Effect of different feeding regimes on the production performance and meat quality of BLRI improved Hilly chicken

A THESIS

BY

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DEDICATED

TO

MY

BELOVED PARENTS

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Abstract

The experiment was conducted to investigate the effect of different feeding regimes on production performance and meat quality of BLRI improved Hilly Chicken. A total of 30 farmers were selected from the different locations of Dumuriaupazila under Khulna district of Bangladesh. The study was designed using RCBD with 3 treatments (03) e.g. T_1= Scavenging, T_2= Semi-scavenging and T_3= Intensive having replications.Growth parameters were recorded to compare the growth performance of three different feeding systems.All three rearing systems had significantly different*($p<0.01$)* body weight. The highest body weight of cock was 1323.4 g, 1139 g, and 762.2 g in intensive group, semi-scavenging group and scavenging group, respectively at 12th week of age. The highest body weight ofhen (1167.20 g) was found in intensive group at twelve weeks of age followed by semi-scavenging group (1060.6 g). The lowest body weight (792.8 g) was found in scavenging group at twelve weeks of age.The results of weekly feed conversion ratio showed that there were significant difference ($p<0.01$) among the three treatment groups.Carcass parameters e.g. dressed percentage, thigh percentage, breast percentage, and drumstick percentages were not significantly*($p>0.05$)* varied with different feeding systems. The highest weight percentage of drumstick, breast and thigh was found in semi-scavenging group. Non-carcass parameters e.g. head weight, shank weight, sack weight, liver weight, percentages were not significantly*($p>0.05$)* varied with different feeding systems. Immediate after slaughter, except for hue angle (h*) of breast meat, several color indicators of drumstick and breast meats of Hilly Chicken did not change substantially among different levels of treatments. After two weeks, only lightness score (L*) and hue angle (h*) of breast meat were significantly varied ($p<0.01$). Texture parameter e.g. hardness (H) in breast portion and pH of different carcass parts were highly significant($p<0.01$) among the different feeding systems and after two weeks, the results were also highly significantly($p<0.01$) varied in different feeding systems.Nutrient parameters e.g. moisture, CF, EE, Ash and CP were not significantly($p>0.05$)varied with different feeding treatments. Highest CP (%) was found in semi scavenging feeding group and lowest CP (%) was found in intensive feeding group. Ether Extract (%) was found highest in semi scavenging system and lowest was found in scavenging system. Total ash content found almost same for each treatment. Out of all three rearing systems semi-scavenging found effective in terms of growth performances, meat characteristics and protein content.

Key Words: Hilly, Semi-scavenging, Growth, Proximate, Carcass

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Chapter One

Introduction

1.1 Background of the study

In Bangladesh poultry farming is today regarded as one of the most vital and active industries, generating both direct and indirect employment opportunities. The poultry sector has a total investment of almost 35,000 crore BDT (USD 4.12 billion) and employs over 6.0 million people, the majority of whom are young and women. Over the last five years, the production of eggs and meat has increased by around 10% on average. In 2019, the country produced around 46.6 million eggs and 3.1 million kg of poultry meat per day. However, the recent Covid-19 has had a significant impact on the entire chicken value chain, resulting in an unfavorable demand-supply mismatch for poultry products. As a result, poultry farmers, the private sector, service providers, the government, and other stakeholders are implementing suitable coping mechanisms to address the supply of inputs and the sale of finished goods (Saleque, 2020).

The annual egg production of BLRI improved ND (Non- Descriptive), HI (Hilly) and NN (Naked Neck) increased up to 150-160g, 130-140g and 175-190g, respectively and the average body weights 1074g, 1279g and 1041g, respectively at the age of 16th weeks, age at sexual maturity decreased to 154 days from 168 days and egg weight increased by 2-3g under standard feeding and management conditions. These genotypes are called as improved varieties. To get better performance from the genetically improved varieties in terms of their productivity there is need some extra feeding, care and management. Therefore, the birds should have explored in different production systems (intensive, Semi-scavenging and scavenging) to judge its better productivity in terms of both the quantity and quality (Faruque *et al.*, 2015).

Scavenging chicken production system is practiced in most rural areas of the country and objectives of production are for household consumption and as source of additional income for the household. It contains small flock sizes (5-20 chickens per household) which are indigenous breed types mostly depend on locally available feed material as supplement with low health services and other management practices. The chicken does not have their own constructed chicken house rather maintained in the main house with the family. The major feed sources for chicken are worms obtained from legumes, cereals and sometimes there is supplemental feed during feed shortage. The amount given is small and do not fulfill their nutrient requirement resulting low productivity. Indigenous poultry breed in this system of production does not produce more than 60 eggs per hen per year (Melesse, 2014).

Semi-scavenging is used for small poultry flocks under partly controlled management and where the scavenged feed accounts for a substantial part of the total feed consumed. A Semi-Scavenging Poultry Model is an integrated system to provide supplies and services to establish and to maintain a semi-scavenging poultry sector. In Bangladesh there has, during the past decade, been developed a successful model for semi-scavenging poultry holding. In 1995 more than 6000,000 smallholders were established and the number is now increasing by more than 100,000 per year. (https://graduatefarmer.co.ke/2017/03/17/chicken-production-)

Intensive chicken production system use more inputs than the above two chicken production systems. It is market oriented and the main objective of production is to get more profit. The number of chickens involved are relatively high (more than 200 chicken). They should provide the expected product within that time. (https://graduatefarmer.co.ke/2017/03/17/chicken-production-)

BLRI improved varieties especially the Hilly genotype which already been popularized for its better growth performance should be explored its productivity in intensive, semi-scavenging and scavenging conditions for judging optimum return from the genetically improved birds by the farmers. Therefore, the current study is designed to know the production performance and meat quality of BLRI improved Hilly chicken in those production systems.

Remarkably, the improved genotypes most often not perform satisfactorily under low input or subsistence level farming condition or in a changed environment. On the other hand, the meat quality of the birds also deviated or changed in different feeding and/or rearing systems that also influence the consumer preferences. Hence, the improved genetic potentialities of a varieties or types should be judged and explored by validating their performances in different production systems and conditions.

1.2 Objectives

The goal of the research is to determine the production performance and meat quality of BLRI improved Hilly Chicken under different feeding systems.

Considering all those facts into accounts the study was aimed with the following objectives-

i) To investigate the production performance of BLRI improved Hilly Chicken under different feeding systems.

ii) To determine the meat quality of BLRI improved Hilly Chicken in different feeding systems.

Chapter Two

Review of Literature

Review of Literature

In Bangladesh, livestock, particularly poultry, is a promising area for poverty alleviation. Around 140 million hens are strewn across the country's 68, 000 villages, the majority of which are of the indigenous nondescript variety. For indigenous chickens, the production system e.g. with each family raising an average of 6-7 hens, smallholder backyard scavenging in nature, to meet the needs of the family, and from which a cash income can be produced as necessary. About 75% of the eggs and 78 percent of the meat consumed are produced by indigenous hens (Bhuiyan, A, 2005).

In most developing and poor countries, indigenous/native chicken breeds play an essential role in rural economics. They provide a significant source of income for the rural poor and marginalized sections of the population, as well as nutritious chicken eggs and meat for their personal sustenance. Changes in husbandry, food, and health coverage can all help local birds to perform better. However, genetic improvement can be achieved through either selection or crossbreeding, or by combining the two methods. Improvement through selection may take some time, but the results will be long-lasting. Improvement may be faster through crossbreeding, but research must focus on the generation of native-type birds with higher production potential. (Bhuiyan, A, 2005)

2.1 Free-range chicken production system

Scavenging chicken production system is practiced in most rural areas of the country and objectives of production are for household consumption and as source of additional income for the household. It contains small flock size (5-20 chickens per household) which is indigenous breed types mostly depend on locally available feed material as supplement with low health services and other management practices.

The advantages of free-range chicken production system include, the chickens are healthy since they exercise in the open air freely, there is minimal infection with parasites if enough space is available, there is little or no labor input, the chickens in this type of production system help to limit the amount of rubbish in a productive way and the direct costs of the system are low. The disadvantages of free-range chicken production system include, it is difficult to control and manage the chicken especially the young chicks are easily exposed for predators and unfavorable weather conditions, the chickens eat sown seed when looking for feed, a large percentage of the eggs can be lost as the laying hens are not accustomed to laying nests, high diseases transmission and occurrence of high death, chickens are less productive. (Melesse,2014).

