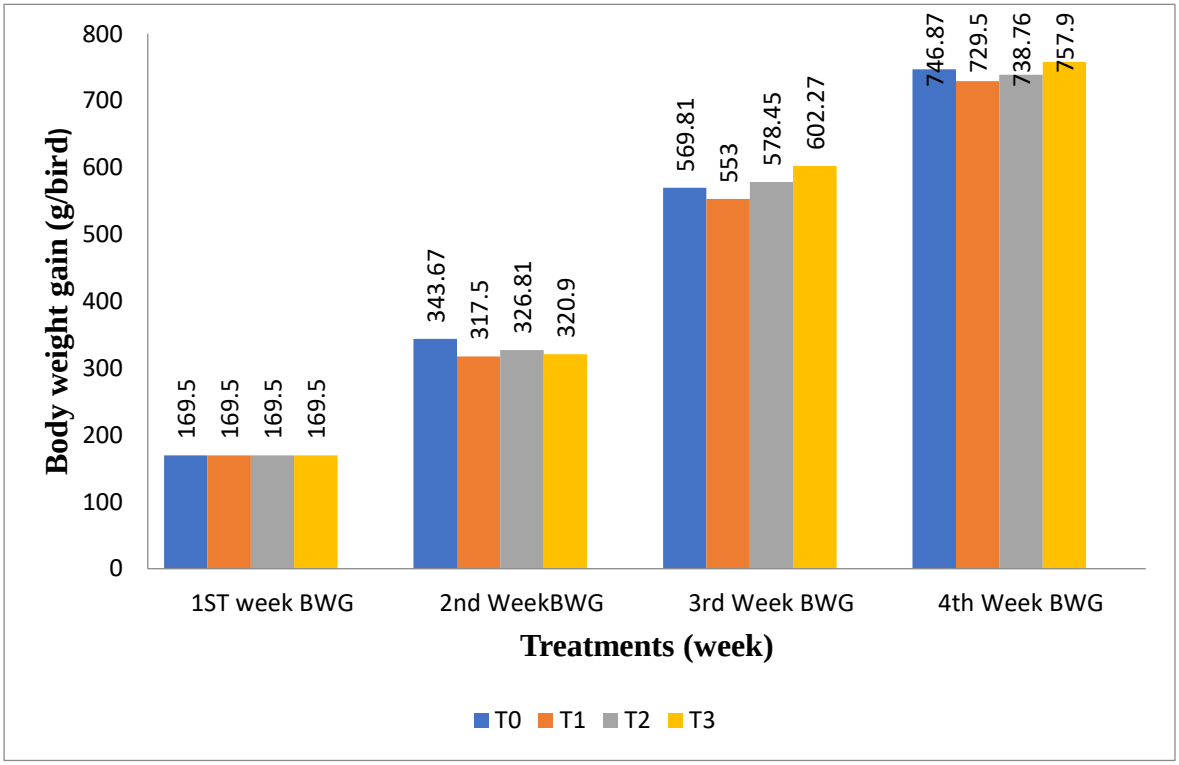

Fig. 2: Effects of Moringa leaf and *Spirulina* on body weight gain (BWG) (g/bird) of broiler

The present findings are contradictory with Okafor *et al*., (2014) who reported that *M. oleifera* supplemented groups recorded a higher daily weight gain. Banjo (2012); Gadzirayi *et al.* (2012); Kout *et al.* (2015) showed that birds fed on Moringa leaf powder gained significantly (P<0.05) higher body weights than birds fed the control diet.

On the other hand, these results are in agreement with those of previous researchers (Kharde *et al*., 2012; Shanmugapriya and Saravana Babu, 2014) reported that dietary Moringa significantly (P<0.05) improved weight gain of chickens compared with the control groups. There was no previous work found on the combined effect of Moringa leaf and *Spirulina* on the body weight gain of broiler chicken. The present study showed that height result was found in T_3 group where birds fed combinedly 1% Moringa leaf and 0.5% *Spirulina* powder.

Table 8: Effects of Moringa leaf and *Spirulina* on body weight gain (BWG) (g/bird) of broiler chicken at different weeks

Treatments	1st Week±SE	2nd Week±SE	3rd Week±SE	4th Week±SE	Total BWG±SE
T_0	169.50±0.00	343.67±16.52	569.81^{ab}±2.68	746.87±29.67	1829.85±37.25
T_1	169.50±0.00	317.50±3.60	553.00^{b}±14.57	729.50±15.68	1769.50±30.43
T_2	169.50±0.00	326.81±4.88	578.45^{ab}±17.49	738.76±35.61	1813.52±48.17
T_3	169.50±0.00	320.90±8.46	602.27^{a}±12.23	757.90±14.85	1850.57±36.62
Mean±SE	169.50±0.00	327.22±5.15	575.88±7.70	743.26±11.35	1815.86±17.65

Here, T_0 = (Control), T_1 = (2% Moringa leaf powder), T_2 = (1% *Spirulina*), T_3 = (1% Moringa leaf powder+0.5% *Spirulina*); Values: Mean ± SE; Applying: One-way ANOVA (SPSS, Duncan method)

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

4.1.3 Feed consumption (FC)

Data presented in table 9 and figure 3 showed that the effect of treatments on final feed consumption (gram per broiler chicken) was not significant (P>0.05).

Total feed consumption of broiler chicks at the end of 4th week in the dietary group T_0, T_1, T_2 and T_3 were 2471.46±81.21, 2383.17±6.66, 2397.21±14.55, and 2469.87±28.93 respectively.

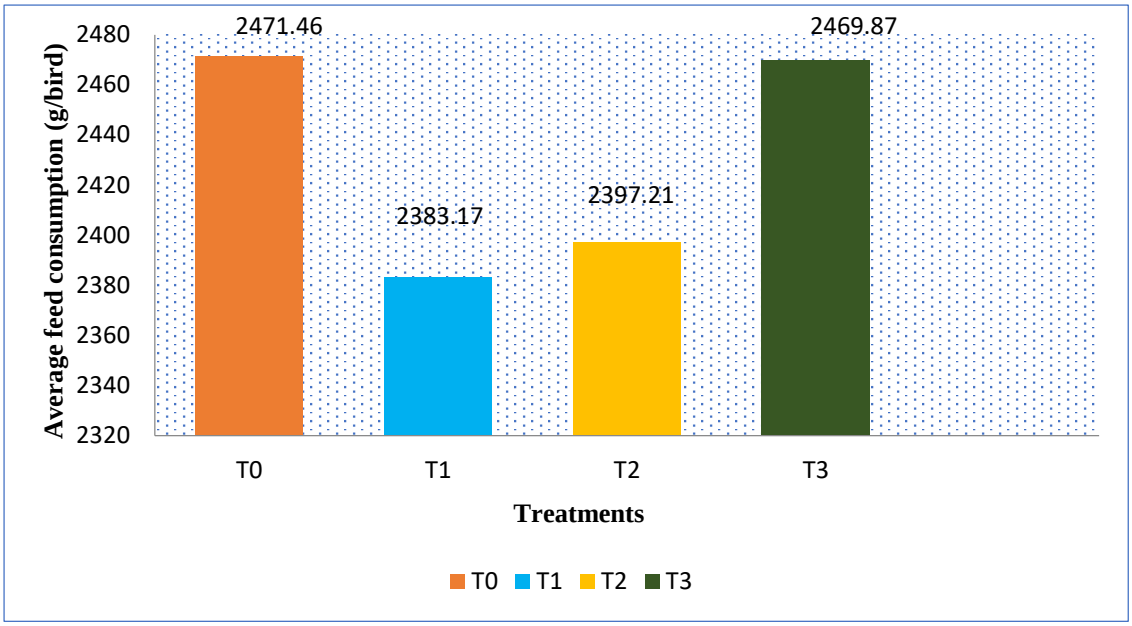

Fig. 3: Average feed consumption (g/bird)

The highest average feed consumption was found in T_0 (2471.46±81.21) and lowest result was in T_1 (2383.17±6.66) group. The average feed consumption of T_2 is also lower than others. Combine supplementation of MLP and SP showed higher feed consumption than individual supplementation. These results are in agreement with those of previous researchers (Ross & Dominy, 1990; Venkataraman *et al*., 1994; Qureshi *et al*., 1996), who recorded nonsignificant (P>0.05) effects of dietary *Spirulina* supplementation on performance parameters. In this result it seems that feed consumption decreased with the supplementation of Moringa leaf and *Spirulina.* This effect may be found due to Moringa and *Spirulina*.

