QUALITY EVALUATION OF COMMERCIAL BROILER FEEDS AT TANNERY INDUSTRIAL AREA IN BANGLADESH: A FOOD SAFETY PERSPECTIVE

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CERTIFICATE

*This is to certify that the thesis entitled "**QUALITY EVALUATION OF COMMERCIAL BROILER FEEDS AT TANNERY INDUSTRIAL AREA IN BANGLADESH: A FOOD SAFETY PERSPCTIVE"** submitted to the Department of Animal Production and Management, Faculty of Animal Science and Veterinary Medicine, Sher-e-Bangla Agricultural University, Dhaka in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE in ANIMAL SCIENCE,** embodies the results of a piece of bona fide research work carried out by **MST. AREFATUL ZANNAT, Registration No. 19-10082** under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.*

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

Dated:
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_____

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Dedicated to my beloved Parents

LIST OF THE SYMBOLS & ABBREVIATION

Symbols & Abbreviation	Narration
CP	Crude Protein
DM	Dry Matter
CF	Crude Fiber
NFE	Nitrogen Free Extract
EE	Ether Extract
DLS	Department of Livestock Services
Cr	Chromium
Pb	Lead
Cd	Cadmium
Zn	Zinc
Ca	Calcium
Mn	Manganese
Ni	Nickle
Cl	Chlorine
WHO	World Health Organization
FAO	Food and Agricultural Organization
BDL	Below Detection Level
DOC	Day Old Chick
Pvt.	Private
Ltd.	Limited

Symbols & Abbreviation	Narration
MT	Metric ton
FCR	Food Conversion Ratio
WHC	Water Holding Capacity
BD	Bulk Density
CETP	Common Effluent Treatment Plant
SPGS	Sludge Power Generation System
Kg	Kilogram
SD	Standard Deviation
NRC	National Research Council
EAA	Essential Amino Acid
NEAA	Non -Essential Amino Acid
%	Percentage
ppm	Parts Per Million
et al.,	And Others

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QUALITY EVALUATION OF COMMERCIAL BROILER FEEDS AT TANNERY INDUSTRIAL AREA IN BANGLADESH: A FOOD SAFETY PERSPECTIVE

ABSTRACT

Quality of feed is essential at all stages in the production of broiler so that birds can get wholesome nutrition. The aim of the study was to evaluate the quality of commercial broiler feeds (starter & grower) collected from tannery industrial area to ensure the food safety. Under the study, registered and unregistered (local) company's feeds were collected from the farmers who were related to rearing broiler at Saver, Dhaka. Samples were collected to observe the physical properties, the proximate component (moisture & crude protein) and the concentration of heavy metals (Cr, Pb) of broiler feeds. To know the physical properties, feeds were visually observed. The feeds were normal in color, smell and free from any foreign matters & molds, indicated the fresh quality of feeds. The moisture was obtained in normal range and calculated as (11.31-14.03) % and (9.65-11.48) % for broiler starter and grower respectively. The crude protein contents ranged from (8.45-25.36) % and (10.23-19.34) % for broiler starter and grower feeds respectively. Almost all of the local feed samples were composed of low amount of crude protein than the registered company's feeds. The concentration of heavy metals of most of the feed samples were below detection level that indicated the good quality of feeds. No alarming material was found in feeds and for both broiler starter and grower feeds, which indicates that the meat from broiler fed the evaluated feeds are safe for human consumption.

CHAPTER: I

INTRODUCTION

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INTRODUCTION

Poultry is one of the major protein sources for people in Bangladesh (Islam *et al*., 2007). Over the last decade poultry has become a very popular and promising sector in Bangladesh. A large section of Bangladesh people consume poultry meats and eggs to fulfill their protein requirement. Poultry is a very demandable source of animal protein (Raloff and Janet 2003). Chicken meat delivers huge amount of proteins, vitamins, minerals but low amount of cholesterol. It also maintains a healthy eating pattern in diet. As a densely populated country in Bangladesh, people mainly depend on poultry meat and egg as it is affordable to all. Now a days, poultry products such as chicken tandoory, chicken burger, chicken meat ball, chicken nugget etc have been considered as attractable to the younger generation. The main ingredients of poultry feed are corn, wheat, soybean, cotton seed, sunflower seed, meat and bone meal (Bale *et al*., 2002). The quality poultry production is very necessary to produce good quality poultry products for human. However, it is the burning question to all that poultry feed has been affected by the use of heavy metals (Islam *et al*., 2007). Although metals like zinc, copper, iron are the essential elements for poultry and supply nutrients for poultry but chromium, lead, arsenic, cadmium are health hazardous and also toxic in high amount (Munoz *et al*., 2001). These may have adverse effect on human body. Contamination of poultry meat with heavy metals may cause different health hazard (Demirezen *et al*., 2006). Serious types of diseases like heart disease, kidney disease, cancer, gastrointestinal disease, disorder to nervous systems may happen for absorbing the heavy metals through food chain (Jarup *et al*., 2003). If chicken feed is contaminated by

the heavy metals it can be accumulate to chicken meat and enter the human body through consumption (Okoyo *et al.*, 2011).

There are many commercial producers of poultry feed in Bangladesh. The raw materials for the production of poultry feed are of various origin. Now a days, in Bangladesh shaving dust of tannery industry is used as protein concentrate. The main reason of using is the costless and availability of it. In Bangladesh, about 185 tanning industries located in Saver Tannery Area. Leather is one of the main export item in Bangladesh and has a good reputation all over the world. The tanning industries are processed about 220 matric tons of hide in a day and produced around 600-700 kg of tanning waste from each ton (Zahid *et al*., 2004). These wastes are converted to protein concentrate and used in poultry feed. The major concern of this, different types of chemicals used in tanning process, mostly chromium. Chromium is the main reason of cancer disease. The solid wastes are cut into sliced and greenish blue colored. Different types of solid wastes are found in tanning processed and can be distinguished by the color of solids. About 40 heavy metals and various acids are used in tanning process (UNIDO, 2005). Chromium sulphate mainly used in tanning process and this is the main concern to all. About 47% of chromium collagen and 85% chemicals enter the waste (UNIDO, 2000). Chrome shaving dust contain 3.204% of chromium (Ferreira *et al*., 1999). Use the shaving dust, it is boiled with a mixture of H_2SO_4 and water in a big container for 3 to 4 hours. After cooling, liquid is removed from the container and the rest part is dried in the sunlight for few days and grinded to make powder. Powder is then mixed with other feed ingredients likes soya oil cake, corn grain and dried fish to make final feed (Mottalib *et al*., 2016). There is a high possibility of

transportation of these heavy metals from tannery waste contaminated poultry feed to chicken and then to the human body (Mottalib *et al*., 2016).

As Saver area is the tannery populated area, so there is a high possibility to contaminate poultry feed with tannery waste. Therefore, this study was carried out to determine the nutritional constituents such as physical, chemical and heavy metals in feeds available in Bangladesh

Hippocrates, an ancient Greek physician who is the founder of Western medicine told, "Let your food be your medicine, and medicine and your medicine be your feed". But now we do not understand the importance of food for keeping health sound and treating as medicine. Foods we consume daily could be dangerous by contaminating with different health hazardous substances and serious threat for the public health. Unsafe food can be a significant reason of many chronic and non- chronic diseases including but not limited to diarrhea, cancer, heart diseases, various kidney diseases and birth defects (WHO, 2012)

Considering the above discussion, the present study was therefore, undertaken with the following objectives-

i. To evaluate the physical and chemical qualities of broiler feeds
ii. To determine the concentration of heavy metals in broiler feeds
iii. To assess the overall quality of broiler feeds by interpretation of the results for food safety aspect

CHAPTER: II

REVIEW OF LITERATURE

CHAPTER: II

REVIEW OF LITERATURE

A literature review is a type of review article. A literature review is a search and evaluation of available literature in ones given subject or topic area. Literature reviews are secondary sources and do not report new or original experimental work. Most often associated with academic oriented literature. The purpose of this chapter is to review the past research works which are related to present study. The most relevant works, which have been conducted in the recent past related to the present research work, are presented below:

2.1 Poultry feeds in Bangladesh

Poultry sector is an integral part of farming system in Bangladesh. The sector accounts for 14% of the total value of livestock output (Raihan *et al*., 2008). This sector plays an important role in our national economy. It has created job opportunity more than 6 million of people and supply quality protein at the lowest price in the world.

