EFFECT OF GINGER (*Zingiber officinale*) POWDER SUPPLEMENTATION ON THE PERFORMANCE OF BROILER

A THESIS

BY

Student ID.1605461

Registration No. 1605461

Session: 2016-2017

Thesis Semester: Jan-June, 2018

MASTER OF SCIENCE (M.S.)
IN
POULTRY SCIENCE

DEPARTMENT OF DAIRY AND POULTRY SCIENCE

HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY UNIVERSITY, DINAJPUR

May 2018

EFFECT OF GINGER (*Zingiber officinale*) POWDER SUPPLEMENTATION ON THE PERFORMANCE OF BROILER

A THESIS

BY

Student ID.1605461

Registration No. 1605461

Session: 2016-2017

Thesis Semester: Jan-June, 2018

Submitted to the Department of Dairy and poultry Science, Hajee Mohammad Danesh Science and Technology University, Dinajpur in Partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE (M.S.)

IN

POULTRY SCIENCE

DEPARTMENT OF DAIRY AND POULTRY SCIENCE

HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY UNIVERSITY, DINAJPUR

May 2018

EFFECT OF GINGER (*Zingiber officinale*) POWDER SUPPLEMENTATION ON THE PERFORMANCE OF BROILER

A THESIS

BY

Student ID.1605461

Registration No. 1605461

Session: 2016-2017

Thesis Semester: Jan-June, 2018

Approved as to style and contents by

……..	……
Prof. Dr. Tahera Yeasmin	Prof. Dr. Mst. Afroza Khatun
Supervisor	Co-supervisor

…….

Prof. Dr. Tahera Yeasmin
Chairman
Examination Committee
And
CHAIRMAN, DEPARTMENT OF DAIRY AND POULTRY SCIENCE

HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY UNIVERSITY, DINAJPUR

May 2018

DEDICATED TO MY BELOVED PARENTS

ACKNOWLEDGEMENTS

All praises are gone to the almighty ALLAH, the supreme ruler of the universe give me the chance to complete this present research work and to prepare the thesis.

The author takes the opportunity to express his sincere gratitude, heartfelt respect, immense indebtedness and the deepest appreciation to his reverend teacher and research supervisor ***Professor Dr. Tahera Yeasmin,*** *Professor, Department of Dairy and Poultry Science, Hajee Mohammad Danesh Science and Technology University, Dinajpur, for his ingenious suggestions, encouragement, guidance to complete this study and also for his constructive criticism and meticulous review of the manuscript.*

The author is honored to express his heartfelt appreciation and gratitude to his co-supervisor ***Professor Dr. Mst. AfroZa Khatun,*** *Department of Dairy and Poultry Science, Hajee Mohammad Danesh Science and Technology University, Dinajpur, for his co-operation and helpful suggestions to conduct the research work and in the preparation of this manuscript.*

The author would like to express his sincere respect to ***Dr. Kamruzzaman Mithu,*** *Assistant Professor, Department of Dairy and Poultry Science, Hajee Mohammad Danesh Science and Technology University, Dinajpur for his encouragement, advice and constructive criticism during research work.*

The author is also grateful to Topon, Senior Lab. Technician, Gobindo, lab attendant, field worker Moslem for their cordial co-operation.

Finally, the author would like to take the opportunity to express his boundless gratitude and profound respect to his parents, brother, sisters, friends, well-wishers, roommates and relatives for their blessings, inspiration and co-operation throughout the period of the study.

The Author

ABSTRACT

This experiment aimed to investigate the effect of ginger (*Zingiber officinale*) powder on the performance of commercial broiler chicken. In this study ninety six (96) Cobb-500 day old chicks of the similar weight divided into 4 groups, each group consists of 3 replicates and containing 8 birds in erach replication and experiment period are 4 weeks. Treatment groups included T_0= control, T_1= 0.5g ginger powder per kg diet, T_2 = 1g ginger powder per kg diet T_3 =2g ginger powder per kg diet Average weight gain, feed consumption, feed efficiency, dressing yield and survivability were used as criteria of response to feeding ginger powder. Organs weight including heart, liver and gizzard were also recorded. The mean body weight per broiler was 1585.74, 1634.07, 1703.9 and 1840.27g in 28 days for the treatment of groups T_0, T_1, T_2, and T_3, respectively. The highest weight gain was found in T_3(1840.27g) $P<0.01$). The highest body weight gain was found in T_3 (1840.27g) compared to the control. The average feed consumption per broiler was 2886.33, 2680.5, 2781.93 and 2802.2 g ($P<0.01$) in 28 days for the groups of T_0, T_1, T_2, and T_3, respectively. The average feed efficiency (feed/gain) was 1.82, 1.64, 1.63 and 1.52 ($P<0.01$) in 28 days for group T_0, T_1, T_2, and T_3, respectively. The FCR was significant($P<0.01$) lowest in T_3 . The mean dressing yield was 56.16%, 59.63%, 58.89% and 60.42% ($P<0.01$) for the groups of T_0, T_1, T_2, and T_3, respectively. The average weight of abdominal fat was 2.51, 1.82, 1.67 and 1.58g ($P<0.01$) and heart was 8.28, 8.46, 9.30 and 9.41g ($P<0.05$). The average weight of liver was 41.1, 43.5, 42.2 and 46.5g ($P>0.05$) for the groups of T_0, T_1, T_2, and T_3, respectively. The mean gizzard weight was 38.57, 42.47, 45.77 and 46.5g ($P>0.05$) for the groups of T_0, T_1, T_2, and T_3, respectively. Survivability was 98.67%, 100%, 100% and 100% ($P>0.05$) for the groups of T_0, T_1, T_2, and T_3, respectively. It may be concluded that the use of ginger (*Zingiber officinale)* as feed additive 2gm ginger powder per kg diet enhances the overall performance of broiler chicks.

Key words: Ginger, broilers, carcass characteristics**,** Dressing yield, Survivability

LIST OF CONTENTS

LIST OF TABLE

LIST OF FIGURE

CHAPTER-I
INTRODUCTION

Broiler is an excellent source of protein to nourish human health. Poultry production system has triggered the discovery and widespread use of a number of “feed additives”. The broiler industry in Bangladesh is developing rapidly and its success depends on how rapidly a bird attains maximum marketable weight. The principle of poultry production is to achieve high level of performance through efficient utilization of feed keeping survivability as maximum as possible. The main objective of adding feed additives are increasing their growth rate, better-feed conversion efficiency, greater livability and lowered mortality in poultry birds. These feed additives are termed as "growth promoters" and often called as non-nutritive feed additives **(**Singh and Panda**,** 1992**).** Growth promoters are chemical and biological substances, which are added to livestock feed with the aim to improve the growth of chickens in fattening, improve the utilization of feed and in this way realize better production and financial results. Their mechanism of action varies. Positive effect can be expressed through better appetite, improved feed conversion, stimulation of the immune system and increased vitality, regulation of the intestinal micro-flora, etc.

Ginger (*Zingiber officinale*) is a perennial herb which is used widely as a spice, for pickles, candies, preservatives and many medicinal purposes. The plant belongs to the family Zingiberaceae; which are aromatic herbs with fleshy, tuberous or nontuberous rhizomes and, often have tuber bearing roots (Ke *et al.,* 2000). The rhizome contains a spectra of biologically active compounds such as curcumin, 6 gingerol i.e., [5-hydroxy-1-4-hydroxy-3-methoxy phenyl), 6-shogoals, zingiberene, bisaboline and several other types of lipids that confers on ginger the characteristic medicinal properties of being pungent and a stimulant **(**Bliddal *et al.,* 2000). The major components of ginger are zingiberen and zingerol that can stimulate the digestive system by controlling the digestive pH and the activity of digestive enzyme including microbial activity. Ginger has also been known to have antioxidant activity due to presence of gingerol-related compounds and diarylheptanoids **(**Kikuzaki and Nakatani, 1993). Ginger as a natural

feed additive may be of immense benefit and value in poultry nutrition especially for broilers due to their antibacterial, anti-inflammatory, Introduction…. 4 antiseptic, anti-parasitic and immunomodulatory properties **(**Onu, 2010). Ginger is one of the natural plants which can be used as phytobiotic to improve broiler's performance.

The significant biological properties of ginger powder make it a potential substitute for in feed antibiotics in livestock diets. A number of studies have been conducted to evaluate its effect on the performance of broiler chickens, laying hens and rabbits. There is growing interest in developing natural alternatives to antibiotic growth promoters in order to maintain both bird's performance and health. In the last decade, ginger has been extensively used in poultry diets. Wide range medicinal properties of this plant have been advocated. In poultry feed, ginger has been extensively used in different concentrations, dosages and durations.

Considering the above things, the objectives of the present study are:

1. To study the effect of supplementation of ginger powders on body weight ,feed intake and feed conversion ratio of broiler .
2. To study the effect of supplementation of ginger powders on carcass characteristics of broiler

CHAPTER-II
REVIEW OF LITERATURE

2.1 Composition and Nutritional value of Ginger

In Bangladesh, ginger is widely used as spice, it has high medicinal value and used in Allopathic and Hamdard medicine

The bulk of ginger produced is often exported from the producing areas in processed form as dried ginger powder and extracts. Badreldin *et al.,* (2008). In world trade, the quality of ginger rhizome is majorly based on its aroma, pungency; the primary chemical components of ginger responsible for these sensory quality attributes are the volatile (essential oils) and non volatile (oleoresin). Other constituents are fat, protein, carbohydrate, vitamins (C and B) and minerals (potassium, calcium, magnesium). Ginger rhizomes also contain proteolytic enzyme called zingibain (Stewart and Wood, 1991). These chemical components are influenced by factors such as the specie, variety, maturity and processing conditions.

According to Jakes and Susan (2007), dried ginger is traded traditionally in whole split form is used in wide range of foods when grounded into powdery form and used for preservation of meat, baking spice, soups and puddings. Most of the world's ginger is processed into concentrates for the manufacture of ready-to-serve ginger drinks which can be alcoholic or non-alcoholic; (Yiljep *et al.,* 2005; Jakes and Susan, 2007).

Yiljep *et al.* (2005) Oven dried sliced ginger gave the highest quantity of volatile oil (1.36%) which is in agreement with result from that dried ginger yield 1-3% volatile oil.

Pruthi (2000) found that dry ginger has the composition of moisture 6.9%, protein 8.6%, fat 6.4%, fibre 5.9, carbohydrate 66.5%, ash 5.7%, calcium 0.1%, phosphorus 0.15%, iron 0.011%, sodium 0.03%, potassium 1.4%, vitamin A175 IU/100 gm, vitamin B1 0.05 mg/100 gm, vitamin B2 0.13 mg/100 gm, niacin 1.9%, vitamin-C 13 mg/100 gm and calorific value (food and energy) 380 k cal/100 gm.

Anonymous (1999) reported that the proximate nutrient composition of (per 100 gm) ginger are moisture 80.9 gm, minerals 1.2 gm, fiber 2.4 gm, energy 67 kilocalories,

protein 2.3 gm, fat 0.9gm, calcium 20 mg, iron 2.6 mg, carotene 40 µgm, vitamin B1 0.06mg, vitamin B2 0.03mg, vitamin-C 6mg.

Purseglove *et al.,* (1998) found that the crude fiber content of unpeeled may be as high as 10 percent (on a dry basis), but in commercial dried ginger it is usually 1-3 percent. The volatile oil content of commercial dried gingers has been reported to be 0.5-4.4 percent, but for the major types the range is usually 1-3 percent. The abundance of the pungent constitute, the gingerols, in dried ginger is less certain owing to inadequacies in current analytical methods, but it is probably in the range of 1-2 percent for freshly prepared commercial dried ginger.

Commercial dried gingers have been reported to provide oleoresins in yields of 3.5-10 percent and to contain 15-28 percent of volatile oil. The pungent principle content of the oleoresins in again less certain owing to short comings in analytical methods but it is believed to be in the range of 17-28 percent for fresh extracts (Nambudri *et al.* 1975).

Nobriga *et al.,* (1997) reported the chemical composition of ginger (Zingiber offcinale roscoe) essential oils extracted either with ethanol, isopropanol or supercritical CO_2 was determined and compared. Frozen ginger was cut, ground in a domestic foods processor and dried to 14% moisture particle size distribution was determined in a sieve shaker with 648 mesh sieves organic.

John and Ferreria (1997) reported statistically significant differences ($p<0.05$) in mass in fresh rhizomes, moisture and crude fiber content but not in the oleoresin and ginger oil content. In Brazilian ginger, the mass of fresh rhizomes with high moisture contents but lowest in the crude fiber on wet basis. In Taiwan ginger, they recorded that a high crude fiber content of 6.8% on dry basis the best results in terms of oleoresin (3.06%) and oil (0.52%) contents, however the dry ginger recovery was highest (27.5%) with West Indies ginger. Thus among these studied Brazilian ginger gave better results for early harvesting ginger industry for the drying and extraction industries respectively, the selection of West Indies ginger and Taiwan ginger are preferable.

Koketsu, *et al.,* (1997) conducted studies on 2 grades of ginger produced in Brazil, ginger (large rhizomes) and calpira (small rhizomes). Data are given for proximate composition volatile and non-volatile extract content of the rhizome essential oil yield, and density, refractive index, optical rotation and composition of the essential oil. Brazilian ginger essential oils tended to have a lemon aroma note, attributable to presence of citral, this aroma note was more marked for ginger than for caipira samples

and paroled differences in citral content. No evidence of varieties within the gigantic group was observed.

Dubichev *et al.* (1991) reported that the mean biologically active compounds found in the rhizome were salidroside, rosiridin and the cinnamyl glycosides rosavine, and rosine. The content of resaving in fresh rhizomes from roseroot stonecrop plants cultivated in Moscow province was 2%. This decreased rapidly during storage of rhizomes, during pulping and extraction owing to auto fermentation, reaching e.g. 0.29% after 28 min at 40^0C. Negligible change occurred in the contents of the glicosides or rosanin, whose only difference from rosavin is that its terminal arabinose residue is furanose rather than pyranose.

Macleod and pienis (1984) examined Sidda and Chinese varieties and prepared essential oils of both fresh and dried samples. Both varieties had relatively high oil content (between 1.8 and 4.3%) and total aroma volatiles (about 5 mg/g for dried samples). Analysis showed tarpenes were the main aroma components. A number of the identified volatiles have not previously been reported, including trans-beta-ocimene ethyl alcohol, terpinen-4-01, myrtenal, gualene, alphacubene, and delta-cadinene found. On dying, both varieties showed considerable decease in monoterpene content and sharp increase in sesquiterpenes. Comparing the aroma volatiles of Srilankan dried ginger with those reported from other countries, it was concluded the Srilankan dried ginger showed high levels of ar-curcumese together with reasonable levels of citral isomers and all other constituents previously claimed to be important to ginger aroma; also it is apparently unusual in containing very low amounts of gingering but very high amounts of beta-bisabolenc.

Natrajan *et al.* (1972) reported that in 26 varieties of ginger, ranges were volatile oil 1 to 2.7, acetone extract 3.9 to 9.3, crude fiber 4.79 to 9.8 and starch 40.4 to 50%. contents of first 3 increased steadily from September to December. Peeling for 60s in abrasive peeler was conductive to the production of high ginger, but hand peeler ginger was bitter in uniform size and color. The optimum temperature for drying of ginger was 60^0C. The fatty acid of oil in dried sample contained saturated and unsaturated fatty acids in a ratio of 46:53; and the major component acids were found to be palmitic, oleic and linoleic acids, each having a relative abundance of about 23 percent. By contrast, a qualitative analysis of fourteen Indian cultivars revealed a predominance of saturated acids in the fatty oil, and linoleic acids as the major individual fatty acid. The second subject concerned the flavor of preserved ginger**.**

Leveringtan (1969) has attributed the characteristic fermented flavor of Chinese ginger to yeast formation which proceeds either during the scraping stages or during the subsequent storage period.

Leung et al.(1972) reported that the proximate nutrient composition of (per 100 gm) ginger are food energy 46 Cal, moisture 87.4 gm, protein 1.6 gm, fat 0.8 gm, total carbohydrate 9.2gm, ash 1 gm, calcium 19 gm, phosphorus 32 mg, iron 1.3 mg, potassium 316mg, beta-carotene equivalent 55Sµg, thiamine 0.01mg, riboflavin 0.03mg, niacin 1.7mg , ascorbic acid(Vit-C) 4mg. Dry ginger has the composition of food energy 281 Cal, moisture 10.2gm, protein 7.6gm, fat 2.6gm, total carbohydrate 72.4gm, as 6.9gm, calcium 180mg, beta-carotene equivalent102µg, thimine0.16mg, riboflavin0.27mg, niacin .4mg, scorbic acid (Vit-C) 0mg.Solvent extraction was carried out in duplicate for 1-6 hrs with constant shaking, using 10-100 ml solvent; the leached phase was weighed and the clear oleoresin extracts and analyzed. For super critical CO_2 extraction, the dried ginger samples were extracted in a semi-continuous fixed bed extractor for $\leq$ 3 hrs at 160^0C and 70 bar with solvent flow rate 5.3±0.1 g CO_2/minute. Ethanol and isopropanol extracts (2 hrs) had the same composition (irrespective of solvent vol), and contained monoterpenes, sesquiterpenes and fatty acids.

After 4 hrs, gingerols were also found in small amounts in the ethanol. After 6 hrs, supercritical CO_2 extracts differed from organic solvent extracts, with no oc-pinene, camphene on 0 pinene detected after 1 on 2 hrs extraction. After 1 and 2 hrs CO_2 of extraction, concentration of gingerol was much higher (14.07 and 80.71% of total, extract, respectively) than in the ethanol and isopropanol extracts (1.32-3.81%). It is suggested that the much higher gingerol concentration of the 2 hrs CO_2 extract could be the due to a vacuum pressure effect during depressurization of the system, which could have promoted cell rupture and gingerol extraction.

Table 2.1 Composition of fresh ginger:

Composition	Quantity (per 100 gm)
Water	78.89 g
Energy	80 calorie

Energy	333 Kcal
Protein	1.82 g
Total lipid (fat	0.75 g
Ash	0.77 g
Fiber, total dietary	2.0 g
Sugars, total	1.70 g
Calcium, Ca	16 mg
Iron, Fe	0.60 g
Magnesium, Mg	43 mg
Phosphorus, P	34 mg
Potassium, K	415 mg
Sodium, Na	13 mg
Zinc, Zn	0.34 mg
Copper, Cu	0.226 mg
Manganese, Mn	0.229 mg
Selenium, Se	0.7 mcg
Vitamin C	5.0 mg
Thiamin	0.025 mg
Riboflavin	0.034 mg
Niacin	0.750 mg
Pentothanic acid	0.203 mg

2.2 Feed consumption and efficiency in poultry

Feed cost represents approximately 60 –70% of the total cost of production for the most classes of livestock and the improvement of the feed efficiency should be a major consideration of the breeding and feeding programs. To investigate the effect of ginger on the feed consumption, many studies were conducted. Feed intake was noted that significantly decreased in treated broilers compared to the not supplement broilers during the grower period (day 11to 22) and Whole trial (Day 0 to 28) although the differences was not statistically during the starting (day0to 10) and finisher (day 23to28) periods. Consequently, feed conversion ratio was significantly improved in ginger supplemented broilers for the starter, finisher and whole periods.

Herawati and Marjuk (2011) used different levels of ginger powder 0.5, 1, 1.5 and 2% in the diets of 5 days old Hubbard strain broiler chicken, feed consumption was significantly (P< 0.01) decreased in a group fed 2% ginger compared to the control group being (3966.7 and 4180 g/bird) respectively through 5 weeks of experimental period, while feed consumption was significantly (P< 0.01) increased in the group received 0.5% being (4405.5g), but there were no significant differences in the feed consumption of groups fed 1 and 1.5% of ginger powder when compared to the control group.

Mohamed *et al.* (2012) stated that feed consumption of broiler chickens was significantly (P< 0.05) decreased by the supplementation of dietary ginger powder at levels 0.1 and 0.2% compared to the control, being (2852.66, 2791.67 and 2909.62 g/bird) respectively over 42 days.

