**Chapter-1: Introduction**

Poultry industry has immense scope for the developing country like Bangladesh through changing livelihood & food habit, reduction of dependence of meat related to cow and goat, positive impact on GDP growth rate of the country and ensuring food security (Islam et al., 2014). It has recently been immersed as one of the most important divisions of agriculture in Bangladesh. The present situation and future of this sector in our country is very potential (Bhuiyan, 2011). In addition, commercial poultry production has been growing rapidly since the early of 18th century by using improved genetics, manufactured feeds and management (Raha, 2013).

The contribution of livestock sector in total country’s GDP of Bangladesh is about 1.78% (Bangladesh Economic Census, 2015). Poultry industry contributes a lion’s share to this GDP covering at least 10 million people as employee in the sector as claimed by poultry industry leaders (Source: Financial Report, Bangladesh, 2016). Poultry meat, which is a notable item in human diet, can attribute around 37% of the total animal protein supply in Bangladesh. High quality proteins and micro-nutrients are present in broiler meat which has beneficial effect for human health and nutrition (Barroetoa, 2007). In recent years the price of poultry feed has abruptly increased. In commercial poultry industry feed cost represents 60-70% of the total economic input. High cost of basic or conventional feed ingredients has made poultry production very expensive (Kleyn, 2009).

Fats and oils are usually added to poultry feed as dietary energy yielding ingredients to improve palatability, absorption and digestion of lipoproteins and to decrease dustiness. Efficient fat digestion is crucial for growth of chicken (Blanch et al., 1996). Animal or vegetable fats/oils are desirable for feeding both the animals and poultry. But the limitation arises when mixed micelles is formed in the intestinal lumen decreasing fat digestion & absorption of nutrients (Marzooqi and Leeson, 1999). Furthermore, fat slows down the rate of feed passage through the digestive tract, allowing more time for better digestion and absorption of nutrients (NRC, 2014). In young birds, the assimilation of dietary fat is limited because they have reduced capacity to produce & secret bile salts and lipase until their gastrointestinal tracts mature (Zhang et al., 2011).

Fats are not efficiently used until lipase activity reaches in its maximum level. Fat is water-insoluble, thus an emulsion step is required in fat absorption. Several studies found that dietary supplementation of emulsifier improve emulsion formation and fat digestibility in chickens. As fat energy is cheap compared with the energy of other carbohydrate sources, it is economical to use more fat or oil in poultry diet. But high level of fat in poultry diet causes indigestion and mal-assimilation of fat because bile secretion in poultry are not efficient. Addition of emulsifiers to high fat diet may improve its utilization (Yun-he, 2013).

Lysolecithin and lecithin are two excellent emulsifying agents which are easily absorbed; promote better absorption of fatty materials and other food elements. They are commercially available. Lysolecithin is derived from lysophosphatidylcholines and acts as a membrane fluidity modulator (Soaresm et al., 2002). It forms the liposomes that can be filled with useful substrates and help in rapid absorption of nutrients (Gatlin et al., 2002). It also improves the digestion of fat and enters into the structure of living cells (Aguilar et al., 2013). Liver lecithin has been found to contain saturated acids (i.e. palmitic, stearic) and the unsaturated acids (i.e. oleic, linoleic, arachidonic). Researchers in previous study has reported that birds fed diets containing supplemented lecithin represents better body weight, weight gain and feed conversion ratio (Neto et al., 2011; Alzaqwari et al., 2010, Maertens et al., 2013). Dietary lysolecithin has anti-fatty liver and carcass fat repartition effects and enhances the removal of body cholesterol in broilers (Dan et al., 2013).

**Therefore the objectives of the present study were,**

1. To investigate the growth performance of commercial broiler with the addition of lecithin and lysolecithin as emulsifying agents in poultry diet containing high level of oils and
2. To compare the carcass quality of broiler with or without addition of lecithin and lysolecithin.

**Chapter-2: Review of Literature**

Emulsification of fat is the most crucial step to achieve the maximum metabolizable energy (ME) value from the added fat source. However, secretion of bile and lipase in young chick is always insufficient to get an optimum emulsification and this often results in depressed ME value of the fat added to the diet. To assure that these added fats are absorbed efficiently by the bird’s digestive system one should add emulsifiers. The literature which related to the current studies is reviewed in this chapter under the following headings:

**2.1. Emulsifier substances**

An emulsion is usually defined as a system in which one liquid is relatively distributed or dispersed, in the form of droplets, in another substantially immiscible liquid. The emulsion formation is a result of the co-production of water from the oil reservoir. During processing, pressure over ingredients introduces sufficiently high mechanical energy input to disperse water as droplets in the oil phase (Ahmad, 2009).

It has a two-phase system; one is an oil phase and an aqueous (water) phase. The aqueous phase is water plus any combination of materials which are polar and dissolved into the ingredients. The oil phase comprises one or more oily materials, or other ingredients which are non polar and exhibit at least some solubility in oily materials. It is a special type of colloidal dispersions, which has at least one dimension between 1 and 1000 nm. The dispersed phase is sometimes referred to as the internal phase which also forms a special kind of colloidal system in the droplets often exceed the 1000 nm limited size.

Emulsifier is a surface active chemical agent (as soap) which promotes the formation and stabilization of an emulsion process (Mohamed, 2007).

**2.1.1. Sources of emulsifier**

**2.1.1. A Natural source:** On the basis of their hydrophilic groups, there are basically four categories of natural food emulsifiers and emulsifiers. These are

• Anionics

• Non-ionics

• Cationics

• Amphoterics

Bile salts are natural emulsifiers. Young animals have a limited production of bile salts and therefore fat digestibility is premature in the early stage of life.