There are about 100 breeder farms & hatcheries, 8 grandparent stock farms, 70,000 commercial layer & broiler farms, over 200 feed mills and 500 animal health companies in this country. Top ten private farms (breeder farms and hatcheries) produce over 70% broiler day-old chicks and only 14 breeder farms & hatcheries produce layer day-old chicks. From the report of ACI Animal Health, it is revealed that 10% of total layers and 7% of broiler birds are reared in an integrated system. There is a notable growth of the

day-old broilers and breeders production and it is more than double over the last 10 years (Saleque *et al*., 2020)

In recent, difficult challenges facing the poultry industry. The overall production of poultry products (meat and eggs) have been increased by about 10% on average over the last 5 years. Still, it is a major part of animal protein consumed by humans. As per the DLS & BPICC report (2019), the country is producing approximately 46.6 million eggs and 3.1 million kg of poultry meat per day in 2019 compared to 30.1 million eggs and 2.2 million poultry meat per day in 2015

A fully developed poultry industry tends to be characterized by high volumes with low margins as it must compensate for the low margins at each stage of production. Vertical integration has strengthened the large farms, increased their profit constantly, and increased their capacity for diversifying their losses. Furthermore, the entry of the larger farms into the rapidly growing processing industry has opened their eyes to make the poultry business more stable under a complete "Farm to Fork" integration system (Sahidur *et al*., 2017)

Poultry rearing has become an integral part of agro-based economy of Bangladesh and gaining prominence over the last two decades. For the huge demand, commercial feed production experienced almost 25% growth and increased popularity and low cost of commercially feed have increased the demand for ready mix feed.

Presently, there are 74 feed manufacturing and marketing company in the country (Jacob *et al*., 2015). In which, 35-40 feed industries are in large size

and producing poultry and fish feeds but the amount can not satisfy the needs of the growing poultry farms. Bangladesh produces only 2.73 million tons of commercial animal feeds most of which is used for commercial poultry production against a total poultry feed requirement of 5.94 million tons (Kryger *et al.* 2010) meeting only 46% of the need. As a result there is enough scope for increased growth of poultry feed industry (Kamalanta *et al*., 2020).

Among these, the top producers (CP, Paragon, Aftab, Quality, Kazi) meet 50% ot total feed demand of 240,000 MT/month (Hamid *et al*., 2017). Besides these, there are many local poultry feed mills in Bangladesh and contribute in poultry feed production.

Table 1: Annual production of commercial poultry feeds

Name of the organization	Feeds category	PrProduction per year (MT)
ACI Godrej Agro Pvt., Ltd.	Poultry, fish and cattle	1,09,680
Aftab feed products	Poultry, fish and cattle	2,91,360
Apt pellet feed	Poultry and fish	30,000
AIT	Poultry, fish and cattle	81,000
Aman feed Ltd.	Poultry, fish and cattle	44,400
Aleya feeds	Poultry, fish and Shrimp	22,800
BRAC feed Ltd.	Poultry and fish	52,800

CP (Bangladesh) Co., Ltd.	Poultry	1,21,200
City poultry and fish feeds	Poultry, fish and cattle	55,800
Fresh feed Ltd.	Poultry	50,000
Jayson agro-vet Ltd.	Poultry	43,200
Kazi feeds Ltd.	Poultry	2,28,000
Krishibid feed Ltd.	Poultry, fish and cattle	36,000
Paragon poultry Ltd.	Poultry	2,52,300
Lion feeds Ltd.	Poultry and fish	51,000
M.M. Agha Ltd.	Poultry	30,000
New hope feed Ltd.	Poultry, fish and cattle	91,000
Nourish poultry and hatchery	Poultry and fish	2,82,300
National feed Ltd.	Poultry	72,000
Mono feed Ltd.	Poultry, fish and cattle	45,000
Provita feed Ltd.	Poultry	37,000
Quality feeds Ltd.	Broiler, fish and shrimp	2,73,300
Saudi-Bangla fish feed Ltd.	Poultry, fish and cattle	2,16,000
Savar co-operative feed Ltd.	Poultry and fish	44,400
Spectra hexa feed Ltd.	Poultry and fish	48,000

Sub-total		26,07,640
From other feed mills		1,87,400
Total		27,95,040

(Hamid *et al*., 2017)

2.2 Quality of poultry feeds & it's impact on broiler performance

The quality of feed ingredients determines the quality of compounded feeds or finished products. Therefore, it is necessary to have a standard for every feed ingredient including the supplements and additives. The physical properties of the feed are a very important factor for feed processing. The physical properties of the feed should be known to know the loss due to the handling of feed can be avoided (Jaelani *et al*., 2007). The quality of feed ingredients and feed can be assessed based on their physical & chemical characteristics and by feed microscopy Knowledge of the physical properties of the feed is important that affect the storage, drying and processing of feed materials (Chung and Lee 1995).

Broiler production is one of the agricultural production segments to have experienced the greatest changes over recent decades. Common feed forms in animal feed are pellets, crumbles or mash. However, in the broiler industry, pellets and crumbles are mainly used. In less intensive areas, mash production for broilers is common too. Furthermore, the size of the single particles is a crucial factor that influences bird performance and health, independent of the feed form (Anna *et al*., 2019).

Chickens prefer to pick coarse particles, and this is observed at all ages. Regarding feed intake, one pellet is equal to one particle, regardless of the size. Broiler choose feed particles by form, color, size and consistency. Broiler prefer feed that is easy to pick like crumbles or pellets. Due to the higher feed intake, performance is increased when animals are fed pellets compared with mash feeding. High-quality pelleted feed is essential to achieve maximum feed intake and high animal production. High pellet quality results in increased feed intake, body weight gain and feed conversation rate compared with poor pellet quality, which has a high amount of fines (Anna *et al*., 2019).

The particle size of the raw materials in the pellets also has an influence as the pellets dissolve in the crop. Because that the gizzard of broilers has the same function as a roller mill that acts as grinding the feed into smaller particles. Coarse particles in the feed stimulate gizzard activity, which helps to improved grinding and gizzard development. It also helps to increase stimulation of digestion and improve body weight gain (Anna *et al*., 2019).

Chewning *et al*., (2015), was conducted to evaluate the effect of feed form and corn particle size on broiler performance. Broilers had an improvement in feed conversion when fed pelleted (P) diets as compared with mash (M) diets. Feed form (P and M) and corn particle size (300 and 600 μm). The corn and soybean meal starter P diet was crumbled and the grower and finisher P diets were fed as pellets. The average corn particle size in the 300 and 600 treatment diets was 267 and 570 μm, respectively. Pellet durability index of the P300 diets and P600 diets, produced with a hammermill equipped with either a 1.6 or 7.9-mm screen, averaged 88%

and 84%. The chicks fed the P300 diet showed a significantly higher BW to 21 d. The 44-d BW of broilers in the P treatment was higher and FCR was better than for those fed M diets. No significant difference was observed in the FCR of birds fed the P300 (1.88) or P600 (1.85) diets at 44 d. On the basis of these results, broilers performed better when fed the P diets, and they demonstrated a positive BW response to feeding finer particles up to 21 d.

Omede *et al*., (2011) studied that, physical characteristics such as particle size (PS), bulk density (BD), water holding capacity (WHC) and specific gravity (SG) of eight feed raw materials were studied. Particle size effect was significant for BD, WHC and SG characteristics of the feed ingredients studied. SBM and PKC consistently recorded higher BD values across PS than other feed raw materials in their individual groups.

Amerah *et al*., (2008) reviewed, particle sizes of broiler diets based on maize or sorghum, optimum particle size should be between 600-900 µm. Previous data showed that grain particle size is more critical in mash diets than in pelleted or crumble diets. Although increases substrate availability for enzymatic digestion and coarser grinding to a more uniform particle size improves the performance of birds maintained on mash diets. This result from the positive effect of feed particle size on gizzard development. Although grinding to fine particle size improve pellet quality. It will increase energy consumption during milling.

Nir *et al*., (1995) reported that, broilers fed with wheat and sorghum mash diets shown the heavier body weights and better feed efficiency compared to the finely ground diets.

Amerah *et al*., (2008) also found that broilers fed fine particle had lower weight gains and feed intake. It was examined that the digestive tract of birds fed the fine particle mash diet became impacted.

According to Zaefarian *et al*., (2016) the effect of crumble size on VH of jejunum and VT of ileum was tended to be significant. The results showed that as the crumble size was increased, the VH of Ileum was significantly decreased. Pellet and crumble diets disintegrated rapidly in upper gut sections and pass directly through gizzard to duodenum

Shirani *et al*., (2018) studied that, to enhance the performance, an optimum functionality of gastro-intestinal tract in broilers is crucial. An interaction between feed particle and crumble size was observed for FCR and FE. It seems that positive impact of coarse particles. Poultry fed the diets consist of coarsely feed particle size (1500 µm) and smaller crumble size (1.5 mm) showed better FCR. According to, Yasar *et al*., (2003) Broiler fed with fine mash diets compared to medium or coarse wheat diets high digesta viscosity.

Douglas *et al*., (1990) reported that mash feeding (GMD, 1470-1800 µm) depressed weight gain and feed efficiency in broilers compared with finely hammer milled grains (GMD, 833-947 µm). The poor performance of birds fed large particles was attributed to the preferential selection of large particles. The chemical composition of poultry feeds such as moisture, crude protein, crude fibre, crude fat and total ash (Sundaram *et al*., 2001).