4.1.4 Weekly feed consumption (FC)

Data presented in table 9 showed that the mean feed consumption (g) of broiler chicks at the end of 1st week in T_0, T_1, T_2, T_3 groups were 191.67±0.00, because the 1st week was common brooding period.

The mean feed consumption (g) of broiler chicks at the end of 3rd week in different groups were 775.15±24.99 (T_0), 737.50±3.05 (T_1), 761.50±18.14 (T_2) and 778.00±7.63 (T_3) respectively. The overall mean feed consumption of different groups showed that there was no significant (P>0.05) effects. The higher feed consumption was in T_3 group and lowest in T_1 group.

Feed consumption (g) of broiler chicks at the end of 4th week in different groups were 1067.11±38.11 (T_0), 1039.00±0.00 (T_1), 1020.44±1.44 (T_2) and 1077.33±23.33 (T_3) respectively.

The highest feed consumption was found in both MLP and SP feeding group (T_3) and lowest feed consumption was found in T_2 group.

The finding of the present study was contradictory to the findings of Kharde *et al*. (2012) and Shanmugapriya and Saravana Babu (2014) who reported that dietary *Spirulina* significantly ($P<0.05$) improved feed consumption (FC) of broiler chickens. However, there was no previous work found on combined effect of Moringa leaf and *Spirulina* on the weekly feed consumption of broiler chicken. These results showed highest feed consumption in combined group. It seems that combine effect of MLP and SP increased feed consumption of broiler chicken.

Table 9: Effects of Moringa leaf and *Spirulina* on the feed consumption (g/bird) of broiler chicks at different weeks

Treatment	1st Week±SE	2nd Week±SE	3rd Week±SE	4th Week±SE	Total FC±SE
T_0	191.67±0.00	430.90±16.47	775.15±24.99	1067.11±38.11	2471.46±81.21
T_1	191.67±0.00	415.67±5.20	737.50±3.05	1039.00±0.00	2383.17±6.66
T_2	191.67±0.00	417.35±0.55	761.50±18.14	1020.44±1.44	2397.21±14.55
T_3	191.67±0.00	422.90±0.00	778.00±7.63	1077.33±23.33	2469.87±28.93
Mean ±SE	191.67±0.00	421.70±4.09	763.04±8.35	1050.97±11.70	2430.43±22.33

Here, T_0 = (Control), T_1 = (2% Moringa leaf powder), T_2 = (1% *Spirulina*), T_3 = (1% Moringa leaf powder+0.5% *Spirulina*); Values: Mean ± SE; Applying: One-way ANOVA (SPSS, Duncan method)

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

4.1.5 Feed conversion ratio (FCR)

Data presented in table 7 and figure 4 showed that feed conversion ratio (FCR) was not significant ($P>0.05$). FCR found comparatively better in T_2 (1.33±0.03) and T_3 (1.33±0.01) group.

However, feed conversion ratio (FCR) was relatively higher in T_0 group (1.35±0.02) and T_1 group (1.34±0.02) compared to T_2 (1.33±0.03) and T_3 (1.33±0.01) groups.

The findings of present study support the findings of Onu and Aniebo (2011), who found that FCR was better in birds fed MLP supplemented diet compared to control birds. Banjo (2012) indicated that, broilers fed 1%, 2% and 3% MLP had significantly superior FCR in all MLP supplemented groups compared to control birds. These results are in agreement with those of previous researchers (Kharde *et al*., 2012; Shanmugapriya and Saravana Babu, 2014) reported that dietary *Spirulina* improved feed efficiency of broiler chickens compared with the control groups. There was no previous research found on the combine effect of MLP and SP on FCR of broiler chicken. But this result showed that combine effect of MLP and SP didn't improve FCR of broiler chicken compared to SP group.

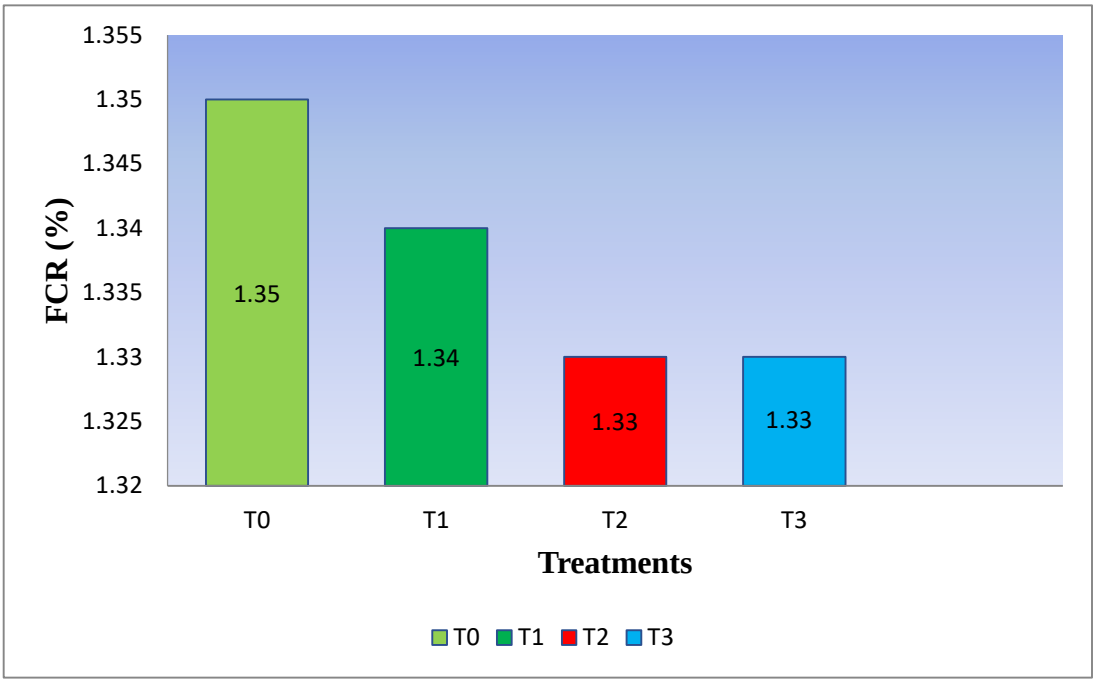

Fig. 4: Feed conversion ratio

4.1.6 Survivability

The Survivability rate showed on table 7 was higher for the MLP and combined MLP & SP supplemented group (100±0.00) than the control and *Spirulina* supplemented group (96.67±3.33) but there is no significant (P>0.05) difference.

4.1.7 Dressing percentage

Data presented in table 10 and figure 5 showed that the dressing percentage at *Spirulina* treated (T_2) group (64.47±0.93) was significantly ($P<0.05$) higher compared with the other treatment group T_0 (61.88±0.32), T_1 (63.97±0.56) and T_3 (63.08±0.14).

In the present study, the effects of *Spirulina* on broiler performance parameters including average dressing percentage (DP) was in agreement with previous studies (Cavazzoni *et al*., 1998; Jin *et al*, 1997; Zulkifli *et al*., 2000; Kabir, *et al*., 2004; Mountzouris *et al*., 2007). Furthermore, Bellof and Alarcon (2013) reported that under organic farming, dietary *Spirulina* supplementation improved carcass performance parameters of broilers significantly ($P<0.05$). However, *Spirulina platensis* dried-supplement displayed a greater growth-promoting effect and increased the carcass yield percentage.

