

**EFFECT OF MOLASSES SUPPLEMENTATION ON**

**PRODUCTIVE PERFORMANCE, CARCASS CHARACTERISTICS AND HAEMATOBIOCHEMICAL PARAMETERS IN BROILER**

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Examination Roll No. 0116/03; Registration No. 286

Semester: January-June 2016

A thesis submitted in partial of the requirements for the fulfillment of the degree of Master of Science in Animal and Poultry Nutrition

Department of Animal Science and Nutrition

Faculty of Veterinary Medicine

Chittagong Veterinary and Animal Sciences University

Khulshi, Chittagong-4225, Bangladesh

**June 2018**



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This is to certify that we have examined the above Master’s thesis and have found that the thesis is complete and satisfactory in all respects and that all revisions required by the thesis examination committee have been made

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**June 2018**

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**The Author**

**June 2018**

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**June 2018**

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**Abbreviations**

|  |  |  |
| --- | --- | --- |
| ALT | - | Alanine aminotransferase |
| ANOVA | - | Analysis of variance |
| AST | - | Aspartate aminotransferase |
| BBS | - | Bangladesh Bureau of Statistics |
| BCRDV | - | Baby Chick Ranikhet Disease Vaccine |
| BMD | - | Bangladesh Meteorological Department |
| CF | - | Crude fibre |
| CP | - | Crude protein |
| DM | - | Dry matter |
| EE | - | Ether extract |
| FAO | - | Food and agriculture organization |
| FCR | - | Feed conversion ratio |
| g | - | Gram |
| IBD | - | Infectious Bursal Disease |
| IBD | - | Infectious Bronchitis Disease |
| Kg | - | Kilogram |
| LW | - | Live weight |
| ME | - | Metabolizable energy |
| NFE | - | Nitrogen free extract |
| NS | - | Non-significant |
| SEM | - | Standard error of mean |
| SGOT | - | Serum Glutamic Oxaloacetic Transaminase |
| SGPT | - | Serum Glutamic Pyruvic Transaminase |

**Abstract**

One hundred and sixty Cobb 500™ unsexed broiler chicks were used in a 28-day trial in a poultry farm at Guimara, Khagrachari Hill district to study the effect of molasses supplementation on productive performance, carcass characteristics and haemato-biochemical parameters in commercial broiler. Birds were randomly distributed into four dietary treatment groups and molasses was supplemented at 0%, 0.5%, 1% and 1.5% of drinking water for T0, T1, T2 and T3 groups, respectively. Each treatment was further divided into four groups having 10 birds per replicate. All birds had free access to ad-libitum feed and water. Results indicated that, weekly average live weight increased significantly in 1st (p˂0.05), 2nd (p˂0.05) and 4th (p˂0.01) weeks due to supplementation of molasses. Highest (1620.5 g/bird) and lowest (1569.4 g/bird) average live weights were recorded in T3 and T0 groups, respectively at 4th week. Unlike live weight, weight gain increased in 1st (p˂0.01) and 3rd (p˂0.05) weeks. Maximum (77.8 g/bird/d) and minimum (71.5 g/bird/d) weekly average weight gains were recorded in T3 and T2 groups, respectively at 4th week. Weekly average feed intake increased non-significantly (p>0.05) throughout the whole experimental periods. FCR did not differ (p>0.05) within experimental birds irrespective of the levels of molasses supplementations. Drumstick weight increased (p<0.01) from 4.1 to 4.4% and gizzard weight increased from 2.1 to 2.2% at 4th week as the level of molasses supplementation increased from 0 to 1.5%. Hemato-biochemical parameters exhibited normal range among different dietary groups (p>0.05) except for total protein which increased significantly (p˂0.01) at 4th week. It was concluded that, molasses is a potential feed supplement which in addition to basal diet, at an inclusion level of 1.5% of drinking water gives maximum result in terms of productive performance, carcass characteristics and hemato-biochemical parameters.

**Keywords:** Carcass characteristics, molasses, hemato-biochemical parameter, productive performance

**Chapter I: Introduction**

Poultry meat and egg contribute approximately 37% of total animal protein supplied in the country. Chickens are the most commonly brought up poultry birds of Bangladesh. There is a great market for professional poultry agriculture in Bangladesh and it is already a well-established income opportunity. Broiler industry is becoming famous day by day due to its low cost of installment and quicker return. As Bangladesh is a country of huge population, there is a certain shortage of land. By broiler farming, people can easily utilize their fragmented lands in a proper way **(Hamid et al., 2016; Khaled, 2015).**

Bangladesh has a friendly environment for poultry farming which encourage entrepreneurs to invest in poultry farming. As of 2017, about 300 billion BDT has been invested in the poultry sector. There is an estimated 150,000 poultry farms in [Bangladesh](https://en.wikipedia.org/wiki/Bangladesh). The farms annually produce 570 million tons of meat and 7.34 billion eggs. Although poultry farming is becoming popular day by day there are some constraints which cannot be overlooked. The high cost of poultry feed is the main reason which discourage people from farming **(DLS, 2015; Raha, 2013)**.

The cost of feed covers a major portion of the total cost. In addition, there are some potentially pathogenic microorganisms such as *Escherichia coli*, *Salmonella ssp*., *Clostridium perfringens* and *Campylobacter sputorum* which are directly involved in the digestion of the poultry birds. These microorganisms compete with the host for nutrients and thus reduce the digestion of fat and fat-soluble vitamins due to the conjugating effects of bile acids. That is why farmers use some feed additives such as antibiotics, hormones, vitamins and other growth promoters to improve the growth of broilers for better production and economic return **(Akyildiz, 2015).**

Although these growth promoters promote health of the birds, use of antibiotics and hormones have shown harmful effects on poultry which directly affect the human body. Growth promoters are also discouraged to use because of their residual effect in broiler meat. Addition of growth promoter to poultry ration is considered to be a good assurance to improve growth and production of poultry and protect them from deficiency diseases **(Saif et al., 2008)**. They have positive effect on the growth performance of chickens in terms of improving feed utilization and metabolism, stimulating the immune system and minimizing many stresses **(Sahin et al., 2003).**

Molasses is a by-product of the sugar industry. Molasses refers to the final effluent obtained in the separation of sucrose by repeated evaporation, crystallization and centrifugation of juices from sugar cane or sugar beets **(Curtin, 1983)**. In general, any liquid feed ingredient that contains sugar in excess of 43% is termed as molasses. The chemical composition of molasses shows a wide variation as its composition is influenced by many factors such as the type of soil used for cultivation of the crop, ambient temperature, moisture, season of crop production, variety, plant processing and storage conditions.