2.1.1 Growth parameters

Under free range system, the experiment was conducted to compare the growth performance of indigenous chicken genotypes: Non-Descriptive (ND), Improved Native (IN), Hilly Chicken (HC) and Naked Neck (NN). Live weight gains in all four types chicken were changed almost in a similar pattern. Significant differences were observed in live weight, dressing percentage, breast, meat, drumstick, thigh meat among the four types chicken. (Akhter et al., 2018)

Hilly cocks are slightly heavier than other indigenous chickens *($p>0.05$)*.In comparison to the other Deshi populations, the Red Jungle Fowl and Assel cocks had shank lengths of 11.3cm and 10.83cm, respectively. The shank length of the dwarf chicken (7.50cm) is the shortest among the local chickens. Except for Red Jungle Fowl cock, where the cock appears to be higher than the hen, there is no significant *($p>0.05$)* difference in shank length between male and female. According to Bhuiyan et al. (2005), the indigenous females' and males' shank lengths are 7cm and 8.5cm, respectively. The dwarf chicken, local cocks, and Deshi hen had the largest shank circumferences of 0.87cm, 0.70cm, and 0.70cm, respectively, while Assel cocks (0.70cm) and Hilly and Assel (0.53cm) hens have the smallest. The difference in wing length between the male and female is not significant *($p>0.05$)*. Body weight at day old was another economic indicator that showed morphological variances (25.55g - 29.26g). (Islam, 2011).

2.1.2 Nutritional Parameters

According to, da Silva, D., et al. (2017), the proximate composition analysis of the breast, thigh, and drumstick revealed a statistical difference *($p > 0.05$)* between the chickens in terms of protein content (18 percent), total fat content (2.2 percent).

In breast meat from three commercial strains, Abeni and Bergoglio (2001) reported reduced moisture (74.81–75.5%) and higher total fat (1.85–2.58%) levels. Lichovnková et al. (2009) evaluated the meat quality of two strains of chickens, one fast-growing and the other slow-growing, at 49 and 90 days after slaughter, and found that the fast-growing chickens had a higher fat percentage ($p > 0.05$) and reduced moisture content as they aged. Faria et al. (2009) compared two free-range chicken strains and found that as age advanced (65–95 days), fat deposition increased from 0.44 to 0.61 percent and 0.76 to 0.87 percent (breast) and 1.90 to 2.74 percent and 2.32 to 2.39 percent (thigh) for Pescoço Pelado (Spanish breed) and Paraso Pedrês (Spanish breed), respectively. The moisture content of the breast and thigh of Pescoço Pelado and Paraso Pedrês hens dropped with age, from 74.22 to 73.28 percent (breast), 75.80 to 75.70 percent (thigh), and 76.38 to 75.93 percent (thigh), in that order. The moisture content of male Paradise Pedrês breasts increased gradually with age (73.39 percent at day 65 to 73.40 percent at day 95), similar to the drumstick, which had higher moisture content in free-range chickens than in industrial chickens. Taking into account the meat's advanced age at slaughter, the moisture content is reduced and the fat content is increased (Fanatico et al. 2005).

According to Bogosavljevic-Boskovic et al. (2010), "Label" broilers have 10% higher muscular development and a lower intramuscular total fat content, leading in morphological variations in the chickens' tissues and organs, as well as metabolic biochemical processes. These researchers compared the effects of two breeding systems ("extensive indoor" and "free-range") on the protein and total fat content of the breast (white fibers) and legs (dark fibers) of chickens bred with access to paddocks, finding higher levels of protein and lower levels of total fat in chickens bred with access to paddocks, with no significant effect on dry matter content or ash.

2.2 Semi- scavenging chicken production system

This type of chicken production system is better than free ranging production system since it uses inputs like supplemental feed, vaccine, etc. It has a small house which accommodate laying nest and feeders which serves as chicken house for night time.

This system include, complete control over operation, useful for record purposes, operational throughout the year, economic use of land (free range) and there is better protection during the cold season. The disadvantage of this system of chicken production system include, high cost in fencing, danger of over stocking and exposure for different disease if the compound is not clean and dry(https://graduatefarmer.co.ke/2017/03/17/chicken-production-).

2.2.1 Growth Parameters

According to Jahan et al. (2021), a total of 288 day-old chicks (72 from Deshi, 72 from Fayoumi, 72 from RIR, and 72 from Sonali) were employed in this 20-week study with four genotypes. 144 chicks were raised in a farm environment, while another 144 were raised in a semi-scavenging environment. The highest day-old chick weight was found in RIR, followed by intermediate and similar weights in Sonali and Fayoumi, and the lowest in Deshi *($p<0.01$)*. The weight of day-old chicks did not differ between farm and semi-scavenging groups *($p>0.05$)*. At 20 weeks of age, RIR had the highest live weight, followed by Sonali, Fayoumi, and Deshi. Except for Deshi, all genotypes were heavier on the farm than in semi-scavenging. RIR had the largest live weight growth at 20 weeks of age, followed by Sonali, Fayoumi, and Deshi *($p<0.01$)*. In semi-scavenging, Deshi chicken was heavier than in farm conditions. Sonali, Fayoumi, and RIR had similar and higher survival rates, but Deshi had a lower rate *($p<0.01$)*. Feed consumption was comparable and greater in RIR and Sonali, intermediate in Fayoumi, and lowest in RIR and Sonali.RIR had the best feed conversion, followed by Sonali, Fayoumi, and Deshi. Semi-scavenging had a greater feed conversion than farm *($p<0.01$)* condition.

2.2.1 Nutritional Parameters

Salma et al., 2016 found in their investigation, there were no significant changes in crude protein and ash content in FAY (Fayoumi) and WLH (White Leg Horn) breast and thigh meat. In the FAY and WLH breeds, there was a similar non-significant difference in the moisture content of breast and thigh meat.

2.3 Intensive chicken production system

This type of chicken production system use more inputs (feeds and feeding, breed, health, housing and other inputs) than the above two chicken production systems. It is market oriented and the main objective of production is to get better profit.(https://graduatefarmer.co.ke/2017/03/17/chicken-production-)

2.3.1 Growth Parameters

According to Talukder et al., 2016, adult female and male Hilly birds weighed 2129, 1786, and 1457g, and 2436, 2834, and 2249g, respectively. The average daily feed intake per bird was 105g and *($p<0.01$)*, with death rates of 6.2, 5.1 and 11.1 %, respectively.

According to Khatun, R., et al. (2005), there was no significant difference *($p>0.05$)* in age at sexual maturity, fertility, dead in germ, normal chicks, and abnormal chicks between the three native genotypes Naked neck (NN), Hilly, and Non-descript deshi (ND).

2.3.2 Nutritional Parameters

The genetic makeup, age, food, and care of the carcass, as well as environmental factors, will all influence the proximate composition of the carcass (Baracho et al. 2006 and Koblitz 2011). Aside from age at slaughter and sex, differences in physical and chemical traits are linked to the chickens' sexual maturity, growth capacity, muscle development, and lineage (Faria et al. 2009). According to, da Silva, D. et al. (2017), the proximate composition of the breast, thigh, and drumstick revealed a statistical difference *($p< 0.05$)* between the chickens in terms of protein content of the thighs (15.7%), total fat content of the thigh (3.4%), and the drumstick (5.0%), as well as the drumstick's caloric value (121.9%) for industrial broilers.

De Oliveria J. et al. (2016) found that, treatments had no effect on the proximate composition of breast and thigh meat *($p> 0.05$)*. Poultry meat has roughly 60% to 80% water, 15 % to 20% protein and 1.5% to 5.3% lipids. Due to the influence of diet, animal age, breeding habitat, and anatomical cut, the latter is the most variable component, with the largest contents in the thigh, (Castellilin, 2002).

2.4 Color, texture, pH of meat at different feeding systems

Olubenga et al., 2016 found that meat color is a critical qualitative factor that defines the appearance of meat and has a significant impact on consumer acceptability. Early research (Ewa et al., 2005) found that adding vitamins to feed had no discernible effect on meat acidity or color, while redness was improved. Natural antioxidants given to diet stabilize meat color, according to other researchers (Kirchheim et al., 2001). Heavier birds (those with a thicker layer of breast muscles) have a darker color of breast muscles than lighter birds (Bianchi et al., 2006).

According to, da Silva, D et al. (2017), the L* scores were greater than 53, indicating that the color was lighter than usual, indicating that the meat may have quality issues, referred to as PSE (pale, soft, and exudative) (Koblitz, 2011), more specifically due to insufficient antemortem management, such as pre-slaughter factors, stunning methods, and cooling regimes (Karunanayaka et al., 2016). The a* scores for industrial broiler chickens were higher than those for free-range chickens, whereas the b* scores were lower, indicating that free-range chicken meat had the highest intensity of yellow color, which could be seen regardless of the colorimeter's measurement, and industrial broiler meat had higher red intensity. According to Faria et al. (2009), slow-growing chickens that consume a larger amount of forage rich in carotenoids have a greater intensity of yellow color in the flesh, resulting in a higher b* value. While studying the meat of three commercial groups of chicken breasts, Qiao et al. (2002) noticed pale, soft, and exudative (PSE) meats in industrial broilers chicken. They discovered the anomaly in samples with no statistical difference in L* values (61.49, 61.60, and 61.66), but substantial differences in a* (3.63, 4.10, and 4.52) and b* (8.78, 9.23, and 9.87). Although there was strong evidence of the impact of short-term ante mortem stress on meat color, the author emphasized that the differences could be attributable to a possible genetic predisposition or other factors related with the rearing of these chickens in the long run. According to scientific evidence, there is a negative relationship between L* values and pH, and the loss of lightness as one gets older is frequently linked to a rise in pH levels.