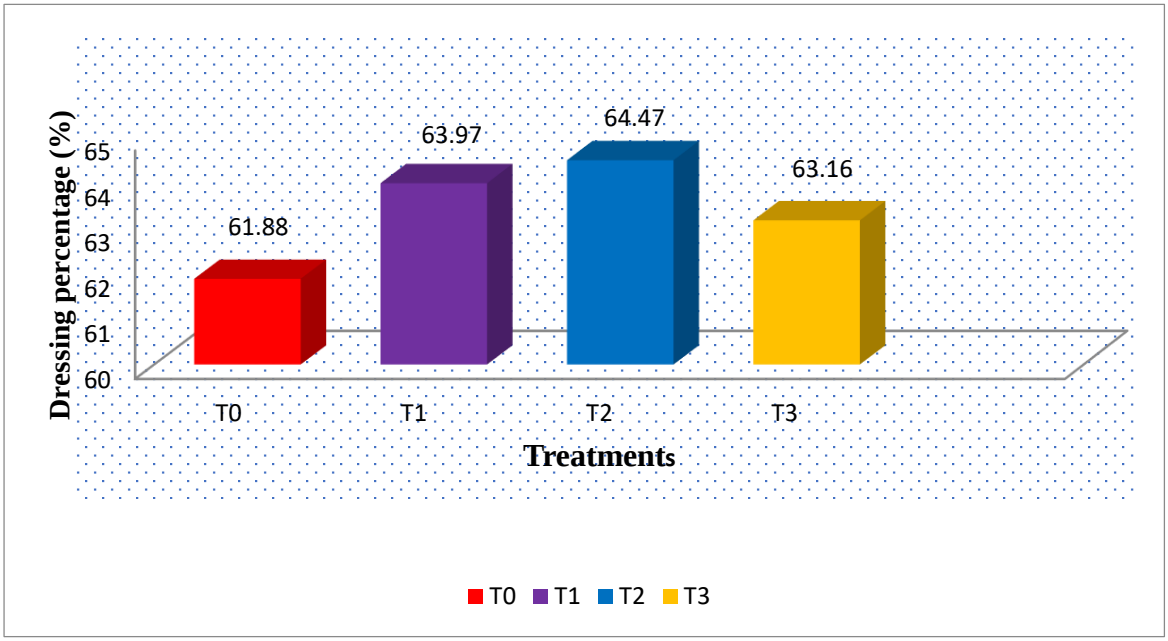

Fig. 5: Effects of Moringa leaf and *Spirulina* on the dressing percentage of broiler chicken

Table 10: Effects of Moringa leaf and *Spirulina* on the dressing percentage of broiler chicken

Treatments	Average live weight±SE (g)	Eviscerated weight±SE (g)	Dressing percentage±SE (%)
T_0	2015.00^{b}±54.84	1246.50^{b}±27.42	61.88^{c}±0.32
T_1	1920.00^{b}±69.28	1228.50^{b}±50.51	63.97^{ab}±0.56
T_2	1970.00^{b}±28.86	1270.50^{b}±29.15	64.47^{a}±0.93
T_3	2222.50^{a}±27.42	1400.50^{a}±21.07	63.08^{b}±0.14
Mean±SE	2031.88±40.38	1286.50±24.96	63.35±0.33

Here, T_0 = (Control), T_1 = (2% Moringa leaf powder), T_2 = (1% *Spirulina*), T_3 = (1% Moringa leaf powder+0.5% *Spirulina*); Values: Mean ± SE; Applying: One-way ANOVA (SPSS, Duncan method)

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

4.1.8 Flock uniformity

Data presented in table 11 and figure 6 showed that the flock uniformity was higher in T_3 group than other groups. It seems that combine effect of MLP and SP increased flock uniformity than other groups.

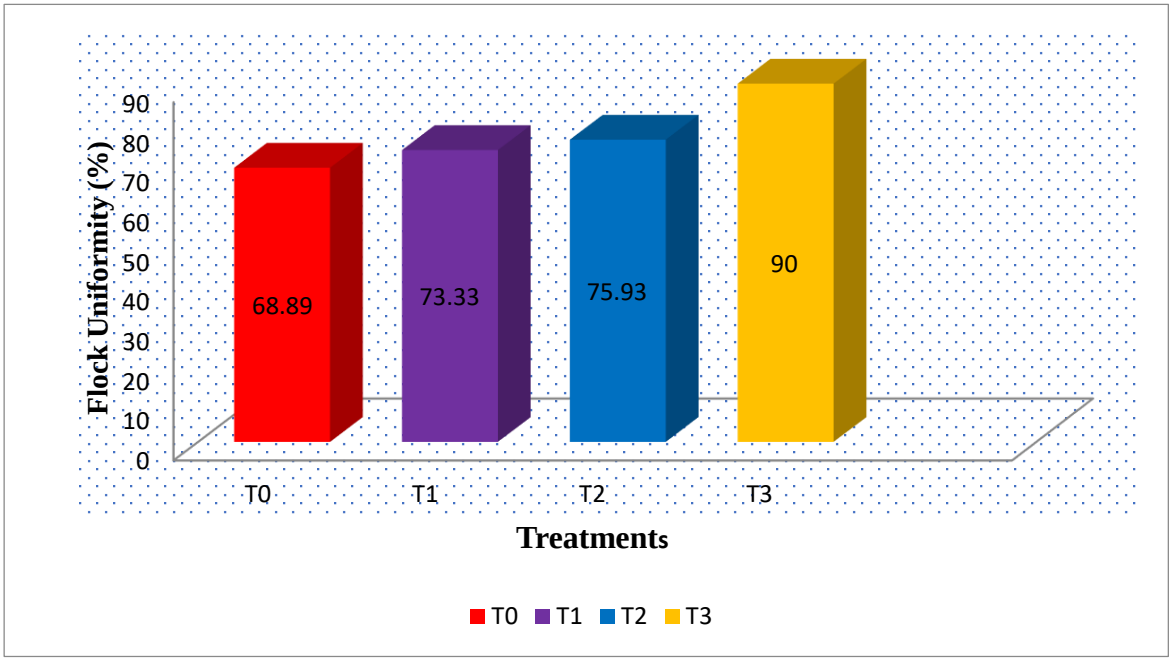

Fig. 6: Effects of Moringa leaf and *Spirulina* on uniformity of broiler chicken

The flock uniformity is better in combined group T_3 (90.00±5.77) and comparatively lower in control group T_0 (68.89±5.87). Other treatment group is more or less similar.

Table 11: Effects of Moringa leaf and *Spirulina* on uniformity of broiler chicken

Treatments	Uniformity±SE (%)
T_0	68.89^{b}±5.87
T_1	73.33^{b}±3.33
T_2	75.93^{ab}±3.03
T_3	90.00^{a}±5.77
Mean±SE	77.04±3.11

Here, T_0 = (Control), T_1 = (2% Moringa leaf powder), T_2 = (1% *Spirulina*), T_3 = (1% Moringa leaf powder+0.5% *Spirulina*); Values: Mean ± SE; Applying: One-way ANOVA (SPSS, Duncan method)

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

4.1.9 Carcass weight

Data presented in table 12 showed that the carcass weight in the T_0, T_2 and T_3 groups are better than the T_1 group. The results revealed that the treatments had significant effects in dressed wings, thigh and drumstick (P<0.05), but no difference in breast, back and neck (P>0.05). However, in treatment T_3 group (Moringa and *Spirulina*) the carcass weight is better than other treatment groups.

Table 12: Effects of Moringa leaf and *Spirulina* on carcass characteristics of broiler chicken

Treatment	Breast±SE	Back±SE	Thigh±SE	Drum stick±SE	Wing±SE	Neck±SE
T_0	473.00±1.73	263.50±28.00	208.00^{ab}±5.00	168.00^{b}±1.73	110.50^{a}±5.48	44.53±2.02
T_1	503.50±27.42	261.00±0.57	186.50^{b}±4.90	146.00^{b}±13.85	92.67^{b}±2.60	39.33±1.20
T_2	468.00±8.66	266.00±4.04	201.50^{b}±11.83	172.00^{ab}±7.50	94.67^{b}±0.66	45.00±3.46
T_3	521.50±12.41	287.00±5.77	227.00^{a}±2.88	197.50^{a}±0.50	114.50^{a}±2.02	53.00±1.73
Mean ±SE	491.50±9.42	269.38±6.90	205.75±5.23	170.88±6.46	103.08±3.18	45.47±1.76

Here, T_0 = (Control), T_1 = (2% Moringa leaf powder), T_2 = (1% *Spirulina*), T_3 = (1% Moringa leaf powder+0.5% *Spirulina*); Values: Mean ± SE; Applying: One-way ANOVA (SPSS, Duncan method)

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

4.1.10 Relative giblet weight

Data presented in table 13 showed that relative weight of giblet organs (liver, heart, gizzard, proventiculus and spleen) in different treatment groups T_0, T_1, T_2 and T_3. The results revealed that the treatments had significant effects in liver, heart, proventiculus and intestine ($P<0.05$), but no difference ($P>0.05$) in gizzad, and spleen in different treatment group.