The variations in composition exists in nutrients content, flavor, color, viscosity and total sugar content **(Wornik, 1969; Hendrickson and Kesterson, 1971; and Presten and Willis, 1974).** In addition to sucrose, molasses contains glucose, fructose, raffinose and numerous non-sugar organic materials and a small quantity of crude protein **(Champman et.al., 1965).** The nitrogenous material in molasses consists mainly of non-protein nitrogen compounds (amides, albuminoids, amino acids and other simple nitrogenous compounds).

In comparison to commonly used sources of dietary energy, mainly cereal grains, the calcium, potassium, magnesium, sodium, chlorine, and the sulfur content of cane molasses are high. The trace minerals i.e., copper, iron, manganese content are high in cane molasses. The vitamin content of molasses is subject to wide variations **(Olbinch, 1963; Curtin, 1983).** It is deficient in thiamine, riboflavin, vit. A and vit. D, but it is rich in niacin and pantothenic acid. Soluble ash content also varies among molasses types.

Sugar cane molasses has been proven suitable when included in high levels in diets for both broilers and layers with no detrimental effect on health or performance. However, certain limitations were shown with total replacement of cereal grains by molasses, due to difficulties in mixing diets containing high levels of molasses in addition to its laxative effects **(Connor et al., 1972)**. Inclusion of high levels of molasses in broiler diets increased body weight and feed consumption during 0-4 weeks of age, but the increase of feed intake was not statistically significant, whereas at 4-8 weeks of age molasses inclusion had no effects on either feed intake, weight gain, feed efficiency or live weight **(Connor et al, 1972; Rahman, 1984 and Kabuage et al, 2000).**

Sugar cane molasses is capable of yielding greater quantities of soluble carbohydrate which can be used as a source of energy in poultry diets **(Woldroup, 1981)**. Cane molasses is a cheap source of energy compared to other energy rich feeds, especially sorghum and other cereal grains. **Eisa (1996)** reported that, obtaining energy from molasses is far much cheaper than obtaining it from cereal grains, because molasses has a relatively high content of soluble carbohydrate in the form of sugars. **Satava et al. (1981)** reported that, up to 20% molasses could be used in broiler diets with no reduction in body weight. Despite many advantages, literature related to supplementation of molasses in drinking water in addition to regular pellet diet is scarce in Web of science, Pubmed and Google scholar. Therefore, following research hypothesis, general objective and specific objectives were developed for the study.

**1.1 Research hypothesis**

Supplementation of molasses in drinking water in addition to basal diet may improve productive performance, carcass characteristics and hemato-biochemical parameters in commercial broiler.

**1.2 General objective**

Assess the feasibility of using molasses in the drinking water of commercial broiler birds in addition to regular diets.

**1.3 Specific objectives**

1. To study the effect of molasses supplementation on productive performance in commercial broilers.
2. To measure the effects of various levels of molasses supplementation on carcass characteristics of commercial broiler.
3. To study the effect of molasses supplementation on hemato-biochemical parameters of commercial broiler.

**Chapter 2: Review of Literature**

This chapter is organized with a view to review some previous work relevant to the research work undertaken. Very limited researches have so far been conducted with molasses supplementation in commercial broilers to observe the effect on performances parameter, carcass characteristics and hemato-biological parameters. Sugar cane molasses is capable of yielding greater quantities of soluble carbohydrate which can be used as a source of energy in poultry diets **(Woldroup, 1981)**. Cane molasses is a cheap source of energy compared to other energy rich feeds, especially sorghum and other cereal grains. **Eisa** **(1996)** reported that, obtaining energy from molasses is far much cheaper than obtaining it from cereal grains, because molasses has a relatively high content of soluble carbohydrate in the form of sugars. Furthermore, there are many reports in the literature indicating that molasses can be used effectively to replace sorghum grains in poultry diets.

**2.1. Molasses**

Molasses is the principal by product of the sugar industry. The term molasses specifically refers to the final effluent obtained in the separation of sucrose by repeated evaporation, crystallization and centrifugation of juices from sugar cane or sugar beets **(Curtin, 1983)**. In general any liquid feed ingredient that contains sugar in excess of 43% is termed molasses.

**2.2. Types of molasses**

There are many types of molasses which have been described and specified by the Association of American Feed Control Officials **(AAFCO, 1982)**. These types include cane molasses, beet molasses, citrus molasses, hemicellulose extract and starch molasses.

**2.3. Types of sugar cane molasses**

The early literature on production and processing of cane molasses, has been presented by **Anonymous (1970)** and **Meade and Chem (1977)**. There are many types of sugar cane molasses. The molasses usually available for animal feeding is known as Black strap or final molasses.

**2.3.1. Black strap (Final molasses)**

It is a by- product of cane sugar industry, from which the maximum crystalline sugar has been extracted by the normal methods. It is most commonly used in animal feeding. In addition to sucrose, it contains glucose and fructose which are fermentable. Black strap molasses also contain substances which are not fermentable by yeast. The non-fermentable reducing content of molasses may be present as high as 17% in black strap molasses Under **Curtain (1973).**

**2.3.2. Integral molasses**

It is unclarified molasses, made by partially inverting sugar cane juice to avoid crystallization of sucrose.

**2.3.3. High test molasses**

High test molasses result from the conversion of clarified whole sugar cane juice into molasses. The process involves application of invertase enzyme and sulphuric acid to the cane juice resulting in syrup. Because the sugar was not excreted the high –test molasses has a greater concentration of sugars and lower concentration of minerals compared to other types of molasses.

**2.3.4. Condensed molasses**

This is the by- product developed by condensing the residue from yeast fermentation to commercial alcohol.

**2.4. Composition of molasses**

The chemical composition of molasses shows a wide variation as its composition is influenced by many cultural factors such as the type of soil used for cultivation of the crop, ambient temperature, moisture, season of crop production and variety; in addition to production practices, plant processing, and the storage conditions. The variation in composition exists in nutrients content, flavor, color, viscosity and total sugar content **(Wornik, 1969; Anonymous, 1970; Hendrickson and Kesterson, 1971; and Presten and Willis, 1974).**

All types of molasses contain relatively large amounts of total sugars and other carbohydrates; and these compounds are responsible for the feeding value of molasses. Sugar content of molasses varies according to the production technology employed. In addition to sucrose, molasses contains glucose, fructose, raffinose, and numerous non- sugar organic materials.

Molasses and sugar cane juice are characterized by their extremely high NFE value, and no fiber, and negligible amount of ether extract and protein. All types of molasses contain a small quantity of crude protein (3% in mineral soil reaching 10% in organic soil). Also the nitrogenous material in molasses consists mainly of non- protein nitrogen compounds (amides, albuminoids, amino acids and other simple nitrogenous compounds). These two factors limit its nutritional value for non- ruminants. The mineral content of molasses reveals wide variation within molasses types, and variability of trace minerals can be quite high **(Curtin, 1983)**. In comparison to commonly used sources of dietary energy, mainly cereal grains, the calcium, potassium, magnesium, sodium, chlorine, and the sulfur content of cane molasses are high, whereas the phosphorus content is low. The trace minerals (copper, iron and manganese) content are high in cane molasses.