**2.1.1. B Chemical source**

1. Lecithin

2. Polyoxyethylenesorbitan esters

3. Mono diglycerides (MDG) of fatty acids

4. Acetic acid esters of MDG

5. Lactic acid esters of MDG

6. Citric acid esters of MDG

7. Mono- and diacetyl tartaric acid esters of MDG

8. Sucrose esters of fatty acids

9. Polyglycerol esters of fatty acids

10. Polyglycerolpolyricinoleate

11. EmulsiVet is a unique and carefully controlled combination of lysophospholipids, phospholipids and glycolipids.

**2.1.2. Lecithin**

Lecithin is a mixture of glycerol-phospholipids obtained from animal, vegetable or microbial source, containing varying amounts of substances, such as sphingosyl-phospholipids, triglycerides, fatty acids and glycolipids. The choline derivatives of phosphatidic acid are commonly known as the lecithin. Since the lecithin contain the acidic OH of phosphoric acid and the very basic OH of choline (Attia et al., 2008). The isoelectric pH of a pure lecithin is usually components give rise to different lecithin (Liu et al., 2009). A lecithin containing stearic acids and oleic acids is different from one containing palmitic acids and oleic acids. They had presented that various combinations of saturated and unsaturated acids occur in lecithin. Many contain both saturated and unsaturated acids (Pena et al., 2014). To accompany animal and vegetable fats is lecithin, a fatty substance containing nitrogen and phosphorus. Lecithin denotes a group of fatty substance, phosphatides, which occur throughout nature as an essential part of living organisms. Commercial soybean lecithin is one of the substances contained in the commercial product is an inositol compound which functions in the growth of feathers. Inositol has a bearing on the transport contains ethanolamine and small amounts of biotin and tocopherol (vitamin E). Lecithin has protective action against enzymes of nutritional origin and helps maintain the animal in the state of good health (Azman and Ciftci, 2004).

**2.1.3. Lysolecithin (Lysophosphatidylcholine)**

Lysolecithin is derived from lysophosphatidylcholines, are class of chemical compounds which are derived from phosphatidylcholines which removes one of the fatty acids group (Soares et al., 2002). It acts as a membrane fluidity modulator. This results in very rapid absorption of nutrients. Body weight and ether extract (EE) percentage of breast muscle was increased in treated groups as compared with the control (P<0.05). Relative weight and EE percentage of liver (P<0.05) and percentage of abdominal fat (P=0.051) were lower in broilers fed lysolecithin (Dan et al., 2013). Liver lysolecithins have been found to contain the saturated acids palmitic and stearic, and the unsaturated acids oleic, linoleic and arachidonic.

Stearic, palmitic, oleic, linoleic and linolenic acids have been found in soybean lysolecithins (Liu et al., 2012). The variety of acids occurring in the lysolecithins and other phospholipids is markedly restricted as compared with the glycerides of fats. Lysolecithin is able to form micelles or liposomes spontaneously, so creating microscopic envelopes that can be filled with useful substrates including nutrients (Soares et al., 2002). Normal phospholipids produce micelles but they tend to be large and less well absorbed in the intestine. Lysolipids, on the other hand, naturally form small, tightly packed liposomes that are very well absorbed. Thus, lysolecithin is a superior bio-surfactant and emulsifier than lecithin.

**2.1.4. Bile salts**

Bile is a complex fluid containing water, electrolytes and a battery of organic molecules including bile acids, cholesterol, phospholipids and bilirubin that flows through the biliary tract into the small intestine. Bile contains some acids such as hydroxylatedcholanic acids. Quantitatively, the principal acids are cholic acids (3α, 7α, 2α, trihydroxycholanic acid), chenodeoxycholic acid (3α, 7α dihydroxycholanic acid) and de-oxycholic acid (3α, 12α dihydroxycholanic acid). The acids are conjugated with glycine and taurine in variable ratios. There conjugates are present as sodium salts (called bile salts) due to nearly complete ionization of the acids at physiological pH. It was also added that besides the part played absorption of fats, the bile salts are important because of their capacity to lower surface tension. This property accounts for the emulsification of fats with the concurrent production of a great surface area, which enables lipase and other enzymes to act more efficiently (Orban and Harmon, 2000). The formation of micelle between fats and fat digestion products with bile salts is part of the emulsification process. Various molecules (bile salts, detergents, soaps) which possess both polar and non-polar groups and are themselves water soluble have the property of combining and aggregating with other compounds to form partially water soluble complexes (Maisonnier et al., 2003).

These bile salt-lipid complexes are the micelles, so important to fat absorption. Lipase is activated by surface tension lowering substances. Bile salts can shift the optimum pH of pancreatic lipase from around pH 8.5 in the absence of bile salts to about 6.5, the approximate pH of the duodenum. Bile salts stimulate peristalsis, and they also have a cholagogue effect, that stimulates the further production of bile (Lefebvre et al., 2009). Most of the functions of the bile are attributable to the bile salts it contains. However, the alkalinity of the bile is of value in neutralizing part of the acid chime from the stomach. Also, certain substances are excreted via the bile that is cholesterol, bile pigments, and certain drugs.

When fat digestion is impaired, other foodstuffs are also poorly digested, since the fat covers the food particles and prevents enzymes from attacking them. Under these conditions, the activity of the intestinal bacteria causes considerable putrefaction and production of gas. Bile salts have considerable ability to lower surface tension. This enables them to emulsify fats in the intestine and dissolve fatty acids and water insoluble soaps. The presence of bile in the intestine is an important adjunct to accomplish the digestion and absorption of fats as well as the absorption of the fat soluble vitamins A, D, E and K (Reinhart et al., 1988).

**2.1.5. Glyceryl polyethylene glycol ricinoleate (GPEGR)**

Glyceryl polyethylene glycol ricinoleate (GPEGR) is a nutritional emulsifier derived from castor oil. It is hydrophilic in nature which dissolves in aqueous phase, outside the body or in small intestine. It naturally biodegrades and is non-toxic. It has superior emulsification properties due to formation of smaller micelles which have large surface area and hence more emulsification. It reduces the viscosity (Arnouts and Lippens, 2006).

It bounds moisture (as moisture is inside the feed particle), it does not evaporate thereby maintains the nutrient value intact without any loss and inhibits the growth of yeast and mold. It is also helpful in uniform mixing of not only fat or oil but also liquid amino acids, molasses, liquid vitamins and liquid acidifiers. Glyceryl polyethylene glycol ricinoleate (GPEGR) is easily absorbed, and functions in part as an emulsifying agent to promote better absorption of fatty materials and other nutrients. It is an excellent emulsifying agent which improves food utilization and enters into the structure of living cells (Sreedevi et al., 2012). It prevents paresis in poultry.