Also Arshad *et al.* (2012) reported that using ginger extract (40 and 50) ml/liter through drinking water of broilers caused a significant (P< 0.05) decrease in the feed intake per bird compared to the Chapter Two Review of Literature 15 control, being (2243g, 2302g and 2399g) respectively. Using 2 and 6% of ginger powder in the broiler diets did not affect the daily feed consumption during the period 1 –6 week, but from 6 –7 weeks of age, the level 6% had a significant positive effect (P< 0.05) on the daily feed consumption compared to group 2% and the control, being (121g, 147.5g and 154g) respectively (Al-Homidan, 2005).

Tekeli *et al.* (2011) showed that feed consumption increased significantly (P< 0.05) in groups fed on antibiotic and 240 ppm ginger compared to the group which fed control diet through the experimental period 1 –42 days, (3970.13, 3909.71 and 3334.86 g/bird) respectively.

Moorthy *et al.* (2009) concluded that using 0.2% ginger in the broiler diets did not affect the feed intake.

Similar results were found by El- Deek *et al.* (2002) when they used 0.05% of ginger powder in broiler diets and did not find any effect on feed intake. The same researchers in the trial 2 used 0.1% of ginger powder in the broiler diets but there were no differences in the levels of feed intake between treatments and control.

These results were in agreement with those of Ademola *et al.* (2009) who reported that using 1, 1.5 and 2% of ginger powder in broiler diets had no significant effect on feed intake. Similar results were obtained by Kehinde *et al.* (2011) when they used different

levels of ginger 1.5, 3 and 4.5% and there were no differences in the levels of feed intake of cockerel chicks. A

Incharoen (2009) feed dried fermented ginger (1and 5%) to White Leghorn laying hen and found that feed consumption and FCR tended to increase in ginger fed groups. Likewise, the use of 2% red ginger in ration of broiler chickens has resulted in higher feed intakes and FCR (Herawati, 2010).

Onu (2010) reported that the addition of ginger (0.25%) broiler chicks in the basal diet of broiler chicks resulted in improved FCR although feed intake did not change.

Ginger has been found to increase secretion of gastrointestinal enzymes including lipase, disaccharide and maltase (Zhang *et al.*, 2009).

Zhao *et al*, (2008/2011) reported that ginger enhances animal's nutrient digestion and absorption because of its positive effect on gastric secretion, enterokinesia and digestive enzyme activities.

An experiment was conducted by Barazesh *et al.* (2013) on 192 commercial broiler chicks for 42 days. There were 4 treatments with 4 replicates and each replicate contained 12 chicks. The treatments T_1, T_2, T_3 and T_4, contained 0.0, 0.50, 1.00, and 1.50 % of ginger powder, respectively in the basal diet. The results showed that increasing levels of dietary ginger powder lead to a significant reduction in feed intake. The treatment with 0.50 % ginger powder during the sixth week showed the highest feed intake (891.36 g) than the other groups 0.0 % (819.43 g), 1.00 % (732.11 g) and 1.50 % (817.08 g) but the differences between treatments were not significant.

Elmakki *et al.* (2013) evaluate the effect of ground ginger root (Zingiber officinale) addition in the diet of broiler chicks 160 day old boiler unsexed chicks (COBB strain) were reared till 42 days of age. Four experimental diets contained 0, 0.25, 0.50, and 0.75 % ground ginger root powder. Dietary incorporation of ginger had no significant effect on feed intake in the first four weeks. Data revealed the significant decrease in feed intake by broilers fed 0.50 % ginger powder containing diet (841.0 g and 777.0 g in the 5th and 6th week, respectively) in comparison to other treatments, whereas the chicks fed 0.0 % (884.0 g and 835.0 g), 0.25 % (884.0 g and 938.0 g) and 0.75 %

(928.0 g and 809.0 g) ginger powder in 5th and 6th week, respectively did not differ significantly ($p < 0.05$) from each other.

Ahmed *et al.,* 2014 targeted to know the effect of addition of ginger root powder as natural feed additive on feed intake in broilers **(**One hundred and sixty unsexed one day-old broiler chicks strain (Ross) were divided randomly into four groups following completely randomized design. Each group represented a treatment having 4 replicates (10 birds under each replication). The four diets were formulated to meet the nutritional requirements of broiler chicks according to NRC (1994) having 0.0, 0.50, 0.75 and 1.00 % levels of ginger root powder, respectively. No significant difference was observed in total feed intake (2266.1 g, 2432.6 g, 2396.3 g and 2443.6 g), respectively for broilers under different treatments.

Arkan *et al.,* 2012 was conducted a study to explore the effect of incorporation of ginger at 0.0, 0.10 and 0.20 % levels in the diets on feed intake of broiler chicks One hundred and eighty, 3 weeks old broiler chicks (ROSS) were distributed into 3 treatment groups with three replicates per treatment and 20 birds per replicate (10 males + 10 females). The broilers received T_3 diet (0.20 % ginger) consumed significantly less feed (2791.67 ± 8.54 g) in comparison to diet T_2 (2852.66 ± 11.01 g) and control (2909.62 ± 10.12 g).

An experiment was conducted to know the feed intake of broilers fed diet supplemented with red ginger (Zingiber officinale Rosc) as phytobiotic by Herawati (2010). Two hundred broiler chickens of 5 days old were divided into 5 different feed treatment groups, namely: control group without red ginger (R-0) and treatment groups containing 0.50 (R-0.50), 1.00 (R-1.00), 1.50 (R-1.50) and 2.00 % (R-2.0) of red ginger, respectively. Each group was divided into 5 sub groups as replication, consisted of 8 chickens under each. The chickens were raised for five weeks. Feed consumption was daily measured in each sub-group. The results showed that supplementation of red ginger reduced total feed intake ($p < 0.05$) at 1.00 % (4,108.00 g/head), 1.50 % (4,196.50 g/head), 2.00 % (3,966.70 g/head), but there was improvement in feed intake at level of 0.50 % (4, 4054.50 g/head) as compared to control (4,180.00 g/head).

2.3 Growth performance and body weight gain

A study was conducted on 3 weeks old 180 broiler chicks by Arkan *et al.* (2012**)** which were raised up to 6 weeks of age. The ginger powder was supplemented at the rate 0.10 and 0.20 % level in their diets under T_2 and T_3, respectively while T_1 Review of

Literature….. 15 served as control. The differences for body weight gain were significantly higher (1467.42 ± 11.08 g) for broiler chicks fed diet with 0.20 % ginger as compared to control (1289.17 ± 13.10 g).

In another study supplementation of ginger powder at 1.50 % (459.96 g) level in diet significantly increased body weight gain as compared to control (357.00 g) at fifth weeks of age in broilers (Barazesh *et al.*, 2013).

Similar findings were also observed by Herawati (2010) for body weight gain in broilers when 1.50 % level of ginger powder was supplemented ($p < 0.05$) in their diet (1,955.53 g/head) in comparison to the broilers received the control (1,899.71 g/head) diet while the other treatments containing 0.50 % (1,888.44 g/head), 1.00 % (1,858.25 g/head) and 2.00 % (1,859.50 g/head) level of ginger powder did not differ significantly.

Elmakki *et al.* (2013) reported that weight gain in broilers was affected by inclusion of different levels of ginger in their diet for three weeks at the levels of 0.0, 0.25, 0.50 and 0.75 %. Total weight gain of the group at 0.75 % (1918 g) was significantly lowered than control (2035 g). While the weight gain in other two groups was similar to control group i.e. 2035 g.

The result of a study conducted by Ahmed *et al.* (2014) in broilers reveled no significant differences ($p > 0.05$) in the final body weight (1103.3 g, 1140.2 g, 1141.2 g and 1146.9 g) as well as body weight gain (1064.3 g, 1101.2 g, 1102.2 g and 1107.8 g) among the four treatments supplemented with graded levels of ginger root powder at 0.50, 0.75 and 1.00 %.

Zomrawi *et al.* (2012) reported significant decrease ($p < 0.05$) in weight gain for birds fed 0.50 % (1267.47 g) ginger root powder in relation to control (1447.56 g).

In an another study conducted by for 49 days of experimental period on broiler chicks, also revealed significant variations ($p < 0.05$) for final body weight when ginger (2168.75 g) and garlic (2475.00 g) powders were supplemented in the diet Review of Literature….. 18 at 14 g/kg as compared to control (1950.0 g) and also in daily body weight gain (261.43 g, 292.86 g and 336.45 g) under control, ginger and garlic, respectively**.**

Kehinde (2011) elicited that ginger supplementation at 0.0 (23.37 ± 1.24 g), 1.50 (23.70 ± 1.41 g), 3.00 (24.67 ± 1.38 g) and 4.50 % (23.37 ± 1.40 g) had no significant effect on weekly weight gain.

Onu(2010)reported that the addition of ginger (0.25%)broiler chicks in the basal diet of broiler chicks resulted in higher body weight and lower FCR.

Farinu *et al.* (2004) reported that supplementation of ginger at the levels of 5,10, or 15 g/kg slightly improved growth in broilers.

2.4 Effect on feed conversion ratio (FCR):

Feed conversion is an index associated with both feed consumption and weight gain and well known that broiler chickens are more efficient in conversion feed than other farm animals. Many medicinal herbs used in human diet which are known as "spices" and improve digestibility. The same property can be used in poultry to increase the FCR which results in increasing body weight and more profit (Moorthy *et al.*, 2009).

Herawati and Marjuk, (2011) stated that feed conversion ratio was significantly improved ($P< 0.05$) when different levels of dietary ginger powder used in broilers 0.5, 1, 1.5 and 2% compared to the control group, being (2.15, 2.20, 2.15, 2.14 and 2.27) respectively during 35 days, which are in agreement with those of Mohamed *et al.* (2012) who found that feed conversion ratio of broilers was significantly improved ($P< 0.05$) by the supplementation of dietary ginger powder 0.2% compared to the group 0.1% and the control, which were (1.90, 1.98 and 2.25) respectively through 42 days of experimental period. On the other hand, Moorthy *et al.* (2009) did not observe any differences in the FCR of broilers fed 0.2% ginger powder compared to the control.

Also El-Deek *et al.* (2002) did not find any differences between FCR of the treatments and the control in the trial (1) and (2) when used 0.05 and 0.1% ginger powder respectively in broilers diets.

Ademola *et al.* (2009) noted that using high dose of ginger powder 2% had a highly significant negative impact ($P< 0.01$) on the broilers FCR compared to the treatments 1%, 1.5% and the control, (3.14, 2.71, 2.67 and 2.56 respectively) during 56 days of age, while there Chapter Two Review of Literature 18 were no differences in the FCR of broilers fed 1 and 1.5% ginger compared to the control group. Otherwise,

Thayalini *et al.* (2011) mentioned that there was no improvement in feed conversion ratio of broiler chickens fed on high dose of dried Zingiber officinale rhizomes supplement 2% compared to the chickens fed the control.

Using different levels of ginger powder 1.5, 3 and 4.5% statistically did not affect the feed conversion ratio of cockerel chicks (Kehinde *et al.*, 2011), which is in agreement with that of Tekeli *et al.* (2011) who used different percentages of ginger and propolis extract (ginger 240 ppm, propolis 1000 ppm, ginger 120 + propolis 500 ppm, ginger

240 + propolis 1000 ppm, ginger 360 + propolis 1500 ppm) as alternatives for antibiotic growth promoter, but they did not observe any significant differences between the treatments and the groups of control and antibiotic.

Mohammed and Yusuf (2011) carried out a study to evaluate the effect of ginger (*Zingiber officinale*) inclusion as a feed additive. Eighty four- day old Anak strain broiler chicks were fed on various levels of supplemental ginger in addition to a control diet (treatment1) without ginger. The FCR was 2.65, 2.50 2.45 and 2.44 for broilers received the diet containing 0, 250, 500 and 750 g ginger per 100kg feed, respectively. No significant difference was observed for FCR between treatments containing various levels of ginger in comparison to control.

The effect of ginger powder supplementation @ 250 (G1), 500 (G2) and 750 (G3) g/q in the feed of broilers reared for 42 days of age was studied by Wadhwa *et al.* (2011). The broilers were fed different treatment diets G1, G2 and G3 with different levels of ginger showed 21.91, 34.04 and 17.71 % better feed conversion ratio in comparison to broilers received control diet

A study on broiler chicks was conducted by Arkan *et al.* (2012) using treatments T1 (control), T2 (0.10% ginger) and T3 (0.20% ginger) diets. The data for FCR showed a significant difference ($p < 0.05$) between T2 (1.98 ± 0.04), T3 (1.90 ± 0.03) and control (2.25 ± 0.09).

Zomravi *et al.* (2011) reported that there were no significant differences ($p > 0.05$) in feed conversion ratio among all dietary treatments containing 0.00 % (2.18), 0.50 % (2.19), 1.00 % (2.15) and 1.50 % (2.24) of ginger powder

2.5 The Effect of ginger on carcass cuts and visceral organs

Studies have been concentrating on improvement of broiler carcass in order to meet the customer's desire. This improvement accomplishes through genetic selection, nutrition and breeding technology to produce high carcass weight with limited abdominal fat.

Herawati and Marjuki (2011) noted when compared between control and four levels of red ginger powder that diets supplementation with 1, 1.5 and 2% red ginger powder had significant ($P< 0.05$) higher carcass percentage (dressing %) (62.9, 62.9 and 64.9 %) respectively than those received 0.5% and control diet being (59.6 and 57.8%), abdominal fat percentage decreased significantly ($P< 0.05$) in broilers fed diets supplemented with red ginger powder 0.5, 1, 1.5 and 2% compared to those broilers fed the basal diet, (1.87, 1.85, 1.81, 1.75 and 2.56) respectively.

Ademola *et al.* (2009) showed that there were no significant differences in the relative weights of (neck, thighs, breast and back) when used 1 and 1.5% ginger powder in broilers diets but relative weight of wings was positively affected (P< 0.001) compared to the control group, which were (9.21, 9.00 and 8.55%) respectively, while using 2% of ginger caused a significant (P< 0.001) decrease in relative weight of (breast and back) being (12.86 and 12.23%) respectively compared to the control group, (14.59 and 13.06%) respectively, but did not affect the relative weights of (neck, thighs Chapter Two Review of Literature 22 and wings), relative weight of abdominal fat pad decreased significantly (P< 0.001) when using different levels of ginger 1, 1.5 and 2% compared to the control, being (0.85, 0.56, 0.45 and 1.88%) respectively.

While Tekeli *et al.* (2011) did not find significant differences in carcass yield, hot carcass, cold carcass, proventriculus, gizzard and heart weight of broilers fed on 240 ppm of ginger powder compared to the antibiotic and control groups, while there was a significant (P< 0.05) increase in the percentage of abdominal fat in the birds fed on ginger powder 240 ppm compared to the control group, (1.86 and 1.25%) respectively. Also liver weight increased significantly (P< 0.05) in birds received ginger powder 240 ppm and antibiotic compared to the control group, (44.40g, 47.61g and 38.22g) respectively.

Moorthy *et al.* (2009) noted that adding 0.2% ginger powder into the broilers diet did not affect the weights of carcass, gizzard, liver, heart and dressing percentage.

El-Deek *et al.* (2002) found no differences in dressing percentage, abdominal fat and liver relative weights of broilers fed diets supplemented with 0.05 and 0.1% ginger powder

Zhang et al.(2009) observed that birds fed ginger produced higher carcass weights compared to untreated birds .He suggested that improved carcass quality of broilers may be associated with the antioxidant effect of ginger which enhances protein and fat metabolism.

Dressing percentage, breast weight and leg weights increased significantly in response to an aqueous extract of a plant mixture containing ginger at 5g/liter water (Javed *et al.*, 2009).

The findings of Barazesh *et al.* (2013) suggested that inclusion of ginger powder at different levels (0.0, 0.50, 1.00 and 1.50 %) in diets had no significant change in the

weight of liver (3.62, 3.45, 3.02, 3.12), gizzard (3.52, 3.17, 2.84, 3.59) and spleen (0.18, 0.17, 0.17, 0.21) as % of live weight respectively among the four treatments.

Moorthy *et al.* (2009) conducted an experiment by keeping following treatments viz. T_1: Control; T_2: 0.20 % ginger powder; T_3 : 0.20 % pepper powder; T_4 : 0.20 % curry leaf powder; T_5: 0.20 % ginger + 0.20 % pepper; T_6 : 0.20 % ginger + 0.20 % curry leaf powder and T_7 : 0.20 % pepper + 0.20 % curry leaf powder. The carcass characteristics viz. ready-to-cook yield (77.27, 77.43, 77.93 77.82, 76.11, 76.21 and Review of Literature….. 23 78.12 %) , gizzard weight (42.25 ± 1.24, 48.13 ± 1.47, 47.27 ± 1.47, 45.63 ± 1.23, 42.29 ± 1.23, 42.29 ± 1.65, 44.26 ± 2.54 and 45.72 ± 2.27 g), liver weight (39.00 ± 1.75, 38.88 ± 1.59, 37.65 ± 1.59, 38.88 ± 1.59, 37.24 ± 1.43 and 38.23 ± 2.56 g) and heart weight (9.88 ± 0.52, 8.88 ± 0.23, 8.75 ± 0.23, 8,75 ± 0.75, 9.10 ± 0.23, 8.26 ± 0.47 and 8.59 ± 0.17 g), respectively and did not differ significantly between the treatment groups fed different levels of dried ginger, pepper and curry leaf powder from 1- 6 weeks of age.

Elmakki *et al.* (2013) reported that carcass weight was higher for birds fed with 0.25% level of ginger (1591 g), in comparison to control (1562 g). The dressing percentage was also found to be numerically higher in 0.25 % ginger powder supplemented group (75 %) and in comparison to control (74.4 %) and did not differ statistically.

A study was conducted by Zomrawi *et al.* (2012) had recorded significant decrease ($p < 0.05$) in pre-slaughter weight of birds fed 0.50 % ginger root powder (1310.28 g/bird) in comparison to control (1489.06 g/bird). No significant differences were observed in dressing percentage by supplementing of 0.50 % level of ginger root powder (75.91 %) when compared with control (75.88 %).

Ebrahimnezhad *et al.* (2014) conducted an experiment to study the effects of ginger (Z. officinale) processed to different levels on carcass characteristics in broiler chickens. A total of 360 one–day–old broilers (Cobb × Cobb 500) were allotted to 6 equal experimental groups in a complete randomized design, with different levels of ginger (0.0, 5.0, 10.0, 15.0, 20.0, and 25.0 g/kg of diet) for 42 days. Carcass traits (relative weights of carcass, liver, abdominal fat, fat around gizzard and intestine) were assessed on day 42. The carcass characteristics were not altered significantly altered except relative weight of eviscerated carcass for different level of supplementation of ginger as 62.56, 62.59, 59.19, 62.59, 62.03 and 62.70 g, respectively.

A study using one hundred and forty four one-day-old Arbor Acres broilers was conducted to assess the effects of dried ginger root (Zingiber officinale) powder of

particle sizes of 300, 149, 74, 37, and 8.4 μm by Zhang *et al.* (2009) on carcass characteristics. The birds were housed in 24 wire cages in an environmentally controlled room. Dietary treatments were - control and treatment groups supplemented with ginger root processed to 5 particle sizes at the level of 5.00 g/kg of diet. At the end of the experiment the birds were subsequently killed to determine carcass yield and abdominal fat content. Birds in the ginger-supplemented groups had a higher (P = 0.014) carcass yield 72.58, 73.78, 76.06, 76.72 and 72.49 % as per the treatment and a slightly lower (P = 0.096) abdominal fat content (g/kg) 14.84, 14.39, 14.93, 15.11, 13.79 in comparison to control group (carcass yield=71.2 %, and abdominal fat content= 16.80 g/kg) at 42 d of age

2.6 Mortality rate

Mortality rate is defined as the death of birds as a result of many factors; for example, by disease, injury, physiological system failure or unidentified causes, which show that the welfare has been poor, so increasing in mortality rate will lead to decrease the number of birds at marketing age and finally will lower the income of project. For this reason, many researchers tried to minimize the percentage of mortality using different feed additives including medicinal plants.