The relative weight of liver (g) of broiler chicks in the dietary group T_0, T_1, T_2 and T_3 were 42.00±1.73, 42.50±4.33, 46.50±1.44 and 54.00±3.46 respectively. The highest results were obtained in T_3 and lowest was in T_0 (Control) group. There was significant ($P<0.05$) difference in the relative weight of liver between the groups.

The comparative weight of gizzard of different groups did not show any significant ($P>0.05$) difference in groups T_0 (29.50±3.75), T_1 (27.50±3.17), T_2 (28.00±0.57) and T_3 (29.50±0.86).

Table 13: Effects of Moringa leaf and *Spirulina* on internal organ of broiler chicken under different treatment group

Treatment	Liver±SE	Heart±SE	Gizzad±SE	Proventiculus±SE	Spleen±SE	Intestine±SE
T_0	42.00^{b}±1.73	11.50^{a}±0.28	29.50±3.75	9.00^{a}±0.57	1.68±0.07	102.52^{b}±9.76
T_1	42.50^{b}±4.33	11.50^{a}±0.28	27.50±3.17	7.50^{b}±0.28	1.68±0.10	105.58^{b}±7.17
T_2	46.50^{ab}±1.44	10.00^{b}±0.57	28.00±0.57	9.00^{a}±0.00	1.60±0.17	150.55^{a}±4.35
T_3	54.00^{a}±3.46	12.00^{a}±0.00	29.50±0.86	8.50^{ab}±0.28	1.88±0.02	155.13^{a}±1.14
Mean ±SE	46.25±1.93	11.25±0.27	28.62±1.10	8.50±0.23	1.71±0.05	128.44±7.87

Here, T_0 = (Control), T_1 = (2% Moringa leaf powder), T_2 = (1% *Spirulina*), T_3 = (1% Moringa leaf powder+0.5% *Spirulina*); Values: Mean ± SE; Applying: One-way ANOVA (SPSS, Duncan method)

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

4.2 Cost benefit analysis

The cost benefit analysis of different treatment groups and control group presented in table 14. Total expenditure per bird was significantly ($P<0.05$) higher T_2 (210.97±0.64) group than control and other treated groups. Feed cost is non significantly ($P>0.05$) higher in control group (T_0) compared to different treated group.

Moringa leaf were collected from Moringa tree in Sher-e-Bangla Agricultural University campus without any cost. The price of *Spirulina* was 2500tk/kg and the charge for incorporation in feeding was calculated. Profit per bird (PPB) was also presented in table 14, demonstrated the economic impact of the treatment groups compared with the untreated group. Return was calculated after selling the live birds per kg weight and profit was computed by subtracting the expenditure. Profit per bird was significantly ($P<0.05$) higher T_1 (80.94±3.65) group than control and other treated groups. Net profit is higher in T_1 group due to availability of Moringa leaf without any cost. Net profit is lower in T_2 (30.48±5.77) and T_3 (59.80±2.19) group due to high price of *Spirulina*. In this result, it seems that T_1 group was more profitable than other groups.

Table 14: Cost benefit analysis of different treatment groups (cost and profit per bird)

Treatment	Feed cost (Tk)±SE	Cost of MLP & SP/bird (Tk)±SE	Antibiotic cost (Tk)±SE	Common Cost (Tk)±SE	Total cost (Tk)±SE	Sell price (Tk)±SE	Profit (Tk)±SE
T_0	108.74±3.57	0.00±0.00	10.00±00	50.00±0.00	168.74^{c}±3.57	243.62±4.83	74.88^{a}±3.12
T_1	104.83±0.29	0.00±0.00	0.00±0.00	50.00±0.00	154.83^{d}±0.29	235.78±3.94	80.94^{a}±3.65
T_2	105.47±0.64	55.50±0.00	0.00±0.00	50.00±0.00	210.97^{a}±0.64	241.45±6.28	30.48^{c}±5.77
T_3	108.70±1.28	27.80±0.00	0.00±0.00	50.00±0.00	186.50^{b}±1.28	246.31±2.77	59.80^{b}±2.19
Mean ±SE	106.94±0.98	20.82±6.94	2.50±1.31	50.00±0.00	180.26±6.38	241.79±2.29	61.53±6.11

Here, T_0 = (Control), T_1 = (2% Moringa leaf powder), T_2 = (1% *Spirulina*), T_3 = (1% Moringa leaf powder+0.5% *Spirulina*); Values: Mean ± SE; Applying: One-way ANOVA (SPSS, Duncan method)

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

CHAPTER V

SUMMARY AND CONCLUSION

A study was designed to investigate the comparative efficacy of Moringa leaf (*Moringa oleifera*) and *Spirulina* (*Spirulina platensis*) and their combined effect on the productive performance of commercial broilers. A total of 120 day-old Lohmann broiler chicks were reared in Sher-e-Bangla Agricultural University Poultry Farm, Dhaka. Chicks were divided randomly into 4 experimental groups of 3 replications and each replication contains 10 chicks. These groups were allotted to four treatment designated as T_0, T_1, T_2 and T_3 group. T_0 was offered basal feed and antibiotic without other supplementation and served as a control. Whereas, group T_1, T_2 and T_3 were offered basal feed supplemented with Moringa leaf powder (MLP) 2%, *Spirulina* powder 1% and combination of Moringa leaf powder 1% & *Spirulina* powder 0.5% respectively. No antibiotic was added in T_1, T_2 and T_3 group. Final live weight was insignificantly ($P>0.05$) higher in T_3 (1894.57 g) group than control group (1873.85 g). Total feed consumption was insignificantly ($P>0.05$) higher in control group (2471.46 g) than other treatment group T_1 (2383.17 g), T_2 (2397.21 g) & T_3 (2469.87 g). Final FCR was comparatively better ($P>0.05$) in T_2 (1.33±0.03) and T_3 (1.33±0.01) group than T_0 (1.35±0.02) and T_1 (1.34±0.02) group. Survivability of the chicken was non-significant ($P>0.05$) in different treatment groups and found higher in T_3 (100%) and T_1 (100%) group than T_0 (96.67%) and T_2 (96.67%) group. Dressing percentage was significant ($P<0.05$) by the dietary inclusion of MLP (T_1), SP (T_2) and both MLP+SP (T_3) as compared to control (T_0) fed broilers. Dressing percentage was significantly ($P<0.05$) higher in T_1 (63.97%), T_2 (64.47%) and T_3 (63.08%) group than control group T_0 (61.88%). The relative weight of spleen and gizzard of different groups showed that there were no significant ($P>0.05$) difference between the groups. In addition, the present study showed that feeding dietary MLP (T_1), SP (T_2) and MLP+SP (T_3) treated group had significant ($P<0.05$) effects on liver, heart, proventiculus and intestine weight. Liver, heart and intestine weight were significantly ($P<0.05$) higher in T_3 (221.13 g) group than T_0 (156.02 g), T_1 (159.58 g) and T_2 (207.05 g) group. On the other hand, proventiculus weight was significantly ($P<0.05$) higher in T_0 (9.00 g) and T_2 (9.00 g) group than T_1 (7.50 g) and T_3 (8.50 g) group. In case of cost benefit analysis, net profit was highest in MLP (T_1) treated group than control (T_0), SP (T_2) and both MLP & SP (T_3) treated group.

Therefore, it could be concluded that combine effect of Moringa leaf powder and *Spirulina* improves the growth performance of broiler chickens. However, net return was highest in MLP treated group than other groups.

CHAPTER VI

REFERENCES

Abbas, T. E. (2013). The use of *Moringa oleifera* in poultry diets. *Turkish Journal of Veterinary and Animal Sciences*, *37*(5), 492-496.

Abd El-Baky, H. H. (2003). Over Production of Phycocyanin Pigment in Blue Green Alga Spirulr'na sp. and it's Inhibitory Effect on Growth of Ehrlich Ascites Carcinoma Cells. Journal of Medical Sciences 3(4), 314-324.