**2.2. Effect of fat addition in diet on broiler performance**

Fat supplementation of diets is recognized as valuable method of meeting the high energy equipment of the rapidly growing broiler chicken. Besides the obvious advantages of being high in caloric density, fat has also been observed to exert an “extra caloric effect”. This effect is apparently due to several factors, the first being a decreased rate of passage and therefore, improved digestion and intestinal absorption. Secondly, there is synergistic enhancement of turreted fatty acid absorption in the presence of the unsaturated fatty acids of the basal diet. The final factor is a lowered heat increment of the supplement diet resulting in improved utilization of the metabolizable energy. Fat may improve the physical characteristic and palatability of the diet to an extent which promotes increased feed consumption. In combination, these effects provide for a very efficient source of energy. Supplemental fats may enhance energy utilization from diets by slowing rate of food passage. A reduction in rate of food passage could results in a more complete digestion and utilization of the diet. Badawy and Neamat (1997) found that the addition of either sunflower or palm oil in the high level significantly improved the feed conversion especially in the second phase of the growing period (from 28 to 42 days). On other hand, the final body weight gain was not affected by the different dietary fat level (Crespo and Esteve, 2001). They added that intake decreased significantly as dietary fat increased, feed efficiency was better in birds fed diets with 10% fat because of the higher ME content.

**2.3. Effect of fat type in diet on broilers performance and carcass characteristics**

Feeding different fat sources were found to affect fatty acid pattern in the abdominal fat (Pinchasov and Nir, 1992 and Scaife et al., 1994) and intramuscular fat of broiler (Sheehy et al., 1993). Moreover, the selection of certain dietary fat sources has a major impact on the melting point of broiler adipose tissues (Hrdinka et al., 1996).

Final body weight and body gain were not affected by the type of oils in the diets (Crespo and Esteve, 2001). They added that feed intake and feed efficiency were affected by the different fats, sunflower and linseed oil showed better feed efficiency in all cases. Also, they found that broiler females fed olive oil had better feed efficiency than those fed tallow.

**2.4. Effect of fat on birds’ age affecting growth performance**

A notable improvement in the absorption of fat from tallow and corn oil as chicks aged from 2 to 15 days. The most marked increase in fat absorption occurred between 7 and 9 days of age. An increase was detected in fatty acid binding protein (FABP) activity in the small intestine of broiler chicks. Also working with chicks, demonstrated an increase in fat utilization with increasing age (Chen and Zhou, 2012).

**2.5. Effect of dietary fat level in carcass composition**

Replacing soy oil with tallow increased the amount of abdominal fat in chickens. Studies with rats have reported less fat accumulation in animals fed safflower oil than in those fed beef tallow (Shimomura et al., 1990). Sunflower acid produced less abdominal fat deposition in broilers than tallow acid oil at different levels of fat inclusion; although the ME of tallow was lower than that of sunflower (Vila and Esteve, 1996). Abdominal fat deposition increased with increasing fat inclusion level in birds fed tallow, whereas it remained constant in birds fed sunflower. Less abdominal fat in broilers fed sunflower oil than in those fed tallow or lard. All these studies suggest that dietary fatty acid profile could affect abdominal fat deposition (Sanz et al., 1999). However, there are still few experiments designed to study this effect on broiler abdominal fat. Abdominal fat pad is well correlated with body fatness in broilers (Whitehead et al., 1990). The fatty acid profile of the different tissue reflected dietary fatty acid profile. Monounsaturated fatty acids were higher in abdominal fat, whereas polyunsaturated fatty acids were higher in muscle fat. These results suggest that polyunsaturated fatty acids produce lower abdominal fat deposition than saturated or monounsaturated fatty acids (Crespo and Esteve, 2001).

**2.6. Nutritional emulsifier and fat digestion**

An emulsifier is a molecule with a water soluble (hydrophilic) part and a fat soluble (lipophilic) part. The combination of these two characteristics in one molecule gives it the unique property that the emulsifier can dissolve as well in fat, as in water, and can aid in mixing the two fractions. An emulsion is usually defined as a system in which one liquid is relatively distributed or dispersed, in the form of droplets, in another substantially immiscible liquid. The emulsion formation is a result of the co-production of water from the oil reservoir. During processing, pressure over ingredients introduces sufficiently high mechanical energy input to disperse water as droplets in the oil phase (Ahmad, 2009).

Emulsifiers can help to increase the formation of emulsion droplets (which lowers the surface tension), stimulate the formation of micelles, increase the concentration of monoglycerides in the intestine, and facilitate the nutrient transport through the membrane, allowing a better nutrient absorption and utilization of energy. Different types of emulsifiers are commercially available. When selecting a commercial emulsifier it is important to note the Hydro- Lipophilic Balance (HLB) (Cox et al., 2002). The HLB demonstrates the fat and water solubility of a product on a range from zero to 20. Lower HLB products are more fat soluble, while higher HLBs are more water soluble. When feeding poultry, a higher number would be desirable because the content of the gut is more watery. Exogenous nutritional emulsifiers can assist in the digestibility. Obviously, the positive effect of adding such emulsifiers is more pronounced for lower digestible fats than for very high digestible fats. The effect will also be more pronounced at higher levels of added fat. Nevertheless, even with high digestible fats, positive effects have been observed (Shaffiq, 2013). When a small amount of water is mixed into a fat-rich environment, a lower HLB is advised (fat soluble). If a small amount of fat is mixed into an aqueous environment, an emulsifier with a higher HLB is advised (water soluble). In the case of a nutritional emulsifier, a limited amount of fat is added to the watery environment of the gut. As birds consume 1.5 to 2 times more water than feed and the feed contains only a small amount of fat, the water amount is much higher than the fat amount in the intestine. In this case a high HLB is more suitable**.** The use of emulsifiers in poultry diets have also increased of lipids absorption, growth performance and feed efficiency and modified the blood lipids. The nutritional emulsifiers improve the natural fat digestion in three ways: by enhancing the formation of emulsion droplets, by stimulating the formation of micelles and by increasing the concentration of monoglycerides in the intestine (Dennis, 2008). By increasing the number of emulsion droplets formed, the size of these droplets will decrease. This will increase the total surface of the emulsion droplets on which the lipase enzymes can act. This process increases the amount of monoglycerides that are formed in the intestine. These monoglycerides also act as emulsifiers that further improve fat digestion. Furthermore, the stimulation of the formation of more and smaller micelles also enhances fat digestion (Dennis, 2008).