Poultry feeds are composed primarily of a mixture of several feedstuffs such as cereal grains, soybean meal, animal by-product meals, fats, and

vitamin and mineral premixes. Poultry feed industry is closely connected to the primary agricultural production. Feed represents the major cost of poultry production which lies between 65 and 75%. So, any improvement in the performance of broilers due to their diet can unavoidably have a strong effect on profitability. The feedstuffs, with water, provide the energy and nutrients of birds and that are essential for the bird's development, reproduction, and health, mainly proteins, carbohydrates, fats, minerals, and vitamins. Balanced diets involves the mixture of the right proportions of various ingredients for better growth and development of broiler. Unbalanced diets may produce economic loss with animal health, feed conversion efficiency and the output of animal products (Gizzi *et al*., 2004).

Arifur *et al*., (2014) showed that commercial feeds available in Bangladesh contained appreciable amount of carbohydrate, protein and minerals and could be useful as feed supplement for poultry. Therefore, adequate processing and treatment could be carried out to improve the quality of the commercial feed.

Morshed *et al*., (2019**)** carried out a study to determine the quality of poultry feed samples. Several branded of poultry feeds including starter and grower types were used in that experiment. The qualitative analysis of all samples was revealed that in both starter and grower samples, the protein was obtained in the range of (16.95 – 18.61)% & (16.67 – 18.97)% followed by (88.32 – 90.19)% & (85.00 – 91.32)% for dry matters, (6.55 – 8.09)% & (5.50 – 7.10)% for total ash, (5.50 – 8.09)% for total ash, (2.10 – 3.01)% & (2.03 – 3.32)% for fat, (60.41 – 62.68)%

& (58.23 – 64.53)% for carbohydrates and (0.15 – 0.24)% & (0.20 – 0.26)% for acid insoluble ash.

Ashraf *et al*., (2014) analyzed the commercial broiler feed for the estimation of proximate components. The mean values of crude protein (CP), crude fiber (CF), ether extract (EE) and total ash in corn were found to be 9.77, 4.20, 10.15 and 2.50%, respectively. The minimum and maximum values of CP, CF, EE and total ash in canola meal were recorded as 33.8 to 43.7%, 2.0 to10.0%, 3.3 to 9.9% and 10.50 to 12.0%, respectively. The minimum and maximum values of CP, CF, EE and total ash in sunflower meal were found 27.1 to 28.0%, 9.5 to 22.50%, 1.0 to 5.30% and 4.0 to 7.5%, respectively. Among animal protein sources, the mean values of CP, CF, EE and total ash in feather meal were found 39.47, 2.00, 19.87 and 11.87%, respectively.

In Asian countries, fish meal is prepared from mixture of trash fish and byproducts of the canning industry, resulting in a product of very variable composition. Fish meal is an excellent source of protein. Fish meal is considered to be one of the best ingredients for broilers and layers rations. It enhances the feed consumption and feed efficiency (Naulia *et al*., 1998).

Fish meal samples were examined for proximate analysis and found CP contents varied from 42.29 to 56.39%, EE varied from 11.0 to 15.83% and total ash contents varied from 21.03 to 25.71% (Khatoon *et al*., 2006). The nutrient composition of fish meal can vary and depends on the type and species of fish. According to National Research Council (1994).

Bhuyan *et al*., (2011), a mixture of feed ingredients will provide more balance nutrients than only use limited feed ingredients to formulate feed and beneficial for higher growth and development.

2.3 Health hazardous substances in feeds

2.3.1 Status of the tannery industry in Bangladesh

There are about 113 tanneries in Bangladesh and produce 180 million square feet of hide and skin per year. The sector employs approximately 558000 people. Most of the tanneries have no proper effluent plants and produce 232 tonnes solid waste per day (Hira *et al.*, 2013).

Tanning refers to the process by which collagen fibers in a hide react with a chemical agent. However the process is known as leather making process. The flesh side of the hide or skin is much thicker and softer. The three types of hides and skins most often used in leather manufacture are from cattle, sheep, and pigs. From per ton of raw hides about 850 kg solid waste are generated. Moreover, sludge will generate from CETP. The solid waste basically generates from the Beam-house (pre-tanning process) which includes soaking, liming/unhairing, fleshing, splitting, de-liming, bating, decreasing and pickling process.

A project has been authorized by Bangladesh Government to relocate tannery industries from Hazaribagh to Saver over 200 acres of land. It includes the installation of modern technology based CETP (Common Effluent Treatment Plant) and SPGS (Sludge Power Generation System) constructed integrally with CETP. It is capable of generating power of 5MW/hour. Minimization, optimization and ease of handling of sludge and

management of solid waste generated from adjacent tannery area are the core challenges accepted in constructing the SPGS.

Excess heavy metal accumulation in soil is toxic to humans and other animals. Exposure to heavy metals is normally chronic (exposure over a longer period of time), due to food chain transfer. Acute (immediate) poisoning from heavy metals is rare through ingestion or dermal contact, but is possible. Some of tannery solid waste contains chromium metal which is the most widely used in tanning industries as chromium salt and it causes carcinogenic effect when it enters human body through food chain (Anita *et al.*, 2010).

2.3.2 Heavy metals in broiler feeds

Normally poultry feeds are consist of grains such as corn. Wheat bran, oil cake, rice bran, soybean and protein products of animal origin such as fish meal, meat and bone meal (Bale *et al*., 2002). Globally, heavy metal cotaminations of chicken meat, eggs and other products is a matter of concern (Ding *et al*., 2000).

Heavy metal refers to any metallic element that has relatively high density and toxic. The most commonly heavy metal contaminats are chromium, cadmium, copper, lead, arsenic, zinc etc. But in the study we assessed Cr, Cd, Co, Pb which have most adverse effect on human health.

Human exposure to high amount of chromium concentration cause harm through its toxic effects (Flora *et al*., 2016). WHO has classified Cr as carcinogenic to human being (WHO 1996).

Acute effects include irritation and chronic effects of pulmonary irritation may occur as asthma, chronic irritation, chronic bronchitis, hyperemia

(SCHER 2015). Chromium related cancer often occurs in the respiratory system, mainly lung (WHO 1998). Cr has been reported to inhibit epigenetically the tumor suppressor gene (ACHIG 2013). It has mild symptoms- dizziness, eye irritation etc. several symptoms kidney, heart, liver, gastrointestinal, cardiac, reproduction disorders, growth problems. Abnormalities of teeth such as erosion and accompanied by high concentration in tongue papillae.

Lead is absorbed in our body and stored in bones, blood and tissues. As we age, our bones demineralize and as a result of releases of lead from bone tissue. When a person exposed lad to very high levels over a short period of time, the person may feel: abnormal pain, memory loss, weak, pain in the hands and feet, loss of appetite, constipated etc. exposure to high amount may cause kidney and brain damage, anemia, weakness and even death. Lead affects children more than adults. Lead can damage a developing baby's nervous system when it transmitted through placenta from mother to faetus.

Hossain *et al*., (2007) studied on Heavy Metal Concentration in Tannery Solid Wastes Used as Poultry Feed and The Ecotoxicological Consequences. In Bangladesh, the tannery solid wastes are converted to protein-concentrate and used as animal feed. Major concern is that, the heavy metals, especially chromium, used in the tanning processes. The various types of solid waste processing for protein-concentrate production were covered in sampling, and the heavy metal status were studied. The maximum chromium content of the waste was found to be 3.2 %. The final products sampled at two different places contained as high as 2.49 % and 1.94 % chromium. Cadmium, lead, arsenic, and mercury contents of all samples were also determined.

According to Islam *et al*., (2016) the alarming matter that the protein concentrate oriented from tannery wastes is also used as poultry and animal feed, which is affected by heavy metal contamination.

According to Arifur *et al*., (2014), a study was dealt with the determination of heavy metal in poultry feed available in Bangladesh. Fe, Mn, Pb, Cd, Cu, Zn were analyzed. From the study, it was found that the level of Cd and Ni in all feed exceeded the guideline value.

Latiful *et al*., (2015) showed that, the presence of Cr content ranging from 0.12-3.11 mg/kg and lead (Pb) content ranging from 8.06-22.0 mg/kg in SCW. In addition, Cr and Pb were present in the range of 0.27-0.98 mg/kg and 10.27-10.36 mg/kg, respectively, in poultry feed. When contaminated feed was fed to live poultry, the presence of those heavy metals were observed in the edible portions such as skin, liver, gizzard, and meat. Irrespective of the edible parts and chicken type, Cr values ranged from 0.1-2.440 mg/kg; Pb values ranged from 0.257-1.750 mg/kg; and Cd values ranged from below detection limit (BDL) to 0.037 mg/kg.

Islam *et al*., (2016) was conducted a study about risk assessment of chromium in broiler feeds and meats in Bangladesh. In that research, the highest concentration of chromium in broiler meat was 1.31±0.20 g/g and in feed sample was 1.71±0.24 g/g. The concentration of chromium was higher than the permissible level declared by WHO and FAO. Necessary steps should be taken to avoid use of such health hazardous substances in poultry feed.