The vitamin content of molasses is subject to wide variations **(Olbrich, 1963; Curtin, 1983)**. It is deficient in thiamine, riboflavin, vit. A and vit. D., but it is rich in niacin and pantothenic acid. Soluble ash content also varies among molasses types. Generally, molasses is low in phosphorus but cane molasses is an excellent source of trace minerals.

**2.5. Molasses as an animal feed**

Molasses has been used as an animal feed for livestock and poultry stock since a long time, starting at the nineteenth century. Review articles in this respect were published **(Van Niekerk, 1980; Waldroup, 1981)**. Molasses is used with dry feeds of animals to increase palatability, setting dust, carrier for other essential nutrients, serving as a binder for pelleting and as a source of trace minerals and some microelements **(Gohl, 1975).** Commercially it is included in animal rations at a level of 15% for cattle and pigs, 8% for calves and sheep, and 5% for poultry **(Crampton and Harries, 1969).** However the maximum amount to be used is often determined by the absorbability of molasses by other ingredients in the diet.

The use of molasses in animal feeding is limited, because overconsumption of molasses causes molasses toxicity in ruminants and laxative effects in monogastric animals. **Losada et al. (1971)** reported that molasses toxicity is related to the change in the nature of the end products of digestion produced. This was supported by the finding that molasses toxicity reported in turkeys is associated with extensive fermentation in the crop but not in pigs where there are few differences in the nature of the fermentation pattern **(Ly, 1987a)**.

The laxative effect of molasses is attributed to osmotic effects caused by the great quantity of potassium ions in the final molasses. It was also suggested that the insufficient intestinal saccharase, used to complete hydrolization of the sucrose present in molasses, would cause the laxative effect. Other problems that limited the use of high levels of molasses are the difficulty of mixing quantities in excess of 20% of the diet; in addition to the problems of storage and handling of this type of diet, when using automatic feeders.

**2.6. Molasses in broiler diet**

The earliest document report showing the value of cane molasses in poultry feeding was published by **Gohl (1975)** in North America. Sugar cane final molasses proved to be suitable when included in quite high levels in diets for both broilers and layers with no detrimental effect on health or performance **(Ly, 1990 and Ricci et al., 1980).** However, certain limitations were shown with total replacement of cereal grains by molasses, due to difficulties in mixing diets containing high levels of molasses, in addition to its laxative effects **(Rossenberg, 1955; Kondo and Ross,1962; Perez,1968 and Connor et al., 1972)**. Inclusion of high levels of molasses in broiler diets increased body weight and feed consumption at 0-4 weeks of age, but the increase of feed intake was not statistically significant; whereas at 4-8 weeks of age molasses inclusion has no effect on either feed intake, body weight gain, feed efficiency or live weight **(Connor et al, 1972; Abdel Rahman, 1984; and Kabuage et al, 2000)**. Similarly **Satava et al., (1981)** indicated that up to 20% molasses could be used in broiler diets with no reduction in body weight. The same workers concluded that sugar molasses can be included safely at 15 and 20% in finishing diets of broiler. Storage of diets with high levels of molasses causes loss in the nutritive value of mixed feeds which would reduce the growth rate of birds and feed efficiency.

**2.7. Molasses feeding and internal organs of broiler**

Anatomical modifications have been found in broilers fed increasing levels of sugar cane final molasses. Remarkable increases in the crop, proventricle, small intestines, empty caecum and kidney weights were reported by **Alvarez, (1976).**

**2.8. Digestion of molasses by poultry**

Poultry shows a fast rate of passage of digesta through the gastrointestinal tract when sugar cane final molasses are included in large proportion in diet **(Alvarez, 1976).** The laxative effect of sugar cane final molasses, defined as a rapid rate of passage of digesta through the entire gastrointestinal tract, brings about a sharp decrease in the digestibility of diets, thus causing deterioration in the daily body weight gain and feed utilization efficiency. This laxative effect can be neutralized by mixing the molasses with raw sugar or high-test molasses which contains large amounts of sugar **(Perston, 1987).** When a laxative condition appears in chicken fed cane molasses, there is no change in the ratio of water excretion between faeces and urine.

**2.9. Molasses as a source of energy**

Energy is derived from the metabolism of carbohydrates, lipids, and protein. Most energy in the animals feed is derived from carbohydrates such as cereal grains, in form of starch. Sorghum is the most important cereal grain for poultry feed in the Sudan, which contains 14-46Mj/kg metabolizable energy. Molasses is the alternative source of CHO which contains high metabolizable energy of about 10-15Mj/kg.

**2.10. Energy requirement for broilers**

The energy requirement of birds is met by the chemical energy contained in the feed. Energy is required for maintenance function, growth and other forms of production, and any excess is stored in the form of fats. The optimum energy needs must be provided in the diet. Most energy requirement is derived from soluble carbohydrate represented by starch and sugars. The efficiency of feed utilization depends upon metabolic energy in nutrients containing adequate amounts of all others required nutrients.

**2.11 Hemato-biochemical parameters**

A blood glucose test measures the amount of glucose in blood. The amount of sugar in blood is usually controlled by a hormone called insulin. However, animals suffering from diabetes, either doesn’t make enough insulin (type 1 diabetes) or the insulin produced doesn’t work properly (type 2 diabetes). This causes sugar to build up in blood. Increased levels of blood sugar lead to severe organ damage. Both types of diabetes may lead to frequent urination, feeling very thirsty, hungry and fatigued, blurry vision and cuts or sores that don’t heal properly.

The total protein test measures the total amount of albumin and globulin. Albumin and globulin are two most important types of proteins in body.. Elevated total protein indicates inflammation or infections of organs and disorders of bone marrow. Low total protein indicates unusual bleeding, liver disorder, kidney disorder, mal-absorption of nutrients or malnutrition.

A hemoglobin test measures the amount of hemoglobin in blood. Hemoglobin is a protein in red blood cells that carries oxygen in different organs and tissues and transports carbon dioxide from your organs and tissues to the lungs. Lower levels of hemoglobin reveals a low red blood cell count (anemia). However, if a hemoglobin test shows a higher than normal level, there may have several potential blood disorders i.e., polycythemia (elevated hematocrit).

The erythrocyte sedimentation rate (ESR) is the rate at which red blood cells sediment in a period of one hour. It is a common hematology test, and is a non-specific measure of inflammation. The ESR is increased in inflammation, pregnancy, anemia, autoimmune disorders, infections, some kidney diseases and some cancers. The ESR is decreased in polycythemia, sickle cell anemia, leukemia, low plasma protein and congestive heart failure.