**2.7. Mode of action of an emulsifier**

Emulsifier makes polymerizations of styrene which is carried out using two kinds of polyoxyethylene lauryl ether having different hydrophilic−lipophilic balances (HLB): 1. Emulgen 109P (HLB 13.6) and 2. Emulgen 150 (HLB 18.3). In both cases, incorporation of emulsifier inside polystyrene (PS) particles is clearly functioned and observed on emulsion polymerization of styrene and methacrylic acid using polyoxyethylenenonyl phenyl ether (Emulgen 911, HLB 13.7). In general the incorporation phenomenon of nonionic emulsifier inside polymer particles in emulsion polymerization is clarified. In the case of Emulgen 109P, which is more hydrophobic than Emulgen 150, about 30% of the total amount is incorporated inside the PS particles, higher than for Emulgen 150 (15%).

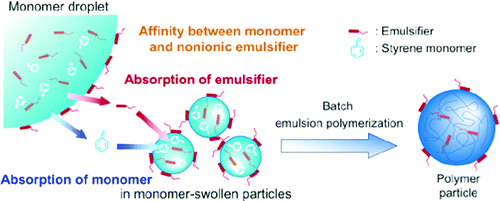


Fig 2.1: Chemical process of emulsification.

The difference seemed to be ascribed to the difference in the affinities between the nonionic emulsifiers and styrene, which cause the incorporation of emulsifier. On the basis of this idea, suppression of the incorporation is achieved by decreasing the polymerization temperature and the monomer-feed rate. This strongly supports the proposed incorporation mechanism (Masayoshi et al., 2006).

**2.8. Importance of emulsifier in high fat diet on broilers**

The absorption of saturated fats partly appears to involve the availability of bile acids. The young chicks are unable to replenish bile salts lost by excretion as readily as older birds. An increase in the absorption of fat from 47% to 69% by the addition of 0.5% of bile to chick diets containing 20% beef tallow. However, other authors reported that supplementation of emulsifier increases digestibility of nutrients, but had less effect on growth performance and carcass traits (Jones et al., 1992). Those responses have been attributed to high degree of saturation and long chain length of fatty acids in animal fats, factors that decrease micelle formation (Melegy et al., 2001) and about 3 and 6 % of a bile salt improved fat absorption of chicks fed unheated soybean meal. The addition of bile salts had no effect on the metabolizable energy values of the fat free diet. However, in the case of the diet rich in saturated fats, they compensated either for insufficient bile secretion or for endogenous bile salts degraded by the intestinal microflora. Thus, the digestive utilization of dietary fat especially that of the saturated fatty acids, palmitic and stearic acids were increased. In addition, metabolizable energy was significantly improved (P<0.01) by the addition of bile salts when the dietary intake level increased to the ad-libitum level. Lecithin is easily absorbed, and functions in part as an emulsifying agent to promote better absorption of fatty materials and other food elements. It is an excellent emulsifying agent which improves food utilization and enters into the structure of living cells. Lecithin contains choline which prevents paresis in poultry. In the form of lecithin, choline is particularly effective. Lecithin has protective action against enzymes of nutritional origin and helps maintain the animal in the state of good health. Lysolecithin forms the liposome that can be filled with useful substrates (Soaresm et al., 2002). Lysolecithin is able to form micelles or liposomes spontaneously, so creating microscopic envelopes that can be filled with useful substrates including nutrients. Normal phospholipids produce micelles but they tend to be large and less well absorbed in the intestine (Soaresm et al., 2002).

**2.8.1. Effect of emulsifier on broiler performance**

The different fat and choline treatments had no marked effect weight gains up to 7 weeks of age, but a significant (P<0.01) improvement in feed efficiency resulted from feeding 8 percent of either fat. Choline (lecithin) additions were effective in improving feed efficiency in the animal fat fed groups, but had no significant effect on those not receiving added fat or those receiving soybean oil. Supplementation of 400 mg·kg-1 emulsifier can increase the growth performance of broiler. Supplementation with emulsifier in diets containing oils could markedly improve the digestibility of dry matter (DM) and apparent metabolic energy (AME) (Nini et al., 2013).

**2.8.2. Effect of emulsifier on carcass composition**

Body weight and ether extract (EE) percentage of breast muscle was increased in treated groups as compared with the control. Relative weight and EE percentage of liver and percentage of abdominal fat were lower in broilers fed lysolecithin (Dan et al., 2013). The slaughter rates, whole net carcass rates, breast muscle percentages and leg muscle rates of low-level concentrated soybean lecithin groups were significantly higher than that of blank control group. The abdominal fat rates of low and mid level concentrated soybean lecithin groups were (1.36±0.13) % and (1.43±0.05) % respectively and they were significantly lower than that of lard group. The liver fat percentage of lard group was (10.50±0.15 % and it was significantly higher than that of blank control group and low and mid level concentrated soybean lecithin groups. Compared with low and mid-level concentrated soybean lecithin groups, the contents of fat and cholesterol in breast muscle were enhanced significantly in lard group (Yun-he, 2013)**.** Supplementation of 200 mg per kg emulsifier can improve breast muscle quality (Yue-ping et al., 2015). For 200 and 400 mg/kg emulsifier groups, the intramuscular fat content of duck breast muscle increased by 6.97% (P<0.05) and 2.05% (P<0.05), intramuscular fat content of leg muscle increased by 22.53% (P<0.05) and 11.46% (P<0.05) respectively. The difference of crude protein content of breast muscle between the two groups was not significant, but that of leg muscle were both higher (P<0.05). The difference of water content between duck breast muscle and leg muscle was not significantly affected by supplemented emulsifier (Yue-ping et al., 2015).

**Chapter-3: Materials and Methods**

**3.1. Study area**

The current experiment was conducted from July to August 2015, at the Experimental Poultry Shed and Laboratory of Department of Animal Science and Nutrition, Chittagong Veterinary and Animal Sciences University (CVASU), Khulshi, Chittagong, Bangladesh.

**3.2. Preparation of poultry shed**

The broiler shed was at first thoroughly swiped and then washed up by using tap water mixed with caustic soda. Brooding boxes and broiler cages were also cleaned up similarly. Then copper sulphate solution was sprayed for 2 days. Formalin solution was also used as disinfectant for two days. After that potassium permanganate solution was used for two days. After cleaning and disinfecting, the house was left for seven days to dry. All windows were kept open for proper ventilation. Finally lime was spread all around the shed for bio-security after one week.