Al-Hamadani *et al.* (2010) used two levels of ginger powder 0.4 and 0.8% and they reported that mortality rate was zero in the group fed 0.8% ginger powder compared to the 0.4% ginger, antibiotic and control groups which were (2.27, 2.27 and 6.82 %). While

Thayalini *et al.* (2011) mentioned that there was no significant difference in mortality rate of broiler chickens fed on dried Zingiber officinale rhizomes supplement 2% compared to the control, which is in agreement with the finding of Mohamed *et al.* (2012) who did not observe any mortality case during 42 days of experimental period when used 0.1 and 0.2% ginger powder through diet in broiler chickens.

Also Zomrawi *et al.* (2012) who used different levels of ginger root powder 0.5, 1 and 1.5% in broilers diets did not find significant differences in mortality rate when compared to the control group.

CHAPTER-III

MATERIALS AND METHODS

3.1 Statement of the research work

The experiment was conducted at the poultry shed under the Department of Dairy and Poultry Science, in Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur, to investigate the effect of Ginger (*Zingiber officinale*) powder in broiler production (Cobb 500) during the period from 8 August to 5 September, 2016. To complete the research work following steps were followed:

3.2 Preparation of the experimental house and equipment

An open sided house with two rooms was used for rearing the experimental birds. The experimental house was properly washed and cleaned by forced water using a hosepipe. After washing with clean water, the rooms were disinfected by quick lime and then left vacant for 15 days. At the same time all feeders, plastic buckets, waterers and other necessary equipments were also properly cleaned, washed and disinfected with detergent and potassium permanganate, subsequently dried and left them empty for at least one week before the arrival of chicks. Ceiling, walls, and wire nets were also thoroughly disinfected by spraying Virocid® (4ml/lit).

Fig. 1 Broiler growing in separate treatment area and vaccinated

3.3 Collection of the experimental birds

A total 96 number of day-old broiler chicks (Cobb-500) were purchased from Kazi Firms Limited, Ranirbondor, Dinajpur, Bangladesh.

3.4 Layout of the experiment

The day-old chicks were reared at brooder house to adjust with the environmental condition up to 7 days. After 7 days, chicks were randomly allocated into four dietary treatment groups containing 24 chicks in each; each treatment was composed of three replications containing 8 birds in each replication. The layout of the experiment is shown in Table 3.1.

Table 3.1 Layout showing the distribution of experimental broilers

Dietary treatment	No. of chicks in each replication			Total number of chicks in each treatment
	R_1	R_2	R_3	
T_0	8	8	8	24
T_1	8	8	8	24
T_2	8	8	8	24
T_3	8	8	8	24

3.5 Procurement of feed ingredients

Required amounts of feed ingredients for making the experimental diets were procured from the local market of Dinajpur town. During procurement, ingredients were evaluated carefully for their freshness by observing its color with naked eye and smell with nose.

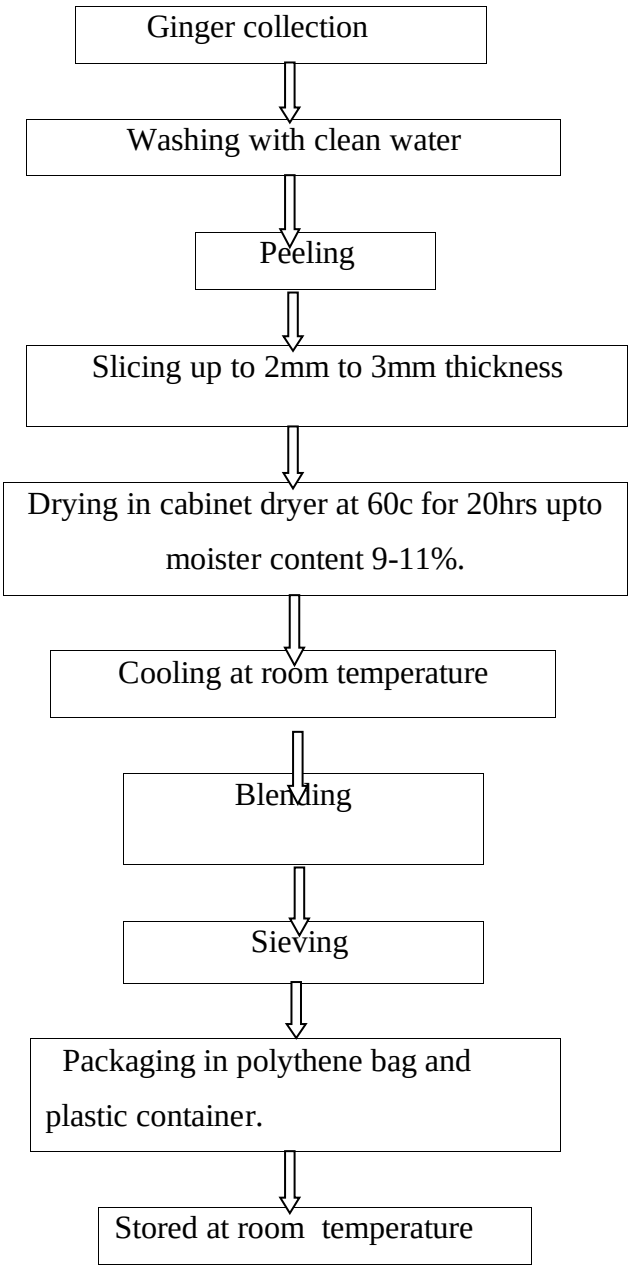
3.6 Collection, processing and storage of ginger powder

Ginger (*Zingiber officinale*) purchased from Local market, Dinajpur Bangladesh. The samples were further ground into powder using pestle and morter at Dairy and Poultry Science

Lab. The obtained powder was packed in a polythelene bag and preserved in the feed storage room until used for feed formulation. Proper care was taken in the feed storage room to avoid spoilage.

3.7 Preparation of ginger powder

Flow diagram of preparation of ginger powder:



3.8 Preparation of the experimental diet

Ready feed was used throughout the experimental study. The experimental period were divided into two phases (broiler-starter and broiler-finisher). Broiler starter diet was

provided between 0 and 14 days, and broiler grower was fed from 15 to 28 days. Ginger powder was incorporated into the experimental diets manually in appropriate doses.

Fig. 2: Fresh Ginger

Fig. 3: Slicing Ginger

Fig. 4. Ginger powder

At first required amount of ready feed ingredients were weighed by digital weighing balance. Then different level of ginger powder was mixed with different treatment. During the time of mixing cross mixing was applied. Mixing was done manually and

no coccidiostat or any other feed additives were added to the formulated diets in order to obtain clear-cut effect of the test-diet. The experimental diets were designed as-

T_0	:	control
T_1	:	control+0.5 g ginger powder per kg feed
T_2	:	control+ 1 g ginger powder per kg feed
T_3	:	control+ 2 g ginger powder per kg feed

3.9 Routine management

The experimental birds were exposed to similar care and management in all treatment groups throughout the experimental period. The following management practices were followed during the whole experimental period and these management practices were identical for all dietary groups.

3.9.1 Litter management

Fresh, clean and dried rice husk was used as litter materials at a depth of about 3 inch. The litter was well covered by clean newspaper up to the first 3 days. Before use of litter calcium carbonate was spread on the floor. After first week, upper part of the litter with droppings were removed regularly and stirred three times a week up to the end of the experiment. The litter was disinfected with Virocid® solution in every other day. Litter materials, when found damp for any reason, were removed to prevent accumulation of ammonia and other harmful gases. At the end of each week, litter was stirred to break its compactness and maintain proper moisture. At the end of 2nd and 3rd weeks of age, dropping were cleaned from the surface of litter.

3.9.2 Floor space

All the broilers were given a floor space of 1.2 sq. feet. Fresh dried rice husk were used as litter materials on the floor at a depth of 3 inch.

3.9.3 Brooding of broiler

The experiment was conducted in summer (August to September 2017). During the experimental period, the experimental temperature was higher than that requirement. The broilers were housed on floor and routinely managed as any other commercial broiler flock. Heating was provided by a single electric brooder, where the initial temperature was set at 35^{o} C and decreased gradually at the rate of 3^{o}C in each week until they were adjusted to normal environmental temperature of the house and final temperature was 28^{o} C at the end of experiment. Additional heat was provided by fitting 200-watt electric bulb at the center of the pen about 12 inches above the floor from the 7-day old. The height of the bulbs was increased by raising the bulb gradually as per need of temperature. Paper was used on two sides of the house and in ventilators to protect cold and stormy wind. These sheets were removed partly or completely particularly at the later stage of finishing period when room temperature was found favorable. Daily room temperature was recorded every six hours with a thermometer.

Fig. 5 Brooding environment of chicks

3.9.4 Lighting

All birds were exposed to continuous lighting of 23 hours and one hour dark period per day throughout the experimental period. The dark period was practiced to make the broilers familiar with the possible darkness due to electricity failure. Supplementary light at night was provided by electric bulb by hanging at a height of 2.8 m to provide necessary lighting.

3.9.5 Feeding and drinking

Feeds were supplied to the chicks on clean newspapers at three hours interval for the first 3 days. Linear feeder and round plastic drinker were used during brooding period. After that linear feeder was replaced by round plastic drinker. After 2 weeks, feeds were supplied thrice daily (once at morning, at noon and again at night) and water was supplied thrice daily (once at morning, at noon and again at night). Fresh water was offered to the bird adlibitum. One round plastic feeder and drinker were provided for fifteen birds**.** Feeders were cleaned at the end of each week and drinkers were washed daily. All broilers in different treatments had fresh feed and drinking water adlibitum throughout the experimental period.

Fig. 6 Feeding of broiler

Fig. 7 Watering of broiler

3.9.6 Immunization

All broilers were vaccinated against New Castle (Ranikhet) Disease and Infectious Bursal (Gumboro) Disease. The birds were vaccinated against Ranikhet and Gumboro diseases-

Table 3.2 Applied vaccination program

Diseases	Day	Manufacture vaccine	Route	Time
Ranikhet	4	ND Clone 30	Eye	Evening
Gumboro	10	Gumboro 228E	Eye	Evening
Gumboro	15	Gumboro 228E	Drinking water	Evening
Ranikhet	21	ND Clone 30	Drinking water	Evening

Fig. 8. Vaccination

3.9.7 Medication

Immediately after unloading from the chick boxes the chicks were given Glucose and Vitamin-C to prevent the stress occurring during transport. Water soluble vitamin and normal saline were also provided for the first 3 days of brooding. During the course of experimental period, electrolytes and vitamin-C were added with the drinking water to combat stress due to high environmental temperature (33 to 35^{o} C).

3.9.8 Sanitation

Proper hygienic measures and strict sanitation programs were followed during experimental period. The entrance point and surrounding area were kept clean and disinfectant (virocid) was sprayed regularly. In addition, the service area of the experimental rooms, outside wall and feed storage room were kept clean and disinfected.

3.9.9 Bio-security:

Bio-security means to prevent the outbreak of diseases.

- Entrance of visitors were restricted only worker, researcher, supervisor and manger who visited farm by following special care.
- Before entrance, hands were washed with soap and shoes were changed, feet were dipped in a footbath containing disinfectant solution (PPM) and the footbath was at the entrance point.
- All equipment of the experimental house was kept clean.
- A special dress was used inside the house during working.
- Dead broilers were removed promptly and buried far away from the experimental house.
- Sick broilers were promptly isolated to a separate place from the experimental areas.
- The experimental areas were kept free of rats, cats, dogs and wild flying birds.

3.9.10 Postmortem examinations of broilers

After postmortem examination, the results were collected and necessary measures were taken to remove the problem without applying medicines

Fig. 9. Postmortem for diagnosis of Omphalitis

3.10 Processing of broilers

At 28 days of age, one bird from each replication was selected randomly. Before slaughtering the birds were kept in fasting condition for 4 hours. Just before slaughtering the birds were weighed. Birds were slaughtered according to halal method. Following slaughter, broilers were allowed to bleed for about 2 minutes. Then the birds were scaled in hot water (60-65^{o} C) for about 120 seconds in order to loosen the feather of the carcasses and weighed again. Breast meat, thigh meat, drumstic meat were separated from the carcass. Finally, processing was performed by removing head, shank, viscera, oil gland, kidney and giblets. As soon as these were removed the gall bladder was removed from the liver and pericardial sac and arteries were cut from the heart. Cutting it loose in front of the proventriculus and then cutting with both incoming and outgoing tracts removed the gizzard. Then, it was split open with knife, emptied and washed and the lining removed by hand.

3.11 Data collection and record keeping

The following records were kept during 28 days of rearing period:

i. Live weight.
ii. Feed consumption.
iii. Survivability: Recorded from mortality
iv. Temperature: Four times daily during the experimental period.
v. Dressing yield: At the end of the experiment one broiler was slaughtered from each replication to estimate dressing yield.

Fig.10. Carcass of broiler

Fig.11. Different parts of broiler

Fig.12. Visceral parts after slaughtering

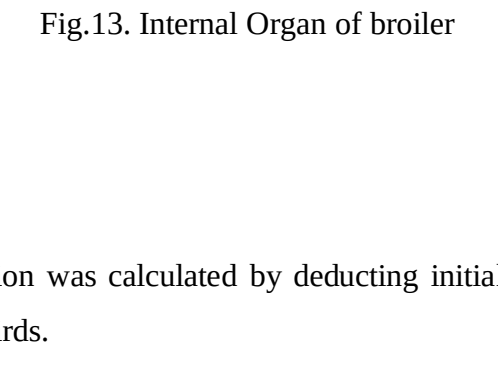


Fig.13. Internal Organ of broiler

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 weight of the birds.

Final Weight- Initial weight

3.11.2 Feed intake

Feed intake was calculated as the total feed consumption in a replication divided 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 (F.C.R) was calculated as the total feed consumption divided by weight gain in each replication.

$$\text{F.C.R} = \frac{\text{Feed Intake (kg)}}{\text{Weight gain (kg)}}$$

3.11.4 Survivability

Survivability percentage was calculated as the total broilers survived divided by the number of starting birds multiplied by 100

3.11.5 Dressing yield

Dressing yield is based on the relationship between the dressed carcass weight and live bird weight after things like skin and internal organs have been removed. Dressing yield can be calculated by taking weight of the carcass divided by weight of live bird

$$\text{Dressing yield} = \frac{\text{Weight of the}}{\text{Weight of live}} \times 100$$

3.12 Statistical analysis

Data on different variables were subjected to analysis of variance (ANOVA) in a Completely Randomized Design (CRD), . The significant differences between the treatment means were calculated from analysis of variance (ANOVA) table. The mean difference among the treatment groups was performed by Duncan test. All analyses were performed by using ‘‘IBM SPSS Statistics 20’’ Program.

CHAPTER-IV
RESULTS AND DISCUSSION

4.1 Performance of broiler

The results of productive performance in terms of feed consumption, live weight gain, feed conversion ratio, survivability, dressing yield, organ growth weight, were used as criteria for response of broiler to different dietary levels of ginger powder are presented in the following sections.

4.2 Effect of ginger powder on body weight gain

Initial body weight of day-old broiler chicks fed on different dietary treatment was similar ($P>0.05$) (Table 4.1). From 1 to 14 days of age, the highest (520.70g) body weight gain was attained by broilers received ginger powder at 2 g/kg feed ($P<0.01$) and also from 15 to 28 days of age, the body weight gain was significant ($P<0.01$) in treatment T_3 (1840.27g) in birds fed diet containing ginger powder at level of 2 g/kg feed was significantly higher ($P<0.01$) followed by birds received 1g/kg feed (1703.9g), .5g/kg feed (1634.07g) and 0g/kg feed (1585.74g) ginger powder. The significant increase in body weight in treatment T_3 (1840.27g) may be due to activity of ginger (*Zingiber officinale*) at the level of 2 g/kg feed that can stimulate protein synthesis by bird's enzymatic system.

A study was conducted on 3 weeks old 180 broiler chicks by Arkan *et al.* (2012**)** which were raised up to 6 weeks of age. The ginger powder was supplemented at the rate 0.10 and 0.20 % level in their diets under T_2 and T_3, respectively while T_1 served as control. The differences for body weight gain were significantly higher (1467.42 ± 11.08 g) for broiler chicks fed diet with 0.20 % ginger as compared to control (1289.17 ± 13.10 g).
In another study supplementation of ginger powder at 1.50 % (459.96 g) level in diet significantly increased body weight gain as compared to control (357.00 g) at 5^{th} weeks of age in broilers (Barazesh *et al.,* 2013

Onu (2010) reported that the addition of ginger (0.25%) broiler chicks in the basal diet of broiler chicks resulted in higher body weight and lower FCR.

Farinu *et al.* (2004) reported that supplementation of ginger at the levels of 5, 10 or 15 g/kg slightly improved growth in broilers.

4.3 Effect of ginger powder on feed intake

Feed intake of broilers in different dietary treatments from 1 to 14 days of age, 15 to 28 and also 1-28 days of experimental periods was statistically significant ($P<0.05$). Mohamed *et al.* (2012) stated that feed consumption of broiler chickens was significantly ($P< 0.05$) decreased by the supplementation of dietary ginger powder at levels 0.1 and 0.2% compared to the control, being (2852.66, 2791.67 and 2909.62 g/bird) respectively over 42 days.

Also Arshad *et al.* (2012) reported that using ginger powder (40 and 50) ml/liter through drinking water of broilers caused a significant ($P< 0.05$) decrease in the feed intake per bird compared to the control, being (2243g, 2302g and 2399g) respectively. Using 2 and 6% of ginger powder in the broiler diets did not affect the daily feed consumption during the period 1 –6 week, but from 6 –7 weeks of age, the level 6% had a significant positive effect ($P< 0.05$) on the daily feed consumption compared to the group 2% and the control, being (121g, 147.5g and 154g) respectively (Al-Homidan, 2005). Tekeli *et al.* (2011) showed that feed consumption increased significantly ($P< 0.05$) in groups fed on antibiotic and 240 ppm ginger compared to the group which fed control diet through the experimental period 1 –42 days, (3970.13, 3909.71 and 3334.86 g/bird) respectively. Incharoen and Yamauchi (2009) feed dried fermented ginger (1and 5%) to White Leghorn laying hen and found that feed consumption and FCR tended to increase in ginger fed groups. Likewise, the use of 2% red ginger in ration of broiler chickens has resulted in higher feed intakes and FCR (Herawati, 2010).

Table 4.1 Effect of ginger powder supplementation on the performance of broiler chicks

Parameters	T_0	T_1	T_2	T_3	Level of significance
Initial body weight (g/bird)	45.21±0.050	45.23±0.005	45.41±0.050	45.31±0.050	NS
Feed consumption (g/bird)					
1-14 days	$850.46±0.07^{a}$	$790.05±1.32^{b}$	$757.94±0.57^{d}$	$798.10±0.60^{c}$	**
15-28 days	$2035.87±0.50^{a}$	$1890.45±1.0^{d}$	$2023.99±0.10^{b}$	$2004.1±0.03^{c}$	**
1-28 days	$2886.33±0.44^{a}$	$2680.5±2.32^{d}$	$2781.93±0.47^{c}$	$2802.2±0.63^{b}$	**
Weight gain (g/bird)					
1-14 days	$470.50±10^{d}$	$477.59±0.95^{c}$	$486.29±1.35^{b}$	$520.70±1.5^{a}$	**
15-28 days	$1115.24±1.0^{d}$	$1156.48±1.0^{c}$	$1217.61±0.5^{b}$	$1319.57±0.49^{a}$	**
1-28 days	$1585.74±1.0^{d}$	$1634.07±0.05^{c}$	$1703.90±1.85^{b}$	$1840.27±1.99^{a}$	**
FCR					
1-14 days	$1.81±0.00428^{a}$	$1.65±0.00653^{d}$	$1.56±0.00328^{c}$	$1.53±0.0068^{c}$	**
15-28 days	$1.82±0.02092^{a}$	$1.63±0.00086^{b}$	$1.66±0.00086^{b}$	$1.52±0.0008^{c}$	**
1-28 days	$1.82±0.01598^{a}$	$1.64±0.00149^{b}$	$1.63±0.0017^{b}$	$1.52±0.0027^{c}$	**
Survivability (%)	98.67±0.000	100±0.000	100±0.000	100±0.000	NS

Where, T_0 =0 g; T_1 =0.5 g; T_2 =1g; T_3 =2 g of ginger powder /1kg feed.