The aspartate aminotransferase (AST) test is a blood test that checks for liver damage. Liver is the most vital organ that has many important jobs. It makes a fluid called bile that helps digestion of lipids. It also removes waste products and toxins from blood. It produces proteins and other substances that help blood clot. Other organs, like your heart, kidneys, brain, and muscles, also make smaller amounts. AST is also called SGOT (serum glutamic-oxaloacetic transaminase). Normally, AST levels in blood are low. When liver is damaged, it puts more AST into blood raising levels high. A high AST level is a sign of damage of liver and other organs that make it.

High density lipoprotein (HDL) considered the “good” cholesterol which clears low density lipoprotein (LDL) from body via the liver. HDL may therefore prevent the buildup of plaque, protecting arteries from atherosclerotic cardiovascular disease. Its higher levels are better. The higher the HDL, the lower is the risk for stroke. In contrast to HDL, LDL is considered the “bad” cholesterol. It carries cholesterol to the arteries and contribute to the formation of plaque known as atherosclerosis which leads to the decreased blood flow to the heart muscle (coronary artery disease), leg muscles (peripheral artery disease), or abruptly close artery in the heart or brain, leading to a heart attack or stroke. Therefore, lower the LDL, the better the health.

An alanine aminotransferase (ALT) test measures the amount of this enzyme in the blood. ALT is found mainly in the liver, but also in smaller amounts in the kidneys , heart, muscles, and pancreas. ALT is also called SGPT (serum glutamic pyruvic transaminase). ALT is measured to see if the liver is damaged or diseased. Low levels of ALT are normally found in the blood. But when the liver is damaged or diseased, it releases ALT into the bloodstream, which makes ALT levels go up.

**2.12 Summary**

The above discussions have clearly identified the feasibility of using molasses in broiler diets. However, in all the above cases, molasses was supplemented with feed not in drinking water. Although, molasses is a potential feed supplement, it is very sticky in nature which plugs mixing devices of feed mill while added with mash feed resulting decreased feed mixing efficiency. As a result, feed millers are not interested to use molasses in poultry feed. From this perspective, it appears, there is a clear research gap for incorporation of molasses in the drinking water of commercial broiler birds. Taking these views in mind, a 28-day trial was conducted to study the effects of molasses supplementation on productive performance, carcass characteristics and hemato-biochemical parameters in commercial broiler.

**Chapter III: Materials and Methods**

**3.1 Study area**

The exploration was conducted during May to June 2018 in khagracchari Hill district, South-eastern part of Bangladesh and research laboratories of the Department of Animal Science and Nutrition, Chittagong Veterinary and Animal Sciences University, Khulshi, Chittagong-4225, Bangladesh. May-June is considered as summer season in Bangladesh. In May, average temperature was 31.5oC, average humidity was 82.0% and average precipitation was 184.8 mm. In June average temperature was 32.8o C, humidity was 88.0% and average precipitation was 67.5 mm **(BMD, 2015).**

**3.2 Design of the experiment**

The experimental birds were assigned to a Completely Randomized Design. A total of 160 birds were randomly distributed into four dietary treatment groups designated as T0, T1, T2 and T3 and supplemented with 0%, 0.5%, 1% and 1.5% molasses supplement for T0, T1, T2 and T3 groups, respectively. Each treatment was further divided into four replicates having 10 birds per pen.

**Table 3.1** Layout of the experiment

|  |  |  |  |
| --- | --- | --- | --- |
| Dietary treatments | No. of birds per replicate | | Birds/treatment |
| T0=Diet without molasses | R1 | 10 | 40 |
| R2 | 10 |
| R3 | 10 |
| R4 | 10 |
| T1=Diet containing 0.5% molasses | R1 | 10 | 40 |
| R2 | 10 |
| R3 | 10 |
| R4 | 10 |
| T2=Diet containing 1.0% molasses | R1 | 10 | 40 |
| R2 | 10 |
| R3 | 10 |
| R4 | 10 |
| T3=Diet containing 1.5% molasses | R1 | 10 | 40 |
| R2 | 10 |
| R3 | 10 |
| R4 | 10 |
| Grand total | | | 160 |

**3.3 Animals and housing**

One Hundred Sixty Cobb 500 day old unsexed broiler chicks were purchased from Nahar Agro Complex Limited, Chittagong, Bangladesh. All chicks were examined for abnormalities and uniform size. Average body weight of the chicks was 48.74±0.26 g. The experimental shed was brick cemented with corrugated metal wiring. Floor space for each bird was 0.17 square feet in brooding box and 0.75 square feet in the cage. The cage was further divided into 20 pens. The pens were selected in an unbiased way for uniform distribution of chicks. The chicks were brooded in the wooden box. After 14 days, birds were transferred to the respective pens. Each pen was allocated for 10 birds. Dry and clean newspapers were placed in the brooding box and changed for every 6 hours. Room temperature and humidity were maintained using 200 watt incandescent lamps and ceiling fans. The birds were exposed to continuous lighting. During brooding period, chicks were brooded at a temperature of 95 °F, 90 °F, 85 °F and 80 °F for the 1st, 2nd, 3rd and 4th weeks, respectively with the help of incandescent bulbs. Temperatures were measured by using thermometer.

**3.4 Cleaning and sanitation**

The shed was thoroughly cleaned and washed by using tap water with caustic soda. For disinfection, phenyl solution (1% v/v) was sprayed on the floor, corners and ceiling. Following spray, cleaning was done by using brush and clean water. Brooding boxes, rearing cages and pens were cleaned in the same manner. After cleaning and disinfection, the house was left one week for proper drying. After drying, all doors and windows were closed. The room was fumigated (Adding 35 ml of formalin to 10 g potassium permanganate per cubic meter) and sealed for 24 hours. On the next day, lime was spread on the floor and around the shed. Footbath containing potassium permanganate (1% w/v) was kept at the entrance of the poultry shed and changed daily. Feeders were cleaned and washed with Temsen® solution (0.3% v/v) weekly before being used further. Drinkers were washed with potassium permanganate (1% w/v) and dried up daily in the morning.

**3.5 Experimental diets**

Individual feed ingredients were purchased from Pahartali market, Chittagong, Bangladesh. During purchase, cleanliness and date of expiry were checked. Molasses supplement was provided at 0%, 0.5%, 1% and 1.5% to prepare the experimental mash diets. Dry mash was provided to the birds throughout the whole experimental period. Five different types of rations were formulated. Each ration had two different types i.e., starter (0 to 14 days) and finisher (15 to 28 days). All rations were iso-caloric and iso-nitrogenous. The composition of different feed ingredients and nutritive value of starter and grower rations are given in Table 3.1 and 3.2.