According to, da Silva D et al. (2017), the shear force was used to determine the meat tenderness, and there was a significant difference *($p < 0.05$)* between the birds. The flesh of free-range broilers had a greater value (2.95 kgf cm^{-2}), indicating that it was less tender than that of industrial broilers (2.52 kgf cm^{-2}). Contreras-Castillo et al. (2007) found a substantial inverse association between shear force and pH, i.e., low pH meat is less tender; this link was verified in the current investigation. According to Ramos and Gomide (2009), the meat of younger animals is tenderer, but this trait diminishes with age due to the accumulation and, in particular, the maturation of connective tissue in muscle fibers.

Chapter three

Materials & Methods

Materials and Methods

3.1 Location and selection of farmer:

Farmers were selected from the different locations of Dumuria upazila under Khulna district of Bangladesh. The farmers were divided into 3 different feeding systems (Intensive, Semi-scavenging and Scavenging) replicating 3 times of each rearing system. The study was designed using RCBD with 3 treatments (03) e.g. T_1= Scavenging, T_2= Semi-scavenging and T_3= Intensive having three (03) replications. The farmers were divided into 3 groups for 3 different feeding systems replicating 3 times of each rearing system.

3.1.1. Lay out of experiment:

Treatment/ Rearing system	Replication/ Birds		
	R_1	R_2	R_3
T_1	10	10	10
T_2	10	10	10
T_3	10	10	10

. T_1= Intensive, T_2= Semi-scavenging and T_3= Scavenging, having three (03) replications.

3.2 Collection and distribution of birds

The experimental birds were collected from the BLRI research flock and distributed among the selected farmers. Initially, each farmer was provided a total of 30 birds at the age of 6 weeks (15 males and 15 female birds).

3.3 Management of the research birds

Housing: The low cost houses were built for all the groups as per the birds' number. Proper ventilation and protection from predators were ensured especially during night.

Brooding: The DOC was brooded up to 4 weeks of age in one house in each location and then the birds were distributed according to the selected farmers group.

Feeding and watering: The locally available ready commercial broiler starter feed were provided up to 4 weeks of age followed by broiler grower feed at the end of the experimental period (12 weeks of age).

Table 3.3.1: Ration composition of commercial feed

Feed ingredients	Amount (kg)
Maize	54
Wheat	10
Rice	10
Soya meal	20
Fish meal	3
Soya bean oil	1
Salt	0.3
Lime stone	1
DCP	0.5
Vitamin premix	0.3
Lysine	0.1
Methionine	0.1
Mold inhibitor	0.1
Coccido stat	0.05
Toxin binder	0.15
Multi enzyme	0.05
Sodium bi-carbonate	0.1
Anti-oxidant	0.01
Total	100

Table 3.3.2: Nutritional composition of commercial feed

Nutritional parameters	Percentages (%)
Crude protein	18.6
Crude fibre	3.49
Ether extract	5.49
Ca	1.1
P	0.68
Metabolic energy	2964 kcal

The allocated feed was provided in 2 times a day to the birds. The intensive birds were given 40 g/bird from 6^{th} week which was increased by 5g/ bird per week. Similarly, semi-scavenging birds were given 24 g/bird feed from 6^{th} week and increased by 3g/ bird per week.

The semi-scavenging birds were allowed to scavenge inside the fence and scavenging group of birds were allowed to scavenge around the house during day time. Seasonal vegetable gardening and soil culture was done for growing of natural earthworm and other insects (According to, the Entomology Division, BARI, Gazipur for this purpose). The feed and water were supplied into the feeder and waterier in all the groups. The clean and fresh water were provided to the birds at all the times. The feeder and waterier were cleaned regularly.

Vaccination and medication: vaccination was performed as per pre-selected vaccine schedule. Medication was administered using indigenous knowledge/ technologies as well as available literatures (e.g. Moringa leaf for growth promoter, guava leaf for diarrhea, Tulshi leaf for cold, pineapple leaf for anthelmintic etc.) to minimize the medication cost as well as to make the produce consumer/organic friendly.

Lighting: The birds were provided artificial light as per standard schedule maintained for layer.

3.4 Meat quality assessment

At 12 weeks of age at least 4 birds (2 males and 2 females) from each treatment from each location were collected and slaughtered.

3.4.1 Crude Fiber Analysis

Test Procedures

1g sample was taken in crucibles were fixed with the channels. 150 ml 1.25% H_2SO_4 was taken in the flask of the analyzer adding 3-5 drops n-octanol as anti-foam agent. The switch of the fibre analyzer (using Velp Scientifica Raw Fibre Extractor) was turned on. Boil exactly for 30 minutes. After 30 minutes, washing was done three times with 30 ml (crucible filled to the top) of hot deionized water, connecting each time to compressed air for stirring the content of crucible. After draining last wash, 150 ml 1.25% KOH and 3-5 drops of anti-foam agent were added. Again after boiling for 30 minutes and washing 3 times, a last washing was done with cold deionized water to cool the crucible and then the crucible content with 25 ml of acetone was washed and stirring by compressed air. After that crucibles were dried at 105° C for one hour in oven and then cooled down in a desiccator to take the dry weight (F_1). The crucibles were placed into a muffle furnace and heated up to 550° C for three hours to reweight after cooling in a desiccator (F_2).

Calculation

% Crude Fibre = $\frac{F1-F2}{F0} \times 100$

Where,

F_0 = Weight of sample in gram

F_1 = Weight of oven dried sample in gram

F_2 = Weight of ash containing crucible in gram

3.4.2 Ash Analysis

Test Method procedure

Crucibles were placed in muffle furnace, allowing 30 minutes to reach 600˚C. Weight of crucible was recorded to 0.0001g (W_1). About 3g sample was weighted into a crucible which had been tarred. Weight of sample was recorded to 0.0001g (W_2). Ash crucibles containing samples in muffle furnace at 600˚C for 6 hours after the furnace had reached the temperature. Crucibles were allowed to cool in furnace to less than 20˚C and crucibles were placed in desiccator with a vented top. Crucibles were cooled in desiccator to room temperature and were weighed immediately. Weight was recorded to 0.0001g (W_3). Ash% was calculated and reported to one decimal place.

Calculation

$$Ash\% = \frac{W_3 - W_1}{W_2} \times 100$$

Where,

W_1 = Weight of crucible in gram

W_2 = Weight of sample in gram

W_3 = Weight of crucible and ash in gram

3.4.3 Ether Extract

Test method procedure

- Sample: 3 g (F1) of grounded and homogenized material was weighed in an extraction thimble with 1 mg approximation. Total weight- thimble weight = wet sample weight.
- Chemicals: Petroleum ether 40-60° C, with an evaporation of residue not higher than 10mg/l.
- Sample drying: Sample was dried in the thimble for one hour in a 125° C oven.
- Immersion: Sample containing thimble or the glass crucible containing dry hydrolysed sample were introduced into the extraction equipment. After weighing extract collecting vessel (F2), 40ml of petroleum ether was added. Thimble with sample, assembled with thimble connector to extraction unit. After closing the extraction unit, the cooling water flow started and the heating. When the solvent started boiling, the thimble or glass crucibles were placed into "Immersion" position for 30 minutes.
- Washing: After 30 minutes extracted, thimble or glass crucible were placed into "Washing" position for 60 minutes.
- Recovery: After washing, the stopcock located under the water, was closed and cooled in condenser and evaporated completely the solvent from the extraction vessel.
- Weighing: The extract containing cups were dried in oven at 125° C for 30 minutes and weighed (F3) it after cooling a desiccator.

Calculation

$$\%\ \text{ether extract} = \frac{F3-F2}{F1} \times 100$$

Where,

F_1 = Weight of sample in gram

F_2 = Weight of empty vessel in gram

F_3 = Weight of vessel and ether extract in gram

3.4.4 Crude Protein Analysis

Test Procedures

Digestion

1g of sample was weighed with an accuracy of ±0.1mg. For each sample 2 catalyst, 5 ml of H_2O_2 (30-35%)and 20ml H_2SO_4 (96-98%) were added and then placed into digestion block. The temperature of the digestion block was taken at 250°C for 30 mins, 350° C for 30 mins and 420° C for 60 mins, sample was heated (using Velp Scientifica DK-8 Heating Digester) until the fumes stopped. Then the sample was taken to cool 50-60°C.

Distillation

After cooling the sample it was mixed with 50ml distilled water. 70ml NaOH was added with the solution. The digestion flask was then given into the distillation chamber. 30ml Boric acid solution was taken in a conical flask and 3 drops of mixed indicator were added into it. The water flow was previously adjusted. The distillation process was done until the colour of indicator mixture solution did not turn into green colour.