^{abcd} value in the row with similar superscripts alphabet did not differ significantly.

**=(P<0.01), *=(P<0.05), NS=(Non-significant).

Table 4.2 **Effect of ginger powder supplementation in diet of broiler on meat yield at 28 days of age**

Parameters(g)	T_0	T_1	T_2	T_3	Level of significance
Abdominal fat	2.51±0.010 [a]	1.82±0.010 [b]	1.67±0.010 [c]	1.58±0.010 [d]	**
Heart	8.28±0.5[d]	8.46±0.25[c]	9.28±0.5[b]	9.41±0.20[a]	*
Liver	41.1±0.1	43.5±1.5	42.2±1.0	46.5±0.5	NS
Gizzard	38.57±0.25	42.47±1.0	45.77±0.25	46.8±0.50	NS
Dressing yield (%)	56.16±0.0 [c]	59.63±0.015[b]	58.89±0.01[b]	60.42±0.11[a]	**

Where, T_0 =0 g; T_1 =.5 g; T_2 =1g; T_3 =2 g of ginger powder /kg feed

[abcd] value in the row with similar superscripts alphabet did not differ significantly.

**=(P<0.01), *=(P<0.05), NS=(Non-significant).

4.4 Effect of ginger powder on feed conversion ratio

Feed conversion ratio in different dietary treatments during the whole experimental period was statistically significant ($P<0.01$). At the end of the trial (28 days of age), the FCR was lowest in treatment T_3 (1.52) followed by T_2 (1.63), T_1 (1.64) and T_0 (1.82), respectively indicating that the best feed efficiency was due to optimum antioxidant activity of ginger powder at the level of 2g/kg.

Herawati and Marjuk, (2011) stated that feed conversion ratio was significantly improved ($P< 0.05$) when different levels of dietary ginger powder used in broilers 0.5, 1, 1.5 and 2% compared to the control group, being (2.15, 2.20, 2.15, 2.14 and 2.27) respectively during 35 days, which are in agreement with those of Mohamed *et al.* (2012) who found that feed conversion ratio of broilers was significantly improved ($P< 0.05$) by the supplementation of dietary ginger powder 0.2% compared to the group 0.1% and the control, which were (1.90, 1.98 and 2.25) respectively through 42 days of experimental period. On the other hand, Moorthy *et al.* (2009) did not observe any differences in the FCR of broilers fed 0.2% ginger powder compared to the control. Also El-Deek *et al.* (2002) did not find any differences between FCR of the treatments and the control in the trial (1) and (2) when used 0.05 and 0.1% ginger powder respectively in broilers diets. Ademola *et al.* (2009) noted that using high dose of ginger powder 2% had a highly significant negative impact ($P< 0.01$) on the broilers FCR compared to the treatments 1%, 1.5% and the control, (3.14, 2.71, 2.67 and 2.56 respectively) during 56 days of age,

4.5 Effect of ginger powder on survivability

Survivability of broilers fed on different dietary treatments was very high during the study period. The survivability did not vary significantly ($P>0.05$) among different treatment groups during the whole experimental period.

Al-Hamadani *et al.* (2010) used two levels of ginger powder 0.4 and 0.8% and they reported that mortality rate was zero in the group fed 0.8% ginger powder compared to the 0.4% ginger, antibiotic and control groups which were (2.27, 2.27 and 6.82 %). While Thayalini *et al.* (2011) mentioned that there was no significant difference in mortality rate of broiler chickens fed on dried *Zingiber officinale* rhizomes supplement

2% compared to the control, which is in agreement with the finding of Mohamed *et al.* (2012) who did not observe any mortality case during 42 days of experimental period when used 0.1 and 0.2% ginger powder through diet in broiler chickens.

4.6 Effect of ginger powder on meat yield

Data on carcass characteristics and organ weights are presented in Table 4.2. This study showed that fat content of broiler was decreased significantly by supplementation of ginger powder in broiler ration ($P<0.01$). Among different dietary treatments, amount of abdominal fat was lowest in T_3 (1.58g) followed by T_2 (1.67g), T_1 (1.82g) and T_0 (2.51g), respectively

Herawati and Marjuki (2011) noted when compared between control and four levels of red ginger powder that diets supplementation with 1, 1.5 and 2% red ginger powder had significant ($P>0.05$) higher carcass percentage (dressing%) (62.9, 62.9 and 64.9 %) respectively than those received 0.5% and control diet being (59.6 and 57.8%), abdominal fat percentage decreased significantly ($P>0.05$) in broilers fed diets supplemented with red ginger powder 0.5, 1, 1.5 and 2% compared to those broilers fed the basal diet, (1.87, 1.85, 1.81, 1.75 and 2.56) respectively**.**

Zhang *et al.* (2009) observed that birds fed ginger produced higher carcass weights compared to untreated birds .He suggested that improved carcass quality of broilers may be associated with the antioxidant effect of ginger which enhances protein and fat metabolism. Elmakki *et al.* (2013) reported that carcass weight was higher for birds fed with 0.25% level of ginger (1591 g), in comparison to control (1562 g). The dressing percentage was also found to be numerically higher in 0.25 % ginger powder supplemented group (75 %) and in comparison to control (74.4 %) and did not differ statistically.

CHAPTER-V

SUMMARY AND CONCLUSION

The objectives of this study were to evaluate the varying doses of ginger powder supplemented diets on broiler chicks. The feeding value of ginger powder on broiler (Cobb 500) was evaluated in the poultry shed, Hajee Mohammad Danesh Science and Technology University, Dinajpur. In a feeding trial, four diets were prepared including of ginger powder at levels of 0 g (control), .5 g, 1 g and 2 g per kg feed . Body weight and feed consumption were recorded on daily basis and weekly basis. At the last day of the experiment, a total of eight broilers were sacrificed and meat yield, dressing percentage, internal organ weight and fat content were recorded. Survivability was also recorded throughout the study.

By using experimental diets feed intake of different dietary treatments were the differences statistically significant (showed in Table 4.1). Feed consumption by the broilers during the entire experiment period in different treatment groups was recorded and expressed as g/bird. Although the rate of feed intake varied from day to day the highest feed intake (g/bird) was recorded in control group (2886.33g) followed by in treatments containing 2g (2802.2g), 1 g (2781.93g) and 0.5 g (2680.5g) level of ginger powder. Data obtained on final average body weight indicated that there was no positive correlation between body weight and feed consumption. Feed conservation ratio (FCR) was the highest at 2gm level of ginger powder (1.52) compared with other groups. The FCR values were 1.82, 1.64, and 1.63 at 0 g , .5 g , and 1 g per kg feed. The best FCR was found in T_2 (1.63) compared to control (1.82). The best FCR was found in T_3 (1.52) compared to control.

Survivability was almost similar in all dietary treatments ($p>0.05$). In this experiment, highest survivability (100%) was observed in all three group (T_1, T_2, T_3) without control group. Survivability was 98.67% at 0gm level of ginger powder. Fat content was reduced due to inclusion of ginger powder. The highest fat content was observed in control group (2.51g) and the lowest (1.58g) at 2gm level of ginger powder.

The slaughter data of broiler chicks fed experimental diets were represented in % of live weight. No significant ($p>0.05$) effect was observed for internal organs (liver and gizzard) weight of broilers fed experimental rations but there was significant ($P<0.05$)

difference found on heart and dressing yield. The highest dressing yield (60.42%) was found in T_3 (2 g) and the lowest value (56.16%) found in control group.

Based on the results of the present study, it may be concluded that ginger powder supplemented at a level of 5 g has significant effect on body weight gain, FCR, abdominal fat content, and survivability of broiler, except feed intake and dressing percentage. The results of the study also suggest that the supplementation of ginger powder at 2 g level in diets has high potential as commercial applications for production performance of broiler. Therefore, ginger powder can be used along with the other conventional feed ingredients. However, further research to investigate the effect of different levels of ginger (*Zingiber officinale*) in layers and breeders is recommended.

REFERENCES

Ademola, S.G,. G.O. Farinu and G.M. Babatunde (2009). Serum lipid, growth and hematological parameters of broilers fed garlic, ginger and their mixtures. World Journal of Agricultural Sciences. 5 (1): 99 –104.

AL- Jaheel, R. A. Abd (2012). Use of tumeric (Curcuma longa) on the performance and some physiological traits on the broiler diets. The Iraqi J. Vet. Med., 36(1): 51-57.

Al-Hamadani, A. A., I. Nadhum and A. Nadhum (2010). The effect of diet supplementation with antibiotic and ginger on broiler performance. Al-Anbar Journal of Agricultural Sciences. 4 (8): 1 – 10.

AL-Homidan, A. A. (2005). Efficacy of using different sources and levels of *allium cepa, allium sativum* and *zingiber ofjicinale* on broiler chick's performance. Saudi Journal of Biological Sciences. 12 (2): 96 - 102.

Anonymous1999, C. E. Allen (1973). Ginger rhizome: A new source of proteolytic enzyme. J. Food Sci. 38:652–655.

Arkan, B. M.; Al-Rubaee, M. A. M. and Ali, Q. J. (2012). Effect of ginger on performance and blood serum parameters of broiler. Int. J. Poultry. Sci., 11(2): 143- 146.

Arshad, M., A. H Kakar, F. R. Durrani, A. Akhtar, Shakirullah, Sanaullah and M. Niamatullah (2012). Economical and immunological impact of ginger (z. Officinale) extract on broiler chicks. Pakistan Journal of Science. 64(1): 46-48.

Awang, D. V. C. 1992. "Ginger." *Can. Pharm. J*. 125:309–311. Bhandari, U., J. N. Sharma, and R. Zafar. 1998. "The protective action of ethanolic ginger (Zingiber officinale) extract in cholesterol fed rabbits

Badreldin, H.A., B. Gerald, O.T. Musbah and N. Abderrahim (2008). Some phyto-chemical, pharmacological and toxicological properties of ginger (zingiber officinale roscoe): a review of recent research. Food Chemistry and Toxicology. 46: 409–420.

Barazesh, H.; Pour, M. B.; Salari, S. and Abadi, T. M. (2013).The effect of ginger powder on performance, carcass characteristics and blood parameters of broilers. Int. J. Adv. Biom. Res., 1(12): 1645-1651. References iii BIS (1992).

Poultry Feed Specification: IS: 1374 (4th revision).

Bliddal, H.; Rosetzsky, A.; Schlichting, P.; Weidner, M. S. and Andersen, L. A. (2000). A randomized, placebo-controlled, cross over study of ginger extracts and ibuprofen in osteoarthritis. *Osteoarthritis Cartilage,* 8(1): 9-12.

Dieumou, F.E., Teguia, A., Kuiate, J.R., Tamokou, J.D., Fonge, N.B., Dongmo, M.C. (2009) Effects of ginger and garlic essential oils on growth performance and gut microbial population of broiler chickens. Livest Res Rural Dev. 21: 25-34.

Dubichev *et. al,* (1991). Medicinal herbs with their formulation. Volume 1- *Allium sativum*¸ Daya Publishing House, Delhi,110035.

Ebrahimnezhad, Y.; Azarakhsh, V. and Salmanzadeh, M. (2014). The effects of ginger root (Zingiber officinale) processed to different levels on growth performance, carcass characteristics and blood biochemistry parameters in broiler chickens. Bull. Env. Pharmacol. Life Sci., 3(5): 203-208.

El-Deek, A.A., Y.A. Attia, M. Maysa, and M. Hannfy. (2002). Effect of anise (Pimpinella anisum), ginger (Zingiber officinale Roscoe) and fennel (Foeniculum vulgare) and their mixture on performance of broilers. *Arch. Geflugelkd.* 67: 92–96

Elmakki, A. M.; Khadig A.; Dousa, B. M.; Elagib, H. A. A.; Huwaida E. E. M. and Khalid M. E. (2013). Effects of dietary ground ginger (Zingiber officinale) root additive on broiler performance. Global J. Animal. S. Res., 1(1): 76-83.

Farinu, G.O., S.G. Ademola, A.O. AjayiObe, and G.M. Babatunde. (2004). Growth, haematological and biochemical studieson garlic and ginger-fed broiler chickens. *Moor. J. Agric. Res.*, 5: 122–128

Ferreira, L. A. F.; Henriques, O. B.; Andreoni, A. A. S.; Vital, G. R. F.; Campos, M.; Habermehl G. G. and De Moraes, V. L. G. (1992). Antivenom and biological effects of arturmerone isolated from Curcuma longa (Zingiberaceae). Toxicon, 30: 1211-1218.

Herawati 2010."The effect of feeding red ginger as phytobiotic on body weight gain, feed conversion and internal organs condition of broiler."*Int. J. Poult. Sci*. 9: 963-967.

Herawati and Marjuki, (2011). The effect of feeding red ginger (*zingiber officinale* rosc) as phytobiotic on broiler slaughter weight and meat quality. International Journal of Poultry Science. 10 (12): 983-985.

Herawati Veterinary Medical School University of Brawijaya Malang 65145 Indonesia (2010). The Effect of Red Ginger as Phytobiotic on Body Weight Gain, Feed Conversion and Internal Organs Condition of Broiler. *Int. J. Poult. Sci.*, 9(10): 963 – 9

Herawati. 2006. "Effect of red ginger (Zingiberofficinale Rosc) phytobiotic addition to the broiler performance and blood profile." *Pengaruh Penambahan Fitobiotik Jahe Merah*. 14: 173-142.

Jakes and Susan 2007 Yi (2003). Effects of Isolmalto ligosaccharides on Broiler Performance and Intestinal Micro flora. Poultry Science. 82: 657-663.

Javed, M., Durrani, F., Hafeez, A., Khan, R.U., & Ahmed, I. (2009) Effect of aqueous extract of plant mixtures on carcass quality of broiler chicks. ARPN Journal of Agricultural and Biological Science 4: 37-40. Javendel, F., Blaridshad, B., Seifarati, J., Pourrahimi

John and Ferria (1997). Effects of z. Officinale and propolis extracts on the performance, carcass and some blood parameters of broiler chicks. Current Research in Poultry Science. 1 (1): 12 –23.

Ke *et. al*.2000 ., Zhou, H. (2009), Influences of flavomycin, ropadiar and saponin on nutrient digestibility, rumen fermentation and methane emission from sheep. *Anim. Feed Sci. Technol., 148, 157-166*

Kehinde, A. S., C. O. Obun, M. Inuwa and O. Bobadoye (2011). Growth performance, haematological and serum biochemical indices of cockerel chicks fed ginger (zingiber officinale) additive in diets. Animal Research International. 8 (2): 1398 –1404.

Kikuzaki, H. and Nakatani, N. (1993). Antioxidant effects of some ginger constituents. J. Food Science, 58: 1407-1410.

Kokestsu *et. al.* (1997). Effect of dietary supplemental plant extracts on performance, carcass characteristics, digestive system development, intestinal microflora and some blood parameters of broiler chicks. Proceedings of 12th European Poultry Conference, Sept. 10 –14, Verona, Italy, Pp: 307 –308.

Leverringtan 1969 ,Abdel Atti KHA, Dousa BM, Mahala AG (2012). The effect of ginger root powder (*Zingiber officinale*) Supplementation on broiler chicks performance

Lueng, A. Y. and S. Foster (1996). Encyclopedia of commonnatural ingredients used in food, drug, cosmetics. Second Edition. New York, NY: Wiley & Sons.

Macleod and pienis (1984). The essential oil of ginger from Fiji. Phytochemistry, 20: 203-206.

Mishra SJ, Singh DS. Effect of feeding root powder of *Withania somnifera* (L.) Dunal (aswagandha) on growth, feed consumption, efficiency of feed conversion and mortality rate in broiler chicks. Bioved (Annual). 2000; 11:79-83

Mohamed, A. B., M. A. M. Al-Rubaee and A. Q. Jalil (2012). Effect of ginger (*zingiber officinale*) on performance and blood serum parameters of broiler. International Journal of Poultry Science. 11 (2): 143-146.

Mohammed, A. A. and Yusuf, M. (2011). Evaluation of ginger (Zingiber officinale) as a feed additive in broiler diets. Livestock Res. Rural Dev., 23(9): 1-5.

Moorthy, M., S. Ravi, M. Ravikumar, K. Viswanathan and S. C. Edwin (2009). Ginger, pepper and curry leaf powder as feed additives in broiler diet. International Journal of Poultry Science. 8 (8): 779 –782.

Nambrudu *et. al.*1975, V. K. (2011). Effect of ginger (*Zingiber officinale*) powder supplementation on growth performance of commercial broilers under field conditions. Himachal J. Agri. Res., 37(1): 75-80.

Natrajan *et. al*, 1972 Dousa BM, Mahala AG (2013). The effect of dietary ginger root powder (*Zingiber officinale*) on broiler chicks' performance, carcass characteristic and serum constituents. J. Anim. Sci. Adv. 3:42-47

NRC (1994). National Research Council, Nutrient Requirements of Poultry. 9th Edition, National Academic Press, Washington. Okoleh, O. V. U.; Chukwu, G. C. and Adeolu, A. I. (2014). Effect of ground ginger and garlic on the growth performance, carcass quality and economics of production of broiler chickens. Global J. Biosci. & Biotechnol., 3(3): 225-229

Onu PN (2010). Evaluation of two herbal spices as feed additives for finisher broilers. Biotechnol. Anim. Husb. 26(5-6):383-392

Platel, K. and K. Srinivasan (1996). Influence of dietary spices or their active principles on digestive enzymes of small intestinal mucosa in rats. International Journal of Food Science and Nutrition. 47: 55 – 59.

Platel, K. and K. Srinivasan (2000). Influence of dietary spices and their active principles on pancreatic digestive enzymes in albino rats. Nahrung. 44: 42 – 46.

Pruthi 2000. Gai, and Y.F. Yang. (2008). Effect of superfine grinding on properties of ginger powder. *J Food Eng.*, 91: 217–2Farinu, G.O., Ademola, S.G., Ajayi, A.O., Babatunde, G.M. (2004) Growth, haematological and biochemical studieson garlic and ginger-fed broiler chickens. Moor J Agric Res. 5: 122–128

Purseglove et. Al. (1998). Determination of the effects of z. Officinale and propolis extracts on intestinal microbiology and histological characteristics in broilers. International Journal of Poultry Science. 9 (9): 898-906.

Singh, M.P. and Panda, H. (1992). Medicinal herbs with their formulation. Volume 1-*Allium sativum*¸ Daya Publishing House, Delhi,110035.

Smith, R. M. and Robinson, J. M. (1981). The essential oil of ginger from Fiji. Phytochemistry, 20: 203-206.

Stewart and wood 1991 Wang, Y., Jiang, S. Z. and Gai, G. S 2009. Effects of ginger root processed to different particle sizes on growth performance, antioxidant status, and serum metabolites of broiler chickens. *Poult. Sci.* 88:2159-2166.

Tekeli, A., H. R. Kutlu and L. Celik (2011). Effects of z. Officinale and propolis extracts on the performance, carcass and some blood parameters of broiler chicks. Current Research in Poultry Science. 1 (1): 12 –23.

Tekeli, A., H. R. Kutlu, L. Celik and F. Doran (2010). Determination of the effects of z. Officinale and propolis extracts on intestinal microbiology and histological characteristics in broilers. International Journal of Poultry Science. 9 (9): 898-906.

Tekeli, A., L. Çelik, H. R. Kutlu and M. Görgülü (2006). Effect of dietary supplemental plant extracts on performance, carcass characteristics, digestive system development, intestinal microflora and some blood parameters of broiler chicks. Proceedings of 12th European Poultry Conference, Sept. 10 –14, Verona, Italy, Pp: 307 –308.