**Table 3.2** Ingredient and nutrient composition of the broiler starter ration (0-14 days)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Ingredient** | **Dietary treatments** | | | |
| **T0** | **T1** | **T2** | **T3** |
| Maize | 56.7 | 56.7 | 56.7 | 56.7 |
| Rice polish | 6.0 | 6.0 | 6.0 | 6.0 |
| Soybean oil | 0.3 | 0.3 | 0.3 | 0.3 |
| Soybean meal | 30.0 | 30.0 | 30.0 | 30.0 |
| Fish meal | 2.6 | 2.6 | 2.6 | 2.6 |
| Meat and bone meal1 | 1.9 | 1.9 | 1.9 | 1.9 |
| Limestone | 0.8 | 0.8 | 0.8 | 0.8 |
| Dicalcium phosphate2 | 1.00 | 1.00 | 1.00 | 1.00 |
| L-Lysine | 0.10 | 0.10 | 0.10 | 0.10 |
| DL-Methionine | 0.05 | 0.05 | 0.05 | 0.05 |
| Vitamin-min. premix3 | 0.20 | 0.20 | 0.20 | 0.20 |
| Vitamin ADEK | 0.05 | 0.05 | 0.05 | 0.05 |
| Common salt | 0.25 | 0.25 | 0.25 | 0.25 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 |
| **Estimated nutrients** |  |  |  |  |
| Metabolizable energy4 | 3000.0 | 3000.0 | 3000.0 | 3000.0 |
| Crude protein | 22.0 | 22.0 | 22.0 | 22.0 |
| Crude fibre | 3.56 | 3.56 | 3.56 | 3.56 |
| Ether extract | 3.84 | 3.84 | 3.84 | 3.84 |
| Calcium | 1.00 | 1.00 | 1.00 | 1.00 |
| Total phosphorus | 0.81 | 0.81 | 0.81 | 0.81 |
| Available phosphorus | 0.50 | 0.50 | 0.50 | 0.50 |
| L-Lysine | 1.38 | 1.38 | 1.38 | 1.38 |
| DL-Methionine | 0.37 | 0.37 | 0.37 | 0.37 |
| Cystine+Methionine | 0.82 | 0.82 | 0.82 | 0.82 |
| Tryptophan | 0.28 | 0.28 | 0.28 | 0.28 |

T0=Diet without molasses; T1=Diet containing 0.5% molasses; T2=Diet containing 1.5% molasses; T3=Diet containing 1.5% molasses; 1MBM (52.0% CP, imported from Australia by Rahman and Brothers, Asadgonj, Chittagong, Bangladesh); 2DCP (23% Ca, 18% P); 3Vitamin-mineral premix (Per kg vitamin mineral premix provided: Vitamin A 5000 IU, D3 1000 IU, K 1.6 mg, B1 1 mg, B2 2 mg, B3 16 mg, B6 1.6 mg, B9 320 µg, B12 4.8 µg, Cu 4 mg, Mn 40 mg, Zn 20 mg, Fe 2.4 mg, I 160 µg); 4Metabolizable energy (kcal/kg)

**Table 3.3** Ingredient and nutrient composition of the broiler finisher ration (14-28 days)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Ingredient** | **Dietary treatments** | | | |
| **T0** | **T0** | **T0** | **T0** |
| Maize | 60.1 | 60.1 | 60.1 | 60.1 |
| Rice polish | 5.0 | 5.0 | 5.0 | 5.0 |
| Soybean oil | 3.0 | 3.0 | 3.0 | 3.0 |
| Soybean meal | 25.0 | 25.0 | 25.0 | 25.0 |
| Fish meal | 4.5 | 4.5 | 4.5 | 4.5 |
| Meat and bone meal1 | 0.0 | 0.0 | 0.0 | 0.0 |
| Limestone | 0.7 | 0.7 | 0.7 | 0.7 |
| Dicalcium phosphate2 | 1.00 | 1.00 | 1.00 | 1.00 |
| L-Lysine | 0.10 | 0.10 | 0.10 | 0.10 |
| DL-Methionine | 0.05 | 0.05 | 0.05 | 0.05 |
| Vitamin-min. premix3 | 0.20 | 0.20 | 0.20 | 0.20 |
| Vitamin ADEK | 0.05 | 0.05 | 0.05 | 0.05 |
| Common salt | 0.25 | 0.25 | 0.25 | 0.25 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 |
| **Estimated nutrients** |  |  |  |  |
| Metabolizable energy4 | 3200.0 | 3200.0 | 3200.0 | 3200.0 |
| Crude protein | 20.0 | 20.0 | 20.0 | 20.0 |
| Crude fibre | 3.28 | 3.28 | 3.28 | 3.28 |
| Ether extract | 6.27 | 6.27 | 6.27 | 6.27 |
| Calcium | 1.00 | 1.00 | 1.00 | 1.00 |
| Total phosphorus | 0.82 | 0.82 | 0.82 | 0.82 |
| Available phosphorus | 0.53 | 0.53 | 0.53 | 0.53 |
| L-Lysine | 1.29 | 1.29 | 1.29 | 1.29 |
| DL-Metthionine | 0.35 | 0.35 | 0.35 | 0.35 |
| Cystine+Methionine | 0.77 | 0.77 | 0.77 | 0.77 |
| Tryptophan | 0.25 | 0.25 | 0.25 | 0.25 |

T0=Diet without molasses; T1=Diet containing 0.5% molasses; T2=Diet containing 1.5% molasses; T3=Diet containing 1.5% molasses; 1MBM (52.0% CP, imported from Australia by Rahman and Brothers, Asadgonj, Chittagong, Bangladesh); 2DCP (23% Ca, 18% P); 3Vitamin-mineral premix (Per kg vitamin mineral premix provided: Vitamin A 5000 IU, D3 1000 IU, K 1.6 mg, B1 1 mg, B2 2 mg, B3 16 mg, B6 1.6 mg, B9 320 µg, B12 4.8 µg, Cu 4 mg, Mn 40 mg, Zn 20 mg, Fe 2.4 mg, I 160 µg); 4Metabolizable energy (kcal/kg)

**3.6 Feeding of birds**

Feed was prepared manually and supplied ad-libitum to the birds on round small feeder and waterer for 0-7 days. After 7th day, small round feeders and waterers were replaced by medium linear feeders (2.21 ft X 0.25 ft) and round waterers. At 15th day, large linear feeder (3.5 ft X 0.38 ft) and round waterers (3 liter capacity) were provided for feeding and drinking of the birds.

**3.7 Medications**

All birds were vaccinated against Newcastle disease (BCRDV live) and Infectious Bursal Disease on the 4th day followed by a booster dose on 14th day. After each vaccination, multivitamin (Rena-WS, Renata; 1g/ 5liter of drinking water) was supplied along with vitamin-C to overcome the effect of stress due to vaccination and cold shock.