Titration

The sample of the flask was then taken for titration. Then 0.1N $H_2SO_4$was taken in burette pipe and added drop wise. The procedure was continued until the colour of the solution of the conical flask turn from green to blue. When the solution colour had changed the titration procedure ended. The strength of the titration was then recorded.

Calculation

$$\%\ N = \frac{0.1 \times 0.014 \times \text{titrate value}}{\text{Wight of sample}} \times 100$$

Crude Protein = %N × 6.25

3.4.5 Texture analysis

Texture profile analysis was conducted as per Bourne (1978) using a Universal Testing Machine (TRAPEZIUM EZ-SX, Shimadzu, Japan). A crosshead speed of 10mm/min was used, applying 500 N load cell and texture parameters like hardness, springiness, cohesiveness and adhesiveness were estimated (Gupta, S. 2015).

Explanations of Terms

1. Hardness (H)

This is the maximum test force (N) loaded on food products using a plunger.

2. Adhesiveness (A3)

This is the force (N) required to remove food that has bonded to the hands during handling or to the teeth, tongue and roof of mouth during eating.

3. Cohesiveness (A2/A1)

This is the deformation and destruction of a food product when a load is added to it. The load is added twice to draw comparisons of load areas (energy) for first and second loads.

4. Brittleness (B)

This is the breakdown force (N) of food in the mouth.

5. Elasticity quality

This is the comparison of indentation and displacement when a load is added twice in succession to a food product using a plunger.

6. Gumminess (H × A2/A1)

Hardness × elastic quality × cohesive quality.... Dry food product

7. Chewiness (H × A2/A1 × T2/T1)

Hardness × cohesive quality.... Semi-dry food product

3.4.6 Color analysis

A boneless chicken muscle section 12 cm thick was removed from the drumstick and breast portion. Meat samples were individually, vacuum packaged and frozen at −20 °C. Each frozen sample was standardized into two 2.54 cm thick steak samples (AMSA, 1995) for objective color evaluation (L, a*, b*, c* and h*).Readings were taken near the center of each core using a CM (Minolta Chromameter CR-300, Osaka,Japan) with a 1 cm aperture, illuminant C and a2_ viewing angle. Before data collection, the instrument was calibrated with a white calibration plate (L* = 97.06,a* = _0.14, b* = 1.93) covered in the same film wrapping the samples. Data were collected in CIE L*a*b* color space through the meat film. Lightness (L*), redness (a*), yellowness (b*), chroma [or color saturation,ða_2 þ b_2Þ0:5], and hue angle [arctangent (b*/a*) _ 360_/(2 _ 3.14)] were evaluated. Chicken meat color coordinates (L*, a* and b*) were recorded with a digital Minolta CR300 chromometer (Minolta Co., Osaka, Japan) on the surface exposed by drumstick and breast meat. Coordinate a* ranged from red (+a*) to green (−a*) and coordinate b* from yellow (+b*) to blue (−b*) (Hunter lab, 1996). Three readings of L*, a*, b*, c* and h* values were obtained at different sites.

3.4.7 pH analysis

The meat sample was homogenized at 1000 rpm for 30 s using a Polytron (Brinkman instruments, New York, NY) blender. A 10 g sample of homogenized sample was weighed into a beaker, and 50 mL of distilled, deionized water was added to the sample. A stir bar was placed in the homogenized solution, and pH was measured while stirring. A bulb tip combination electrode with a Hanna pH 211 Microprocessor Meters (Hanna Instruments) was used in this procedure. After 2 h postmortem the ultimate carcass pH of Hilly Chicken muscle was evaluated. Same procedure was followed for evaluating ultimate carcass pH after two weeks of slaughter.

3.5 Data analysis

The data on weekly live weight (g/bird) and weekly live weight gain (g/bird) was recorded. All the collected data were compiled and analyzed using General Linear Model (GLM) procedures of SAS Institute (SAS, version 9.4,1994) with $p<0.01$ or $p<0.05$ level of significance. The Duncan's Least Significance Difference test was used to determine significant difference among treatment groups for various parameters considered in the experiment.

Chapter Four
Results & Discussion

Results & Discussions

The experiment was carried out to investigate the effects of feeding regimes on the growth parameters and meat characteristics of the BLRI improved Hilly Chicken. In the following section, data from various parameters were presented.

Growth performance

4.1 Weekly live weight of Hilly Chicken Cock

The weekly live weight of Hilly Chicken cock of three different feeding systems (intensive, semi-scavenging, scavenging) is shown in table 4.1.1. It reveals from the table 4.1.1 that feeding managements had significant ($p<0.01$) effect on live body weight of Hilly Chicken cock. The highest body weight (1323.4g), was found in intensive group and the lowest body weight (762.2g) was found in scavenging group at 12th week of age.

In recent article, Faruque *et al.* (2015) demonstrated that, weight of different types of indigenous chicken, where they mentioned that the Hilly Chicken had highest live weight (1110.7g). These findings partially support the present findings where live weight of Hilly Chicken cock which was 1323.4g at 12th weeks of age.

Table 4.1.1 Weekly live weight (g/bird) of Hilly Chicken Cock

Age in week	Treatment			p value	Sig. value
	T_1 ($\bar{x}$±SE)	T_2 ($\bar{x}$±SE)	T_3 ($\bar{x}$±SE)		
6th	454.6 ^{a} ±40.38	484.8 ^{a} ±38.73	308.2 ^{b} ±16.00	0.0065	**
7th	680.2 ^{a} ±33.00	562.6 ^{b} ±29.50	365 ^{c} ±12.29	0.0001	**
8th	829 ^{a} ±41.08	669.80 ^{b} ±27.26	465.6 ^{c} ±10.54	0.0001	**
9th	1002.4 ^{a} ±41.96	795.20 ^{b} ±36.81	585.2 ^{c} ±13.3	0.0001	**
10th	1110.4 ^{a} ±26.46	916.20 ^{b} ±38.05	633.2 ^{c} ±5.74	0.0001	**
11th	1252.6 ^{a} ±30.25	1030.60 ^{b} ±31.95	732.4 ^{c} ±11.77	0.0001	**
12th	1323.4 ^{a} ±19.70	1139 ^{b} ±26.29	767.2 ^{c} ±13.03	0.0001	**

*Here, ^{a,b,c} means bearing uncommon superscripts in a row differ significantly.T_1= Intensive, T_2= Semi-scavenging, T_3= Scavenging, ** labeled as $p<0.01$.*

4.2 Weekly live weight gain of Hilly Chicken Cock

Weekly live weight gain of three different feeding systems (intensive, semi-scavenging, scavenging) is shown in table 4.2.1. The results of weekly live weight gain of experimental birds were differed significantly ($p<0.01$) among the three treatment groups in 7th and 12th weeks. The highest weight (108.4g) gain was found in semi-scavenging group followed by intensive group (70.8g) at 12th weeks of age. The lowest value of live weight gain (34.8g) was found in scavenging group at 12thweeks of age.

Rashid et al. (2004) found that supplementing scavenging, Non-descriptive Native hens with 60 g grain daily enhanced body weight gain significantly ($p<0.01$) compared to not supplementing group. They also reported weekly body weight gains of 41.16, 43.19, and 43.89 g/bird for Naked Neck, Hilly, and Non-descriptive Native at 8th week of age, respectively, under intensive management which is quite lower than that of the current research (148.8 g). The reasons behind the higher weekly body weight gain might be the gender variation. Halima (2007), observed

Faruque et al. (2015) compared the weight of several types of indigenous chickens and found that the Hilly Chicken had the greatest live weight (1110.7g). These findings support the present findings where weekly live weight of Hilly Chicken hen was 1167.20 g.

Table 4.4.1 Weekly live weight (g/bird) of Hilly Chicken Hen

Age in week	Treatment			*p* value	Sig. value
	T_1 ($\bar{x}$±SE)	T_2 ($\bar{x}$±SE)	T_3 ($\bar{x}$±SE)		
6th	405.2^a±17.05	385^a ±25.67	307.2^b±11.24	0.008	**
7th	516.2^a ±24.7	462^a ±18.73	375.4^b±13.81	0.001	**
8th	621.4^a ±35.78	573.0^a±16.71	448.8^b ±16.7	0.001	**
9th	804.8^a ±31.26	671.6^b±18.03	542.4^c±29.04	<.0001	**
10th	868.4^a ±26.93	801.4^a ±36.5	628.8^b±11.61	0.0001	**
11th	1029.6^a ±16.08	913.8^b±33.38	734.6^c ±15.2	<.0001	**
12th	1167.20^a±40.33	1060.6^a±47.7	792.8^b±23.42	<.0001	**

*Here, a,b,c means bearing uncommon superscripts in a row differ significantly. T_1= Intensive, T_2= Semi scavenging, T_3= Scavenging, ** labeled as $p<0.01$, NS= Non-Significant.*

4.5 Weekly live weight gain of Hilly Chicken Hen

Weekly live weight gain of three different feeding systems is shown in table 4.5.1. The results of weekly live weight gain of experimental birds were differed significantly (*$p<0.01$*) among the three treatment groups at 7th and 9th week of age. The highest value of weight gain (146.8g) was found in semi-scavenging group and the lowest value of live weight gain (58.2g)was found in scavenging group at 12th week of age.