**3.3. Experimental design**

The experiment was conducted for a period of 28 days where starter period was 0-14 days and grower period was 15-28 days. The design of this experiment was CRD (Completely Randomized Design) where total 90 birds were allocated into three treatment groups (30 birds/treatment) having three replicates (10 birds/replication) in each. Chicks were equally and randomly distributed in three dietary treatment groups (T0, T1 and T2) with three replications. The T0 was control group, T1 group was supplemented with 0.06% lysolecithin with a dose of 60g/100 kg of feed and T2 group was supplemented with 0.2% lecithin with a dose of 2g/kg of feed (according to company recommendation). All rations during starter and grower periods in three treatments were iso-caloric and iso-nitrogenous. Layout of the experiment is shown in Table 3.1.

**Table 3.1:** Layout of the experiment showing the distribution of DOC to the treatment group and replication

|  |  |  |  |
| --- | --- | --- | --- |
| **Dietary treatment groups** | **No. of broilers/replication** | | **Total no. of broilers/treatment** |
| T0  (control) | R1 | 10 | 30 |
| R2 | 10 |
| R3 | 10 |
| T1  (0.06%Lysolecithin with a dose of 60g/100kg of feed) | R1 | 10 | 30 |
| R2 | 10 |
| R3 | 10 |
| T2  (0.2% Lecithin with a dose of 2g/kg of feed) | R1 | 10 | 30 |
| R2 | 10 |
| R3 | 10 |
| **Grand total =** | | | **90** |

**3.4. Collection of day old chicks**

A total of 90 day-old unsexed chicks (Cobb 500 strain) were purchased from an agent of Nahar Agro Complex Limited, Jhautala Bazar, Khulshi, Chittagong, Bangladesh on August, 2015. During purchasing all chicks were examined for any kind of abnormalities and ensuring that all chicks were of uniform size.

**3.5. Collection of emulsifiers**

Different types of emulsifiers are available in the market. For this research work commercial emulsifiers such as Leciphos (Manufactured by Berg + Sachmidt, Germany; Marketed By The Acme Laboratories Ltd., Bangladesh) which is based on lecithin and also Eurolipid (Manufactured by Vitafor, Belgium; Marketed by ACI limited, Bangladesh) which is based on lysolecithin, were collected from Hazarigoli medicine market, Chittagong.

**3.6. Feeding standard**

Feeding standard maintained in the study was the Bangladesh standard specification for poultry feed (2nd Revision, BDS 233: 2003; Bangladesh Standards and Testing Institution). The birds were provided with dry mash feed throughout the experimental period. All the rations were iso-caloric and iso-nitrogenous. Feeds were supplied ad-libitum along with fresh clean drinking water for round the clock.

**3.7. Ration formulation**

The birds were fed dry mash feed. Mash feed was prepared manually from raw feed ingredients, which were collected from retail and wholesale market. Two types of ration were used such as broiler starter and broiler grower. Ration was formulated according to the requirement of birds. Starter ration was given from day 0 to 14 days, and grower ration was given from day 15 to 28. All the rations were iso-caloric and iso-nitrogenous. Emulsifiers were supplied from 1st day to 28th day with other feed ingredients. Feed was supplied ad-libitum along with fresh clean drinking water. Feed and drinking water were given three times in a day. The composition of different feed ingredients and nutritive value of starter and grower rations are given in Table 3.2 and Table 3.3.

**Table 3.2:** Feed ingredients used in experimental broiler diets

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Ingredients (kg/100kg)** | **Starter ration(0-14 days)** | | | **Grower ration(15-28 days)** | | |
| **T0** | **T1** | **T2** | **T0** | **T1** | **T2** |
| Maize | 53.5 | 53.44 | 53.3 | 55 | 54.94 | 54.80 |
| Molasses | 0.85 | 0.85 | 0.85 | 0.635 | 0.635 | 0.635 |
| Soya meal | 35 | 35 | 35 | 33.75 | 33.75 | 33.75 |
| Protein con | 1.5 | 1.5 | 1.5 | 0.8 | 0.8 | 0.8 |
| Rice polish | 3.7 | 3.7 | 3.7 | 3.5 | 3.5 | 3.5 |
| Salt | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Methionine | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 |
| Lysine | 0.1 | 0.1 | 0.1 | 0.233 | 0.233 | 0.233 |
| Vit-min Premix | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Feed Enzyme | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Soya oil | 2.5 | 2.5 | 2.5 | 3.5 | 3.5 | 3.5 |
| Lime stone | 1.103 | 1.103 | 1.103 | 1.35 | 1.35 | 1.35 |
| Maduramycin | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 |
| Antioxidant | 0.012 | 0.012 | 0.012 | 0.012 | 0.012 | 0.012 |
| D.C.P | 0.95 | 0.95 | 0.95 | 0.535 | 0.535 | 0.535 |
| **Lysolecithin** | **0.00** | **0.06** | **0.00** | **0.00** | **0.06** | **0.00** |
| **Lecithin** | **0.00** | **0.00** | **0.2** | **0.00** | **0.00** | **0.2** |
| **Total** | **100** | **100** | **100** | **100** | **100** | **100** |

**N.B:** T0 = control, T1 = 0.06%Lysolecithin with a dose of 60g/100kg of feed, T2= 0.2% Lecithin with a dose of 2g/kg of feed. Vitamin Mineral Premix provided following per kg diet: Vit. A 5000 IU, D3 1000 IU, K 1.6 mg, B1 1 mg, B2 2mg, B3 16 mg, B6 1.6 mg, B9 320 µg, B12 4.8 µg, H 40 mg, Cu 4 mg, Mn 40 mg, Zn 20 mg, Fe 2.4 mg, I 160 µg.