**3.8 Carcass measurement**

On 4th week of the study period, four birds were randomly selected from each replicate and killed by severing the jugular vein and carotid artery. Once a bird was adequately bleed out, it was scalded and feather was removed. After defeathering, the birds were eviscerated and the head and feet were removed as per technique described by **Jones (1984).** During evisceration process, abdominal fat, lung, liver, kidney, spleen, gizzard and proventriculus were excised separately and weighed. Dressed birds were weighed to obtain a dressed carcass weight.

**3.9 Analysis of feed and meat**

From each treatment, 100 g of prepared mash feed was taken and preserved in an air tight bag to carry them in the laboratory for analysis during the experimental period. After slaughter, 120 g of meat was collected in the air tight bag from each carcass for estimation of the chemical composition of meat. Feed and meat samples were dried at 80°C and ground to powder. After drying, chemical analyses of the feed and meat samples were carried out in triplicate for dry matter (DM), crude protein (CP), crude fiber (CF), nitrogen free extracts (NFE), ether extracts (EE) and total ash (TA) in the animal nutrition laboratory, Chittagong Veterinary and Animal Sciences University, Chittagong as per **AOAC (2005).**

**3.10 Hemato-biochemical analysis**

Blood samples were collected from the brachial vein of four birds from each group (Two birds from each replicate) using a 3 ml sterile syringe and a 23-gauge needle. Each blood sample was transferred immediately into a sterile tube containing the anticoagulant, ethylene diamine tetra acetic acid. The total red blood cell counts were performed in a 1:200 dilution of blood in Hayem’s solution. The differential leukocyte counts were determined by preparation of blood smears stained with Wright’s stain. The hemoglobin concentration was estimated by matching acid hematin solution against a standard colored solution found in Sahl’s hemoglobinometer. Packed cell volume was measured after centrifugation of a small amount of blood using micro-hematocrit capillary tubes.

**3.11 Serum analysis**

For serological tests blood was collected without anticoagulant from four birds of each group at 21st and 28th days of age. Clotted blood in the vacutainer tube was kept overnight at normal room temperature (25oC) and serum was collected into the Eppendorf tube by micropipette. Sera samples were marked and stored in -20°C until being analyzed for glucose, total protein, albumin, serum glutamic oxaloacetic transaminase (SGOT), serum glutamate-pyruvate transaminase (SGPT) by Humalyzer 3000 (Semiautomatic, microprocessor-controlled photometer with large graphic LCD screen, Wisbaden, Germany). Randox® veterinary reagent kits were used for determination of the serum parameter of interest. Serum sample was mixed with the respective reagents in an ependroff tube. The serum with reagent was aspired by spectrophotometric method which measured the target parameter and immediately the printed result was recorded.

**3.12 Data collection**

Weight gain, feed intake and FCR were recorded at weekly intervals. Carcass characteristics, hematological and biochemical parameters were recorded at 3rd and 4th weeks. Weight gain was calculated by deducting initial body weight from the final body weight of the birds. Feed intake was calculated by deducting leftover from the total amounts of feed supplied to the birds. FCR was calculated dividing feed intake by the weight gain.

**3.13 Statistical analysis**

Data were compiled in MS Excel. Raw data related to weight gain, feed intake, FCR, carcass characteristics, hematological and biochemical parameters were tested for outlier and influential factors by using graph matrix. Multicollinearity of the independent variables was tested by using collinearity diagnostic test. Normality of all the explanatory variables were tested by using Shapiro-Wilk W and Shapiro-Francia test. Equality of variance was tested by using Bartlett's test. The corrected data were tested and analyzed for 2-WAY ANOVA by using Stata (Stata/SE 14.1, Stata Statistical Software, Stata Corporation, College Station, TX, USA). Means showing significant differences were compared by Duncan’s New Multiple Range Test **(Duncan, 1955).** Statistical significance was accepted at p<0.05 for F-tests.

**Chapter IV: Results**

**4.1 Live weight**

Weekly average live weight increased significantly among different dietary treatment groups in 1st (p˂0.05), 2nd (p˂0.05) and 4th (p˂0.01) weeks due to supplementation of molasses in the drinking water of commercial broiler birds (Table 4.1). Highest (1620.5 g/bird) and lowest (1569.4 g/bird) average live weights were recorded in T3 and T0 groups, respectively at 4th week.

**Table 4.1** Live weight, weight gain, feed intake and FCR of the experimental broiler birds fed diet supplemented with different levels of molasses in drinking water from 1st to 4th weeks.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **Age** | |  | **Dietary treatments** | | | **SEM** | **Sig.** |
| T0 | T1 | T2 | T3 |
| Live weight (g/bird) | Initial | | 40.1 | 40.2 | 40.5 | 40.2 | 0.35 | NS |
| 1st wk | | 180.1a | 181.6a | 188.9b | 188.6b | 1.56 | \* |
| 2nd wk | | 490.1a | 495.2a | 506.1b | 502.7b | 2.58 | \* |
| 3rd wk | | 1000.7 | 1024.2 | 1072.7 | 1035.3 | 10.77 | NS |
| 4th wk | | 1569.4a | 1592.6b | 1613.1c | 1620.5c | 7.81 | \*\* |
| Weight gain (g/bird/d) | 1st wk | | 20.0a | 20.2a | 21.2b | 21.2b | 0.21 | \*\* |
| 2nd wk | | 38.6 | 39.1 | 39.6 | 39.1 | 0.19 | NS |
| 3rd wk | | 67.2a | 69.8a | 75.2b | 70.3a | 1.19 | \* |
| 4th wk | | 75.5 | 75.5 | 71.5 | 77.8 | 0.99 | NS |
| Feed intake (g/bird/d) | 1st wk | | 22.1 | 23.1 | 23.6 | 23.9 | 0.28 | NS |
| 2nd wk | | 54.4 | 56.5 | 58.2 | 58.1 | 0.66 | NS |
| 3rd wk | | 104.3 | 105.6 | 107.9 | 107.6 | 0.89 | NS |
| 4th wk | | 130.9 | 134.5 | 127.2 | 130.9 | 1.14 | NS |
| FCR | | 1st wk | 1.0 | 1.1 | 1.0 | 1.1 | 0.01 | NS |
| 2nd wk | 1.3 | 1.4 | 1.4 | 1.4 | 0.01 | NS |
| 3rd wk | 1.4 | 1.4 | 1.3 | 1.4 | 0.02 | NS |
| 4th wk | 1.6 | 1.7 | 1.7 | 1.6 | 0.02 | NS |
| 0-4 wk | 1.4 | 1.4 | 1.4 | 1.4 | 0.00 | NS |

abc=Means sharing different superscripts in the same row differ at least at 5% level (p<0.05); T0=Diet containing 0% molasses in drinking water; T1=Diet containing 0.5% molasses in drinking water; T2=Diet containing 1.0% molasses in drinking water; T3=Diet containing 1.5% molasses of drinking water; NS=Non-significant (P>0.05); \*=Significant (P<0.05); \*\*=Significant (P<0.01)

**4.2 Weight gain**

Similar to live weight, weekly average weight gain increased significantly among different dietary treatment groups in 1st (p˂0.01) and 3rd (p˂0.05) weeks due to supplementation of molasses in the drinking water (Table 4.1). Maximum (77.8 g/bird/d) and minimum (71.5 g/bird/d) weekly average weight gains were recorded in T3 and T2 groups, respectively at 4th week.