Rashid et al. (2004) found that supplementing scavenging Non-descriptive Native hens with 60 g grain daily enhanced body weight gain significantly (*$p<0.01$*) compared to not supplementing group. They reported weekly body weight gains of 41.16, 43.19, and 43.89 g/bird for Naked Neck, Hilly, and Non-descriptive Native at 8th week of age, respectively, under intensive management system. These findings are quite lower than that of the current observation (105g). Due to different source of supplementation the ratio of two findings are different. Halima (2007), observed daily body weight gain in Sonali (RIR X Fayoumi) pullets kept in a semi-scavenging system supplemented with a balanced feed were also much greater. These findings supported the current findings (146.8g).

Table 4.5.1 Weekly live weight gain (g/bird) of Hilly Chicken Hen

Age in week	Treatment			p value	Sig. value
	T_1 ($\bar{x}$±SE)	T_2 ($\bar{x}$±SE)	T_3 ($\bar{x}$±SE)		
7th	$110.60^{a}\pm11.69$	$77^{b}\pm10.51$	$68.2^{b}\pm4.13$	0.018	**
8th	105.2±28.60	111±24.87	74 ±5.05	0.467	NS
9th	$183.4^{a}\pm28.50$	$98.6^{b}\pm14.38$	$91.8^{b}\pm30.1$	0.045	*
10th	63.60±9.54	129.8±42.43	86.4±29.9	0.3297	NS
11th	161.2±20.77	112.4±17.44	105.8±18.79	0.122	NS
12th	137.6±27.5	146.8±53.5	58.2±15.2	0.2004	NS

*Here, ^{a,b,c} means bearing uncommon superscripts in a row differ significantly. T_1= Intensive, T_2= Semi- scavenging, T_3= Scavenging, * labeled as $p<0.05$& ** labeled as $p<0.01$, NS= Non –Significant.*

4.6 Weekly Feed Conversion Ratio (FCR) of Hilly Chicken Hen

Weekly feed conversion ratio (FCR) of three different feeding regimes e.g. intensive, semi scavenging, scavenging is shown in table 4.6.1. It reveals from the table 4.6.1 that there were significant ($p<0.01$) differences in weekly FCR among three feeding groups at the age of 7th, 10th and 11th weeks. The highest value (4.28) i.e. poor FCR was recorded in intensive and the lowest value (3.02) i.e. best FCR was found in scavenging group at 12th week of age.

Yeasmin (2000) found that typical feathered indigenous birds under farm conditions had an FCR of 3.95 at 12thweek of age, which is almost identical to the FCR of the BLRI enhanced Naked Necked genotype (SC Das et al, 2018). These findings supported the current findings (4.28) of the Hilly Chicken hen. In contrast to the findings of this study, a publication by Faruque et al.

(2016) found a non-significant (*p<0.01*) difference in FCR across the three native chicken genotypes, namely non-descriptive native, Hilly, and Naked Neck.

According to Khondoker (1993), the FCR of indigenous chickens at the 12thweek of age was 5.38, which is consistent with the present FCR of intensive group (7.28). Hossen (2003) found that pullets reared in a semi-scavenging system and supplemented with balanced feed performed better in terms of feed conversion efficiency than those reared in a completely scavenging system and supplemented with broken rice and soya bean crushed. These findings also support the present findings where the FCR of semi-scavenging was 3.37 and scavenging was 3.02 after 12th week.

Table 4.6.1 Weekly Feed Conversion Ratio (FCR) of Hilly Chicken Hen

Age in week	Treatment			*p* value	Sig. value
	T_1 ($\bar{x}$±SE)	T_2 ($\bar{x}$±SE)	T_3 ($\bar{x}$±SE)		
7th	2.95^{a}±0.27	2.69^{a}±0.43	1.42^{b}±0.11	0.007	**
8th	4.64±1.29	3.62±2.02	1.44±0.09	0.287	NS
9th	2.39±0.49	2.61±0.48	2.38±1.14	0.973	NS
10th	7.29^{a}±1.23	3.04^{b}±0.99	2.57^{b}±0.92	0.015	**
11th	2.9^{a}±0.32	2.68^{a}±0.41	1.53^{b}±0.35	0.039	*
12th	4.28±0.91	3.37±0.98	3.02±0.51	0.5570	NS

*Here, ^{a,b,c}means bearing uncommon superscripts in a row differ significantly. T_1= Intensive, T_2= Semi- scavenging, T_3= Scavenging, * labeled as p<0.05& ** labeled as p<0.01, NS= Non-Significant.*

Meat Quality

4.7 Carcass characteristics of Hilly Chicken Hen

Weight of different carcass parts of female Hilly Chicken Hen is shown in table 4.7.1. Carcass characteristics e.g. dressing percentage, thigh weight, breast weight, and drumstick weight were not significantly *($p>0.05$)* varied with different feeding systems. Out of three treatments highest (70%) dressing percentage was found in T_2, which was in semi scavenging treatment and lowest (67%) percentage was found in T_1, intensive feeding system. Neck percentage was found maximum (7.3%) in $T_3$and minimum (5.5%) was found in T_2. Percentage of wing, thigh, breast, and drumstick were found maximum(6.7%,14.5%, 17.1%, and 10%, respectively) in T_2, whereas minimum Percentage (5.6%, 12.7%) of wing and thigh was found in T_3 and minimum Percentage (7.5% and 12.3% respectively)of breast, and drumstick was found in T_1.

In the research of Akter, et al., 2018, BLRI improved Hilly Chicken, dressing percentage was (69%) which was significantly *($p<0.01$)* higher than other remaining genotypes. These findings are consistent with the present findings as all three feeding system dressing percentage were 67-70%. In this report, Akter, et al., 2018 also demonstrated the percentage of thigh, breast, and drumstick were 15.17%, 13.82% and14.01% respectively. These findings also support our current findings as semi-scavenging system thigh and breast percentage was 14.5% and 17.1 % respectively.

Table 4.7.1 Carcass characteristics of Hilly Chicken Hen

Growth Parameters	Treatment			*p* value	*Sig.* Value
	T_1 ($\bar{x}$±SE)	**T_2 ($\bar{x}$±SE)**	**T_3 ($\bar{x}$±SE)**		
Live weight(g)	$1121.5^a±56.5$	$1033.5^b±65.5$	$810^c±53$	0.05	*
Dressed (%)	67± 4	70±2	69± 2	0.76	NS
Neck weight (%)	5.6±1.4	5.56±0.05	7.34±0.7	0.91	NS
Wing weight (%)	6±1.6	6.7±0.00	5.6±0.5	0.33	NS
Drumstick weight (%)	7.5±1.6	10±0.02	8.7±0.7	0.28	NS
Breast weight (%)	12.3±4.6	17.1±0.02	13.6±1	0.39	NS
Thigh weight (%)	13±4.8	14.5±0.07	12.7±1.3	0.54	NS

*^{a,b,c}means bearing uncommon superscripts in a row differ significantly; T_1= Intensive, T_2= Semi- scavenging, T_3= Scavenging, * labeled as $p<0.05$, NS= Non-Significant.*

4.8 Non-Carcass characteristics of Hilly Chicken Hen

Growth performance in non-carcass part of Hilly Chicken Hen meat is shown in table 4.8.1. Non-carcass parameters e.g. head weight, shank weight, offal weight, and liver weight percentage were not significantly *($p>0.05$)* varied with different feeding systems. The highest liver weight percentage (4.1%) was recorded in semi scavenging system and the lowest percentage (3.8%) was recorded in scavenging group followed by intensive group. The highest offal weight percentage (6.62%) was found in semi scavenging group and lowest percentage (5.03%) was found in intensive group. Weight percentage of head and shank were also higher in semi scavenging group followed by scavenging group.

Table 4.8.1 Non-Carcass characteristics of female Hilly Chicken Hen

Parameters (%)	Treatment			*p* value	Sig. value
	T_1 ($\bar{x}\pm SE$)	T_2 ($\bar{x}\pm SE$)	T_3 ($\bar{x}\pm SE$)		
Head weight	2.65±0	3.35±0.05	3.3±0.25	0.13	NS
Shank weight	3±0.35	3.8±0.05	3.6±0	0.16	NS
Offal weight	5.03±0.25	6.62±1.35	5.8±0.35	0.38	NS
Liver weight	3.8±0.3	4.1±0.1	3.80±0.2	0.58	NS

T_1= Intensive, T_2= Semi- scavenging, T_3= Scavenging, NS= Non-Significant

Nutritional Profile

4.9 Chemical composition of Hilly Chicken meats

Chemical composition of Hilly Chicken meats are shown in Table 4.9.1. All the studied DM and nutritional parameters e.g. percentage of moisture, CF, EE, Ash and CP were not significantly *($p>0.05$)* varied among different feeding systems. Highest CP (%) was found to be 16.55 in semi scavenging feeding group (T_2) and lowest CP% was found to be 16.04 in intensive feeding group (T_1). Ether Extract (%) was found highest (9) in semi scavenging system (T_2) and lowest was found in scavenging system which was (5.61). Total ash content found almost same for each treatment which is 4.31.