Abdulsalam, S., Yahaya, M. S. and Yakasai, M. A. (2015). Performance of broiler chickens fed on *Moringa oleifera* leaf meal supplemented poultry feed. Nigeria Agricultural Journal, 46(1), 139-146.

AbouSekken, M. S. M. (2015). Performance, immune response and carcass quality of broilers fed low protein diets contained either *Moringa oleifera* leaves meal or its extract. Journal of American Science 11(6), 153-164.

Agashe, J. L., Manwar, S. J., Khose, K. K. and Wade, M. R. (2017). Effect of supplementation of *Moringa oleifera* leaf powder on growth performance of broilers. Journal of Poultry Science and Technology, 5(3), 28-34.

Amotz, B. (1987). Presentation to polysaccharides from micro algae. Workshop, Duke University, USA.

Arora, D. S., Onsare, J. G. and Kaur, H. (2013). Bioprospecting of Moringa (Moringaceae): microbiological perspective. Journal of pharmacognosy and phytochemistry, 1(6), 193-215.

Banjo, O. S. (2012). Growth and performance as affected by inclusion of *Moringa oleifera* leaf meal in broiler chicks diet. Journal of Biotechnology, 2(9), 35-38.

Basak, B., Pramanik, M.A.H., Rahman, M.S., Tarafdar, S.U. and Roy, B.C. (2002). Azolla (*Azolla pinnata*) as a feed ingredient in broiler ration. *International Journal of Poultry Science, 1*(1), 29-34.

Beheshtipour, H., Mortazavian, A.M., Mohammadi, R., Sohrabvandi, S. and Khosravi-Darani, K. (2013). Supplementation of *Spirulina platensis* and *Chlorella vulgaris* algae into

probiotic fermented milks. *Comprehensive Reviews in Food Science and Food Safety*, 12(2), 144-154.

Belay, A., Kato, T. and Ota, Y. (1996). Spirulina (Arthrospira): potential application as an animal feed supplement. Journal of Applied Phycology, 8(4-5), 303-311.

Bellof, G. and Alarcon, S.C., (2013). Effect of *Spirulina platensis* in organic broiler production Archiv. Geflug. 77: 73-80.

Bonos, E., Kasapidou, E., Kargopoulos, A., Karampampas, A., Christaki, E., Florou-Paneri, P. and Nikolakakis, I. (2016). Spirulina as a functional ingredient in broiler chicken diets. South African Journal of Animal Science, 46(1), 94-102.

Bonsu, R. K., Kagya-Agyemang, J. K., Kwenin, W. K. J. and Zanu, H. K. (2012). Medicinal response of broiler chickens to diets containing neem (*Azadirachta indica*) leaf meal, haematology and meat sensory analysis. World Applied Sciences Journal, 19(6), 800-805.

Botlhoko, T.D. (2009). Performance of *Cloristridium perfringes*-challenged broilers inoculated with effective microorganisms. MSc Dissertation, University of Pretoria, South Africa. Science. Texas A & M University.

Cavazzoni, V., Adami, A. and Castrovilli, C. (1998). Performance of broiler chickens supplemented with Bacillus coagulans as probiotic. British poultry science, 39(4), 526-529.

Chuang, P. H., Lee, C. W., Chou, J. Y., Murugan, M., Shieh, B. J. and Chen, H. M. (2007). Anti-fungal activity of crude extracts and essential oil of *Moringa oleifera Lam.* Bioresource technology, 98(1), 232-236.

Dahot, M. U. (1988). Vitamin contents of the flowers and seeds of *Moringa oleifera*. Pakistan Journal of Biochemistry, 21(1–2), 21–24.

Das, B. R., Kurup, P. A. and Narasimha, R. P. (1957). Antibiotic principle from *Moringa pterygosperma*. VII. Antibacterial activity and chemical structure of compounds related to pterygospermin. The Indian Journal of Medical Research, 45(2), 191.

Daxenbichler, M. E., Spencer, G. F., Carlson, D. G., Rose, G. B., Brinker, A. M. and Powell, R. G. (1991). Glucosinolate composition of seeds from 297 species of wild plants. *Phytochemistry*, 30(1), 2623-2638.

De Jesus Raposo, M. F., De Morais, A. M. M. B. and De Morais, R. M. S. C. (2016). Emergent sources of prebiotics: seaweeds and microalgae. Marine drugs, 14(2), 27.

De Oliveira, M. A. C. L., Monteiro, M. P. C., Robbs, P. G. and Leite, S. G. F. (1999). Growth and chemical composition of *Spirulina maxima* and *Spirulina platensis* biomass at different temperatures. Aquaculture international, 7(4), 261-275.

Deschepper, K. and DeGroote, G. (1995). Effect of dietary protein, essential and non-essential amino acids on the performance and carcase composition of male broiler chickens. British Poultry Science, 36(2), 229-245.

Devi, M. A., Subbulakshmi, G., Devi, K. M. and Venkataraman, L. V. (1981). Studies on the proteins of mass-cultivated, blue-green alga (*Spirulina platensis*). Journal of agricultural and food chemistry, 29(3), 522-525.

DLS, 2015. Annual report on livestock 2015. Division of Livestock Statistics, Ministry of Fisheries and Livestock, Farmgate, Dhaka, Bangladesh.

Donkor, A. M., Glover, R. L. K., Addae, D. and Kubi, K. A. (2013). Estimating the nutritional value of the leaves of *Moringa oleifera* on poultry. International Journal of Food and Nutritional Science, 4, 10771083.

Doreau, M., Bauchart, D. and Chilliard, Y. (2011). Enhancing fatty acid composition of milk and meat through animal feeding1. Animal Production Science, 51(1), 19-29.

Durrani, F. R., Sultan, A., Jan, M., Chand, N. and Durrani, Z. (2008). Immunomodulatory and growth promoting effects of Neem (*Azadirachta indica*) leaves infusion in broiler chicks. Sarhad Journal of Agricultural, 24(4), 661-664.

Ezeamuzie, I. C., Ambakederemo, A. W., Shode, F. O. and Ekwebelem, S. C. (1996). Antiinflammatory effects of *Moringa oleifera* root extract. International Journal of Pharmacognosy, 34(3), 207-212.

Fahey, J. W. (2005). *Moringa oleifera*: a review of the medical evidence for its nutritional, therapeutic, and prophylactic properties. Part 1. Trees for life Journal, 1(5), 1-15.

Foidl, N., Makkar, H.P.S. and Becker K. (2001). The potential of *Moringa oleifera* for agricultural and industrial uses. In: What development potential for Moringa products? October 20th - November 2nd 2001. *Dar Es Salaam.*

Francis, G., Makkar, H.P.S. and Becker, K. (2005). Product from little research plants as aquaculture feed ingredients. Trees for life Journal, 8, 132-135.

Gadzirayi, C. T., Masamha, B., Mupangwa, J. F. and Washaya, S. (2012). Performance of broiler chickens fed on mature *Moringa oleifera* leaf meal as a protein supplement to soyabean meal. International Journal of Poultry Science, 11(1), 5-10.

Gaia, S. (2005). Wonder tree 100 facts moringa fact 04 exceptional animal feed moringa as livestock feed & pet food. *Moringa Mission Trust.*

Gakuya, D. W., Mbugua, P. N., Kavoi, B., and Kiama, S. G. (2014). Effect of supplementation of *Moringa oleifera* leaf meal in broiler chicken feed. *International Journal of Poultry Science*, 13, 208–213.

Ghasi, S., Nwobodo, E., and Ofili, J. O. (2000). Hypocholesterolemic effects of crude extract of leaf of *Moringa oleifera Lam* in high-fat diet fed Wistar rats. Journal of ethnopharmacology, 69(1), 21-25.

Gongnet, G.P., Niess, E., Rodehutscord, M. and Pfeffer, E. (2001). Algae-meal from lake Chad replacing soybean-meal in broiler diets. *Archiv. Geflug.* 65: 265-268.

Guo, F.C., Kwakkel, R.P., Soede, J., Williams, B.A. and Verstegen, M.W.A. (2004). Effect of a Chinese herb medicine formulation, as an alternative for antibiotics, on performance of broilers. *British Poultry Science*, 45(6): 793-797.