**4.3 Feed intake**

Weekly average feed intake increased non-significantly (p>0.05) among different dietary treatment groups throughout the whole experimental periods (Table 4.1). Highest (134.5 g/bird/d) and lowest (127.2 g/bird/d) weekly average feed intakes were recorded in T2 and T3 groups, respectively at 4th week.

**4.4 Feed Conversion ratio**

FCR did not differ (p>0.05) within experimental birds throughout the whole experimental periods irrespective of the levels of molasses supplementations (Table 4.1). The best (1.6) and worst (1.7) FCR was recorded in the T2 and T3 groups, respectively at 4th week.

**4.5 Carcass characteristics**

Drumstick weight significantly increased (p<0.01) from 4.1 to 4.4% at 4th week as the levels of supplemental molasses increased from 0 to 1.5% in the drinking water. Similarly, gizzard weight increased from 2.1 to 2.2% at 4th week due to supplementation of molasses (Table 4.2). However, other carcass parameters remained unchanged (p˃0.05) throughout the experimental periods.

**Table 4.2** Carcass characteristics of the experimental broiler birds fed diets supplemented with different levels of molasses at 4th week.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Carcass characteristics** | **Dietary treatments** | | | | **SEM** | **Sig** |
| **T0** | **T1** | **T2** | **T3** |
| Dressed weight (%) | 64.1 | 63.9 | 63.4 | 63.6 | 0.13 | NS |
| Wing weight (%) | 3.1 | 3.0 | 3.2 | 3.0 | 0.04 | NS |
| Drumstick weight (%) | 4.1a | 4.1a | 4.2a | 4.4b | 0.05 | \*\* |
| Neck weight (%) | 2.7 | 2.7 | 2.7 | 2.8 | 0.03 | NS |
| Heart weight (%) | 0.7 | 0.7 | 0.7 | 0.6 | 0.02 | NS |
| Proventriculus weight (%) | 0.7 | 0.7 | 0.7 | 0.7 | 0.02 | NS |
| Skin weight (%) | 6.5 | 6.7 | 6.7 | 6.7 | 0.03 | NS |
| Blood weight (%) | 3.4 | 3.5 | 3.6 | 3.5 | 0.05 | NS |
| Intestine and viscera (%) | 4.9 | 4.9 | 4.9 | 4.9 | 0.01 | NS |
| Breast muscle weight (%) | 15.8 | 15.7 | 15.7 | 15.5 | 0.05 | NS |
| Thigh muscle weight (%) | 4.6 | 4.6 | 4.6 | 4.5 | 0.02 | NS |
| Shank weight (%) | 1.4 | 1.4 | 1.4 | 1.4 | 0.02 | NS |
| Liver weight (%) | 2.3 | 2.4 | 2.4 | 2.5 | 0.03 | NS |
| Gizzard weight (%) | 2.1a | 2.2b | 2.2b | 2.2b | 0.02 | \* |
| Head weight (%) | 1.8 | 1.8 | 1.9 | 1.9 | 0.03 | NS |
| Abdominal fat weight (%) | 1.4 | 1.4 | 1.5 | 1.4 | 0.02 | NS |
| Feather weight (%) | 3.7 | 3.5 | 3.6 | 3.5 | 0.05 | NS |

ab=Means sharing different superscripts in the same row differ at least at 5% level (p<0.05); T0=Diet containing 0% molasses in drinking water; T1=Diet containing 0.5% molasses in drinking water; T2=Diet containing 1.0% molasses in drinking water; T3=Diet containing 1.5% molasses of drinking water; NS=Non-significant (P>0.05); \*=Significant (P<0.05); \*\*=Significant (P<0.01)

**4.5 Hemato-biochemical parameters**

Serum parameters exhibited normal ranges among different dietary treatment groups (p>0.05) except for total protein which increased significantly (p˂0.01) at 4th week (Table 4.3). Maximum (3.89 g/dl) and minimum (2.49 g/dl) average values of total protein were recorded in T3 and T2 groups, respectively at 4th week.

**Table 4.3** Serum parameters of the experimental broiler birds fed diets supplemented with different levels of molasses supplementation at 3rd and 4th weeks.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Dietary treatments** | | | | | **SEM** | **Sig.** |
| **Age** | **T0** | **T1** | **T2** | **T3** |
| Glucose (g/dl) | 3rd | 0.21 | 0.22 | 0.31 | 0.23 | 0.25 | NS |
| 4th | 0.23 | 0.21 | 0.12 | 0.21 | 0.17 | NS |
| Total protein (g/dl) | 3rd | 2.56 | 2.78 | 2.89 | 2.63 | 0.25 | NS |
| 4th | 2.69a | 3.12ab | 2.49a | 3.89b | 0.18 | \*\* |
| Albumin (g/dl) | 3rd | 3.49 | 2.79 | 3.93 | 2.81 | 0.19 | NS |
| 4th | 3.39 | 3.21 | 4.01 | 3.59 | 0.14 | NS |
| Cholesterol (g/dl) | 3rd | 0.11 | 0.12 | 0.11 | 0.12 | 6.93 | NS |
| 4th | 0.89 | 1.19 | 1.10 | 1.30 | 0.61 | NS |
| SGPT (U/L) | 3rd | 11.79 | 52.29 | 25.41 | 50.81 | 10.17 | NS |
| 4th | 36.71 | 44.51 | 39.61 | 13.41 | 6.57 | NS |
| SGOT (U/L) | 3rd | 130.41 | 198.91 | 122.81 | 121.91 | 16.28 | NS |
| 4th | 109.59 | 106.69 | 118.89 | 99.79 | 9.93 | NS |

ab=Means sharing different superscripts in the same row differ at least at 5% level (p<0.05); T0=Diet containing 0% molasses in drinking water; T1=Diet containing 0.5% molasses in drinking water; T2=Diet containing 1.0% molasses in drinking water; T3=Diet containing 1.5% molasses of drinking water; NS=Non-significant (P>0.05); \*\*=Significant (P<0.01)

**Chapter V: Discussion**

The research aimed to investigate the effects of molasses supplementation below and above recommended levels to measure its effects on productive performance, carcass characteristics and biochemical parameters in commercial broiler for a typical period of 28 days. This chapter discusses important findings, thier implications and potential limitations of the study.