Thayalini, K., S. Shanmugavelu, P. M. Saminathan, M. S. Siti Masidayu, Y. Nor Idayusni, H. Zainuddin, C. A. Nurul Akmal, and H. K. Wong (2011). Effects of *cymbopogon citratus* leaf and *zingiber officinale* rhizome supplementation on growth performance, ileal morphology and lactic acid concentration in broilers. Malaysian Journal of Animal Science. 14:43-49.

Thompson, E. H., I. D. Wolf, and C. E. Allen (1973). Ginger rhizome: A new source of proteolytic enzyme. J. Food Sci. 38:652–655.

Wadhwa, D.; Kumari, M.; Sharma, K. S. and Sharma, V. K. (2011). Effect of ginger (Zingiber officinale) powder supplementation on growth performance of commercial broilers under field conditions. Himachal J. Agri. Res., 37(1): 75-80.

Wang, C.J., Wang, S.P. and Zhou, H. (2009), Influences of flavomycin, ropadiar and saponin on nutrient digestibility, rumen fermentation and methane emission from sheep. *Anim. Feed Sci. Technol., 148, 157-166*

Yiljep *et. al.* 2005 , M. S. Siti Masidayu, Y. Nor Idayusni, H. Zainuddin, C. A. Nurul Akmal, and H. K. Wong (2011). Effects of *cymbopogon citratus* leaf and *zingiber officinale* rhizome supplementation on growth performance, ileal morphology and lactic acid concentration in broilers. Malaysian Journal of Animal Science. 14:43-49.

Zhang, G. F., Yang, Z. B., Wang, Y., Jiang, S. Z. and Gai, G. S 2009. Effects of ginger root processed to different particle sizes on growth performance, antioxidant status, and serum metabolites of broiler chickens. *Poult. Sci.* 88:2159-2166.

Zhang, W.F., D.F. Li, W.Q. Lu and G.F. Yi (2003). Effects of Isolmalto ligosaccharides on Broiler Performance and Intestinal Micro flora. Poultry Science. 82: 657-663.

Zhao, X.Y., Z.B. Yang, G.S. Gai, and Y.F. Yang. (2008). Effect of superfine grinding on properties of ginger powder. *J Food Eng.*, 91: 217

Zomrawi WB, Abdel Atti KAA, Dousa BM, Mahala AG (2013). The effect of dietary ginger root powder (*Zingiber officinale*) on broiler chicks' performance, carcass characteristic and serum constituents. J. Anim. Sci. Adv. 3:42-47

Zomrawi WB, Abdel Atti KHA, Dousa BM, Mahala AG (2012). The effect of ginger root powder (*Zingiber officinale*) Supplementation on broiler chicks performance, blood and serum Constituents. J. Anim. Feed Res. 1(6):457-460.

Zomrawi, W. B.; Abdel atti, K. A.; Dousa, B. M. and Mahala, A. G. (2011). The effect of ginger root powder (*Zingiber officinale*) supplementation on broiler chicks performance, blood and. serum constituents. *J. Anim. & Feed Res.*, 1(6): 457-460

CHAPTER-I
INTRODUCTION

Broiler is an excellent source of protein to nourish human health. Poultry production system has triggered the discovery and widespread use of a number of “feed additives”. The broiler industry in Bangladesh is developing rapidly and its success depends on how rapidly a bird attains maximum marketable weight. The principle of poultry production is to achieve high level of performance through efficient utilization of feed keeping survivability as maximum as possible. The main objective of adding feed additives are increasing their growth rate, better-feed conversion efficiency, greater livability and lowered mortality in poultry birds. These feed additives are termed as "growth promoters" and often called as non-nutritive feed additives **(**Singh and Panda**,** 1992**).** Growth promoters are chemical and biological substances, which are added to livestock feed with the aim to improve the growth of chickens in fattening, improve the utilization of feed and in this way realize better production and financial results. Their mechanism of action varies. Positive effect can be expressed through better appetite, improved feed conversion, stimulation of the immune system and increased vitality, regulation of the intestinal micro-flora, etc.

Ginger (*Zingiber officinale*) is a perennial herb which is used widely as a spice, for pickles, candies, preservatives and many medicinal purposes. The plant belongs to the family Zingiberaceae; which are aromatic herbs with fleshy, tuberous or nontuberous rhizomes and, often have tuber bearing roots (Ke *et al.,* 2000). The rhizome contains a spectra of biologically active compounds such as curcumin, 6 gingerol i.e., [5-hydroxy-1-4-hydroxy-3-methoxy phenyl), 6-shogoals, zingiberene, bisaboline and several other types of lipids that confers on ginger the characteristic medicinal properties of being pungent and a stimulant **(**Bliddal *et al.,* 2000). The major components of ginger are zingiberen and zingerol that can stimulate the digestive system by controlling the digestive pH and the activity of digestive enzyme including microbial activity. Ginger has also been known to have antioxidant activity due to presence of gingerol-related compounds and diarylheptanoids **(**Kikuzaki and Nakatani, 1993). Ginger as a natural feed additive may be of immense benefit and value in poultry nutrition especially for broilers due to their antibacterial, anti-inflammatory, Introduction…. 4 antiseptic, anti-

parasitic and immunomodulatory properties **(**Onu, 2010). Ginger is one of the natural plants which can be used as phytobiotic to improve broiler's performance.

The significant biological properties of ginger powder make it a potential substitute for in feed antibiotics in livestock diets. A number of studies have been conducted to evaluate its effect on the performance of broiler chickens, laying hens and rabbits. There is growing interest in developing natural alternatives to antibiotic growth promoters in order to maintain both bird's performance and health. In the last decade, ginger has been extensively used in poultry diets. Wide range medicinal properties of this plant have been advocated. In poultry feed, ginger has been extensively used in different concentrations, dosages and durations.

Considering the above things, the objectives of the present study are:

1. To study the effect of supplementation of ginger powders on body weight ,feed intake and feed conversion ratio of broiler .
2. To study the effect of supplementation of ginger powders on carcass characteristics of broiler

CHAPTER-II
REVIEW OF LITERATURE

2.1 Composition and Nutritional value of Ginger

In Bangladesh, ginger is widely used as spice, it has high medicinal value and used in Allopathic and Hamdard medicine

The bulk of ginger produced is often exported from the producing areas in processed form as dried ginger powder and extracts. Badreldin *et al.,* (2008). In world trade, the quality of ginger rhizome is majorly based on its aroma, pungency; the primary chemical components of ginger responsible for these sensory quality attributes are the volatile (essential oils) and non volatile (oleoresin). Other constituents are fat, protein, carbohydrate, vitamins (C and B) and minerals (potassium, calcium, magnesium). Ginger rhizomes also contain proteolytic enzyme called zingibain (Stewart and Wood, 1991). These chemical components are influenced by factors such as the specie, variety, maturity and processing conditions.

According to Jakes and Susan (2007), dried ginger is traded traditionally in whole split form is used in wide range of foods when grounded into powdery form and used for preservation of meat, baking spice, soups and puddings. Most of the world's ginger is processed into concentrates for the manufacture of ready-to-serve ginger drinks which can be alcoholic or non-alcoholic; (Yiljep *et al.,* 2005; Jakes and Susan, 2007).

Yiljep *et al.* (2005) Oven dried sliced ginger gave the highest quantity of volatile oil (1.36%) which is in agreement with result from that dried ginger yield 1-3% volatile oil.

Pruthi (2000) found that dry ginger has the composition of moisture 6.9%, protein 8.6%, fat 6.4%, fibre 5.9, carbohydrate 66.5%, ash 5.7%, calcium 0.1%, phosphorus 0.15%, iron 0.011%, sodium 0.03%, potassium 1.4%, vitamin A175 IU/100 gm, vitamin B1 0.05 mg/100 gm, vitamin B2 0.13 mg/100 gm, niacin 1.9%, vitamin-C 13 mg/100 gm and calorific value (food and energy) 380 k cal/100 gm.

Anonymous (1999) reported that the proximate nutrient composition of (per 100 gm) ginger are moisture 80.9 gm, minerals 1.2 gm, fiber 2.4 gm, energy 67 kilocalories,

protein 2.3 gm, fat 0.9gm, calcium 20 mg, iron 2.6 mg, carotene 40 µgm, vitamin B1 0.06mg, vitamin B2 0.03mg, vitamin-C 6mg.

Purseglove *et al.,* (1998) found that the crude fiber content of unpeeled may be as high as 10 percent (on a dry basis), but in commercial dried ginger it is usually 1-3 percent. The volatile oil content of commercial dried gingers has been reported to be 0.5-4.4 percent, but for the major types the range is usually 1-3 percent. The abundance of the pungent constitute, the gingerols, in dried ginger is less certain owing to inadequacies in current analytical methods, but it is probably in the range of 1-2 percent for freshly prepared commercial dried ginger.

Commercial dried gingers have been reported to provide oleoresins in yields of 3.5-10 percent and to contain 15-28 percent of volatile oil. The pungent principle content of the oleoresins in again less certain owing to short comings in analytical methods but it is believed to be in the range of 17-28 percent for fresh extracts (Nambudri *et al.* 1975). Nobriga *et al.,* (1997) reported the chemical composition of ginger (Zingiber offcinale roscoe) essential oils extracted either with ethanol, isopropanol or supercritical CO_2 was determined and compared. Frozen ginger was cut, ground in a domestic foods processor and dried to 14% moisture particle size distribution was determined in a sieve shaker with 648 mesh sieves organic.

John and Ferreria (1997) reported statistically significant differences ($p<0.05$) in mass in fresh rhizomes, moisture and crude fiber content but not in the oleoresin and ginger oil content. In Brazilian ginger, the mass of fresh rhizomes with high moisture contents but lowest in the crude fiber on wet basis. In Taiwan ginger, they recorded that a high crude fiber content of 6.8% on dry basis the best results in terms of oleoresin (3.06%) and oil (0.52%) contents, however the dry ginger recovery was highest (27.5%) with West Indies ginger. Thus among these studied Brazilian ginger gave better results for early harvesting ginger industry for the drying and extraction industries respectively, the selection of West Indies ginger and Taiwan ginger are preferable.

Koketsu, *et al.,* (1997) conducted studies on 2 grades of ginger produced in Brazil, ginger (large rhizomes) and calpira (small rhizomes). Data are given for proximate composition volatile and non-volatile extract content of the rhizome essential oil yield, and density, refractive index, optical rotation and composition of the essential oil. Brazilian ginger essential oils tended to have a lemon aroma note, attributable to

presence of citral, this aroma note was more marked for ginger than for caipira samples and paroled differences in citral content. No evidence of varieties within the gigantic group was observed.

Dubichev *et al.* (1991) reported that the mean biologically active compounds found in the rhizome were salidroside, rosiridin and the cinnamyl glycosides rosavine, and rosine. The content of resaving in fresh rhizomes from roseroot stonecrop plants cultivated in Moscow province was 2%. This decreased rapidly during storage of rhizomes, during pulping and extraction owing to auto fermentation, reaching e.g. 0.29% after 28 min at 40^0C. Negligible change occurred in the contents of the glicosides or rosanin, whose only difference from rosavin is that its terminal arabinose residue is furanose rather than pyranose.

Macleod and pienis (1984) examined Sidda and Chinese varieties and prepared essential oils of both fresh and dried samples. Both varieties had relatively high oil content (between 1.8 and 4.3%) and total aroma volatiles (about 5 mg/g for dried samples). Analysis showed tarpenes were the main aroma components. A number of the identified volatiles have not previously been reported, including trans-beta-ocimene ethyl alcohol, terpinen-4-01, myrtenal, gualene, alphacubene, and delta-cadinene found. On dying, both varieties showed considerable decease in monoterpene content and sharp increase in sesquiterpenes. Comparing the aroma volatiles of Srilankan dried ginger with those reported from other countries, it was concluded the Srilankan dried ginger showed high levels of ar-curcumese together with reasonable levels of citral isomers and all other constituents previously claimed to be important to ginger aroma; also it is apparently unusual in containing very low amounts of gingering but very high amounts of beta-bisabolenc.

Natrajan *et al.* (1972) reported that in 26 varieties of ginger, ranges were volatile oil 1 to 2.7, acetone extract 3.9 to 9.3, crude fiber 4.79 to 9.8 and starch 40.4 to 50%. contents of first 3 increased steadily from September to December. Peeling for 60s in abrasive peeler was conductive to the production of high ginger, but hand peeler ginger was bitter in uniform size and color. The optimum temperature for drying of ginger was 60^0C. The fatty acid of oil in dried sample contained saturated and unsaturated fatty acids in a ratio of 46:53; and the major component acids were found to be palmitic, oleic and linoleic acids, each having a relative abundance of about 23 percent. By

contrast, a qualitative analysis of fourteen Indian cultivars revealed a predominance of saturated acids in the fatty oil, and linoleic acids as the major individual fatty acid. The second subject concerned the flavor of preserved ginger**.**

Leveringtan (1969) has attributed the characteristic fermented flavor of Chinese ginger to yeast formation which proceeds either during the scraping stages or during the subsequent storage period.

Leung et al.(1972) reported that the proximate nutrient composition of (per 100 gm) ginger are food energy 46 Cal, moisture 87.4 gm, protein 1.6 gm, fat 0.8 gm, total carbohydrate 9.2gm, ash 1 gm, calcium 19 gm, phosphorus 32 mg, iron 1.3 mg, potassium 316mg, beta-carotene equivalent 55Sµg, thiamine 0.01mg, riboflavin 0.03mg, niacin 1.7mg , ascorbic acid(Vit-C) 4mg. Dry ginger has the composition of food energy 281 Cal, moisture 10.2gm, protein 7.6gm, fat 2.6gm, total carbohydrate 72.4gm, as 6.9gm, calcium 180mg, beta-carotene equivalent102µg, thimine0.16mg, riboflavin0.27mg, niacin .4mg, scorbic acid (Vit-C) 0mg.Solvent extraction was carried out in duplicate for 1-6 hrs with constant shaking, using 10-100 ml solvent; the leached phase was weighed and the clear oleoresin extracts and analyzed. For super critical CO_2 extraction, the dried ginger samples were extracted in a semi-continuous fixed bed extractor for $\leq$ 3 hrs at 160^0C and 70 bar with solvent flow rate 5.3±0.1 g CO_2/minute. Ethanol and isopropanol extracts (2 hrs) had the same composition (irrespective of solvent vol), and contained monoterpenes, sesquiterpenes and fatty acids.

After 4 hrs, gingerols were also found in small amounts in the ethanol. After 6 hrs, supercritical CO_2 extracts differed from organic solvent extracts, with no oc-pinene, camphene on 0 pinene detected after 1 on 2 hrs extraction. After 1 and 2 hrs CO_2 of extraction, concentration of gingerol was much higher (14.07 and 80.71% of total, extract, respectively) than in the ethanol and isopropanol extracts (1.32-3.81%). It is suggested that the much higher gingerol concentration of the 2 hrs CO_2 extract could be the due to a vacuum pressure effect during depressurization of the system, which could have promoted cell rupture and gingerol extraction.

Table 2.1 Composition of fresh ginger:

Composition	Quantity (per 100 gm)
Water	78.89 g
Energy	80 calorie
Energy	333 Kcal
Protein	1.82 g
Total lipid (fat	0.75 g
Ash	0.77 g
Fiber, total dietary	2.0 g
Sugars, total	1.70 g
Calcium, Ca	16 mg
Iron, Fe	0.60 g
Magnesium, Mg	43 mg
Phosphorus, P	34 mg
Potassium, K	415 mg
Sodium, Na	13 mg
Zinc, Zn	0.34 mg
Copper, Cu	0.226 mg
Manganese, Mn	0.229 mg
Selenium, Se	0.7 mcg
Vitamin C	5.0 mg
Thiamin	0.025 mg
Riboflavin	0.034 mg
Niacin	0.750 mg
Pentothanic acid	0.203 mg

2.2 Feed consumption and efficiency in poultry

Feed cost represents approximately 60 –70% of the total cost of production for the most classes of livestock and the improvement of the feed efficiency should be a major consideration of the breeding and feeding programs. To investigate the effect of ginger

on the feed consumption, many studies were conducted. Feed intake was noted that significantly decreased in treated broilers compared to the not supplement broilers during the grower period (day 11to 22) and Whole trial (Day 0 to 28) although the differences was not statistically during the starting (day0to 10) and finisher (day 23to28) periods. Consequently, feed conversion ratio was significantly improved in ginger supplemented broilers for the starter, finisher and whole periods.

Herawati and Marjuk (2011) used different levels of ginger powder 0.5, 1, 1.5 and 2% in the diets of 5 days old Hubbard strain broiler chicken, feed consumption was significantly (P< 0.01) decreased in a group fed 2% ginger compared to the control group being (3966.7 and 4180 g/bird) respectively through 5 weeks of experimental period, while feed consumption was significantly (P< 0.01) increased in the group received 0.5% being (4405.5g), but there were no significant differences in the feed consumption of groups fed 1 and 1.5% of ginger powder when compared to the control group.

Mohamed *et al.* (2012) stated that feed consumption of broiler chickens was significantly (P< 0.05) decreased by the supplementation of dietary ginger powder at levels 0.1 and 0.2% compared to the control, being (2852.66, 2791.67 and 2909.62 g/bird) respectively over 42 days.

Also Arshad *et al.* (2012) reported that using ginger extract (40 and 50) ml/liter through drinking water of broilers caused a significant (P< 0.05) decrease in the feed intake per bird compared to the Chapter Two Review of Literature 15 control, being (2243g, 2302g and 2399g) respectively. Using 2 and 6% of ginger powder in the broiler diets did not affect the daily feed consumption during the period 1 –6 week, but from 6 –7 weeks of age, the level 6% had a significant positive effect (P< 0.05) on the daily feed consumption compared to group 2% and the control, being (121g, 147.5g and 154g) respectively (Al-Homidan, 2005).

Tekeli *et al.* (2011) showed that feed consumption increased significantly (P< 0.05) in groups fed on antibiotic and 240 ppm ginger compared to the group which fed control diet through the experimental period 1 –42 days, (3970.13, 3909.71 and 3334.86 g/bird) respectively.

Moorthy *et al.* (2009) concluded that using 0.2% ginger in the broiler diets did not affect the feed intake.

Similar results were found by El- Deek *et al.* (2002) when they used 0.05% of ginger powder in broiler diets and did not find any effect on feed intake. The same researchers in the trial 2 used 0.1% of ginger powder in the broiler diets but there were no differences in the levels of feed intake between treatments and control.

These results were in agreement with those of Ademola *et al.* (2009) who reported that using 1, 1.5 and 2% of ginger powder in broiler diets had no significant effect on feed intake. Similar results were obtained by Kehinde *et al.* (2011) when they used different levels of ginger 1.5, 3 and 4.5% and there were no differences in the levels of feed intake of cockerel chicks. A

Incharoen (2009) feed dried fermented ginger (1and 5%) to White Leghorn laying hen and found that feed consumption and FCR tended to increase in ginger fed groups. Likewise, the use of 2% red ginger in ration of broiler chickens has resulted in higher feed intakes and FCR (Herawati, 2010).

Onu (2010) reported that the addition of ginger (0.25%) broiler chicks in the basal diet of broiler chicks resulted in improved FCR although feed intake did not change.

Ginger has been found to increase secretion of gastrointestinal enzymes including lipase, disaccharide and maltase (Zhang *et al.*, 2009).

Zhao *et al,* (2008/2011) reported that ginger enhances animal's nutrient digestion and absorption because of its positive effect on gastric secretion, enterokinesia and digestive enzyme activities.

An experiment was conducted by Barazesh *et al.* (2013) on 192 commercial broiler chicks for 42 days. There were 4 treatments with 4 replicates and each replicate contained 12 chicks. The treatments T_1, T_2, T_3 and T_4, contained 0.0, 0.50, 1.00, and 1.50 % of ginger powder, respectively in the basal diet. The results showed that increasing levels of dietary ginger powder lead to a significant reduction in feed intake. The treatment with 0.50 % ginger powder during the sixth week showed the highest

feed intake (891.36 g) than the other groups 0.0 % (819.43 g), 1.00 % (732.11 g) and 1.50 % (817.08 g) but the differences between treatments were not significant.