J. de Oliveria et al, (2016) found that, treatments had no effect on the proximate composition of breast and thigh meat ($p>0.05$). Poultry meat has roughly 60% to 80% water, 15 % to 20% protein and 1.5% to 5.3% lipids. These findings support the current study.

Table 4.9.1Chemical composition of Hilly Chicken meats

Nutrient Parameters (%)	Treatment			*P* value	Sig. value
	T_1 ($\bar{x}$±SE)	T_2 ($\bar{x}$±SE)	T_3 ($\bar{x}$±SE)		
DM	24±0.03	20±1.44	26.05±1.76	0.09	NS
Moisture	76±0.03	80±1.44	73.95±1.76	0.09	NS
CF	0.98±0.00	0.97±0.00	0.98±0.02	0.94	NS
EE	5.92±1.69	9.0±1.0	5.61±0.06	0.21	NS
ASH	4.31±0.01	4.31±0.01	4.31±0.01	1.00	NS
CP	16.04±0.44	16.55±0.60	16.47±0.01	0.69	NS

Here; T_1= Intensive, T_2= Semi- scavenging, T_3= Scavenging; DM= Dry Matter ,M= Moisture CF= Crude Fibre, EE=Ether Extract, CP= Crude Protein; NS= Non-Significant.

Color, texture and pH analysis of Hilly Chicken

4.10 Color profiles of Hilly Chicken Hen immediate after slaughter

Color indicators like lightness (L*), redness (a*), yellowness (b*), chroma (c*) and hue angle (h*) for drumstick and breast meats of Hilly Chicken Hens are shown in table 4.10.1.Except for hue angle (h*) of breast meat, several color indicators of drumstick and breast meats of Hilly Chicken Hen did not change substantially among different levels of treatments. The highest score (52.77) of lightness (L*) of drumstick was found in intensive group and the lowest (50.29) score was found in scavenging group. Yellowness (b*) of drumstick were found highest (7.40) in intensive group and the lowest (7.15) was found in semi-scavenging group. Hue angle (h*) of drumstick was found highest (27.51) in scavenging group and lowest (21.34) value was found in semi scavenging group. Hue angle of breast meat was also found highly significant *($p<0.01$)* among treatments. The highest (58.59) score of lightness (L*) for breast meat was found in intensive group and the lowest (54.02) was found in semi-scavenging group. Yellowness (b*), chroma (c*) and hue angle (h*) scores for breast meat were found highest (15.42, 18.82, and 55.20, respectively) in scavenging system. Semi-scavenging feeding group had the lowest (10.8, 39.7) scores of yellowness (b*) and hue angle (h*) whereas intensive system had the lowest (16.85) value of chorma (C*) accordingly.

According to, da Silva et al., (2017),the L* scores were greater than 53, indicating that the color was lighter than usual, might have quality issues, referred to as PSE (pale, soft, and exudative) (Koblitz 2011), more specifically due to insufficient ante mortem management, such as pre-slaughter factors, stunning methods, and cooling regimes (Karunanayaka et al. 2016). In this study, breast part of Hilly chicken of all groups was seen higher scoring than 53 whereas drumstick part of all three feeding systems was less than 53. The reasons for L* scoring high in breast part could be the same as mentioned by Karunanayaka et al. 2016. The a* scores for industrial broiler chickens were higher than those for free-range chickens, whereas the b* scores were lower, indicating that free-range chicken meat had the highest intensity of yellow color, which could be seen regardless of the colorimeter's measurement, and industrial broiler meat had higher red intensity. These facts also support the present research, where scavenging group; a* value is lower (7.01 in drumstick part, 10.78 in breast part) than intensive group a* value

(13.27in drumstick part and 12.15 in breast part). For b* value it also higher in scavenging group (15.42 in breast part) than intensive group (11.65 in breast part).

Table 4.10.1 Color profiles of Hilly Chicken Hen immediate after slaughter

Body parts	Parameters	Treatment T_1 ($\bar{x}$±SE)	T_2 ($\bar{x}$±SE)	T_3 ($\bar{x}$±SE)	*p* value	Sig value
Drumstick	L*	52.77±0.77	52.30±0.83	50.29±2.4	0.55	NS
	a*	13.27±0.26	15.69±0.53	7.01±5.2	0.26	NS
	b*	7.40±1.26	7.15±1.5	7.17±1.6	0.99	NS
	c*	14.74±0.12	16.85±0.7	15.32±1.8	0.49	NS
	h*	25.77±1.37	21.34±1.1	27.51±3.5	0.28	NS
Breast meat	L*	58.59±0.35	54.02±4.1	58.03±1.6	0.49	NS
	a*	12.15±0.07	13.08±2.6	10.78±1.7	0.70	NS
	b*	11.65±0.79	10.8±1.9	15.42±1.6	0.22	NS
	c*	16.85±0.50	16.97±3.2	18.82±2.3	0.81	NS
	h*	43.75^{a}±2.1	39.7^{b}±0.81	55.20^{b}±1.2	0.01	**

*Here;^{a,b,c}means bearing uncommon superscripts in a row differ significantly; T_1= Intensive, T_2= Semi- scavenging, T_3= Scavenging; L=Lightness, a= redness, b= yellowness, c= chroma, h= hue angle; ** labeled as $p<0.01$, NS= Non-Significant.*

4.11 Color profiles after two weeks of slaughter

After two weeks of slaughter, color indicators like lightness (L*), redness (a*), yellowness (b*), chroma (c*) and hue angle (h*) for drumstick and breast meats of Hilly Chicken hens are shown in Table 4.11.1. Only lightness score (L*) and hue angle (h*) of breast meat were significantly varied *($p<0.01$)* among the treatment. The highest scores (15.7) of redness (a*) in drumstick part, was found in semi scavenging group whereas, lowest scores (12.26)was found in scavenging group. Yellowness (b*) was found highest (10.1) in semi-scavenging group and lowest (7.81) was found in scavenging group. Semi-scavenging group was also higher (18.88) in chroma (c*) and scavenging group was the lowest (14.55). Both lightness (L*) and hue angle (h*) was found highest (62.1, and 37.4, respectively) in intensive group. For breast part, lightness (L*) was highest (64) in intensive group and lowest (55.71) in scavenging group. Redness (a*) in breast meat found highest (12.4) semi-scavenging system and lowest (11.7) found in intensive group. Yellowness (b*), chroma (c*) and hue angle (h*) was found highest (13.6, 18.3, and 47.6, respectively) in scavenging group. Chroma (c*) found lowest (16.22) in intensive group whereas yellowness (b*) and hue angle (h*) were found lowest (11.4, and 42.5, respectively) in semi-scavenging group.

Qiao et al., (2002) noticed pale, soft, and exudative (PSE) meats in industrial broilers chicken. They discovered the samples with no statistical difference in L* values (61.49, 61.60, and 61.66), but substantial differences in a* (3.63, 4.10, and 4.52) and b* (8.78, 9.23, and 9.87). Although there was strong evidence of the impact of short-term ante mortem stress on meat color, the author emphasized that the differences could be attributable to a possible genetic predisposition or other factors related with the rearing of these chickens in the long run. This report is closer to the current research where after two weeks of slaughter, L* was recorded 63 in drumstick part and 64 in breast part both in intensive group. According to Faria et al. (2009), slow-growing chickens that consume a larger amount of forage rich in carotenoids have a greater intensity of yellow color in the flesh, resulting in a higher b* value. This findings support the present study where in semi-scavenging group drumstick part attained higher (10.4) yellowness score (b*) but for breast part, scavenging group attained higher (13.6) yellowness (b*) score.