Güroy, B., Şahin, İ., Mantoğlu, S. and Kayalı, S. (2012). Spirulina as a natural carotenoid source on growth, pigmentation and reproductive performance of yellow tail cichlid Pseudotropheus acei. Aquaculture International, 20(5), 869-878.

Hamid, M. A., Rahman, M. A., Ahmed, S. and Hossain, K. M. (2017). Status of poultry industry in Bangladesh and the role of private sector for its development. Asian Journal of Poultry Science, 11(1), 1-13.

Holman, B.W.B. and Malau-Aduli, A.E.O. (2013). *Spirulina* as a livestock supplement and animal feed. *Journal of animal physiology and animal nutrition*, 97(4), 615-623.

Jacela, J. Y., DeRouchey, J. M., Tokach, M. D., Goodband, R. D., Nelssen, J. L., Renter, D. G. and Dritz, S. S. (2010). Feed additives for swine: Fact sheets–prebiotics and probiotics, and phytogenics. Journal of Swine Health and Production, 18(3), 132-136.

Jamil, A.R., Akanda, M.R., Rahman, M.M., Hossain, M.A. and Islam, M.S. (2015). Prebiotic competence of *spirulina* on the production performance of broiler chickens. *Journal of Advanced Veterinary and Animal Research*, 2(3), 304-309.

Jin, L.Z., Ho, Y.W., Abdullah, N. and Jalaludin, S. (1997). Probiotics in poultry-Mode of action. *Worlds Poultry Science. Journal*, 53, 351-368.

Jones, G. P. D. and Farrell, D. J. (1992). Early-life food restriction of broiler chickens i. methods of application, amino acid supplementation and the age at which restrictions should commence. British Poultry Science, 33(3), 579-587.

Kabir, S. L., Rahman, M. M., Rahman, M. B., Rahman, M. M. and Ahmed, S. U. (2004). The dynamics of probiotics on growth performance and immune response in broilers. International Journal of Poultry Science, 3(5), 361-364.

Kakengi, A.M.V., Shen, M.N., Sarvert, S.V. and Fujihara, T. (2003). Can *Moringa oleifera* be used as protein supplement to ruminant diet. *Asian – Australian Journal of Animal Science*, 18 (1), 42 – 47.

Khan, I., Zaneb, H., Masood, S., Yousaf, M. S., Rehman, H. F. and Rehman, H. (2017). Effect of *Moringa oleifera* leaf powder supplementation on growth performance and intestinal morphology in broiler chickens. Journal of animal physiology and animal nutrition, 101, 114-121.

Khan, Z., Bhadouria, P. and Bisen, P. S. (2005). Nutritional and therapeutic potential of Spirulina. Current pharmaceutical biotechnology, 6(5), 373-379.

Kharde, S. D., Shirbhate, R. N., Bahiram, K. B. and Nipane, S. F. (2012). Effect of Spirulina supplementation on growth performance of broilers. Indian Journal of Veterinary Research, 21(1), 66-69.

Kout E., Moustafa M. E., L. Riry, Shata F. H., M. A. M. Hanan, Alghonimy A. H. and Youssef S. F. (2015). Effect of Using *Moringa oleifera* Leaf Meal on Performance of Japanese quail. *Egyptian Poultry Science*, 35(4), 1095-1108.

Loren, L. (2007). *Moringa oleifera* malnutrition relief. Filipino Senator, Wikipedia, the free encyclopedia.

Mahajan, S. G., Mali, R. G. and Mehta, A. A. (2007). Protective effect of ethanolic extract of seeds of Moringa oleifera Lam. against inflammation associated with development of arthritis in rats. Journal of Immunotoxicology, 4(1), 39-47.

Makkar, H. P. S. and Becker, K. (1997). Nutrients and antiquality factors in different morphological parts of the Moringa oleifera tree. The Journal of Agricultural Science, 128(3), 311-322.

Makkar, H. P. S. and Becker, K. (1999). Plant toxins and detoxification methods to improve feed quality of tropical seeds-Review. Asian-Australasian Journal of Animal Sciences, 12(3), 467-480.

Makonnen, E., Hunde, A. and Damecha, G. (1997). Hypoglycaemic effect of Moringa stenopetala aqueous extract in rabbits. Phytotherapy Research: An International Journal Devoted to Medical and Scientific Research on Plants and Plant Products, 11(2), 147-148.

Manoj, G., Venkataraman, L. V. and Srinivas, L. (1992). Antioxidant properties of Spirulina (*Spirulina platensis*). In Spirulina: National Symposium (India), MCRC, Tharamani, Madras (Vol. 48, pp. 154-158).

Matthew, T., Matthew, Z., Taji, S. A. and Zachariah, S. (2001). A review of viricidal Ayurvedic Herbs of India for poultry disease. Journal of American Holistic Veterinary Medicine Association, 20(1), 17-20.

Miranda, M. S., Cintra, R. G., Barros, S. D. M. and Mancini-Filho, J. (1998). Antioxidant activity of the microalga *Spirulina maxima*. Brazilian Journal of Medical and biological research, 31(8), 1075-1079.

Moreki, J. C. and Gabanakgosi, K. (2014). Potential use of *Moringa olifera* in poultry diets. Global Journal of Animal Scientific Research, 2(2), 109-115.

Mountzouris, K. C., Tsirtsikos, P., Kalamara, E., Nitsch, S., Schatzmayr, G. and Fegeros, K. J. P. S. (2007). Evaluation of the efficacy of a probiotic containing Lactobacillus, Bifidobacterium, Enterococcus, and Pediococcus strains in promoting broiler performance and modulating cecal microflora composition and metabolic activities. Poultry science, 86(2), 309-317.

Moyo, B., Masika, P. J., Hugo, A. and Muchenje, V. (2011). Nutritional characterization of Moringa (*Moringa oleifera Lam*.) leaves. African Journal of Biotechnology, 10(60), 12925-12933.

Muriu, J. I., Njoka-Njiru, E. N., Tuitoek, J. K., and Nanua, J. N. (2002). Evaluation of sorghum (*Sorghum bicolor*) as replacent for maize in the diet of growing rabbits (*Oryctolagus cuniculus*). Asian-australasian journal of animal sciences, 15(4), 565-569.

Nikodémusz, E., Páskai, P., Tóth, L. and Kozák, J. (2010). Effect of dietary Spirulina supplementation on the reproductive performance of farmed pheasants. Technical Articles-Poultry Industry, 1-2 of some natural and commercial food products based on *Spirulina*. Analysis, 27: 533–540.

Nouman, W., Basra, S. M. A., Siddiqui, M. T., Yasmeen, A., Gull, T. and Alcayde, M. A. C. (2014). Potential of *Moringa oleifera* L. as livestock fodder crop: a review. Turkish Journal of Agriculture and Forestry, 38(1), 1-14.

Okafor, I. N., Ezebuo, F. C. and Azodo, N. T. (2014). Effect of *Moringa oleifera* leaf protein concentrate supplemented feed on growth and nutritional parameters in broilers. World Applied Sciences Journal, 32(1), 133-138.

Oluduro, A. O. (2012). Evaluation of antimicrobial properties and nutritional potentials of *Moringa oleifera Lam.* leaf in South-Western Nigeria. Malaysian Journal of Microbiology, 8(2), 59-67.

Olugbemi, T. S., Mutayoba, S. K. and Lekule, F. P. (2010). Effect of Moringa (*Moringa oleifera*) inclusion in cassava based diets fed to broiler chickens. International Journal of Poultry Science, 9(4), 363-367.

Onu, P. N. and Aniebo, A. O. (2011). Influence of *Moringa oleifera* leaf meal on the performance and blood chemistry of starter broilers. International Journal of Food, Agriculture and Veterinary Sciences, 1(1), 38-44.

Onunkwo, D. N. and George, O. S. (2015). Effects of *Moringa oleifera* leaf meal on the growth performance and carcass characteristics of broiler birds. IOSR Journal of Agriculture and Veterinary Science, 8(3), 63-66.

Onyimonyi, A. E., Olabode, A. and Okeke, G. C. (2009). Performance and economic characteristics of broilers fed varying dietary levels of neem leaf meal (*Azadirachta indica*). International Journal of Poultry Science, 8(3), 256-259.