Elmakki *et al.* (2013) evaluate the effect of ground ginger root (Zingiber officinale) addition in the diet of broiler chicks 160 day old boiler unsexed chicks (COBB strain) were reared till 42 days of age. Four experimental diets contained 0, 0.25, 0.50, and 0.75 % ground ginger root powder. Dietary incorporation of ginger had no significant effect on feed intake in the first four weeks. Data revealed the significant decrease in feed intake by broilers fed 0.50 % ginger powder containing diet (841.0 g and 777.0 g in the 5th and 6th week, respectively) in comparison to other treatments, whereas the chicks fed 0.0 % (884.0 g and 835.0 g), 0.25 % (884.0 g and 938.0 g) and 0.75 % (928.0 g and 809.0 g) ginger powder in 5th and 6th week, respectively did not differ significantly ($p < 0.05$) from each other.

Ahmed *et al.,* 2014 targeted to know the effect of addition of ginger root powder as natural feed additive on feed intake in broilers **(**One hundred and sixty unsexed one day-old broiler chicks strain (Ross) were divided randomly into four groups following completely randomized design. Each group represented a treatment having 4 replicates (10 birds under each replication). The four diets were formulated to meet the nutritional requirements of broiler chicks according to NRC (1994) having 0.0, 0.50, 0.75 and 1.00 % levels of ginger root powder, respectively. No significant difference was observed in total feed intake (2266.1 g, 2432.6 g, 2396.3 g and 2443.6 g), respectively for broilers under different treatments.

Arkan *et al.,* 2012 was conducted a study to explore the effect of incorporation of ginger at 0.0, 0.10 and 0.20 % levels in the diets on feed intake of broiler chicks One hundred and eighty, 3 weeks old broiler chicks (ROSS) were distributed into 3 treatment groups with three replicates per treatment and 20 birds per replicate (10 males + 10 females). The broilers received T_3 diet (0.20 % ginger) consumed significantly less feed (2791.67 ± 8.54 g) in comparison to diet T_2 (2852.66 ± 11.01 g) and control (2909.62 ± 10.12 g).

An experiment was conducted to know the feed intake of broilers fed diet supplemented with red ginger (Zingiber officinale Rosc) as phytobiotic by Herawati (2010). Two hundred broiler chickens of 5 days old were divided into 5 different feed treatment groups, namely: control group without red ginger (R-0) and treatment groups

containing 0.50 (R-0.50), 1.00 (R-1.00), 1.50 (R-1.50) and 2.00 % (R-2.0) of red ginger, respectively. Each group was divided into 5 sub groups as replication, consisted of 8 chickens under each. The chickens were raised for five weeks. Feed consumption was daily measured in each sub-group. The results showed that supplementation of red ginger reduced total feed intake ($p < 0.05$) at 1.00 % (4,108.00 g/head), 1.50 % (4,196.50 g/head), 2.00 % (3,966.70 g/head), but there was improvement in feed intake at level of 0.50 % (4, 4054.50 g/head) as compared to control (4,180.00 g/head).

2.3 Growth performance and body weight gain

A study was conducted on 3 weeks old 180 broiler chicks by Arkan *et al.* (2012**)** which were raised up to 6 weeks of age. The ginger powder was supplemented at the rate 0.10 and 0.20 % level in their diets under T_2 and T_3, respectively while T_1 Review of Literature….. 15 served as control. The differences for body weight gain were significantly higher (1467.42 ± 11.08 g) for broiler chicks fed diet with 0.20 % ginger as compared to control (1289.17 ± 13.10 g).

In another study supplementation of ginger powder at 1.50 % (459.96 g) level in diet significantly increased body weight gain as compared to control (357.00 g) at fifth weeks of age in broilers (Barazesh *et al.*, 2013).

Similar findings were also observed by Herawati (2010) for body weight gain in broilers when 1.50 % level of ginger powder was supplemented ($p < 0.05$) in their diet (1,955.53 g/head) in comparison to the broilers received the control (1,899.71 g/head) diet while the other treatments containing 0.50 % (1,888.44 g/head), 1.00 % (1,858.25 g/head) and 2.00 % (1,859.50 g/head) level of ginger powder did not differ significantly.

Elmakki *et al.* (2013) reported that weight gain in broilers was affected by inclusion of different levels of ginger in their diet for three weeks at the levels of 0.0, 0.25, 0.50 and 0.75 %. Total weight gain of the group at 0.75 % (1918 g) was significantly lowered than control (2035 g). While the weight gain in other two groups was similar to control group i.e. 2035 g.

The result of a study conducted by Ahmed *et al.* (2014) in broilers reveled no significant differences ($p > 0.05$) in the final body weight (1103.3 g, 1140.2 g, 1141.2 g and 1146.9 g) as well as body weight gain (1064.3 g, 1101.2 g, 1102.2 g and 1107.8 g)

among the four treatments supplemented with graded levels of ginger root powder at 0.50, 0.75 and 1.00 %.

Zomrawi *et al.* (2012) reported significant decrease ($p < 0.05$) in weight gain for birds fed 0.50 % (1267.47 g) ginger root powder in relation to control (1447.56 g).

In an another study conducted by for 49 days of experimental period on broiler chicks, also revealed significant variations ($p < 0.05$) for final body weight when ginger (2168.75 g) and garlic (2475.00 g) powders were supplemented in the diet Review of Literature….. 18 at 14 g/kg as compared to control (1950.0 g) and also in daily body weight gain (261.43 g, 292.86 g and 336.45 g) under control, ginger and garlic, respectively**.**

Kehinde (2011) elicited that ginger supplementation at 0.0 (23.37 ± 1.24 g), 1.50 (23.70 ± 1.41 g), 3.00 (24.67 ± 1.38 g) and 4.50 % (23.37 ± 1.40 g) had no significant effect on weekly weight gain.

Onu(2010)reported that the addition of ginger (0.25%)broiler chicks in the basal diet of broiler chicks resulted in higher body weight and lower FCR.
Farinu *et al.* (2004) reported that supplementation of ginger at the levels of 5,10, or 15 g/kg slightly improved growth in broilers.

2.4 Effect on feed conversion ratio (FCR):

Feed conversion is an index associated with both feed consumption and weight gain and well known that broiler chickens are more efficient in conversion feed than other farm animals. Many medicinal herbs used in human diet which are known as “spices” and improve digestibility. The same property can be used in poultry to increase the FCR which results in increasing body weight and more profit (Moorthy *et al.*, 2009).

Herawati and Marjuk, (2011) stated that feed conversion ratio was significantly improved ($P< 0.05$) when different levels of dietary ginger powder used in broilers 0.5, 1, 1.5 and 2% compared to the control group, being (2.15, 2.20, 2.15, 2.14 and 2.27) respectively during 35 days, which are in agreement with those of Mohamed *et al.* (2012) who found that feed conversion ratio of broilers was significantly improved ($P< 0.05$) by the supplementation of dietary ginger powder 0.2% compared to the group 0.1% and the control, which were (1.90, 1.98 and 2.25) respectively through 42 days of

experimental period. On the other hand, Moorthy *et al.* (2009) did not observe any differences in the FCR of broilers fed 0.2% ginger powder compared to the control.

Also El-Deek *et al.* (2002) did not find any differences between FCR of the treatments and the control in the trial (1) and (2) when used 0.05 and 0.1% ginger powder respectively in broilers diets.

Ademola *et al.* (2009) noted that using high dose of ginger powder 2% had a highly significant negative impact ($P< 0.01$) on the broilers FCR compared to the treatments 1%, 1.5% and the control, (3.14, 2.71, 2.67 and 2.56 respectively) during 56 days of age, while there Chapter Two Review of Literature 18 were no differences in the FCR of broilers fed 1 and 1.5% ginger compared to the control group. Otherwise,

Thayalini *et al.* (2011) mentioned that there was no improvement in feed conversion ratio of broiler chickens fed on high dose of dried Zingiber officinale rhizomes supplement 2% compared to the chickens fed the control.

Using different levels of ginger powder 1.5, 3 and 4.5% statistically did not affect the feed conversion ratio of cockerel chicks (Kehinde *et al.*, 2011), which is in agreement with that of Tekeli *et al.* (2011) who used different percentages of ginger and propolis extract (ginger 240 ppm, propolis 1000 ppm, ginger 120 + propolis 500 ppm, ginger 240 + propolis 1000 ppm, ginger 360 + propolis 1500 ppm) as alternatives for antibiotic growth promoter, but they did not observe any significant differences between the treatments and the groups of control and antibiotic.

Mohammed and Yusuf (2011) carried out a study to evaluate the effect of ginger (*Zingiber officinale*) inclusion as a feed additive. Eighty four- day old Anak strain broiler chicks were fed on various levels of supplemental ginger in addition to a control diet (treatment1) without ginger. The FCR was 2.65, 2.50 2.45 and 2.44 for broilers received the diet containing 0, 250, 500 and 750 g ginger per 100kg feed, respectively. No significant difference was observed for FCR between treatments containing various levels of ginger in comparison to control.

The effect of ginger powder supplementation @ 250 (G1), 500 (G2) and 750 (G3) g/q in the feed of broilers reared for 42 days of age was studied by Wadhwa *et al.* (2011). The broilers were fed different treatment diets G1, G2 and G3 with different levels of

ginger showed 21.91, 34.04 and 17.71 % better feed conversion ratio in comparison to broilers received control diet

A study on broiler chicks was conducted by Arkan *et al.* (2012) using treatments T1 (control), T2 (0.10% ginger) and T3 (0.20% ginger) diets. The data for FCR showed a significant difference ($p < 0.05$) between T2 (1.98 ± 0.04), T3 (1.90 ± 0.03) and control (2.25 ± 0.09).

Zomravi *et al.* (2011) reported that there were no significant differences ($p > 0.05$) in feed conversion ratio among all dietary treatments containing 0.00 % (2.18), 0.50 % (2.19), 1.00 % (2.15) and 1.50 % (2.24) of ginger powder

2.5 The Effect of ginger on carcass cuts and visceral organs

Studies have been concentrating on improvement of broiler carcass in order to meet the customer's desire. This improvement accomplishes through genetic selection, nutrition and breeding technology to produce high carcass weight with limited abdominal fat.

Herawati and Marjuki (2011) noted when compared between control and four levels of red ginger powder that diets supplementation with 1, 1.5 and 2% red ginger powder had significant ($P< 0.05$) higher carcass percentage (dressing %) (62.9, 62.9 and 64.9 %) respectively than those received 0.5% and control diet being (59.6 and 57.8%), abdominal fat percentage decreased significantly ($P< 0.05$) in broilers fed diets supplemented with red ginger powder 0.5, 1, 1.5 and 2% compared to those broilers fed the basal diet, (1.87, 1.85, 1.81, 1.75 and 2.56) respectively**.**

Ademola *et al.* (2009) showed that there were no significant differences in the relative weights of (neck, thighs, breast and back) when used 1 and 1.5% ginger powder in broilers diets but relative weight of wings was positively affected ($P< 0.001$) compared to the control group, which were (9.21, 9.00 and 8.55%) respectively, while using 2% of ginger caused a significant ($P< 0.001$) decrease in relative weight of (breast and back) being (12.86 and 12.23%) respectively compared to the control group, (14.59 and 13.06%) respectively, but did not affect the relative weights of (neck, thighs Chapter Two Review of Literature 22 and wings), relative weight of abdominal fat pad decreased significantly ($P< 0.001$) when using different levels of ginger 1, 1.5 and 2% compared to the control, being (0.85, 0.56, 0.45 and 1.88%) respectively.

While Tekeli *et al.* (2011) did not find significant differences in carcass yield, hot carcass, cold carcass, proventriculus, gizzard and heart weight of broilers fed on 240 ppm of ginger powder compared to the antibiotic and control groups, while there was a significant ($P< 0.05$) increase in the percentage of abdominal fat in the birds fed on ginger powder 240 ppm compared to the control group, (1.86 and 1.25%) respectively. Also liver weight increased significantly ($P< 0.05$) in birds received ginger powder 240 ppm and antibiotic compared to the control group, (44.40g, 47.61g and 38.22g) respectively.

Moorthy *et al.* (2009) noted that adding 0.2% ginger powder into the broilers diet did not affect the weights of carcass, gizzard, liver, heart and dressing percentage.

El-Deek *et al.* (2002) found no differences in dressing percentage, abdominal fat and liver relative weights of broilers fed diets supplemented with 0.05 and 0.1% ginger powder

Zhang et al.(2009) observed that birds fed ginger produced higher carcass weights compared to untreated birds .He suggested that improved carcass quality of broilers may be associated with the antioxidant effect of ginger which enhances protein and fat metabolism.

Dressing percentage, breast weight and leg weights increased significantly in response to an aqueous extract of a plant mixture containing ginger at 5g/liter water (Javed *et al.*, 2009).

The findings of Barazesh *et al.* (2013) suggested that inclusion of ginger powder at different levels (0.0, 0.50, 1.00 and 1.50 %) in diets had no significant change in the weight of liver (3.62, 3.45, 3.02, 3.12), gizzard (3.52, 3.17, 2.84, 3.59) and spleen (0.18, 0.17, 0.17, 0.21) as % of live weight respectively among the four treatments.

Moorthy *et al.* (2009) conducted an experiment by keeping following treatments viz. T_1: Control; T_2: 0.20 % ginger powder; T_3 : 0.20 % pepper powder; T_4 : 0.20 % curry leaf powder; T_5: 0.20 % ginger + 0.20 % pepper; T_6 : 0.20 % ginger + 0.20 % curry leaf powder and T_7 : 0.20 % pepper + 0.20 % curry leaf powder. The carcass characteristics viz. ready-to-cook yield (77.27, 77.43, 77.93 77.82, 76.11, 76.21 and Review of Literature….. 23 78.12 %) , gizzard weight (42.25 ± 1.24, 48.13 ± 1.47, 47.27 ± 1.47, 45.63 ± 1.23, 42.29 ± 1.23, 42.29 ± 1.65, 44.26 ± 2.54 and 45.72 ± 2.27 g), liver weight

(39.00 ± 1.75, 38.88 ± 1.59, 37.65 ± 1.59, 38.88 ± 1.59, 37.24 ± 1.43 and 38.23 ± 2.56 g) and heart weight (9.88 ± 0.52, 8.88 ± 0.23, 8.75 ± 0.23, 8,75 ± 0.75, 9.10 ± 0.23, 8.26 ± 0.47 and 8.59 ± 0.17 g), respectively and did not differ significantly between the treatment groups fed different levels of dried ginger, pepper and curry leaf powder from 1- 6 weeks of age.

Elmakki *et al.* (2013) reported that carcass weight was higher for birds fed with 0.25% level of ginger (1591 g), in comparison to control (1562 g). The dressing percentage was also found to be numerically higher in 0.25 % ginger powder supplemented group (75 %) and in comparison to control (74.4 %) and did not differ statistically.

A study was conducted by Zomrawi *et al.* (2012) had recorded significant decrease ($p < 0.05$) in pre-slaughter weight of birds fed 0.50 % ginger root powder (1310.28 g/bird) in comparison to control (1489.06 g/bird). No significant differences were observed in dressing percentage by supplementing of 0.50 % level of ginger root powder (75.91 %) when compared with control (75.88 %).

Ebrahimnezhad *et al.* (2014) conducted an experiment to study the effects of ginger (Z. officinale) processed to different levels on carcass characteristics in broiler chickens. A total of 360 one–day–old broilers (Cobb × Cobb 500) were allotted to 6 equal experimental groups in a complete randomized design, with different levels of ginger (0.0, 5.0, 10.0, 15.0, 20.0, and 25.0 g/kg of diet) for 42 days. Carcass traits (relative weights of carcass, liver, abdominal fat, fat around gizzard and intestine) were assessed on day 42. The carcass characteristics were not altered significantly altered except relative weight of eviscerated carcass for different level of supplementation of ginger as 62.56, 62.59, 59.19, 62.59, 62.03 and 62.70 g, respectively.

A study using one hundred and forty four one-day-old Arbor Acres broilers was conducted to assess the effects of dried ginger root (Zingiber officinale) powder of particle sizes of 300, 149, 74, 37, and 8.4 μm by Zhang *et al.* (2009) on carcass characteristics. The birds were housed in 24 wire cages in an environmentally controlled room. Dietary treatments were - control and treatment groups supplemented with ginger root processed to 5 particle sizes at the level of 5.00 g/kg of diet. At the end of the experiment the birds were subsequently killed to determine carcass yield and abdominal fat content. Birds in the ginger-supplemented groups had a higher ($P = 0.014$) carcass yield 72.58, 73.78, 76.06, 76.72 and 72.49 % as per the treatment and a

slightly lower (P = 0.096) abdominal fat content (g/kg) 14.84, 14.39, 14.93, 15.11, 13.79 in comparison to control group (carcass yield=71.2 %, and abdominal fat content= 16.80 g/kg) at 42 d of age

2.6 Mortality rate

Mortality rate is defined as the death of birds as a result of many factors; for example, by disease, injury, physiological system failure or unidentified causes, which show that the welfare has been poor, so increasing in mortality rate will lead to decrease the number of birds at marketing age and finally will lower the income of project. For this reason, many researchers tried to minimize the percentage of mortality using different feed additives including medicinal plants.

Al-Hamadani *et al.* (2010) used two levels of ginger powder 0.4 and 0.8% and they reported that mortality rate was zero in the group fed 0.8% ginger powder compared to the 0.4% ginger, antibiotic and control groups which were (2.27, 2.27 and 6.82 %). While

Thayalini *et al.* (2011) mentioned that there was no significant difference in mortality rate of broiler chickens fed on dried Zingiber officinale rhizomes supplement 2% compared to the control, which is in agreement with the finding of Mohamed *et al.* (2012) who did not observe any mortality case during 42 days of experimental period when used 0.1 and 0.2% ginger powder through diet in broiler chickens.

Also Zomrawi *et al.* (2012) who used different levels of ginger root powder 0.5, 1 and 1.5% in broilers diets did not find significant differences in mortality rate when compared to the control group.

CHAPTER-III
MATERIALS AND METHODS

3.1 Statement of the research work

The experiment was conducted at the poultry shed under the Department of Dairy and Poultry Science, in Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur, to investigate the effect of Ginger (*Zingiber officinale*) powder in broiler production (Cobb 500) during the period from 8 August to 5 September, 2016. To complete the research work following steps were followed:

3.2 Preparation of the experimental house and equipment

An open sided house with two rooms was used for rearing the experimental birds. The experimental house was properly washed and cleaned by forced water using a hosepipe. After washing with clean water, the rooms were disinfected by quick lime and then left vacant for 15 days. At the same time all feeders, plastic buckets, waterers and other necessary equipments were also properly cleaned, washed and disinfected with detergent and potassium permanganate, subsequently dried and left them empty for at least one week before the arrival of chicks. Ceiling, walls, and wire nets were also thoroughly disinfected by spraying Virocid® (4ml/lit).

Fig. 1 Broiler growing in separate treatment area and vaccinated

3.3 Collection of the experimental birds

A total 96 number of day-old broiler chicks (Cobb-500) were purchased from Kazi Firms Limited, Ranirbondor, Dinajpur, Bangladesh.

3.4 Layout of the experiment

The day-old chicks were reared at brooder house to adjust with the environmental condition up to 7 days. After 7 days, chicks were randomly allocated into four dietary treatment groups containing 24 chicks in each; each treatment was composed of three replications containing 8 birds in each replication. The layout of the experiment is shown in Table 3.1.