**Table 3.3:** Estimated chemical composition (DM basis) of the experimental broiler diets

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameters** | **Starter ration (0-14 days)** | | | **Grower ration (15-28 days)** | | |
| **T0** | **T1** | **T2** | **T0** | **T1** | **T2** |
| ME (Kcal/kg) | 2939.40 | 2937.40 | 2933.00 | 3014.69 | 3012.70 | 3008.07 |
| CP (%) | 22.04 | 22.03 | 22.01 | 21.16 | 21.16 | 21.14 |
| CF (%) | 3.51 | 3.50 | 3.50 | 3.44 | 3.44 | 3.44 |
| EE (%) | 3.08 | 3.08 | 3.08 | 3.1 | 3.1 | 3.1 |
| Ca (%) | 0.95 | 0.72 | 0.90 | 0.87 | 0.86 | 0.82 |
| P (%) | 0.62 | 0.50 | 0.62 | 0.52 | 0.52 | 0.52 |
| Lysine (%) | 1.20 | 1.20 | 1.20 | 1.24 | 1.24 | 1.24 |
| Methionine (%) | 0.90 | 0.89 | 0.89 | 0.77 | 0.77 | 0.76 |

**N.B:** T0= control, T1= 0.06% Lysolecithin with a dose of 60g/100kg of feed, T2= 0.2% Lecithin with a dose of 2g/kg of feed. ME-Metabolizable energy, CP-Crude protein, CF-Crude fibre, EE-Ether extract, Ca-Calcium, P-Phosphorus.

The rations were made manually through proper mixing ensuring that all kind of ingredients were mixed evenly. Before mixing, individual ingredients were weighed by an eclectic balance. After mixing, formulated feed was packed in air tight plastic bags.

**3.8. Management procedure**

The management procedures of rearing broilers which were uniform among treatment groups of the study are stated below:

**3.8.1. Brooding of the chicks**

After proper cleaning and drying, the brooding boxes were ready for DOCs rearing under strict hygienic conditions. Dry and clean newspaper was also placed in the brooding box. Newspapers were changed for four times in a day from the floor of the brooding box. It was continued for seven days. During the brooding period chicks were brooded at a temperature of 90-95°F during 1st week and 90-85°F during 2nd week respectively with the help of electric bulbs. Each box brooder having 2.38 ft. X 2.08 ft. was allocated for 30 birds and floor space for each bird in the brooding box was 0.17 sq. ft.

**3.8.2. Maintenance of room temperature and lighting**

Basis on requirement temperature was increased and decreased in the brooding box as well as the whole house. The key concern was the comfort of broiler birds. Electric bulbs and fans were used to maintaining the temperature. The birds were exposed to a continuous lighting of 24 hours of photoperiod. Temperature was maintained according to Table 3.4.

**Table 3.4:** Temperature schedule maintained in the house

|  |  |
| --- | --- |
| **Days** | **Temperature °F** |
| 0-7 | 95 |
| 8-14 | 90 |
| 15-21 | 85 |
| 22-28 | 80 |

**3.8.3. Floor space, feeder and drinker spaces**

After brooding period, broiler birds were transferred to cage having 3.5 ft. X 1.63 ft. for 10 birds. The floor space for each bird in the cage was 0.57 sq. ft.

In the early stage of brooding feed and water were given to birds on paper and small drinker. Feeding and watering were performed by using one small round plastic feeder and one round drinker with a capacity of 1.5 liter in each brooding box. The feeders and drinker were fixed in such a way so that the birds could eat and drink conveniently. After 5th day small round feeder was replaced by small liner feeder (2.21 ft. X 0.25 ft.) in each brooding box. During the period of cage rearing large liner feeder (3.5 ft. X 0.38 ft.) and large round drinker with a capacity of three liters was used for feeding and drinking.

**3.8.4. Litter management**

Fresh and dried rice husk was used as litter material at a depth of 3-4 inch during the brooding period. After the ends of brooding period birds were replaced in the cage for rearing until the end of experiment. Each and every day feces materials were cleaned and disinfected hygienically.

**3.8.5. Vaccination and chemo prophylaxis or medication**

All birds were vaccinated (eye drop) properly against Newcastle disease on the 4th day and booster dose again on 14th day. Against Infectious Bursal Disease, the broilers were vaccinated (eye drop) on the 14th day of rearing. After each vaccination, Rena -WS multivitamin was supplied at 1g/5 liter of drinking water along with vitamin-C to overcome the stressed effect of vaccination and cold weather. Chemo prophylactic measures/medication with water soluble vitamins, minerals and electrolyte were used at different ages of birds. Rena-WS, Electrolyte and Gluco-C were administered in water for first seven days of rearing and then repeated from 10th day to 17th day of rearing. From the 18th day of age to 28th day of age of birds, Rena-WS was administered through water along with Electrolyte, guar and lemon.

**3.8.7. Bio-security**

Drinkers were washed with caustic soda and dried up daily in the morning, and feeders were also cleaned and washed with caustic soda every 3 days after. Potassium permanganate was used for washing the floor & nearer places of the shed. Lime powder and bleaching powder was also used for strict bio-security measures those were followed during the whole experimental period.

**3.9. Record keeping**

In order to maintain record, parameters like body weight, feed intake and mortality of broilers were kept into consideration during the experimental period. Body weight of the chicks was recorded at first day and then regular basis at the weekly intervals by a digital weighing balance for whole experimental period. Weekly feed intake was recorded by deducting the left over feeds from the total amount of supplied feed to the broilers. Mortality was recorded throughout the experimental period when death occurred in any replication.

**3.10. Calculation of data**

**3.10.1. Body weight gain**

By deducting initial body weight from the final body weight of the birds, the body weight gain was calculated weekly. It was represented as gm/bird.

Body weight gain = Final body weight – Initial body weight

**3.10.2. Feed consumption**

Weekly, quantity of offered feed was measured. Refusal feed was recorded to determine the feed intake per week. Feed intake was expressed as gm/bird.

Feed consumption = Offered feed – Refused feed

**3.10.3. Feed conversion (FC)**

Feed conversion is the amount of feed intake per unit of weight gain of birds. This was calculated by using following formula.

FC = Feed intake (kg) ÷ Weight gain (kg)

**3.10.4. Mortality**

It was calculated on the basis of total number of birds housed and number of birds died during the experimental period. The mortality was represented in percent.

% Mortality = (No of dead birds / No of live birds) × 100

**3.10.5. Carcass characteristics examination**

On 28 days old, 5 birds per treatment were sacrificed by bleeding of the jugular vein after 4 hours of feed fasting (water was offered ad libitum). Eviscerated body, dressing percentage (%), drumstick, thigh and breast muscle, back and neck region, shanks and wings, abdominal and neck regional fat as well as viscera such as liver, heart were collected, weighted and calculated. Except dressing percentage (%), rest of the data was expressed as gram per kilogram of live body weight.