Oyeyinka, A. T. and Oyeyinka, S. A. (2018). *Moringa oleifera* as a food fortificant: Recent trends and prospects. Journal of the Saudi Society of Agricultural Sciences, 17(2), 127-136.

Pal, S. K., Mukherjee, P. K. and Saha, B. P. (1995). Studies on the antiulcer activity of *Moringa oleifera* leaf extract on gastric ulcer models in rats. Phytotherapy research, 9(6), 463-465.

Parikh, P., Mani, U. and Iyer, U. (2001). Role of Spirulina in the control of glycemia and lipidemia in type 2 diabetes mellitus. Journal of Medicinal Food, 4(4), 193-199.

Peric, L., Zikic, D. and Lukic, M. (2009). Application of alternative growth promoters in broiler production. Biotechnology in Animal Husbandry, 25(5-6-1), 387-397.

Peto, J., Henderson, B.E. and Pike, M.C. (1981). Trends in mesothelioma incidence in the United States and the forecast epidemic due to asbestos exposure during world war II. Brandbury Report 9, Quantification of Occupational.

Qureshi, M. A., Garlich, J. D. and Kidd, M. T. (1996). Dietary *Spirulina platensis* enhances humoral and cell-mediated immune functions in chickens. Immunopharmacology and immunotoxicology, 18(3), 465-476.

Raju, L.N., Rao, S.V.R., Radhika, K. and Chawak, M.M. (2005). Dietary supplementation of *Spirulina* and its effects on broiler chicken exposed to aflatoxicosis. Indian Poultry Science Association (Abstr.).

Ramachandran, C., Peter, K. V. and Gopalakrishnan, P. K. (1980). Drumstick (*Moringa oleifera*): a multipurpose Indian vegetable. Economic botany, 276-283.

Rasool, M., Sabina, E. P. and Lavanya, B. (2006). Anti-inflammatory effect of *Spirulina fusiformis* on adjuvant-induced arthritis in mice. Biological and Pharmaceutical Bulletin, 29(12), 2483-2487.

Ross, E. and Dominy, W. (1990). The nutritional value of dehydrated, blue-green algae (*Spirulina plantensis*) for poultry. Poultry Science, 69(5), 794-800.

Ross, E., Puapong, D. P., Cepeda, F. P. and Patterson, P. H. (1994). Comparison of freeze-dried and extruded *Spirulina platensis* as yolk pigmenting agents. Poultry science, 73(8), 1282-1289.

Shanmugapriya, B. and Saravana Babu, S. (2014). Supplementary effect of *Spirulina platensis* on performance, hematology and carcass yield of broiler chicken. Indian Streams Research Journal, 4, 1-7.

Shanmugapriya, B., Babu, S.S., Hariharan, T., Sivaneswaran, S., Anusha, M.B. and Raja, P.U. (2015). Synergistic effect of *Spirulina platensis* on performance and gut microbial load of broiler chicks. Indo-Asian Journal of Multidisciplinary Research, 1(2), 149-155.

Siddhuraju, P. and Becker, K. (2003). Antioxidant properties of various solvent extracts of total phenolic constituents from three different agroclimatic origins of drumstick tree (*Moringa oleifera Lam*.) leaves. Journal of agricultural and food chemistry, 51(8), 2144-2155.

Sreelatha, S. and Padma, P. R. (2009). Antioxidant activity and total phenolic content of *Moringa oleifera* leaves in two stages of maturity. Plant foods for human nutrition, 64(4), 303.

Sugiharto, S., Yudiarti T., Isroli I. and Widiastuti E. (2017). Effect of feeding duration of *Spirulina platensis* on growth performance, haematological parameters, intestinal microbial population and carcass traits of broiler chicks. *South African Journal of Animal Science*. 2018. 48 (No. 1).

Tahiliani, P. and Kar, A. (2000). Role of *Moringa oleifera* leaf extract in the regulation of thyroid hormone status in adult male and female rats. Pharmacological research, 41(3), 319-323.

Teguia, A. and Beynen, A. C. (2005). Alternative feedstuffs for broilers in Cameroon. Livestock Research for Rural Development, 17, 3.

Teixeira, E. M. B., Carvalho, M. R. B., Neves, V. A., Silva, M. A. and Arantes-Pereira, L. (2014). Chemical characteristics and fractionation of proteins from *Moringa oleifera Lam.* leaves. Food chemistry, 147, 51-54.

Tollba, A. A. H. (2010). Reduction of broilers intestinal pathogenic micro-flora under normal or stressed condition. Egyptian Poultry Science Journal, 30(1), 249-270.

Toyomizu, M., Sato, K., Taroda, H., Kato, T. and Akiba, Y. (2001). Effects of dietary Spirulina on meat colour in muscle of broiler chickens. British Poultry Science, 42(2), 197-202.

Venkataraman, L. V., Somasekaran, T. and Becker, E. W. (1994). Replacement value of blue-green alga (*Spirulina platensis*) for fishmeal and a vitamin-mineral premix for broiler chicks. British Poultry Science, 35(3), 373-381.

Vonshak, A. (2002). Use of *Spirulina* Biomass, In: Vonshak A. (ed.), *Spirulina platensis* (Arthrospira) Physiology Cell Biology and Biotechnology, Taylor & Francis, ISBN 0203-48396-0, London. pp. 159-173.

Windisch, W., Schedle, K., Plitzner, C. and Kroismayr, A. (2008). Use of phytogenic products as feed additives for swine and poultry. *Journal of Animal Science*. 86(14):140–148.

Yang, Y., Iji, P. A., and Choct, M. (2009). Dietary modulation of gut microflora in broiler chickens: a review of the role of six kinds of alternatives to in-feed antibiotics. World's Poultry Science Journal, 65(1), 97-114.

Yoshida, M. and Hoshii, H. (1980). Nutritive value of *Spirulina*, green algae, for poultry feed. Japanese poultry science, 17(1), 27-30.

Zahroojian, N., Moravej, H. and Shivazad, M. (2013). Effects of dietary marine algae (*Spirulina platensis*) on egg quality and production performance of laying hens. Journal of Agricultural Science and Technology, 15(7), 1353-1360.

Zhao, L., Wang, G., Siegel, P., He,C., Wang, H. and Zhao, W. (2013). Quantitative genetic background of the host influences gut microbiomes in chickens. *Sci. Rep*. 3: 1163.

Zhigang, Z., Zhili, L. and Xuexian, L. (1997). Study on the isolation, purification and antioxidation properties of polysaccharides from *Spirulina maxima*. Acta Botanica Sinica, 39(1), 77-81.

Zulkifli, I., Abdullah, N., Azrin, N. M. and Ho, Y. W. (2000). Growth performance and immune response of two commercial broiler strains fed diets containing Lactobacillus cultures and oxytetracycline under heat stress conditions. British poultry science, 41(5), 593-597.

Zvinorova, P. I., Lekhanya, L., Erlwanger, K. and Chivandi, E. (2015). Dietary effects of *M oringa oleifera* leaf powder on growth, gastrointestinal morphometry and blood and liver metabolites in S prague D awley rats. Journal of animal physiology and animal nutrition, 99(1), 21-28.