Table 3.1 Layout showing the distribution of experimental broilers

Dietary treatment	No. of chicks in each replication			Total number of chicks in each treatment
	R_1	R_2	R_3	
T_0	8	8	8	24
T_1	8	8	8	24
T_2	8	8	8	24
T_3	8	8	8	24

3.5 Procurement of feed ingredients

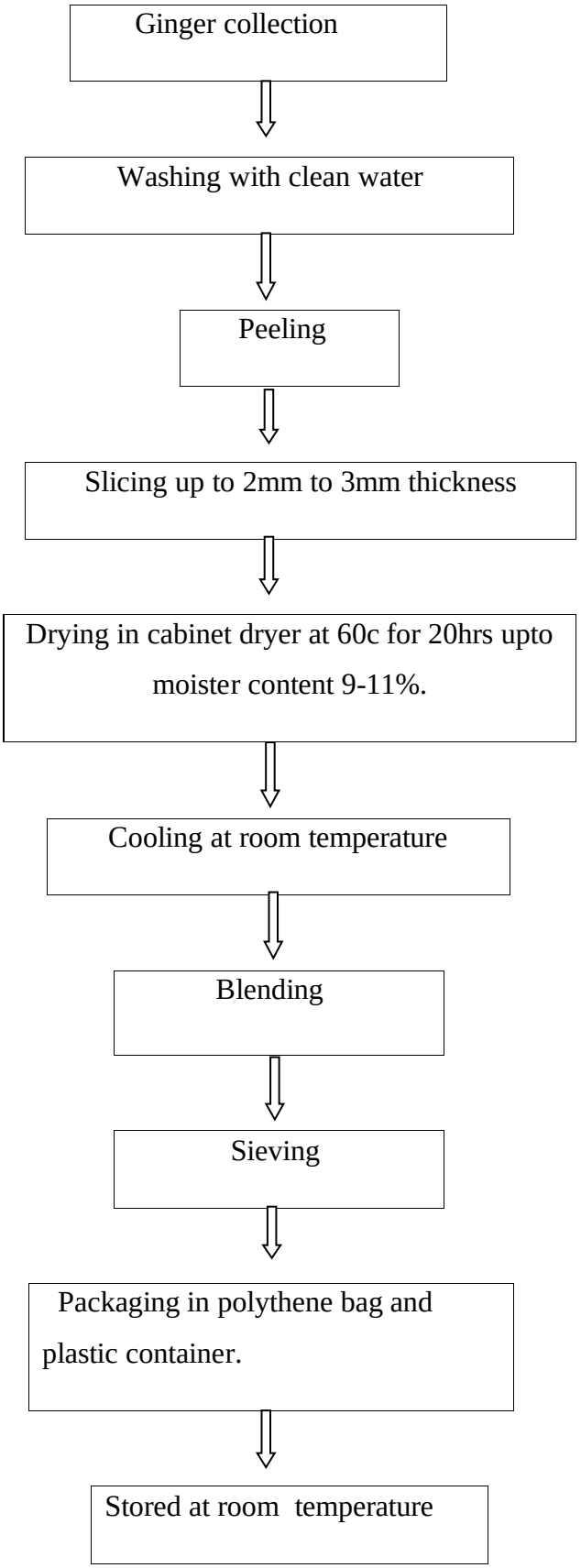
Required amounts of feed ingredients for making the experimental diets were procured from the local market of Dinajpur town. During procurement, ingredients were evaluated carefully for their freshness by observing its color with naked eye and smell with nose.

3.6 Collection, processing and storage of ginger powder

Ginger (*Zingiber officinale*) purchased from Local market, Dinajpur Bangladesh. The samples were further ground into powder using pestle and morter at Dairy and Poultry Science Lab. The obtained powder was packed in a polythelene bag and preserved in the feed storage room until used for feed formulation. Proper care was taken in the feed storage room to avoid spoilage.

3.7 Preparation of ginger powder

Flow diagram of preparation of ginger powder:



3.8 Preparation of the experimental diet

Ready feed was used throughout the experimental study. The experimental period were divided into two phases (broiler-starter and broiler-finisher). Broiler starter diet was provided between 0 and 14 days, and broiler grower was fed from 15 to 28 days. Ginger powder was incorporated into the experimental diets manually in appropriate doses.

Fig. 2: Fresh Ginger

Fig. 3: Slicing Ginger

Fig. 4. Ginger powder

At first required amount of ready feed ingredients were weighed by digital weighing balance. Then different level of ginger powder was mixed with different treatment. During the time of mixing cross mixing was applied. Mixing was done manually and no coccidiostat or any other feed additives were added to the formulated diets in order to obtain clear-cut effect of the test-diet. The experimental diets were designed as-

T_0 : control
T_1 : control+0.5 g ginger powder per kg feed
T_2 : control+ 1 g ginger powder per kg feed
T_3 : control+ 2 g ginger powder per kg feed

3.9 Routine management

The experimental birds were exposed to similar care and management in all treatment groups throughout the experimental period. The following management practices were followed during the whole experimental period and these management practices were identical for all dietary groups.

3.9.1 Litter management

Fresh, clean and dried rice husk was used as litter materials at a depth of about 3 inch. The litter was well covered by clean newspaper up to the first 3 days. Before use of litter calcium carbonate was spread on the floor. After first week, upper part of the litter with droppings were removed regularly and stirred three times a week up to the end of the experiment. The litter was disinfected with Virocid® solution in every other day. Litter materials, when found damp for any reason, were removed to prevent accumulation of ammonia and other harmful gases. At the end of each week, litter was stirred to break its compactness and maintain proper moisture. At the end of 2^{nd} and 3^{rd} weeks of age, dropping were cleaned from the surface of litter.

3.9.2 Floor space

All the broilers were given a floor space of 1.2 sq. feet. Fresh dried rice husk were used as litter materials on the floor at a depth of 3 inch.

3.9.3 Brooding of broiler

The experiment was conducted in summer (August to September 2017). During the experimental period, the experimental temperature was higher than that requirement. The broilers were housed on floor and routinely managed as any other commercial broiler flock. Heating was provided by a single electric brooder, where the initial temperature was set at 35^{o} C and decreased gradually at the rate of 3^{o}C in each week until they were adjusted to normal environmental temperature of the house and final temperature was 28^{o} C at the end of experiment. Additional heat was provided by fitting 200-watt electric bulb at the center of the pen about 12 inches above the floor from the 7-day old. The height of the bulbs was increased by raising the bulb gradually as per need of temperature. Paper was used on two sides of the house and in ventilators to protect cold and stormy wind. These sheets were removed partly or completely particularly at the later stage of finishing period when room temperature was found favorable. Daily room temperature was recorded every six hours with a thermometer.

Fig. 5 Brooding environment of chicks

3.9.4 Lighting

All birds were exposed to continuous lighting of 23 hours and one hour dark period per day throughout the experimental period. The dark period was practiced to make the broilers familiar with the possible darkness due to electricity failure. Supplementary light at night was provided by electric bulb by hanging at a height of 2.8 m to provide necessary lighting.

3.9.5 Feeding and drinking

Feeds were supplied to the chicks on clean newspapers at three hours interval for the first 3 days. Linear feeder and round plastic drinker were used during brooding period. After that linear feeder was replaced by round plastic drinker. After 2 weeks, feeds were supplied thrice daily (once at morning, at noon and again at night) and water was supplied thrice daily (once at morning, at noon and again at night). Fresh water was offered to the bird adlibitum. One round plastic feeder and drinker were provided for fifteen birds**.** Feeders were cleaned at the end of each week and drinkers were washed daily. All broilers in different treatments had fresh feed and drinking water adlibitum throughout the experimental period.

Fig. 6 Feeding of broiler

Fig. 7 Watering of broiler

3.9.6 Immunization

All broilers were vaccinated against New Castle (Ranikhet) Disease and Infectious Bursal (Gumboro) Disease. The birds were vaccinated against Ranikhet and Gumboro diseases-

Table 3.2 Applied vaccination program

Diseases	Day	Manufacture vaccine	Route	Time
Ranikhet	4	ND Clone 30	Eye	Evening
Gumboro	10	Gumboro 228E	Eye	Evening
Gumboro	15	Gumboro 228E	Drinking water	Evening
Ranikhet	21	ND Clone 30	Drinking water	Evening

Fig. 8. Vaccination

3.9.7 Medication

Immediately after unloading from the chick boxes the chicks were given Glucose and Vitamin-C to prevent the stress occurring during transport. Water soluble vitamin and normal saline were also provided for the first 3 days of brooding. During the course of experimental period, electrolytes and vitamin-C were added with the drinking water to combat stress due to high environmental temperature (33 to 35^{o} C).

3.9.8 Sanitation

Proper hygienic measures and strict sanitation programs were followed during experimental period. The entrance point and surrounding area were kept clean and disinfectant (virocid) was sprayed regularly. In addition, the service area of the experimental rooms, outside wall and feed storage room were kept clean and disinfected.

3.9.9 Bio-security:

Bio-security means to prevent the outbreak of diseases.

- Entrance of visitors were restricted only worker, researcher, supervisor and manger who visited farm by following special care.
- Before entrance, hands were washed with soap and shoes were changed, feet were dipped in a footbath containing disinfectant solution (PPM) and the footbath was at the entrance point.
- All equipment of the experimental house was kept clean.
- A special dress was used inside the house during working.
- Dead broilers were removed promptly and buried far away from the experimental house.
- Sick broilers were promptly isolated to a separate place from the experimental areas.
- The experimental areas were kept free of rats, cats, dogs and wild flying birds.

3.9.10 Postmortem examinations of broilers

After postmortem examination, the results were collected and necessary measures were taken to remove the problem without applying medicines

Fig. 9. Postmortem for diagnosis of Omphalitis

3.10 Processing of broilers

At 28 days of age, one bird from each replication was selected randomly. Before slaughtering the birds were kept in fasting condition for 4 hours. Just before slaughtering the birds were weighed. Birds were slaughtered according to halal method. Following slaughter, broilers were allowed to bleed for about 2 minutes. Then the birds were scaled in hot water (60-65^{o} C) for about 120 seconds in order to loosen the feather of the carcasses and weighed again. Breast meat, thigh meat, drumstic meat were separated from the carcass. Finally, processing was performed by removing head, shank, viscera, oil gland, kidney and giblets. As soon as these were removed the gall bladder was removed from the liver and pericardial sac and arteries were cut from the heart. Cutting it loose in front of the proventriculus and then cutting with both incoming and outgoing tracts removed the gizzard. Then, it was split open with knife, emptied and washed and the lining removed by hand.

3.11 Data collection and record keeping

The following records were kept during 28 days of rearing period:

i. Live weight.
ii. Feed consumption.
iii. Survivability: Recorded from mortality
iv. Temperature: Four times daily during the experimental period.
v. Dressing yield: At the end of the experiment one broiler was slaughtered from each replication to estimate dressing yield.

Fig.10. Carcass of broiler

Fig.11. Different parts of broiler

Fig.12. Visceral parts after slaughtering

Fig.13. Internal Organ of broiler

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 weight of the birds.

Final Weight- Initial weight

3.11.2 Feed intake

Feed intake was calculated as the total feed consumption in a replication divided 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 (F.C.R) was calculated as the total feed consumption divided by weight gain in each replication.

$$\text{F.C.R} = \frac{\text{Feed Intake (kg)}}{\text{Weight gain (kg)}}$$

3.11.4 Survivability

Survivability percentage was calculated as the total broilers survived divided by the number of starting birds multiplied by 100

3.11.5 Dressing yield

Dressing yield is based on the relationship between the dressed carcass weight and live bird weight after things like skin and internal organs have been removed. Dressing yield can be calculated by taking weight of the carcass divided by weight of live bird

$$\text{Dressing yield} = \frac{\text{Weight of the carcass}}{\text{Weight of live bird}} \times 100$$

3.12 Statistical analysis

Data on different variables were subjected to analysis of variance (ANOVA) in a Completely Randomized Design (CRD), . The significant differences between the treatment means were calculated from analysis of variance (ANOVA) table. The mean difference among the treatment groups was performed by Duncan test. All analyses were performed by using ‘‘IBM SPSS Statistics 20’’ Program.

CHAPTER-IV
RESULTS AND DISCUSSION

4.1 Performance of broiler

The results of productive performance in terms of feed consumption, live weight gain, feed conversion ratio, survivability, dressing yield, organ growth weight, were used as criteria for response of broiler to different dietary levels of ginger powder are presented in the following sections.

4.2 Effect of ginger powder on body weight gain

Initial body weight of day-old broiler chicks fed on different dietary treatment was similar ($P>0.05$) (Table 4.1). From 1 to 14 days of age, the highest (520.70g) body weight gain was attained by broilers received ginger powder at 2 g/kg feed ($P<0.01$) and also from 15 to 28 days of age, the body weight gain was significant ($P<0.01$) in treatment T_3 (1840.27g) in birds fed diet containing ginger powder at level of 2 g/kg feed was significantly higher ($P<0.01$) followed by birds received 1g/kg feed (1703.9g), .5g/kg feed (1634.07g) and 0g/kg feed (1585.74g) ginger powder. The significant increase in body weight in treatment T_3 (1840.27g) may be due to activity of ginger (*Zingiber officinale*) at the level of 2 g/kg feed that can stimulate protein synthesis by bird's enzymatic system.

A study was conducted on 3 weeks old 180 broiler chicks by Arkan *et al.* (2012**)** which were raised up to 6 weeks of age. The ginger powder was supplemented at the rate 0.10 and 0.20 % level in their diets under T_2 and T_3, respectively while T_1 served as control. The differences for body weight gain were significantly higher (1467.42 ± 11.08 g) for broiler chicks fed diet with 0.20 % ginger as compared to control (1289.17 ± 13.10 g).

In another study supplementation of ginger powder at 1.50 % (459.96 g) level in diet significantly increased body weight gain as compared to control (357.00 g) at 5^{th} weeks of age in broilers (Barazesh *et al.,* 2013

Onu (2010) reported that the addition of ginger (0.25%) broiler chicks in the basal diet of broiler chicks resulted in higher body weight and lower FCR.

Farinu *et al.* (2004) reported that supplementation of ginger at the levels of 5, 10 or 15 g/kg slightly improved growth in broilers.

4.3 Effect of ginger powder on feed intake

Feed intake of broilers in different dietary treatments from 1 to 14 days of age, 15 to 28 and also 1-28 days of experimental periods was statistically significant ($P<0.05$). Mohamed *et al.* (2012) stated that feed consumption of broiler chickens was significantly ($P< 0.05$) decreased by the supplementation of dietary ginger powder at levels 0.1 and 0.2% compared to the control, being (2852.66, 2791.67 and 2909.62 g/bird) respectively over 42 days.

Also Arshad *et al.* (2012) reported that using ginger powder (40 and 50) ml/liter through drinking water of broilers caused a significant ($P< 0.05$) decrease in the feed intake per bird compared to the control, being (2243g, 2302g and 2399g) respectively. Using 2 and 6% of ginger powder in the broiler diets did not affect the daily feed consumption during the period 1 –6 week, but from 6 –7 weeks of age, the level 6% had a significant positive effect ($P< 0.05$) on the daily feed consumption compared to the group 2% and the control, being (121g, 147.5g and 154g) respectively (Al-Homidan, 2005). Tekeli *et al.* (2011) showed that feed consumption increased significantly ($P< 0.05$) in groups fed on antibiotic and 240 ppm ginger compared to the group which fed control diet through the experimental period 1 –42 days, (3970.13, 3909.71 and 3334.86 g/bird) respectively. Incharoen and Yamauchi (2009) feed dried fermented ginger (1and 5%) to White Leghorn laying hen and found that feed consumption and FCR tended to increase in ginger fed groups. Likewise, the use of 2% red ginger in ration of broiler chickens has resulted in higher feed intakes and FCR (Herawati, 2010).

Table 4.1 Effect of ginger powder supplementation on the performance of broiler chicks

Parameters	T_0	T_1	T_2	T_3	Level of significance
Initial body weight (g/bird)	45.21±0.050	45.23±0.005	45.41±0.050	45.31±0.050	NS
Feed consumption (g/bird)					
1-14 days	$850.46±0.07^{a}$	$790.05±1.32^{b}$	$757.94±0.57^{d}$	$798.10±0.60^{c}$	**
15-28 days	$2035.87±0.50^{a}$	$1890.45±1.0^{d}$	$2023.99±0.10^{b}$	$2004.1±0.03^{c}$	**
1-28 days	$2886.33±0.44^{a}$	$2680.5±2.32^{d}$	$2781.93±0.47^{c}$	$2802.2±0.63^{b}$	**
Weight gain (g/bird)					
1-14 days	$470.50±10^{d}$	$477.59±0.95^{c}$	$486.29±1.35^{b}$	$520.70±1.5^{a}$	**
15-28 days	$1115.24±1.0^{d}$	$1156.48±1.0^{c}$	$1217.61±0.5^{b}$	$1319.57±0.49^{a}$	**
1-28 days	$1585.74±1.0^{d}$	$1634.07±0.05^{c}$	$1703.90±1.85^{b}$	$1840.27±1.99^{a}$	**
FCR					
1-14 days	$1.81±0.00428^{a}$	$1.65±0.00653^{d}$	$1.56±0.00328^{c}$	$1.53±0.0068^{c}$	**
15-28 days	$1.82±0.02092^{a}$	$1.63±0.00086^{b}$	$1.66±0.00086^{b}$	$1.52±0.0008^{c}$	**
1-28 days	$1.82±0.01598^{a}$	$1.64±0.00149^{b}$	$1.63±0.0017^{b}$	$1.52±0.0027^{c}$	**
Survivability (%)	98.67±0.000	100±0.000	100±0.000	100±0.000	NS

Where, T_0 =0 g; T_1 =0.5 g; T_2 =1g; T_3 =2 g of ginger powder /1kg feed.

^{abcd} value in the row with similar superscripts alphabet did not differ significantly.

**=(P<0.01), *=(P<0.05), NS=(Non-significant).

Table 4.2 Effect of ginger powder supplementation in diet of broiler on meat yield at 28 days of age

Parameters(g)	T_0	T_1	T_2	T_3	Level of significance
Abdominal fat	2.51±0.010 [a]	1.82±0.010 [b]	1.67±0.010 [c]	1.58±0.010 [d]	**
Heart	8.28±0.5[d]	8.46±0.25[c]	9.28±0.5[b]	9.41±0.20[a]	*
Liver	41.1±0.1	43.5±1.5	42.2±1.0	46.5±0.5	NS
Gizzard	38.57±0.25	42.47±1.0	45.77±0.25	46.8±0.50	NS
Dressing yield (%)	56.16±0.0 [c]	59.63±0.015[b]	58.89±0.01[b]	60.42±0.11[a]	**

Where, T_0 =0 g; T_1 =.5 g; T_2 =1g; T_3 =2 g of ginger powder /kg feed

[abcd] value in the row with similar superscripts alphabet did not differ significantly.

**=(P<0.01), *=(P<0.05), NS=(Non-significant).

4.4 Effect of ginger powder on feed conversion ratio

Feed conversion ratio in different dietary treatments during the whole experimental period was statistically significant ($P<0.01$). At the end of the trial (28 days of age), the FCR was lowest in treatment T_3 (1.52) followed by T_2 (1.63), T_1 (1.64) and T_0 (1.82), respectively indicating that the best feed efficiency was due to optimum antioxidant activity of ginger powder at the level of 2g/kg.

Herawati and Marjuk, (2011) stated that feed conversion ratio was significantly improved ($P< 0.05$) when different levels of dietary ginger powder used in broilers 0.5, 1, 1.5 and 2% compared to the control group, being (2.15, 2.20, 2.15, 2.14 and 2.27) respectively during 35 days, which are in agreement with those of Mohamed *et al.* (2012) who found that feed conversion ratio of broilers was significantly improved ($P< 0.05$) by the supplementation of dietary ginger powder 0.2% compared to the group 0.1% and the control, which were (1.90, 1.98 and 2.25) respectively through 42 days of experimental period. On the other hand, Moorthy *et al.* (2009) did not observe any differences in the FCR of broilers fed 0.2% ginger powder compared to the control. Also El-Deek *et al.* (2002) did not find any differences between FCR of the treatments and the control in the trial (1) and (2) when used 0.05 and 0.1% ginger powder respectively in broilers diets. Ademola *et al.* (2009) noted that using high dose of ginger powder 2% had a highly significant negative impact ($P< 0.01$) on the broilers FCR compared to the treatments 1%, 1.5% and the control, (3.14, 2.71, 2.67 and 2.56 respectively) during 56 days of age,

4.5 Effect of ginger powder on survivability

Survivability of broilers fed on different dietary treatments was very high during the study period. The survivability did not vary significantly ($P>0.05$) among different treatment groups during the whole experimental period.