Table 4.11.1 Color profiles of Hilly Chicken Hen after two weeks of slaughter

Body parts	Parameters	Treatment			*p* value	Sig value
		T_1 ($\bar{x}$±SE)	T_2 ($\bar{x}$±SE)	T_3 ($\bar{x}$±SE)		
Drumstick	L*	62.10±2.8	54.4±1.5	56.22±5.7	0.43	NS
	a*	12.73±0.8	15.7±0.3	12.26±3.0	0.45	NS
	b*	9.7±0.09	10.1±0.04	7.81±1.4	0.23	NS
	c*	16.03±0.6	18.88±0.4	14.55±3.3	0.4	NS
	h*	37.4±2.2	33.6± 0.16	32.97±2.0	0.3	NS
Breast meat	L*	64.0^{a}±1.6	59.6^{ab}±1.08	55.71^{b}±0.9	0.04	**
	a*	11.7± 0.3	12.4±1.4	12.3±0.9	0.88	NS
	b*	11.18±0.11	11.4±1.4	13.6± 1.4	0.38	NS
	c*	16.22±0.3	16.91±2.0	18.3±1.6	0.64	NS
	h*	43.59^{a}± 0.6	42.5^{b}±0.11	47.6^{b}±0.7	0.01	**

*Here;^{a,b,c}means bearing uncommon superscripts in a row differ significantly;T_1= Intensive, T_2= Semi-scavenging, T_3= Scavenging; L=Lightness, a= redness, b= yellowness, c= chroma, h= hue angle; ** labeled as $p<0.01$, NS= Non-Significant.*

4.12 Texture and pH analysis of Hilly Chicken Hen immediate after slaughter

It is shown in table 4.12.1 that, the texture composition and pH of Hilly Chicken Hen based on their slaughtering time. Texture parameter e.g. hardness (H) in breast part and pH of both meat parts were highly significant *($p<0.01$)* in different feeding systems. In drumstick part, the highest value (103.3, and 0.18, respectively) of hardness (H) and adhesiveness (A3) were found in scavenging group and semi-scavenging group accordingly. Whereas the lowest (76.1, and 0.11, respectively) were found in intensive group. In breast part, the maximum value (106.9) of hardness (H) was found in scavenging group whereas minimum value (88.6) of hardness (H) in breast part was found in semi scavenging group. Adhesiveness (A3) was found highest (0.49) in intensive group and lowest (0.18) was found in scavenging group. For drumstick part, the highest value (6.32) of pH was found in scavenging group and the lowest value (5.82) was found in semi scavenging group. For breast part, the highest value (6.43) of pH was recorded in intensive group and the lowest value (5.73) was recorded in scavenging group.

According to da Silva et al, 2017 since pH readings showed a significant difference *($p<0.05$)* between free-range and industrial broiler hens, with free-range broiler chicken having a lower mean (5.75) than industrial broiler chicken (5.90). This statement supports our current findings, where intensive group pH is higher (6.43 in breast) than scavenging group (5.73).

In comparison to normal meat, Qiao et al. (2001) found that pH decrease was influenced by the chickens' behavior during slaughtering, particularly the wings movement, highlighting the paucity of literature on the impact of genetic factors on such behavioral characteristics and their implications on meat quality. Because color, water-holding capacity, and texture are all closely connected with pH, this author found a final pH value of 5.64 for commercial chickens, confirming that it was a key selection factor in evaluating the meat's quality. This finding is also closer to our findings because all three treatments attained more than 5.64 of pH in both the carcass parts.

Table 4.12.1 Texture and pH analysis of Hilly Chicken Hen immediate after slaughter

Body part	Parameters	Treatment			*p* value	Sig. value
		T_1 ($\bar{x}$±SE)	T_2 ($\bar{x}$±SE)	T_3 ($\bar{x}$±SE)		
Drumstick	H	76.1±0.3	100.96±0.3	103.3±1.7	0.46	NS
	A3	0.11±0.03	0.18±0.1	0.14±0.05	0.40	NS
	pH	6.1^{a}±0.01	5.82^{b}±0.0	6.32^{c}±0.01	<.0001	**
Breast meat	H	55.88^{a}±2.9	88.6^{b}±1.6	106.9^{c}±0.7	0.0003	**
	A3	0.49±0.4	0.37±0.3	0.18±0.05	0.76	NS
	pH	6.43^{a}±0.02	5.92^{b}±0.02	5.73^{c}±0.01	0.0003	**

*Here; ^{a,b,c}means bearing uncommon superscripts in a row differ significantly; T_1= Intensive, T_2= Semi-scavenging, T_3= Scavenging; H= Hardness, A3= Adhesiveness; ** labeled as $p<0.01$, NS= Non-Significant.*

4.13 Texture and pH analysis of Hilly Chicken Hen after two weeks of slaughter

After two weeks of slaughter, the texture composition of female Hilly Chicken Hen is shown in table 4.13.1. pH of different carcass parts and hardness (H) in breast part were highly significant*($p<0.01$)*in different feeding groups. In drumstick part, the highest value (106.89) of hardness (H) was found in both scavenging group where the lowest (87.14) were found in intensive group. In breast part, the maximum value (108.58) of hardness (H) was also found in scavenging group whereas minimum value (103.26) of hardness (H) in breast part found in intensive group. Adhesiveness (A3) was found highest (0.09) in intensive group and lowest (0.07) was found for breast part in semi-scavenging group. But in drumstick part, highest value (0.09) for adhesiveness was found in intensive group and lowest (0.02) was found in semi-scavenging group. In drumstick part, the highest value (5.9) pH was found in intensive group and the lowest value (5.4) was found in semi scavenging group. For breast part, the highest value (5.6) pH was recorded in semi-scavenging group and the lowest value (5.32) was recorded in scavenging group.

According to da Silva et al, 2017 since pH readings showed a significant difference *($p<0.05$)* between free-range and industrial broiler hens, with free-range broiler chicken having a lower mean (5.75) than industrial broiler chicken (5.90). This statement slightly supports our current findings, where intensive group pH is higher (5.5 in breast, 5.9 in drumstick) than scavenging group (5.3 in breasts, 5.7 in drumstick). In comparison to normal meat, Qiao et al. (2001)found that pH decrease was influenced by the chickens' behavior during slaughtering, particularly the wings movement, highlighting the paucity of literature on the impact of genetic factors on such behavioral characteristics and their implications on meat quality. Because color, water-holding capacity, and texture are all closely connected with pH, this author developed a final pH value of 5.64 for commercial chickens, confirming that it was a key selection factor in evaluating the meat's quality. This finding also brings current discoveries to closer because the pH of meat portions was around 5.64 in all three treatments.

The low tenderness of free-range broiler meat observed in this study could be attributed to the chickens getting more exercise during pasturing (Santos et al. 2005), which would result in increasing in the diameter, area, and density of myofibrils on the chickens' breast muscles (Pectorals muscle). Other than that, the older age at slaughter is strongly correlated to shear force, increasing its value significantly (Chen et al. 2007). According to Ramos and Gomide (2009), the meat of younger animals is tenderer, but this trait diminishes with age due to the accumulation and, in particular, the maturation of connective tissue in muscle fibers.

Table 4.13.1 Texture and pH analysis of Hilly Chicken Hen after two weeks of slaughter

Chicken part	Parameters	Treatment			*p* value	Sig. value
		T_1 ($\bar{x}$±SE)	T_2 ($\bar{x}$±SE)	T_3 ($\bar{x}$±SE)		
Drumstick	H	87.14±0.3	101.89±14	106.89±0.3	0.43	NS
	A3	0.09±0	0.02±0	0.06±0	0.17	NS
	pH	5.91^{a}±0.01	5.4^{b}±0.0	5.79^{c}±0.01	0.001	**
Breast meat	H	103.26^{a}±0.7	104.8±6.6	108.58^{b}±5.8	0.007	**
	A3	0.09±0	0.07±0	0.08±0	0.51	NS
	pH	5.58^{a}±0.01	5.6^{a}±0.02	5.32^{b}±0.01	0.001	**

*Here;^{a,b,c} means bearing uncommon superscripts in a row differ significantly ; T_1= Intensive, T_2= Semi-scavenging, T_3= Scavenging; H= Hardness, A3= Adhesiveness; ** labeled as $p<0.01$, NS= Non-Significant.*

4.14 Correlation matrix between nutritional properties and carcass parts of Hilly Chicken

The results of Pearson's correlation coefficients correlation analysis among nutritional properties and carcass parts of Hilly Chicken are shown in Table 4.14.1. A highly significant ($p<0.01$) positive correlation was found between live weight and dressed weight (r= 0.98).

The results showed a significant ($p<0.05$) positive correlation between ether extract and drumstick weight (r=0.86); ether extract and breast weight (r=0.87) and highly significant ($p<0.01$) positive correlation between breast weight and drumstick weight (r= 0.98); thigh weight and breast weight (r=0.95); thigh weight and drumstick weight (r=0.92).

Table 4.14.1 Correlation matrix between nutritional properties and carcass parts of Hilly Chicken

Parameters	1	2	3	4	5	6	7	8
1 CF	1.00							
2 EE	-0.06	1.00						
3 CP	0.13	0.15	1.00					
4 Live weight	-0.05	0.34	0.26	1.00				
5 Dressed weight	0.03	0.31	0.28	0.98**	1.00			
6 Drumstick weight	0.13	0.86*	-0.24	0.37	0.36	1.00		
7 Breast weight	0.03	0.87*	-0.31	0.26	0.22	0.98**	1.00	
8 Thigh weight	0.13	0.72	-0.47	0.19	0.14	0.92**	0.95**	1.00

*Here, * labeled as $p<0.05$& ** labeled as $p<0.01$; EE= Ether Extract, CF= Crude Fire, CP= Crude Protein*

4.15 Correlation matrix among color, texture, pH properties of Hilly Chicken drumstick part immediate after slaughter

The results of Pearson's correlation coefficients among color properties of Hilly Chicken drumstick part immediate after slaughter are shown in Table 4.15.1. A highly significant (*p<0.01*) positive correlation n was found between Hardness and Adhesiveness (r= 0.89) of drumstick part. The results showed a significant *(p<0.05)* positive correlation between hue angle and yellowness (r=0.87); lightness and redness (r=0.85).