Mottalib *et al*., (2016) was conducted to determine heavy metals in poultry feed made of shaving dust that was collected from tannery in Savar area,

Dhaka. In recent years shaving dust – a major solid waste of tanning process, is being used in poultry feed production as a protein. However, leather is treated with many chemicals during its tanning process. So, it may be one of the major routes of heavy metals transmission in poultry feed and may accumulate into human body through contaminated chicken meat. An experiment was conducted to determine heavy metals in poultry feed made of shaving dust that was collected from tannery. Assessment of deposition of heavy metal on tissues of broilers reared from day one old to 42 days by feeding this feed was also carried out. Concentration of heavy metals in shaving dust, powder (treated shaving dust with acid), poultry feed and in different edible organs of chicken like thigh, breast, liver, bones were analyzed. Excess amount of Cr, Cu, Ni, Pb and Cd were found in poultry feed as well as in the different organs of chicken

Islam *et al*., (2016) was conducted to evaluate the status of chromium concentration in broiler feeds with the risk assessment of chromium in broiler meat. Seven broiler farms were selected to collect the feed and meat samples of broiler. Atomic absorption spectrophotometer (AAS) was used to determine the chromium concentration in broiler feed and meat samples.

Jothi *et al*., (2016), Heavy metals contamination into food chain is considered as an emerging crisis throughout the world especially in developing countries like Bangladesh. The concentration of heavy metals including Cr and Pb in commercial poultry feed samples (protein meal feed, meat and bone meal and fish meal feed) were detected by using Air/ Acetylene Flame Atomic Absorption Spectrophotometer. The mean concentration of heavy metals were found in protein meal feed in a range where Cr 10.63 to 218.10 mg kg-1 and Pb 7.37 to 52.25 mg kg-1. In meat

and bone meal feed samples, Cr was recorded from 9.15 to 40.59 mg kg-1 and Pb 5.0 to 61.42 mg kg-1. Cr was found 17.68 to 78.39 mg kg-1 and Pb 3.54 to 16.44 mg kg-1 in fish meal feed samples. However, results showed that all feed samples contained chromium and lead where both metals were present at alarming levels in most of the samples.

Jagadeesh *et al*., (2018) was conducted study on the levels of heavy metals in poultry eggs in Andhra Pradesh, India. The result showed that the concentration of other trace elements like chromium, copper, manganese, nickel and iron were ranged 0.04-0.15, 0.87-5.66, 0.220.66, 0.01-0.08 and 1.29-8.54 respectively. Fe, Cu is found in high levels while, Cr, Mn, Ni burden occurred in less levels in all birds eggs. The average of the concentration of the heavy metals in egg samples Cr, Mn, Ni, Fe and Cu were 0.06, 0.40, 0.50, 4.63 and 1.98 respectively.

Morshed *et al*., (2019) conducted a study in qualitative analysis and assessment of heavy metals in some poultry feeds including starter and grower feed. The concentration of heavy metals was obtained in various ranges for two types of samples. Starter type of samples were ranges as (<DL – 1.14) ppm, (0.88 – 150.32) ppm, (2.01 – 3.40) ppm, (67.87 – 141.11) ppm, <DL and (7.99 – 18.69) ppm for chromium (Cr), Lead (Pb), Nickel (Ni), Manganese (Mn), Cadmium (Cd) and Copper (Cu) respectively. On the other side, the concentration of heavy metals like Cr, Pb, Ni, Mn, Cd and Cu in grower samples were found in the range of (<DL – 1.08) ppm, (<DL – 67.31) ppm, (1.49 – 4.09) ppm, (86.30 – 156.30) ppm, (<DL – 0.83) ppm and (10.44 – 22.47) ppm respectively.

Kabir *et al*., (2019) studied to determine the concentration of toxic metals and essential metals in the different types of poultry feeds (Starter, grower

and finisher). The concentration of toxic metals varied for Chromium (Cr): 5.05 ppm-1.45 ppm; Nickel (Ni): 4.40 ppm-23.00 ppm; Lead (Pb): 0.01 ppm-0.15 ppm; Cadmium (Cd): 0.05 ppm-0.50 ppm and Arsenic (As): 0.01 ppm-0.10 ppm. While the amount of essential metals ranged for Calcium (Ca): 14210 ppm -2990 ppm; Magnesium (Mg): 1120 ppm-2543 ppm; Manganese (Mn): 72.8 ppm-147.5 ppm; Zinc (Zn): 57.9 ppm-232.7 ppm; Iron (Fe): 435.8 ppm-231.5 ppm and Copper (Cu): 72.4 ppm-251.5 ppm.

According to Shakeel *et al*., (2019) the possible presence of heavy metals in poultry product cause effect in human body. The study indicated that the level chromium contamination with other heavy metals were above the standard limits recommended by the World Health Organization. Those were the major cause for food-borne illness. Tannery and textile industries were the main sources of environmental pollution of heavy metals in Bangladesh. Research is warranted to determine the contamination of heavy metal discharged from tannery wastes that are found in poultry feed. As regards to food safety, animal feed additives in Dhaka City and elsewhere should be controlled based on appropriate legal limits approved by the regulatory agencies of Bangladesh.

Tithi *et al*., (2020) worked to investigate the concentration of heavy metals in broiler and fish feed. For cadmium the maximum and minimum concentration ranged from 0.012-0.027 ppm, 0.09-0.17 ppm for lead and >0.05-334.82 ppm for chromium. The concentration of chromium is highest and lead is lowest in poultry feed. The lower the concentration of Cd and Pb were found in both broiler and fish feed. Most of the values exceed the recommended value and Cr may be accumulated to human body through the consumption of broiler and fish contaminated with Cr in feed.

Korish *et al*., (2020) assessed the concentrations of heavy metals in chicken meat and meat products, feed, and litter, as well as laying hens' eggs, feed and compared with the permissible values. The results indicated that there were significant levels of most of the trace elements and heavy metals in the different meat sources. The liver contained the highest levels of elements, except for Cr, Co, and Ni. The highest Cr level was detected in the fresh meat. Trace elements (Mn and Co) and heavy metals (Ni and Pb) were not detected in either the frozen or the fresh meat. Differences in most of the trace and toxic elements among the different sources of eggs were not found to be significant, except for Zn. Differences between the broiler meat and table eggs were only substantial for Fe and Zn. Fe was significantly higher in meat than in eggs and the opposite was found for Zn. The liver contained higher heavy metals. Thus, chicken meat and table eggs are safe sources of human nutrition, while liver and meat products may present potential health hazards substances.

According to Abdullah *et al*., (2010) Aflatoxins and heavy metals were investigated in some poultry feed samples. The results indicated that different amounts of aflatoxins were found in the analyzed samples. The study showed that the levels of aflatoxins were generally below the permissible levels. The results, also indicated that different levels of lead, cadmium, chromium, cobalt, nickel, zinc, manganese, iron and copper were detected in all samples. The high levels of zinc, copper, manganese and iron may reflecting the deliberate addition of these metals to meet animal nutrient requirements. Cadmium levels were less than the permissible limit. Lead levels in most feed sample exceeded the permissible limit.

Shahnawaz *et al*., (2020) investigated the concentrations of heavy metals; Lead and Chromium in chicken feed. Relatively higher concentrations of Lead (Pb) were found in commercial feed samples. The results obtained that lead and chromium level exceeded the permissible limit; i.e. 0.05 and 0.1ppm as prescribed by WHO/FAO. They may become toxic if the concentrations exceeded the permissible limits. Excess amount of metals uptake by animals find their way to the human body and very harmful to human health.

Bukar *et al*., (2014) determined the concentration of heavy metals in some selected poultry feed samples. The results show different concentration levels of Cadmium, Cobalt, Copper, Iron, Manganese, Nickel, Lead, Chromium and Zinc detected in all samples. The levels of Zinc, Iron, Manganese and Copper were found to be below the requirement set by SON. Cadmium levels were found in all samples to exceed the permissible limit.

2.3.3 Mycotoxins in broiler feeds

The poultry industry is faced with feed insecurity, associated with high cost of feeds, and feed safety, often contaminated with mycotoxins. Mycotoxins, including aflatoxins (AFs), fumonisins (FBs), trichothecenes, and zearalenone (ZEN) are common contaminants of poultry.

According to Rahim *et al*., (2020) Mycotoxins are fungal metabolic byproducts that can contaminate animal feed and human food. The study was conducted to determine the existence of five mycotoxins, namely aflatoxin, fumonisin, ochratoxin, T-2, and zearalenone. About 94.8% of the

feed and feed ingredient samples contained a minimum of four mycotoxins in different concentrations.