CHAPTER VII

APPENDICES

Appendix 1. Recommended level of nutrients for broiler

Nutrients	Ration	Variation
ME (Kcal/kg)	3000.00	3100.00
CP (%)	22.00	20.00
Ca (%)	1.00	0.85
P (Available) %	0.50	0.40
Lysine (%)	1.20	1.00
Methionine (%)	0.50	0.45
Tryptophan (%)	0.21	0.18

Source: Cobb 500 Broiler management guide 2016

Appendix 2: Recorded temperature and relative humidity (%) during experimental period

Age in weeks	Period	Average Tem. (^{0}C)	Average Humidity (%)
1st	03.11.19-10.11.19	32.2	64.3
2nd	11.11.19-17.11.19	28.0	69.0
3rd	18.11.19-24.11.19	25.5	66.2
4th	25.11.19-01.12.19	25.9	69.0

Appendix 3: Effects of Moringa leaf and *Spirulina* on production performances of broiler

Treatment	Replication	Final Live Weight (g/Bird)	Final Feed Consumption (g/Bird)	Total Body Weight Gain (g/Bird)	Final FCR	Survivability (%)
	R_1	1916.44	2628.11	1872.44	1.40	90
T_0	R_2	1905.50	2430.30	1861.50	1.31	100
	R_3	1799.60	2355.96	1755.60	1.34	100
	R_1	1874.00	2396.50	1830.00	1.31	100
T_1	R_2	1777.50	2376.50	1733.50	1.37	100
	R_3	1789.00	2376.50	1745.00	1.36	100
	R_1	1951.00	2424.10	1907.00	1.27	100
T_2	R_2	1831.00	2374.10	1787.00	1.33	100
	R_3	1790.00	2393.44	1746.50	1.37	90
	R_1	1925.90	2466.56	1881.90	1.31	100
T_3	R_2	1903.50	2521.56	1859.50	1.36	100
	R_3	1854.30	2421.50	1810.30	1.34	100

Appendix 4: Effects of Moringa leaf and *Spirulina* on dressing percentage of broiler (g/bird)

Treatment	Replication	Average Live Weight (g)	Eviscerated Weight	Dressing percentage (%)
	R_1	1920.00	1199.00	62.45
T_0	R_2	2110.00	1294.00	61.33
	R_3	2015.00	1246.50	61.86
	R_1	1920.00	1228.50	64.00
T_1	R_2	1800.00	1141.00	63.39
	R_3	2040.00	1316.00	64.51
	R_1	2020.00	1321.00	65.40
T_2	R_2	1970.00	1270.50	64.47
	R_3	1920.00	1220.00	63.54
	R_1	2175.00	1364.00	62.80
T_3	R_2	2270.00	1437.00	63.31
	R_3	2222.50	1400.50	63.12

Appendix 5: Effects of Moringa leaf and *Spirulina* on carcass characteristics of broiler (g/bird)

Treatment	Replication	Breast	Back	Thigh	Drumstick	Wing	Neck
	R_1	470.00	312.00	213.00	171.00	101.00	48.00
T_0	R_2	473.00	263.50	208.00	168.00	110.50	44.60
	R_3	476.00	215.00	203.00	165.00	120.00	41.00
	R_1	503.50	261.00	186.50	146.00	93.00	40.00
T_1	R_2	456.00	260.00	178.00	122.00	88.00	37.00
	R_3	551.00	262.00	195.00	170.00	97.00	41.00
	R_1	453.00	273.00	181.00	159.00	94.00	39.00
T_2	R_2	483.00	259.00	222.00	185.00	94.00	51.00
	R_3	468.00	266.00	201.50	172.00	96.00	45.00
	R_1	500.00	277.00	222.00	197.00	118.00	50.00
T_3	R_2	543.00	297.00	232.00	198.00	111.00	56.00
	R_3	521.50	287.00	227.00	197.50	114.50	53.00

Appendix 6: Effects of Moringa leaf and *Spirulina* on internal organs of broiler chicken

Treatment	Replication	Liver	Heart	Gizzard	Proventiculus	Spleen	Intestine
	R_1	45.00	11.00	23.00	10.00	1.56	119.44
T_0	R_2	42.00	11.50	29.50	9.00	1.68	102.52
	R_3	39.00	12.00	36.00	8.00	1.80	85.60
	R_1	42.50	11.50	27.50	7.50	1.68	105.58
T_1	R_2	35.00	11.00	22.00	7.00	1.50	118.00
	R_3	50.00	12.00	33.00	8.00	1.85	93.15
	R_1	44.00	9.00	29.00	9.00	1.30	143.00
T_2	R_2	49.00	11.00	27.00	9.00	1.90	158.10
	R_3	46.50	10.00	28.00	9.00	1.60	150.55
	R_1	48.00	12.00	28.00	9.00	1.85	153.15
T_3	R_2	60.00	12.00	31.00	8.00	1.90	157.10
	R_3	54.00	12.00	29.50	8.50	1.88	155.13

Appendix 7: Effects of Moringa leaf and *Spirulina* on flock uniformity of broiler

Treatment	Replication	Uniformity (%)	Av. Uniformity (%)
	R_1	66.67	
T_0	R_2	60.00	68.89
	R_3	80.00	
	R_1	70.00	
T_1	R_2	70.00	73.33
	R_3	80.00	
	R_1	70.00	
T_2	R_2	80.00	75.93
	R_3	77.78	
	R_1	100.00	
T_3	R_2	80.00	90.00
	R_3	90.00	

Appendix 8: Effects of Moringa leaf and S*pirulina* on body weight gain of broiler chicken at different weeks (g/bird)

Treatment	Replication	1st week BWG	2nd week BWG	3rd week BWG	4th week BWG	Total BWG
	R_1	169.50	336.50	606.00	795.00	1907.00
T_0	R_2	169.50	323.00	546.00	748.50	1787.00
	R_3	169.50	320.94	583.34	672.78	1746.56
	R_1	169.50	319.50	582.00	759.00	1830.00
T_1	R_2	169.50	322.50	536.00	705.50	1733.50
	R_3	169.50	310.50	541.00	724.00	1745.00
	R_1	169.50	376.50	564.44	762.00	1872.44
T_2	R_2	169.50	330.50	572.50	789.00	1861.50
	R_3	169.50	324.00	572.50	689.60	1755.60
	R_1	169.50	322.50	615.00	774.90	1881.90
T_3	R_2	169.50	305.50	614.00	770.50	1859.50
	R_3	169.50	334.70	577.80	728.30	1810.30

Appendix 9: Effects of Moringa leaf and *Spirulina* on feed consumption of broiler chicken at different weeks

Treatment	Replication	1st week FC	2nd week FC	3rd week FC	4th week FC	Total FC
	R_1	191.67	463.11	809.44	1143.33	2628.11
T_0	R_2	191.67	420.80	789.50	1029.00	2430.30
	R_3	191.67	408.80	726.50	1029.00	2355.96
	R_1	191.67	425.00	741.50	1039.00	2396.50
T_1	R_2	191.67	415.00	731.50	1039.00	2376.50
	R_3	191.67	407.00	739.50	1039.00	2376.50
	R_1	191.67	416.60	797.50	1019.00	2424.10
T_2	R_2	191.67	417.00	747.50	1019.00	2374.10
	R_3	191.67	418.44	739.50	1023.33	2393.44
	R_1	191.67	422.90	768.00	1084.00	2466.56
T_3	R_2	191.67	422.90	793.00	1114.00	2521.56
	R_3	191.67	422.90	773.00	1034.00	2421.50

Appendix 10: Cost benefit analysis (per bird) of different treatment group

Treatment	Replication	Feed cost (Tk)	Cost of MLP & SP/bird (Tk)	Antibiotic cost (Tk)	Common Cost (Tk)	Total cost (Tk)	Sell price (Tk)	Profit (Tk)
	R_1	115.63	0.00	10.00	50.00	175.63	249.08	73.45
T_0	R_2	106.92	0.00	10.00	50.00	166.92	247.78	80.86
	R_3	103.66	0.00	10.00	50.00	163.66	234.00	70.34
	R_1	105.42	0.00	0.00	50.00	155.42	243.62	88.20
T_1	R_2	104.54	0.00	0.00	50.00	154.54	231.14	76.60
	R_3	104.54	0.00	0.00	50.00	154.54	232.57	78.03
	R_1	106.66	55.5	0.00	50.00	212.16	253.63	41.47
T_2	R_2	104.46	55.5	0.00	50.00	209.96	238.03	28.07
	R_3	105.29	55.5	0.00	50.00	210.79	232.70	21.91
	R_1	108.55	27.8	0.00	50.00	186.35	250.38	64.03
T_3	R_2	110.99	27.8	0.00	50.00	188.79	247.52	58.73
	R_3	106.57	27.8	0.00	50.00	184.37	241.02	56.65

Some pictorial view of my experiment

Plate 01: Preparation of Farm (cleaning and disinfection)

Plate 02: Brooder preparation, chick receiving and vaccination

Plate 03: Moringa leaf power preparation

Plate 04: *Spirulina* measurement

Plate 05: Supervisor observation and final data collection

Plate 06: Vaccine and medicine used during experimental period

Plate 07: Medicine used during experimental period