Table 4.15.1 Correlation matrix of color, texture, pH properties of Hilly Chicken drumstick part immediate after slaughter

Parameters	1	2	3	4	5	6	7	8
1 Lightness	1.00							
2 Redness	0.85*	1.00						
3 Yellowness	-0.71	-0.37	1.00					
4 Chroma	-0.58	-0.21	0.57	1.00				
5 Hue angle	-0.78	-0.87*	0.61	0.07	1.00			
6 Hardness	0.08	-0.39	-0.45	-0.60	0.29	1.00		
7 Adhesiveness	-0.15	-0.51	-0.05	-0.36	0.53	0.89**	1.00	
8 pH	-0.43	-0.74	0.03	-0.4	0.76	0.58	0.52	1.00

*Here, * labeled as p<0.05& ** labeled as p<0.01*

4.16 Correlation matrix among color, texture, pH properties of Hilly Chicken breast part immediate after slaughter

The results of Pearson's correlation-coefficients among color properties of Hilly Chicken breast part immediate after slaughter are shown in Table 4.16.1. A highly significant (*$p<0.01$*) positive correlation was found between Hardness and Hue angle ($r= 0.98$) of breast part.

The results showed a significant (*$p<0.05$*) positive correlation between lightness and redness ($r=0.89$); and chroma and yellowness ($r=0.83$).

Table 4.16.1 Correlation matrix among color, texture, pH properties of Hilly Chicken breast part immediate after slaughter

Parameters	1	2	3	4	5	6	7	8
1 Lightness	1.00							
2 Redness	-0.89**	1.00						
3 Yellowness	-0.15	0.15	1.00					
4 Chroma	-0.62	0.67	0.83*	1.00				
5 Hue angle	0.46	-0.54	0.72	0.24	1.00			
6 Hardness	0.41	-0.47	0.78	0.32	0.98**	1.00		
7 Adhesiveness	0.44	-0.29	-0.37	-0.45	-0.15	-0.25	1.00	
8 pH	0.17	0.21	-0.42	-0.21	-0.50	-0.48	0.37	1.00

*Here, * labeled as $p<0.05$& ** labeled as $p<0.01$*

4.17 Correlation matrix among color, texture, pH properties of Hilly Chicken drumstick part after two weeks of slaughter

The results of Pearson's correlation coefficients among color properties of Hilly Chicken drumstick part after two weeks of slaughter are shown in Table 4.16.1.Ahighly significant (*p<0.01*) positive correlation was found between Adhesiveness and Hue angle(r= 0.86) of drumstick part.

The results showed a significant *(p<0.05)* positive correlation between Redness and Lightness (r= 81*); redness and yellowness (r= 0.80) and highly significant *(p<0.01)* between Chroma and Redness (r= 0.98*) and Chroma and Yellowness (r=0.88) of drumstick part.

Table 4.17.1 Correlation matrix among color, texture, pH properties of Hilly Chicken drumstick part after two weeks of slaughter

Parameters	1	2	3	4	5	6	7	8
1 Lightness	1.00							
2 Redness	-0.81*	1.00						
3 Yellowness	-0.32	0.80*	1.00					
4 Chroma	-0.71	0.98**	0.88*	1.00				
5 Hue angle	0.90*	-0.55	0.02	-0.40	1.00			
6 Hardness	0.16	-0.355	-0.35	-0.34	0.20	1.00		
7 Adhesiveness	-0.71	0.35	-0.13	0.22	-0.86*	-0.41	1.00	
8 pH	0.015	0.47	0.72	0.57	0.25	-0.56	-0.33	1.00

*Here, * labeled as p<0.05& ** labeled as p<0.01*

4.18 Correlation matrix among color, texture, pH properties of Hilly Chicken breast part after two weeks of slaughter

The results of Pearson's correlation coefficients among color properties of Hilly Chicken drumstick part after two weeks of slaughter are shown in Table 4.18.1Ahighly significant ($p<0.01$) positive correlation was found between pH and Hue angle($r= 0.95$) of breast part.

The results showed highly significant ($p<0.01$) between Chroma and Redness ($r= 0.91$); Chroma and Yellowness ($r=0.96$) of breast part.

Table 4.18 Correlation matrix among color, texture, pH properties of Hilly Chicken breast part after two weeks of slaughter

Parameters	1	2	3	4	5	6	7	8
1 Lightness	1.00							
2 Redness	-0.48	1.00						
3 Yellowness	-0.75	0.76	1.00					
4 Chroma	-0.68	0.91**	0.96**	1.00				
5 Hue angle	-0.66	0.15	0.74	0.53	1.00			
6 Hardness	0.75	-0.09	-0.24	-0.19	-0.27	1.00		
7 Adhesiveness	0.08	0.59	0.53	0.59	0.21	0.66	1.00	
8 pH	0.78	-0.09	-0.67	-0.47	-0.95**	0.42	-0.05	1.00

*Here, * labeled as $p<0.05$& ** labeled as $p<0.01$*

Chapter Five

Summary & Conclusions

Summary & Conclusions

The experiment was conducted to investigate the effect of different feeding regimes on production performance and meat quality of BLRI improved Hilly Chicken. A total of 30 farmers were selected from various parts of Dumuria upazila in Khulna district, Bangladesh.

The study was designed using RCBD with 3 treatments (03) e.g. T_1= Intensive, T_2= Semi-scavenging and T_3= Scavenging having three (03) replications. The farmers were divided into 3 groups for 3 different feeding systems (Intensive, Semi-scavenging and Scavenging) replicating 3 times of each rearing system.

Growth parameters of chicken were recorded to compare the growth performance of three different feeding systems. The highest body weight of cock was 1323.4g, 1139g, and 762.2g in intensive group, semi-scavenging group and scavenging group, respectively at 12th week of age which was significantly *($p<0.01$)* varied. The highest hen body weight (1167.20g) was found in intensive group followed by semi-scavenging group (1060.6g) and the lowest body weight (792.8g) was found in scavenging group at 12th weeks of age which was also significantly varied.

The results of weekly feed conversion ratio showed that there were significant difference ($p<0.01$) among the three treatment groups. The best feed conversion ratio was observed in semi-scavenging group (3.46) for cock while the highest value i.e. poor FCR was found in intensive group (7.46) at the end of experiment. Similarly, The best feed conversion ratio was observed in scavenging group (3.02) followed by semi-scavenging group (3.37) for hen while the highest value i.e. poor FCR was found in intensive group (4.28) at the end of experiment.

Carcass parameters e.g. dressed weight, thigh weight, breast weight, and drumstick weight, were not significantly *($p>0.05$)* varied with different feeding systems. The highest weight percentage of drumstick, breast and thigh was found in semi-scavenging group. Non-carcass parameters e.g. head weight, shank weight, sack weight, liver weight percentages were not significantly *($p>0.05$)* varied with different feeding systems.

Immediate after slaughter, except for hue angle (h*) of breast meat, several color indicators of drumstick and breast meats of Hilly Chicken did not change substantially among different levels of treatments. After two weeks, only lightness score (L*) and hue angle (h*) of breast meat were significantly *($p<0.01$)* varied. Texture parameter e.g. hardness (H) in breast part and pH of different carcass parts were highly significant *($p<0.01$)* among the different feeding groups and two weeks later, the results were also highly significant *($p<0.01$)* with different feeding groups.

Nutrient parameters e.g. DM, moisture, CF, EE, Ash and CP were not significantly *($p>0.05$)* varied with different feeding treatments. Highest CP (%) was found in semi scavenging feeding group and the lowest CP (%) was found in intensive feeding group. Ether Extract (%) was also found highest in semi scavenging group and the lowest was found in scavenging group. Total ash content was found almost same for each treatment.

Conclusions

From the present findings, it can be concluded that, out of all three treatments, the highest live weight and dressed weight percentage of Hilly Chicken was found in intensive group followed by semi-scavenging group. Carcass percentage of Hilly Chicken e.g. drumstick weight, breast weight and thigh weight was highest in semi-scavenging group. Percentage of crude protein and ether extract was also found highest in semi-scavenging group. So it can be concluded that semi-scavenging system was effective among all three feeding systems.

Recommendations

This research was conducted only in Dumuria upazila of Bangladesh. But this was not enough to get precise information regarding the output of the research. That's why, such research should repeat in a large scale in other districts as well as in different locations of other divisions. From the output of the research researchers, academician, farmers, and policymakers can be benefited to take decision for market oriented chicken meat and egg production.

Chapter Six

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Appendices

Appendix: Photographic Presentation of the Study