Consumption of poultry meat and products has increased rapidly. Due to this increasing demand, these may involve some chemical and natural compounds with hazardous properties. Among these compounds, residues are of concern, including veterinary drugs, environmental pollutants (such as dioxins, pesticides) natural contaminants (mycotoxins) etc contaminating poultry product. (Ayhan *et al*., 2017)

Abdullah *et al*., (2010) studied a research and aflatoxins were investigated in some poultry feed. The results indicated that different amounts of aflatoxins were found in the analyzed samples. They reached peak values fo aflatoxin**.**

Mycotoxins are toxic secondary fungal metabolites that can negatively affect animal productivity and studied to determine the mycotoxins contamination in feed samples. Protection of public health against possible harmful effects of veterinary drug residues is a relatively recent preoccupation. The initial intention for adequate consumer protection led to the desire to achieve complete elimination of all traces of drug residues in food commodities. A negligible tolerance, based on toxicology data, was developed (Boisseau *et al*., 1993). Assays were developed for the testing of tissues, primarily from the existing milk testing procedures (Huber *et al.* 1969). In 1970 a microbiological test for both detection and identification of antibiotics in meat was described.

Radmila *et al*., (2009) was conducted a study that, All poultry is sensitive to mycotoxins. The presence of mycotoxins results in significant health disorders. This leads to considerable economic loss for the poultry industry.

Morevover, mycotoxin residues in poultry meat, eggs and products derived from them pose a threat to human health.

Now a days, poultry sector plays a significant role in human nutrition. So the quality feed is also mandatory for developing the sector. If the feeds are not fulfill all the requirements of broiler, it hampers all the production process. The quality of local feeds are not as good as the recognized companies feed. No expected profitability is ensued by feeding only the local feeds of broiler. In the study, the concentration of heavy metal in poultry feed is not very alarming. But high amount of these heavy metal contaminated in feed and transmitted from poultry products to human. The toxicity of the heavy metal (Cr & Pb) can't be described in single words for human life. In previous study, sometimes heavy metal were found in poultry meat and poultry products. But in the study, the concentration of heavy metal was below the detection level and not a threating matter.

CHAPTER: III

MATERIALS & METHODS

CHAPTER: III

METERIALS AND METHODS

In this research, feed samples were collected from the farmers who are directly associated with broiler rearing at Saver area in Bangladesh.

3.1 Location of the study

The study was conducted under the department of Animal Production & Management, Sher-e-Bangla Agricultural University, Dhaka 1207, during the period from March 2020 to July 2020 to evaluate the quality of commercial broiler starter and grower feeds of registered and unregistered company's at Saver area in Bangladesh. The assessment of chemical composition and heavy metal was conducted under the laboratory of Animal Nutrition and Feed Section of DLS (Department of Livestock Services), Khamarbari, Dhaka.

3.2 Experimental site selection

The proposed experiment was conducted at Savar upazila near tannery of Dhaka division. Savar with an area of 280 square km, located between 23º44´ and 24º02´ north latitudes and between 90º11´ and 90º22´ east longitudes (Figure 1).

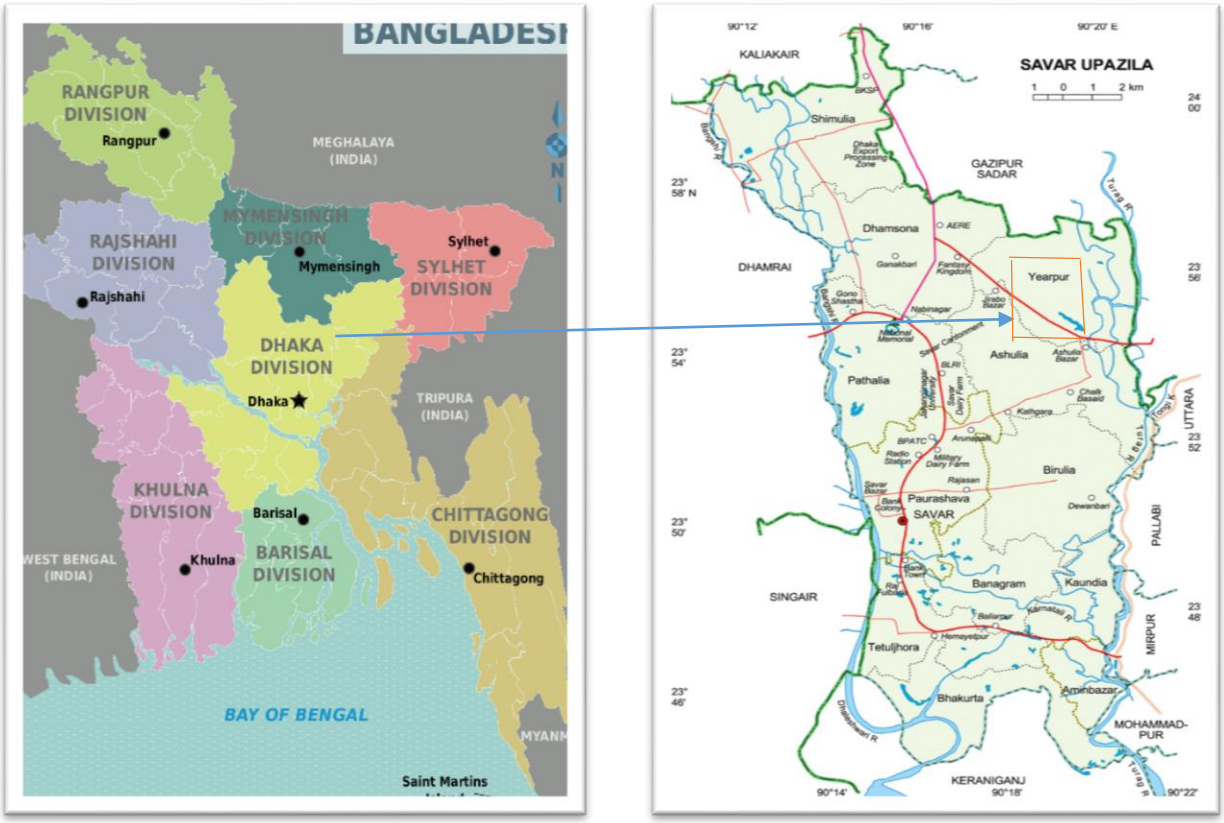


Figure: 1 Sample Collection Area

3.3 Sample collection and categorization:

Total 36 samples of broiler feeds (18 starter and 18 grower) were collected from the farmers near tannery area, Savar. Samples were taken from different spots in the study area. A total 36 samples were collected. Among those 18 were starter and 18 were grower feed samples. Different types of broiler starter feeds were collected from the farmers and collected in zip-lock poly bag. Registered feed company termed as company which is registered and providing a license for feed production by DLS, approximate production 125000MT/year. On the other hand, company which is not registered and no license provided by DLS and produce feed locally is called

unregistered feed company. There are about 198 registered and 33 unregistered feed mills in Bangladesh (DLS 2018). The feed samples were categorized in Figure 2.

3.4 Evaluation of physical properties

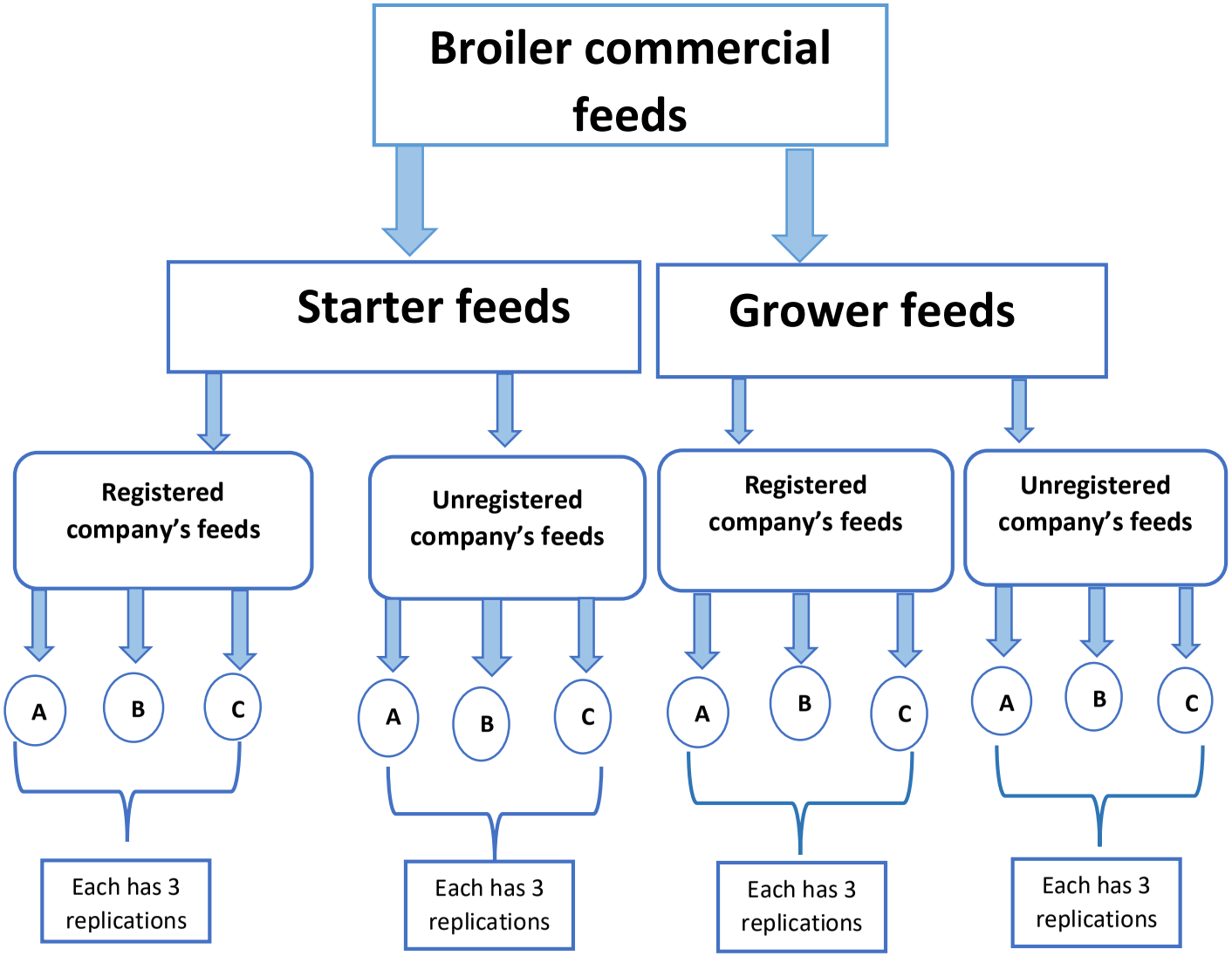
Physical properties such as color, smell, particle size of the samples were physically observed.