**3.10.6. Cost-benefit analysis**

In terms of cost analysis; chick cost, total feed cost, management cost and finally total cost were calculated in Taka per bird. Total feed cost included to feed raw materials cost. Management cost included vaccination cost, labor cost, electricity cost, disinfectant cost and litter materials cost. In case of return, market sale price, total sale price and net profit were calculated in Taka per bird.

**3.11. Study design & statistical analysis**

Completely randomized design (C.R.D) was used as study design. All the data like live weight and its gain, feed consumption, feed conversion and data related to carcass quality analysis of broilers were entered into MS excel (Microsoft office excel-20007, USA). Data were compared among the groups by one way ANOVA in STATA version-12.1 (STATA Corporation, College Station, Texas). Results were expressed as means and SEM. P values of ≤0.05 and ≤0.01 were considered as significant and highly significant, respectively.

**Picture gallery**

**Figure 3.12.1. Day old chicks Figure 3.12.2. Box brooding of chick**

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**Figure 3.12.3. Nursing in brooding period Figure 3.12.4. Vaccination of broiler**

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**Figure 3.12.5. Weighing of feed ingredient**

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**Figure 3.12.6. Weighing of live bird**

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**Figure 3.12.7. Carcass quality examination**

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**Figure 3.12.8. Different primal parts (from left-Drumstick, thigh, back, breast, wing, neck and feet) of a dressed broiler**

**Chapter-4: Results**

Different parameters were recorded to observe the effect of emulsifiers on the performance and carcass characteristics of broilers. The parameters were feed consumption, live weight, live weight gain and feed conversion (FC) of broilers at different ages. Cost benefit analysis was also calculated in this experiment. At the end of the experiment carcass characteristics were also recorded.

**4.1. Effect of emulsifiers on weekly feed consumption of broilers**

**Table 4.1.1:** Weekly feed consumption of broilers among different dietary treatment groups (gm/broiler)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Age of birds** | **Diets** | | | **SEM** | **P value** | **Level of sig.** |
| **T0**  **(Control)** | **T1**  **(Lysolecithin)** | **T2**  **(Lecithin)** |
| **Mean** | **Mean** | **Mean** |
| 1st week | 187.09 | 237.39 | 240.00 | 6.30 | 0.00 | \*\* |
| 2nd week | 306.27 | 324.43 | 353.80 | 8.34 | 0.00 | \*\* |
| 3rd week | 797.35 | 780.78 | 772.80 | 6.81 | 0.24 | NS |
| 4th week | 1030.89 | 1035.10 | 1054.40 | 4.72 | 0.00 | \*\* |

SEM = Standard error of mean, NS = Non significant at 5% level, \*\* = Significant at 1% level

Result of supplementation of commercial emulsifier based energy diet on weekly feed consumption of broiler is shown on table 4.1.1. According to the tabular value, highly significant (P<0.01) differences were observed in feed consumption among the treatment groups at 1st and 2nd weeks with increased amount of feed intake in lecithin group (T2). Lower feed intake was found in both lysolecithin supplemented diet group (T1) and control group (T0) where control group (T0) showed lowest amount of feed consumption. However, the feed intake was closely similar in different groups and the difference was not significant (P>0.05) at 3rd weeks age of broilers. At 4th weeks of age feed consumption was significantly higher (P<0.01) in T1 group in comparison with other two groups.

**Table 4.1.2:** Cumulative feed consumption (gm/broiler) of broiler in different treatment groups

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Age**  **(Week)** |  | **Mean** |  | **SEM** | **P value** | **Level of sig.** |
| **T0**  **(Control)** | **T1**  **(Lysolecithin)** | **T2**  **(Lecithin)** |
| 1-2 | 493.36 | 561.82 | 593.80 | 7.67 | 0.00 | \*\* |
| 1-3 | 1290.71 | 1342.60 | 1366.60 | 7.34 | 0.01 | \*\* |
| 1-4 | 2321.60 | 2377.70 | 2421.00 | 5.54 | 0.00 | \*\* |

SEM = Standard error of mean, \*\* = Significant at 1% level

Cumulative feed consumption of broilers on different treatment groups are given in table 4.1.2. There was highly significant (P<0.01) differences among the treatment groups at whole period of the trial. Cumulative feed consumption of broilers at 2nd, 3rd and 4th weeks of age was higher in T1 and T2 groups. T0 group showed lowest feed consumption among the groups (table 4.1.2).

**4.2. Effect of emulsifiers on live body weight of broilers**

**Table 4.2.1: Weekly live body weight (gm/broiler) of broiler in different treatment groups**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Age of birds** | **Diets** | | | **SEM** | **P value** | **Level of Sig.** |
| **T0**  **(Control)** | **T1**  **(Lysolecithin)** | **T2**  **(Lecithin)** |
| **Mean** | **Mean** | **Mean** |
| Day 1 | 37.12 | 38.49 | 37.06 | 1.19 | 0.29 | NS |
| 1st week | 188.00 | 231.50 | 240.00 | 4.85 | 0.00 | \*\* |
| 2nd week | 413.20 | 483.00 | 530.00 | 7.13 | 0.00 | \*\* |
| 3rd week | 885.01 | 945.00 | 1010.00 | 18.35 | 0.00 | \*\* |
| 4th week | 1488.80 | 1573.00 | 1651.00 | 20.05 | 0.01 | \* |

SEM = Standard error of mean, NS = Non significant at 5% level, \* = Significant at 5% level, \*\* = Significant at 1% level

The body weight of broiler birds on energy base diet, containing commercial emulsifier at different age are presented in table 4.2.1. There was no significant (P>0.05) difference in body weight of broilers among the experimental treatment groups in 1st day which means homogenous birds were used in different groups. However, highly significant differences (P<0.01) were evident from 2nd to 3rd weeks of age. At 4th weeks of age, the difference in body weight of birds was also significant (P<0.05) statistically. Along the whole experimental period, increased body weight was observed in lysolecithin (T1) and lecithin (T2) supplemented groups in comparison with the control group (T0). The highest body weight was observed on lecithin supplemented group (T2) and the lowest body weight was observed on the control group (T0). Body weight in lysolecithin supplemented group (T1) showed better result than that of control group. But it was noted that among the supplemented groups, birds of T2 gave consistently higher body weight.