**5.1. Feed intake**

Gradually increasing levels of molasses supplementation had remarkable positive effects on feed intake in commercial broiler. In the present study, it was found that molasses supplementation increased feed intake in treatment groups compared to control. Birds consumed relatively more feed during finisher phase despite reduced total feed intake **(Liu, 2000).**

Molasses is considered as a good source of energy for animal and poultry. It has been used as an animal feed for livestock and poultry since a long time, starting at the nineteenth century. In the present study, use of molasses in the drinking water of broiler resulted in increased feed intake with increased concentration of molasses in the drinking water of the experimental birds. On the other hand, **Khalid (2007)** reported inconsistent results, that incorporation of cane molasses in broiler diets above 4% decreased feed intake.

Increased feed intake might be due to the fact that, molasses increases the palatability, which was mentioned by **Curtin (1983)**, who indicated that, beside molasses being an energy source, the palatability of molasses makes it an excellent carrier for other feeds especially unpalatable feedstuffs. Similar reports were documented elsewhere **(Gohl, 1975).**

**5.2. Weight gain**

Supplementation of molasses from 1st to 4th weeks of age in commercial broiler birds resulted substantially improved weight gain in treatment groups compared to control. The result is closely consistent with previous studies where, increasing levels of supplementing molasses had significant positive effects on body weight gain in broilers. In the present study, the highest weight gain was recorded in T3 group which is very close to the other studies **(Stipkovits *et al*., 1992; Denli *et al*., 2003).**

The progressive increase of feed intake from the diets with higher levels of molasses in the present study was accompanied by marked increase in final live weight and weight gain of the experimental birds. This effect can be attributed to the increased intake of ME and other nutrients which would promote growth and improve feed efficiency **(Sadagopan *et al*, 1971)**. A significant increase in body weight has also been reported by **Ndelekwute (2015)** who mentioned that, after three weeks of feeding molasses, final weight was improved. Studies conducted by **Connor *et al*. (1972), Satava et al. (1981) and kabuage *et al*. (2000)** reported that, incorporation of molasses up to 6% in the broiler diet could be used without reduction in weight gain.

**5.3. Feed conversion ratio**

The efficiency of feed utilization was improved with increasing molasses levels in the diet. This effect, however, was not significant during the first three weeks of age of the experimental chicks. This finding is in general agreement with that of Aderolu (2013) who reported no significant differences (P>0.05) in the feed conversion ratio among experimental birds. The present study however, disagree with previous report indicating that the inclusion of molasses in broiler diets had no significant effect on feed efficiency **(Rahman, 1984; Khalid *et al*., 2007).**

**5.4. Biochemical changes**

The blood components are particularly sensitive to changes in ambient temperature, being an important indicator of physiological responses of birds to stress factors. During heat stress, increased catabolic effect and higher concentration of adrenocorticotropic hormone result more glucose, uric acid and triglycerides in blood serum. In this study, glucose level at 4th week was normal and lower in treatment group compared to control. In this study cholesterol level was higher in treatment group than control group. But in another study, it was reported that in younger age, cholesterol level remained low due to higher demand of energy used for body development **(Ahmed and Islam, 1990**). The increase in glucose concentration is directly responsive to an increase in glucocorticoids (**Borges et al., 2007**), which may result from various stressors including heat stress. Glucocorticoids have primary effects on metabolism and stimulating gluconeogenesis from muscle tissue proteins.

It was reported that, high environmental temperature increased plasma glucose and cholesterol levels and reduced protein level **(Kutlu and Forbes, 1993; Rashidi et al., 2010**). The increase in blood lipids under heatstress was also explained by **Rashidi et al. (2010)** who reported that high temperature reduces feed intake since broilers compensate their energy need by lipolysis of body lipid which elevates blood cholesterol and triglycerides. In contrast, **Seven et al. (2009**) reported that glucose, total protein, total cholesterol, VLDL cholesterol and triglycerides in blood plasma were not significantly influenced by heat stress. Albumin does not vary with age which is similar to the present study. In fact, life is the continuation of a series of complex biochemical reactions supported by enzymes. Therefore, changes in enzyme activities are considered as an indication of health**.** In the current study, despite various levels of supplemental molasses, all biochemical parameters remained unchanged (p>0.05) except total protein (p<0.05). Normally, total protein value remains high in 28 days. In contrast to the present study, feeding molasses resulted an increase in cholesterol levels in turkey **(Slepickova *et al*., 2008).**

Liver is the main organ for controlling metabolism in entire body. Of all the enzymes, SGPT and SGOT are the most specific types of enzymes of the liver which increase in the plasma due to destruction of cell membrane and cell necrosis in acute liver disease and also due to accumulation of toxic substances in liver **(Meyer and Harvey, 1998).** In the present study, SGOT and SGPT remained normal in molasses supplemented groups. Liver transaminases, SGOT and SGPT are essential in protein biosynthesis and normal range in their concentration reflects better liver function and normal health of the broiler birds.

**5.5. Carcass characteristics**

Gradual progression in supplementation of molasses substantially improved carcass quality in terms of dressed weight, breast weight, drumstick weight and abdominal fat weight of birds. Carcass yields are usually affected by high temperature because of reduced feed intake. This result is in agreement with many previous studies **(Sahin et al., 2002; Sahin et al., 2003; Lohakare et al., 2005**) where supplementation of molasses significantly increased carcass weight and yield as well as the weights of internal organs.

**Limitations of the study**

Due to financial constraints and technical limitations, some of the vital hemato-biochemical parameters specially, Very Low Density Lipoprotein (VLDL), Low Density Lipoprotein (LDL), High Density Lipoprotein (HDL), White blood cell (WBC), calcium, phosphorus and other trace minerals both in feed and meat were not analyzed. These parameters could have potential impact on human health.

**Conclusion**

The study investigated the effects of molasses supplementation on productive performance, carcass characteristics and hemato-biochemical parameters in commercial broiler under intensive rearing system. There was a positive relationship between gradual increase of molasses supplements with productive performance and carcass characteristics of commercial broilers without notable changes in hemato-biochemical parameters.

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**Recommendations**

Molasses is comparatively cheaper and readily available economic source of energy for birds. Therefore, molasses could be an important solution for profitable broiler farming in tropical environment under stressful condition in Bangladesh. Inclusion of 1.5% molasses in drinking water in addition to basal diet is recommended for better growth, optimum FCR and desirable carcass characteristics.

**Future directives**

Long term consistent effect of molasses supplementation on productive performance and hemato-biochemical indices of broilers should be investigated in future for further validation of the study for human health. Large sample size and multi-dimensional temporal pattern is suggested to increase sensitivity and validity of the study under field conditions. This study explores new horizon for investigating additional vital parameters in future applying high sensitivity and specificity diagnostic tests and advanced statistical techniques.

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