3.5 Determination of chemical properties

The feed samples were subjected to proximate analysis by standardized method according to (AOAC, 1990) for the determination moisture and crude protein.

3.5.1 Determination of moisture content:

A clean dried petri-dish was weighed (W1) and 3g of the samples were placed on it, and then weighed (W2). This was then placed in an electric oven at 120 °C for 3hrs. The dish was removed and cooled in desiccators for 30 minutes and finally weighed (W3). The difference between the net weight and the weight after drying to a constant weight was the moisture content (AOAC, 1990).


Broiler commercial feeds
Starter feeds
Grower feeds
Registered company's feeds
Unregistered company's feeds
Registered company's feeds
Unregistered company's feeds
A
B
C
A
B
C
A
B
C
A
B
C
Each has 3 replications
Each has 3 replications
Each has 3 replications
Each has 3 replications

3.5.2 Determination of CP (Crude Protein):

Protein was estimated using Kjeldahl method divided into three steps like digestion, distillation and titration. Weighed 2g of dried sample and kept into a Kjeldahl digestion flask. A catalyst known as digestion mixture was made by combination of mercury (II) oxide (0.04g), sodium sulfate (0.7g) and copper sulfate (0.06g). About 1.0g of catalyst and 10ml of concentrated sulfuric acid were contacted with the sample in the Kjeldahl digestion flask. The mixed materials were heated on the heating mantle until the clear solution was obtained in the Kjeldahl digestion flask. Then the solution was allowed to cool and added about 50ml of distilled water. The digested sample was transformed to alkaline solution with addition 50ml of 40% sodium hydroxide solution. The solution was distilled and produced ammonia gas collected in a beaker containing 100ml of 2% boric acid solution. Then added 2-3 drops of methyl red indicator with the solution and titrated with sulfuric acid.

3.6 Heavy metals determination

3.6.1 Sample preparation and digestion

Metals were measured by using atomic absorption spectrometer (AAS, AA-6200, Kyoto, Japan), equipped with a hollow cathode lamp, a 10 cm long slot-burner head and air/ acetylene flame. The operating conditions adjusted in the spectrometer were carried out according to the standard guidelines of the manufacture. The emission wavelength used, slit width, the correct coefficient for the calibration straight line, the working linear range and detection limit found for each metal are presented in Table 4. Samples were

processed for the analysis by the dry-ashing method. Samples were first dried in oven at 105°C for 24 h and then ground. The ground samples (5.0 g each) were placed in crucibles and few drops of concentrated nitric acid were added as ashing aid. Dry-ashing process was carried out in a muffle furnace by stepwise increase of the temperature up to 550°C and then left to ash at this temperature for 4 h. The ash was left to cool and then rinsed with 1 M nitric acid. The ash suspension was filtered and the filtrate made up to the volume of 25 ml with 1 M nitric acid. Blank solutions were prepared under identical conditions and the average signal was subtracted from analytical signals of samples. Standards solutions were prepared by adequate dilution of a multi-element standard (1000 mg/L) obtained from J. B. Baker Inc. (Phillipsburg, NJ, USA). All solutions and dilutions were prepared with ultra pure deionized water (pH 7.0) of 15 MΩ cm resistivity obtained from a water purification system (PURELAB Option-R, ELGA, UK). Standard curves for heavy metals using atomic absorption spectroscopy (AAS) were carried out using the amounts of elements versus the corresponding absorbance.

3.6.2 Determination of chromium:

Total Chromium concentration was determined from the digest by Analytik JenanovAA 400P Atomic Absorption Spectrophotometer (Analytik Jena, 2017, Germany).

3.6.3 Determination of lead:

Total Lead concentration was determined from the digest by Analytic JenanovAA 400P Atomic Absorption Spectrophotometer (Analytik Jena, 2017, Germany**)**

3.7 Statistical analysis

Data were analyzed by ANOVA using Statistix 10, MS Excel software to compare the data with various parameters. The difference between groups was considered significant when p-value was <0.05. All values were expressed as mean ± SD (Standard Deviation).

CHAPTER: IV

RESULTS & DISCUSSION

CHAPTER: IV

RESULTS AND DISCUSSION

4.1 Quality evaluation of feeds according to physical properties

In broiler starter feeds, the particle size of all feed samples were almost similar. The color of the feeds was slightly varied from each other. The color of feeds were in a ranged from light yellow to dark yellow. All the samples were in normal flavor. No foreign particles and molds were found in the samples. Dusty particles were found in some unregistered feed samples. (Table 2)

Grower feed samples were almost similar in particle size. The color of the feeds was normal and in a range from yellow to dark yellow. All the samples had normal smell and flavor. All the feed samples were free from any foreign particles and molds (Table 3).

This result agreed with Roy *et al*., (2004) who evaluated the quality of broiler feeds and observed the physical and chemical composition of feeds.

Table 2: Physical properties of broiler starter feeds

Sample ID	A1	A2	A3
Registered company's feeds			
	Color : Light yellow		
	Smell : Normal		
	Presences of foreign particles & molds : Absent		
Unregistered company's feeds			
	Color : Yellowish – dark yellow		
	Smell : Normal		
	Presences of foreign particles & molds : Absent		

Sample ID	B1	B2	B3
Registered company's feeds			
	Color : Dark yellow		
	Smell : Normal		
	Presences of foreign particles & molds : Absent		
Unregistered company's feeds			
	Color : Light yellow		
	Smell : Normal		
	Presences of foreign particles & molds : Absent		

Sample ID	C1	C2	C3
Registered company's feeds			
	Color : Dark yellow		
	Smell : Normal		
	Presences of foreign particles & molds : Absent		
Unregistered company's feeds			
	Color : Light yellow, yellowish		
	Smell : Normal		
	Presences of foreign particles & molds : Absent		

Table 3: Physical properties of broiler grower feeds

Sample ID	A1	A2	A3
Registered company's feeds			
	Color : Light yellow, yellowish		
	Smell : Normal		
	Presences of foreign particles & molds : Absent		
Unregistered company's feeds			
	Color : Yellowish		
	Smell : Normal		
	Presences of foreign particles & molds : Absent		

Sample ID	B1	B2	B3
Registered company's feeds			
	Color : Light yellow, yellowish		
	Smell : Normal		
	Presences of foreign particles & molds : Absent		
Unregistered company's feeds			
	Color : Yellowish, dark yellow		
	Smell : Normal		
	Presences of foreign particles & molds : Absent		

Sample ID	C1	C2	C3
Registered company's feeds			
	Color : Yellow, dark yellow		
	Smell : Normal		
	Presences of foreign particles & molds : Absent		
Unregistered company's feeds			
	Color : Light yellow, yellowish		
	Smell : Normal		
	Presences of foreign particles & molds : Absent		

The fine particle size is recommended for broiler starter (Svihus *et al*., 2011). Broilers fed with crumble diets had better FCR in comparison to

mash diet during starter period (Shabani *et al*., 2015). Moreover, broiler fed with crumble diets had higher FI (Feed Intake) and BW (Body Weight) than mash diet during starter period (Xu *et al*., 2002). Therefore, a better comprehension of the interaction between feed particle size and upper gut development and function has become fateful to optimization of broiler performance (Amerah *et al*., 2007). As the crumble size was increased, the VH (Villus Height) of Ileum was significantly decreased (Shirani *et al*., 2018).