Al-Hamadani *et al.* (2010) used two levels of ginger powder 0.4 and 0.8% and they reported that mortality rate was zero in the group fed 0.8% ginger powder compared to the 0.4% ginger, antibiotic and control groups which were (2.27, 2.27 and 6.82 %). While Thayalini *et al.* (2011) mentioned that there was no significant difference in mortality rate of broiler chickens fed on dried *Zingiber officinale* rhizomes supplement 2% compared to the control, which is in agreement with the finding of Mohamed *et al.*

(2012) who did not observe any mortality case during 42 days of experimental period when used 0.1 and 0.2% ginger powder through diet in broiler chickens.

4.6 Effect of ginger powder on meat yield

Data on carcass characteristics and organ weights are presented in Table 4.2. This study showed that fat content of broiler was decreased significantly by supplementation of ginger powder in broiler ration ($P<0.01$). Among different dietary treatments, amount of abdominal fat was lowest in T_3 (1.58g) followed by T_2 (1.67g), T_1 (1.82g) and T_0 (2.51g), respectively

Herawati and Marjuki (2011) noted when compared between control and four levels of red ginger powder that diets supplementation with 1, 1.5 and 2% red ginger powder had significant ($P>0.05$) higher carcass percentage (dressing%) (62.9, 62.9 and 64.9 %) respectively than those received 0.5% and control diet being (59.6 and 57.8%), abdominal fat percentage decreased significantly ($P>0.05$) in broilers fed diets supplemented with red ginger powder 0.5, 1, 1.5 and 2% compared to those broilers fed the basal diet, (1.87, 1.85, 1.81, 1.75 and 2.56) respectively**.**

Zhang *et al.* (2009) observed that birds fed ginger produced higher carcass weights compared to untreated birds .He suggested that improved carcass quality of broilers may be associated with the antioxidant effect of ginger which enhances protein and fat metabolism. Elmakki *et al.* (2013) reported that carcass weight was higher for birds fed with 0.25% level of ginger (1591 g), in comparison to control (1562 g). The dressing percentage was also found to be numerically higher in 0.25 % ginger powder supplemented group (75 %) and in comparison to control (74.4 %) and did not differ statistically.

CHAPTER-V

SUMMARY AND CONCLUSION

The objectives of this study were to evaluate the varying doses of ginger powder supplemented diets on broiler chicks. The feeding value of ginger powder on broiler (Cobb 500) was evaluated in the poultry shed, Hajee Mohammad Danesh Science and Technology University, Dinajpur. In a feeding trial, four diets were prepared including of ginger powder at levels of 0 g (control), .5 g, 1 g and 2 g per kg feed . Body weight and feed consumption were recorded on daily basis and weekly basis. At the last day of the experiment, a total of eight broilers were sacrificed and meat yield, dressing percentage, internal organ weight and fat content were recorded. Survivability was also recorded throughout the study.

By using experimental diets feed intake of different dietary treatments were the differences statistically significant (showed in Table 4.1). Feed consumption by the broilers during the entire experiment period in different treatment groups was recorded and expressed as g/bird. Although the rate of feed intake varied from day to day the highest feed intake (g/bird) was recorded in control group (2886.33g) followed by in treatments containing 2g (2802.2g), 1 g (2781.93g) and 0.5 g (2680.5g) level of ginger powder. Data obtained on final average body weight indicated that there was no positive correlation between body weight and feed consumption. Feed conservation ratio (FCR) was the highest at 2gm level of ginger powder (1.52) compared with other groups. The FCR values were 1.82, 1.64, and 1.63 at 0 g , .5 g , and 1 g per kg feed. The best FCR was found in T_2 (1.63) compared to control (1.82). The best FCR was found in T_3 (1.52) compared to control.

Survivability was almost similar in all dietary treatments ($p>0.05$). In this experiment, highest survivability (100%) was observed in all three group (T_1, T_2, T_3) without control group. Survivability was 98.67% at 0gm level of ginger powder. Fat content was reduced due to inclusion of ginger powder. The highest fat content was observed in control group (2.51g) and the lowest (1.58g) at 2gm level of ginger powder.

The slaughter data of broiler chicks fed experimental diets were represented in % of live weight. No significant ($p>0.05$) effect was observed for internal organs (liver and gizzard) weight of broilers fed experimental rations but there was significant ($P<0.05$)

difference found on heart and dressing yield. The highest dressing yield (60.42%) was found in T_3 (2 g) and the lowest value (56.16%) found in control group.

Based on the results of the present study, it may be concluded that ginger powder supplemented at a level of 5 g has significant effect on body weight gain, FCR, abdominal fat content, and survivability of broiler, except feed intake and dressing percentage. The results of the study also suggest that the supplementation of ginger powder at 2 g level in diets has high potential as commercial applications for production performance of broiler. Therefore, ginger powder can be used along with the other conventional feed ingredients. However, further research to investigate the effect of different levels of ginger (*Zingiber officinale*) in layers and breeders is recommended.

REFERENCES

Ademola, S.G,. G.O. Farinu and G.M. Babatunde (2009). Serum lipid, growth and hematological parameters of broilers fed garlic, ginger and their mixtures. World Journal of Agricultural Sciences. 5 (1): 99 –104.

AL- Jaheel, R. A. Abd (2012). Use of tumeric (Curcuma longa) on the performance and some physiological traits on the broiler diets. The Iraqi J. Vet. Med., 36(1): 51-57.

Al-Hamadani, A. A., I. Nadhum and A. Nadhum (2010). The effect of diet supplementation with antibiotic and ginger on broiler performance. Al-Anbar Journal of Agricultural Sciences. 4 (8): 1 – 10.

AL-Homidan, A. A. (2005). Efficacy of using different sources and levels of *allium cepa, allium sativum* and *zingiber ofjicinale* on broiler chick's performance. Saudi Journal of Biological Sciences. 12 (2): 96 - 102.

Anonymous1999, C. E. Allen (1973). Ginger rhizome: A new source of proteolytic enzyme. J. Food Sci. 38:652–655.

Arkan, B. M.; Al-Rubaee, M. A. M. and Ali, Q. J. (2012). Effect of ginger on performance and blood serum parameters of broiler. Int. J. Poultry. Sci., 11(2): 143- 146.

Arshad, M., A. H Kakar, F. R. Durrani, A. Akhtar, Shakirullah, Sanaullah and M. Niamatullah (2012). Economical and immunological impact of ginger (z. Officinale) extract on broiler chicks. Pakistan Journal of Science. 64(1): 46-48.

Awang, D. V. C. 1992. "Ginger." *Can. Pharm. J.* 125:309–311. Bhandari, U., J. N. Sharma, and R. Zafar. 1998. "The protective action of ethanolic ginger (Zingiber officinale) extract in cholesterol fed rabbits

Badreldin, H.A., B. Gerald, O.T. Musbah and N. Abderrahim (2008). Some phyto-chemical, pharmacological and toxicological properties of ginger (zingiber officinale roscoe): a review of recent research. Food Chemistry and Toxicology. 46: 409–420.

Barazesh, H.; Pour, M. B.; Salari, S. and Abadi, T. M. (2013).The effect of ginger powder on performance, carcass characteristics and blood parameters of broilers. Int. J. Adv. Biom. Res., 1(12): 1645-1651. References iii BIS (1992). Poultry Feed Specification: IS: 1374 (4th revision).

Bliddal, H.; Rosetzsky, A.; Schlichting, P.; Weidner, M. S. and Andersen, L. A. (2000). A randomized, placebo-controlled, cross over study of ginger extracts and ibuprofen in osteoarthritis. *Osteoarthritis Cartilage*, 8(1): 9-12.

Dieumou, F.E., Teguia, A., Kuiate, J.R., Tamokou, J.D., Fonge, N.B., Dongmo, M.C. (2009) Effects of ginger and garlic essential oils on growth performance and gut microbial population of broiler chickens. Livest Res Rural Dev. 21: 25-34.

Dubichev *et. al*, (1991). Medicinal herbs with their formulation. Volume 1- *Allium sativum*¸ Daya Publishing House, Delhi,110035.

Ebrahimnezhad, Y.; Azarakhsh, V. and Salmanzadeh, M. (2014). The effects of ginger root (Zingiber officinale) processed to different levels on growth performance, carcass characteristics and blood biochemistry parameters in broiler chickens. Bull. Env. Pharmacol. Life Sci., 3(5): 203-208.

El-Deek, A.A., Y.A. Attia, M. Maysa, and M. Hannfy. (2002). Effect of anise (Pimpinella anisum), ginger (Zingiber officinale Roscoe) and fennel (Foeniculum vulgare) and their mixture on performance of broilers. *Arch. Geflugelkd*. 67: 92–96

Elmakki, A. M.; Khadig A.; Dousa, B. M.; Elagib, H. A. A.; Huwaida E. E. M. and Khalid M. E. (2013). Effects of dietary ground ginger (Zingiber officinale) root additive on broiler performance. Global J. Animal. S. Res., 1(1): 76-83.

Farinu, G.O., S.G. Ademola, A.O. AjayiObe, and G.M. Babatunde. (2004). Growth, haematological and biochemical studieson garlic and ginger-fed broiler chickens. *Moor. J. Agric. Res.*, 5: 122–128

Ferreira, L. A. F.; Henriques, O. B.; Andreoni, A. A. S.; Vital, G. R. F.; Campos, M.; Habermehl G. G. and De Moraes, V. L. G. (1992). Antivenom and biological effects of arturmerone isolated from Curcuma longa (Zingiberaceae). Toxicon, 30: 1211-1218.

Herawati 2010."The effect of feeding red ginger as phytobiotic on body weight gain, feed conversion and internal organs condition of broiler."*Int. J. Poult. Sci*. 9: 963-967.

Herawati and Marjuki, (2011). The effect of feeding red ginger (*zingiber officinale* rosc) as phytobiotic on broiler slaughter weight and meat quality. International Journal of Poultry Science. 10 (12): 983-985.

Herawati Veterinary Medical School University of Brawijaya Malang 65145 Indonesia (2010). The Effect of Red Ginger as Phytobiotic on Body Weight Gain, Feed

Conversion and Internal Organs Condition of Broiler. *Int. J. Poult. Sci.*, 9(10): 963 – 9

Herawati. 2006. "Effect of red ginger (Zingiberofficinale Rosc) phytobiotic addition to the broiler performance and blood profile." *Pengaruh Penambahan Fitobiotik Jahe Merah*. 14: 173-142.

Jakes and Susan 2007 Yi (2003). Effects of Isolmalto ligosaccharides on Broiler Performance and Intestinal Micro flora. Poultry Science. 82: 657-663.

Javed, M., Durrani, F., Hafeez, A., Khan, R.U., & Ahmed, I. (2009) Effect of aqueous extract of plant mixtures on carcass quality of broiler chicks. ARPN Journal of Agricultural and Biological Science 4: 37-40. Javendel, F., Blaridshad, B., Seifarati, J., Pourrahimi

John and Ferria (1997). Effects of z. Officinale and propolis extracts on the performance, carcass and some blood parameters of broiler chicks. Current Research in Poultry Science. 1 (1): 12 –23.

Ke *et. al*.2000 ., Zhou, H. (2009), Influences of flavomycin, ropadiar and saponin on nutrient digestibility, rumen fermentation and methane emission from sheep. *Anim. Feed Sci. Technol., 148, 157-166*

Kehinde, A. S., C. O. Obun, M. Inuwa and O. Bobadoye (2011). Growth performance, haematological and serum biochemical indices of cockerel chicks fed ginger (zingiber officinale) additive in diets. Animal Research International. 8 (2): 1398 –1404.

Kikuzaki, H. and Nakatani, N. (1993). Antioxidant effects of some ginger constituents. J. Food Science, 58: 1407-1410.

Kokestsu *et. al.* (1997). Effect of dietary supplemental plant extracts on performance, carcass characteristics, digestive system development, intestinal microflora and some blood parameters of broiler chicks. Proceedings of 12th European Poultry Conference, Sept. 10 –14, Verona, Italy, Pp: 307 –308.

Leverringtan 1969 ,Abdel Atti KHA, Dousa BM, Mahala AG (2012). The effect of ginger root powder (*Zingiber officinale*) Supplementation on broiler chicks performance

Lueng, A. Y. and S. Foster (1996). Encyclopedia of commonnatural ingredients used in food, drug, cosmetics. Second Edition. New York, NY: Wiley & Sons.

Macleod and pienis (1984). The essential oil of ginger from Fiji. Phytochemistry, 20: 203-206.

Mishra SJ, Singh DS. Effect of feeding root powder of *Withania somnifera* (L.) Dunal (aswagandha) on growth, feed consumption, efficiency of feed conversion and mortality rate in broiler chicks. Bioved (Annual). 2000; 11:79-83

Mohamed, A. B., M. A. M. Al-Rubaee and A. Q. Jalil (2012). Effect of ginger (*zingiber officinale*) on performance and blood serum parameters of broiler. International Journal of Poultry Science. 11 (2): 143-146.

Mohammed, A. A. and Yusuf, M. (2011). Evaluation of ginger (Zingiber officinale) as a feed additive in broiler diets. Livestock Res. Rural Dev., 23(9): 1-5.

Moorthy, M., S. Ravi, M. Ravikumar, K. Viswanathan and S. C. Edwin (2009). Ginger, pepper and curry leaf powder as feed additives in broiler diet. International Journal of Poultry Science. 8 (8): 779 –782.

Nambrudu *et. al.*1975, V. K. (2011). Effect of ginger (*Zingiber officinale*) powder supplementation on growth performance of commercial broilers under field conditions. Himachal J. Agri. Res., 37(1): 75-80.

Natrajan *et. al,* 1972 Dousa BM, Mahala AG (2013). The effect of dietary ginger root powder (*Zingiber officinale*) on broiler chicks' performance, carcass characteristic and serum constituents. J. Anim. Sci. Adv. 3:42-47

NRC (1994). National Research Council, Nutrient Requirements of Poultry. 9th Edition, National Academic Press, Washington. Okoleh, O. V. U.; Chukwu, G. C. and Adeolu, A. I. (2014). Effect of ground ginger and garlic on the growth performance, carcass quality and economics of production of broiler chickens. Global J. Biosci. & Biotechnol., 3(3): 225-229

Onu PN (2010). Evaluation of two herbal spices as feed additives for finisher broilers. Biotechnol. Anim. Husb. 26(5-6):383-392

Platel, K. and K. Srinivasan (1996). Influence of dietary spices or their active principles on digestive enzymes of small intestinal mucosa in rats. International Journal of Food Science and Nutrition. 47: 55 – 59.

Platel, K. and K. Srinivasan (2000). Influence of dietary spices and their active principles on pancreatic digestive enzymes in albino rats. Nahrung. 44: 42 – 46.

Pruthi 2000. Gai, and Y.F. Yang. (2008). Effect of superfine grinding on properties of ginger powder. *J Food Eng.*, 91: 217–2Farinu, G.O., Ademola, S.G., Ajayi, A.O.,

Babatunde, G.M. (2004) Growth, haematological and biochemical studieson garlic and ginger-fed broiler chickens. Moor J Agric Res. 5: 122–128

Purseglove et. Al. (1998). Determination of the effects of z. Officinale and propolis extracts on intestinal microbiology and histological characteristics in broilers. International Journal of Poultry Science. 9 (9): 898-906.

Singh, M.P. and Panda, H. (1992). Medicinal herbs with their formulation. Volume 1-*Allium sativum*¸ Daya Publishing House, Delhi,110035.

Smith, R. M. and Robinson, J. M. (1981). The essential oil of ginger from Fiji. Phytochemistry, 20: 203-206.

Stewart and wood 1991 Wang, Y., Jiang, S. Z. and Gai, G. S 2009. Effects of ginger root processed to different particle sizes on growth performance, antioxidant status, and serum metabolites of broiler chickens. *Poult. Sci.* 88:2159-2166.

Tekeli, A., H. R. Kutlu and L. Celik (2011). Effects of z. Officinale and propolis extracts on the performance, carcass and some blood parameters of broiler chicks. Current Research in Poultry Science. 1 (1): 12 –23.

Tekeli, A., H. R. Kutlu, L. Celik and F. Doran (2010). Determination of the effects of z. Officinale and propolis extracts on intestinal microbiology and histological characteristics in broilers. International Journal of Poultry Science. 9 (9): 898-906.

Tekeli, A., L. Çelik, H. R. Kutlu and M. Görgülü (2006). Effect of dietary supplemental plant extracts on performance, carcass characteristics, digestive system development, intestinal microflora and some blood parameters of broiler chicks. Proceedings of 12th European Poultry Conference, Sept. 10 –14, Verona, Italy, Pp: 307 –308.

Thayalini, K., S. Shanmugavelu, P. M. Saminathan, M. S. Siti Masidayu, Y. Nor Idayusni, H. Zainuddin, C. A. Nurul Akmal, and H. K. Wong (2011). Effects of *cymbopogon citratus* leaf and *zingiber officinale* rhizome supplementation on growth performance, ileal morphology and lactic acid concentration in broilers. Malaysian Journal of Animal Science. 14:43-49.

Thompson, E. H., I. D. Wolf, and C. E. Allen (1973). Ginger rhizome: A new source of proteolytic enzyme. J. Food Sci. 38:652–655.

Wadhwa, D.; Kumari, M.; Sharma, K. S. and Sharma, V. K. (2011). Effect of ginger (Zingiber officinale) powder supplementation on growth performance of commercial broilers under field conditions. Himachal J. Agri. Res., 37(1): 75-80.

Wang, C.J., Wang, S.P. and Zhou, H. (2009), Influences of flavomycin, ropadiar and saponin on nutrient digestibility, rumen fermentation and methane emission from sheep. *Anim. Feed Sci. Technol., 148, 157-166*

Yiljep *et. al.* 2005 , M. S. Siti Masidayu, Y. Nor Idayusni, H. Zainuddin, C. A. Nurul Akmal, and H. K. Wong (2011). Effects of *cymbopogon citratus* leaf and *zingiber officinale* rhizome supplementation on growth performance, ileal morphology and lactic acid concentration in broilers. Malaysian Journal of Animal Science. 14:43-49.

Zhang, G. F., Yang, Z. B., Wang, Y., Jiang, S. Z. and Gai, G. S 2009. Effects of ginger root processed to different particle sizes on growth performance, antioxidant status, and serum metabolites of broiler chickens. *Poult. Sci.* 88:2159-2166.

Zhang, W.F., D.F. Li, W.Q. Lu and G.F. Yi (2003). Effects of Isolmalto ligosaccharides on Broiler Performance and Intestinal Micro flora. Poultry Science. 82: 657-663.

Zhao, X.Y., Z.B. Yang, G.S. Gai, and Y.F. Yang. (2008). Effect of superfine grinding on properties of ginger powder. *J Food Eng.*, 91: 217

Zomrawi WB, Abdel Atti KAA, Dousa BM, Mahala AG (2013). The effect of dietary ginger root powder (*Zingiber officinale*) on broiler chicks' performance, carcass characteristic and serum constituents. J. Anim. Sci. Adv. 3:42-47

Zomrawi WB, Abdel Atti KHA, Dousa BM, Mahala AG (2012). The effect of ginger root powder (*Zingiber officinale*) Supplementation on broiler chicks performance, blood and serum Constituents. J. Anim. Feed Res. 1(6):457-460.

Zomrawi, W. B.; Abdel atti, K. A.; Dousa, B. M. and Mahala, A. G. (2011). The effect of ginger root powder (*Zingiber officinale*) supplementation on broiler chicks performance, blood and. serum constituents. *J. Anim. & Feed Res.,* 1(6): 457-460