4.2 Quality assessment of feeds according to chemical composition

The major nutrients value of a poultry feeds that are considered when formulating diets are moisture, crude protein, crude fat, crude fiber, ash and carbohydrate. In the present study, it was calculated the value of moisture and crude protein of broiler starter and grower feed samples.

4.2.1 Moisture content

In general the moisture content depicts the amount of moisture content in feeds. Moisture content of registered company's broiler feeds for starter was determined in the range of (11.49-14.03) %. There was a significant difference among the feeds of registered company's (Table 4). This may due to the difference of feed companies. On the other hand, moisture content of unregistered broiler feeds for starter was determined in the range of (11.31-12.13) %. No significant difference was presented among the unregistered company's feeds (Table 4).

Table 4: Moisture percentage in registered and unregistered company's commercial broiler starter feeds

Sample ID	Mean ± SD	
	Registered company's feeds	Unregistered company's feeds
A	13.15^{b} ± 0.23	12.13 ± 0.20
B	11.49^{c} ± 0.85	11.31 ± 0.37
C	14.03^{a} ± 0.075	11.34 ± 0.41
Level of significance	*	NS

*The different superscripts indicated significant difference among the values in the same column; *, p<0.05 (significant); NS, p>0.05 (non-significant)*

Moisture content of registered company's broiler feeds for grower was determined in the range of (10.24-11.48) % (Table 5). Besides moisture content of unregistered company's broiler feeds for grower was determined in the range of (9.65-10.52) %. (Table 5). No significant difference had been found among the feeds of registered and unregistered company's (Table 5).

Table 5: Moisture percentage in registered and unregistered company's commercial broiler grower feeds

Sample ID	Mean ± SD	
	Registered company's feeds	Unregistered company's feeds
A	10.76 ± 0.35	9.71 ± 0.37
B	11.48 ± 0.52	10.52 ± 0.43
C	10.24 ± 0.54	9.65 ± 0.43
Level of significance	NS	NS

NS= p>0.05 (non-significant)

The comparison of the moisture content between the registered and unregistered company's feeds was presented in table 6. The table illustrated no significant difference.

Table 6: Comparison the moisture values between the registered and unregistered company's commercial broiler feeds

Feed categories	Registered companies feeds	Unregistered companies feeds	Level of significance
Starter feeds	12.89 ± 1.28	11.59 ± 0.46	NS
Grower feeds	10.83 ± 0.62	9.96 ± 0.48	NS

NS= p>0.05 (non-significant)

In this study, moisture content was in a range of (11.31-14.03) % for broiler starter feeds (Table 4) which was higher than the normal range of 12% (NRC, 1994 and Ofori *et al*., 2019). Moreover, the moisture content was (9.65- 11.48) % for broiler grower feeds (Table 5) which was in the normal and recommended level (NRC, 1994; Ofori et al., 2019). This result was agreed with Khan *et al*., (2008), Ariful *et al.* (2014) and Morshed *et al.* (2019). The moisture content in broiler feeds was determined in the range of (8.6-9.06) (Ariful *et al*., 2014). Morshed *et al*., (2019) observed the moisture (9.81-11.68) % for broiler starter feeds and (8.68-15) % for broiler grower feeds.

Moisture level is important as it reduces the energy usage during the pelleting process. Feed can be stored for up to 4 months but better usage within 60 days in hot, humid summer months and 90 days in cooler months. Water activity is a parameter for moisture content are crucial for mycotoxigenic fungi and mycotoxin production (Jean *et al*., 2013). High moisture content is favorable for fungal development (Velluti *et al*., 2000). Fungi contamination destroy the quality of feeds.

4.2.2 Crude protein content

In this study crude protein was found in the range of (23.23-25.36) % for broiler starter in registered company's feeds (Table 7). On the contrary crude protein was found in the range of (8.45-23.02) % for broiler starter in unregistered company's feeds (Table 7). There was a significant difference among the feeds of registered and unregistered company's (Table 7). This

may due to the variation of different companies and quality of feed ingredients used during manufacture.

Table 7: Crude protein percentage in registered and unregistered company's commercial broiler starter feeds

Sample ID	Mean ± SD	
	Registered company's feeds	Unregistered company's feeds
A	24.13^{b}± 0.42	23.02^{a}± 0.25
B	23.23^{c}± 0 .39	8.50^{b} ± 0.47
C	25.36^{a} ± 0.45	8.45^{b} ± 0.43
Level of significance	*	*

*The different superscripts indicated significant difference among the values in the same column; * = p <0.05 (significant)*

Crude protein was found in the range of (17.43-19.34) % for broiler grower in registered company's feeds (Table 8). There was a significant difference among the registered company's feeds. Furthermore, crude protein was found in the range of (10.23-11.58) % for broiler grower in unregistered company's feeds (Table 8). No significant difference was presented among the unregistered company's feeds.

Table 8: Crude protein percentage in registered and unregistered company's commercial broiler grower feeds

Sample ID	Mean ± SD	
	Registered company's feeds	Unregistered company's feeds
A	$17.43^{b} \pm 0.43$	10.23 ± 0.67
B	$19.34^{a} \pm 0.41$	11.58 ± 0.43
C	$17.69^{b} \pm 0.62$	11.21 ± 0.63
Level of significance	*	NS

*The different superscripts indicated significant difference among the values in the same column; *, p<0.05 (significant); NS, p>0.05(non-significant)*

For crude protein, the comparison between the registered and unregistered company's feeds was presented in table 9. The data were indicated a value of the significant difference ($p<0.01$) (Table 9).

Table 9: Comparison the crude protein values between the registered and unregistered company's commercial broiler feeds

Feed categories	Registered company's feeds	Unregistered company's feeds	Level of significance
Starter	$24.24^{a} \pm 1.07$	$13.32^{b} \pm 8.39$	**
Grower	$18.15^{a} \pm 1.03$	$11.01^{b} \pm 0.69$	**

*The different superscripts indicated significant difference among the values in the same row; **= p<0.01 (significant)*

In this study, the amount of CP in unregistered company's feeds was below the standard level of 22% for starter and 20% for grower (NRC 1994 ; Ofori *et al*., 2019). Both the two categories of feeds contained low amount of CP. These types of feeds can't fulfill the requirement of protein of broiler. In the study, CP content was in a range (8.45-25.36) % for broiler starter and (10.23-19.34) % for broiler grower (Table 7 & 8).

This result agreed with Khan *et al*., (2008) but contradicted by Arifur *et al*., (2014), Morshed *et al*., (2019) and Roy *et al*., (2004). The CP level was found (8.96-21.73) % for broiler grower (Khan *et al*., 2008). Roy *et al*., (2004) concluded that the range of CP was (21.6-23.9) % for starter feeds and (19.8-23.7) % for grower feeds. The range of CP was (17.5-18.2) % for broiler feeds (Arifur *et al*., 2014). The CP was obtained in the range of (16.95 – 18.61) % & (16.67 – 18.97) % for starter and grower feeds, which was in normal range for broiler (Morshed *et al*., 2019) which were differ from the present study. This contrast may be made due to the variation among the quality of broiler feeds from different manufacturers and the difference of feed ingredients used for feed preparation. So, further studies are recommended to reveal the CP content of local feeds.

Crude protein is one of the most important nutrient to quantify in a prospective feeds due to the fact that is one of the most costly to supply and a deficiency of protein has a drastic effect on growth and production. Generally starter rations are high in protein whereas grower and finisher diets usually contain less protein, because older birds need less. Normally broiler diets contain higher protein than layer diets (Arifur *et al*., 2014).

The CP levels were not to be considered as a requirement of the bird in but to indicate an amount of N that would be sufficient to form all necessary NEAA. A 'significant' reduction in CP while maintaining EAA and all other nutrients at their minimal needs invariably leads to a loss in live performance (NRC 1994).

4.3 Heavy metals content of commercial broiler feeds

The Cr and Pb values of registered and unregistered company's feeds were observed. But, we found, all the feed samples contain very low amount of Cr and Pb. Those values were detected as Below Detection Level (BDL) and not alarming for our health.

Table 10: Heavy metals (Cr, Pb) content of broiler starter feeds

Sample ID	Registered company's feeds		Unregistered company's feeds	
	Cr	Pb	Cr	Pb
A1	BDL	BDL	BDL	0.091
A2	0.031	BDL	BDL	0.082
A3	BDL	BDL	BDL	BDL
B1	0.024	0.08	0.05	BDL
B2	BDL	BDL	BDL	0.083
B3	BDL	BDL	BDL	0.09
C1	BDL	0.094	0.045	0.078
C2	0.04	BDL	BDL	BDL
C3	BDL	BDL	BDL	0.08
Recommended	0.00 ppm	5.00 ppm	0.00 ppm	5.00 ppm

value (WHO)				

BDL= Below Detective Level

After the evaluation of heavy metals, we can say that, all the feed samples were not containing the harmful heavy metals and not hazardous for human beings. In this study, the Cr level was found in a range (BDL-0.05) ppm and Pb was (BDL-0.094) ppm in broiler starter feed (Table 10). This result was not granted to Latiful *et al*., (2015), Morshed *et al*., (2019) and Islam *et al*., (2016). The higher concentration of heavy metals was found in poultry feeds and different edible parts, which was alarming (Latiful *et al*., 2015). In starter feed samples Cr and Pb were ranges as (<DL – 1.14) ppm, (0.88 – 150.32) ppm respectively. On the other side, in grower samples Cr and Pb were found in the range of (<DL – 1.08) ppm, (<DL – 67.31) ppm respectively, indicated the high concentration of heavy metals and which was health hazardous (Morshed *et al*., 2019). In addition, the highest concentration of chromium in broiler meat was observed and higher than the permissible level declared by WHO and FAO (Islam *et al*., 2016). Fe, Mn, Pb, Cd, Cu, Zn were analyzed and found all feed exceeded the guideline value of the concentration of heavy metal (Arifur *et al*., (2014). These contrast may be made duo to the difference of sampling procedure during analysis and arising consciousness among the feed manufacturers.

Generally, the harmful effects of heavy metals include deleterious functional and physiological effects influencing cell metabolism (Ravindran, 2013). These metals are essential to the maintenance of different physiological and biochemical functions in small amounts, but they become harmful when they exceed specific standards can cause cell malfunction and, ultimately, toxicity (Zahng *et al*., 2017*).* Sources of contamination by heavy metals are different

from one element to another (Saleh *et al*., 2018). These mainly depends on the type of soil, environment risks broadens, animal species and product feeds, and geographic area (Khan *et al*., 2016). The poultry diet has the potential to contaminate several components of the environment (Ukpe *et al*., 2018). Heavy metals may enter the production system of livestock by different routes, including land application of inorganic fertilizers, atmospheric deposition, agrochemicals and animal waste. Suggesting that the supply of feedstuffs requires greater governmental quality control (Sarker *et al*., 2017). Heavy metals in animal manure lead to the accumulation of toxic elements in the soil and water due to the use of litter as a fertilizer and for soil amendments (Oyewale *et al*., 2019*)*. It can be transmitted through feed chain to humans.

Chromium is considered as essential element for normal carbohydrate and lipid metabolism (NRC, 1980). Little toxic effect is attributed when present in large concentrations. The most commonly used chromium compound in the tanneries is basic chromium sulfate (BCS). Chromium sulfate is initially trivalent but gets oxidized if left open to atmosphere to hexavalent chromium, which is carcinogenic (Baruthio *et al*., 1992). Ingestion of Cr at just 30 to 40 mg/Kg of BW has induced toxicosis in dairy calves (European Commission, 2003). Lead are nonessential nutrients that are of direct concern to human and livestock health and may accumulate in the body, particularly in the kidney, liver, and to a lesser extent in the muscle (Li *et al*., 2005). Consumption of lead-containing food resulted in numerous cases of toxicosis in humans and animals (Henry *et al*., 2001). Lead compounds may have a variety of targets within the nervous system causing neurotoxicity (Bondy *et al*., 1988). Lead poisoning in humans causes severe dysfunction in

the kidneys, reproductive system, liver, and the brain and central nervous system; causing sickness or death (Manahan *et al.*, 1997).

Now a days, awareness is developing among the citizens about food safety and health hazardous substances. An effective food safety regulatory framework is obligatory to ensure safe food for consumers. Bangladesh is lacking it for a long time which caused serious public health issues. Laws should be properly implemented to solve the health issues in the every sectors.

CHAPTER: V

SUMMARY & CONCLUSION

CHAPTER: V

SUMMARY & CONCLUSION

The study was conducted under the department of Animal Production & Management, Sher-e-Bangla Agricultural University, Dhaka 1207 during the period from March 2020 to July 2020 to evaluate the quality of commercial broiler starter and grower feeds of registered and unregistered company's at Savar in Bangladesh. Quality based on physical properties, chemical composition (Moisture & CP) and heavy metal concentration (Cr & Pb) in feed samples. The assessment of chemical composition and heavy metal was conducted under the laboratory of Animal Nutrition and Feed Section of DLS (Department of Livestock Services), Khamarbari, Dhaka.

Different types of broiler starter feeds were collected from the farmer involved in broiler rearing and collected in zip-lock poly bag. A total 36 feed samples were collected from the farmers of Saver area, in which 18 were starter feed and 18 were grower feed. Among 36 samples, 18 were registered and 18 were unregistered companies feed samples.

The physical quality of the feed samples were visually examined. The color, smell and presence of foreign matter & molds were observed. The color and smell of all the feed samples were normal and good condition. No foreign matters were observed in all feed samples and also all the feed samples were free from molds and insects. In this purpose, it was necessary to measure moisture content in the samples initially. The feed samples were subjected to proximate analysis by standardized method according to (AOAC, 1990) for the determination of moisture and crude protein. Protein was estimated using Kjeldahl method divided into three steps like digestion, distillation and

titration. Metals were measured by using atomic absorption spectrometer equipped with a hollow cathode lamp, a 10 cm long slot-burner head and air/ acetylene flame. Total Chromium and lead concentration was determined from the digest by Analytik JenanovAA 400P Atomic Absorption Spectrophotometer.

In the study, the highest moisture percentage was 14.03% and lowest was 11.31% for starter feed. On the other hand, the highest moisture percentage was 11.48% and lowest was 9.65% for grower feed. High in moisture percentage, increases the molds and pathogens grow in feed. The highest percentage of CP was 25.36% and lowest was 8.45% for starter feed. On the other hand, the highest percentage of CP was 19.34% and lowest was 10.23 % for grower.

The unregistered company's feed samples contained very low amount of CP and the quality of feeds was not satisfactory. Almost all the unregistered company's feeds contain very low amount of crude protein. This may be due to using of low quality protein ingredients during feed formulation. The heavy metal concentration in starter feeds were in very low amount in all feed samples and not hazardous for human. As we have found not alarming concentration of heavy metals in starter feed, so we did not analysis the grower feed. Finally, we can say that the quality of feeds was good. But in previous studies, the harmful level of heavy metals were observed in feeds. Now a days, the feed mill authorities may be concern about the hazardous effects of heavy metals. In the study, the concentration of heavy metals was below the detection level and not a threating matter.

There is a need for evaluate the quality (physical properties, chemical composition and heavy metal concentration) of poultry feed at different

areas in Bangladesh. Further research is needed to obtain more specific information about the heavy metal concentration in different types of poultry feed. There is a great concern on potential health risk of the people in those areas exposed to different heavy metals contaminated poultry feed.

CHAPTER: VI

REFERENCES

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REFERENCES

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CHAPTER: VII

APPENDICES

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APPENDICES

Appendix 1: Amount of moisture and CP in broiler starter feeds

Sample ID	Registered company's feeds		Unregistered company's feeds	
	Moisture	CP	Moisture	CP
A1	13.42	24.58	12.08	23.28
A2	13.06	24.06	12.46	23.01
A3	12.98	23.75	11.85	22.78
B1	11.34	23.68	11.24	8.52
B2	11.02	23.02	11.72	8.97
B3	12.11	22.98	10.99	8.02
C1	14.11	25.25	11.16	8.44
C2	13.96	25.86	11.83	8.89
C3	14.02	24.98	11.02	8.03

Appendix 2: Heavy metals (Cr, Pb) in broiler starter feeds

Sample ID	Registered company's feeds		Unregistered company's feeds	
	Cr	Pb	Cr	Pb
A1	BDL	BDL	BDL	0.091
A2	0.031	BDL	BDL	0.082
A3	BDL	BDL	BDL	BDL
B1	0.024	0.08	0.05	BDL
B2	BDL	BDL	BDL	0.083
B3	BDL	BDL	BDL	0.09
C1	BDL	0.094	0.045	0.078
C2	0.04	BDL	BDL	BDL
C3	BDL	BDL	BDL	0.08

Appendix 3: Amount of moisture and CP in broiler grower feeds

Sample ID	Registered company's feeds		Unregistered company's feeds	
	Moisture	CP	Moisture	CP
A1	10.37	17.84	9.80	9.64
A2	11.02	17.02	9.30	10.08
A3	10.89	17.39	10.02	10.96
B1	10.94	19.22	10.74	11.10
B2	11.52	19.80	10.80	11.75
B3	11.98	19.01	10.02	11.90
C1	9.81	18.24	9.70	10.66
C2	10.07	17.83	9.20	11.89
C3	10.85	17.02	10.05	11.08