**Table 4.2.2:** Cumulative body weight (gm/broiler) of broiler in different treatment groups

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Age (Week)** |  | **Mean** |  | **SEM** | **P value** | **Level of**  **sig.** |
| **T0**  **(Control)** | **T1**  **(Lysolecithin)** | **T2**  **(Lecithin)** |
| 1-2 | 601.20 | 714.50 | 770.00 | 5.05 | 0.25 | NS |
| 1-3 | 1286.21 | 1659.50 | 1780.00 | 17.90 | 0.00 | \*\* |
| 1-4 | 2775.01 | 3232.50 | 3431.00 | 18.46 | 0.04 | \* |

SEM = Standard error of mean, NS = Non significant at 5% level, \* = Significant at 5% level, \*\* = Significant at 1% level

The cumulative body weight of broilers on energy based diets containing commercial emulsifiers at different ages are presented in table 4.2.2. Among the whole treatment groups no significant (P>0.05) difference was observed in 2nd week. However, emulsifier supplemented diet groups (i.e. T1 and T2) showed improved cumulative body weight than control group (T0). The highest cumulative body weight was observed in T2 group and lowest in control group (T0). At 3rd weeks of age, differences in cumulative body weight were highly significant (P<0.01) among the treatment groups and at 4th weeks of age, it was significantly increased (P<0.05) in T1 and T2 groups compared to T0 group.

**4.3. Effect of emulsifiers on body weight gain of broilers**

**Table 4.3.1:** Weekly body weight gain (gm/broiler) of broiler in different treatment groups

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Age of birds** | **Diets** | | | **SEM** | **P value** | **Level of Sig.** |
| **T0**  **(Control)** | **T1**  **(Lysolecithin)** | **T2**  **(Lecithin)** |
| **Mean** | **Mean** | **Mean** |  |  |  |
| 1st week | 150.88 | 193.00 | 203.00 | 5.03 | 0.00 | \*\* |
| 2nd week | 225.20 | 251.50 | 290.00 | 4.98 | 0.00 | \*\* |
| 3rd week | 471.81 | 462.00 | 480.00 | 6.45 | 0.00 | \*\* |
| 4th week | 603.79 | 628.00 | 641.00 | 13.27 | 0.00 | \*\* |

SEM = Standard error of mean, \*\* = Significant at 1% level.

The responses of commercial emulsifiers on weekly body weight gain of broilers are presented in table 4.3.1. Tabular results showed highly significant (P<0.01) differences among the treatment groups at 1st, 2nd, 3rd and 4th weeks of age of birds. The supplementation of lysolecithin and lecithin emulsifier diet in groups, T1 and T2 showed increased weekly body weight gain of broiler than control group (T0). The highest body weight gain was observed on the emulsifier supplemented group (T2) and the lowest body weight was observed on the control group (T0).

**Table 4.3.2:** Cumulative body weight gain (gm/broiler) of broiler in different treatment groups

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Age (Weeks)** |  | **Mean** |  | **SEM** | **P value** | **Level of sig.** |
| **T0**  **(Control)** | **T1**  **(Lysolecithin)** | **T2**  **(Lecithin)** |
| 1-2 | 376.08 | 444.50 | 493.00 | 6.23 | 0.01 | \*\* |
| 1-3 | 847.89 | 906.50 | 973.00 | 6.98 | 0.00 | \*\* |
| 1-4 | 1451.68 | 1534.50 | 1614.00 | 10.23 | 0.00 | \*\* |

SEM = Standard error of mean, \*\* = Significant at 1% level.

The cumulative body weight gain of broilers on energy based diets containing commercial emulsifiers at different ages are presented in table 4.3.2. Among the whole treatment groups, highly significant (P<0.01) differences were observed in 2nd, 3rd and 4th weeks. Emulsifier containing supplemented diet groups (T1 and T2) showed improved cumulative body weight gain than control group (T0). But along the whole period of experiment, increased cumulative body weight gain was observed in T2 group compared to other groups.

**4.4. Effect of emulsifiers on feed conversion (FC) of broilers**

**Table 4.4.1:** Weekly feed conversion of broilers among different dietary treatment groups (gm/broiler)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Age of birds** | **Diets** | | | **SEM** | **P value** | **Level of sig.** |
| **T0**  **(Control)** | **T1**  **(Lysolecithin)** | **T2**  **(Lecithin)** |
| **Mean** | **Mean** | **Mean** |
| 1st week | 1.24 | 1.23 | 1.18 | 0.03 | 0.15 | NS |
| 2nd week | 1.36 | 1.29 | 1.22 | 0.02 | 0.00 | \*\* |
| 3rd week | 1.69 | 1.69 | 1.61 | 0.03 | 0.00 | \*\* |
| 4th week | 1.71 | 1.65 | 1.64 | 0.02 | 0.00 | \*\* |

SEM = Standard error of mean, NS = Non significant at 1% level, \*\* = Significant at 1% level.

The feed conversion (FC) of broilers during different weeks of age under different dietary groups on energy base diet is given in table 4.4.1. There was no significant (P>0.05) difference observed among the whole treatment groups at 1st week of age though highly significant (P<0.01) difference was observed among these groups at 2nd, 3rd and 4th weeks of age. FC was significantly lower in T2 group compared to other groups. Along the whole period highest FC was seen in control group (T0) and lowest in T2 group. In 2nd week, decreased FC was observed in T2 group in comparison with other groups. But in 3rd weeks, FC was similar in T1 group and control group (T0). Improved FC was seen in T2 group and T1 group showed slightly improved FC than control group.

**Table 4.4.2:** Cumulative feed conversion (CFC) of broiler in different treatment groups (T0, T1 and T2)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Age (Weeks)** |  | **Mean** |  | **SEM** | **P value** | **Level of sig.** |
| **T0**  **(Control)** | **T1**  **(Lysolecithin)** | **T2**  **(Lecithin)** |
| 1-2 | 1.31 | 1.26 | 1.20 | 0.10 | 0.15 | NS |
| 1-3 | 1.52 | 1.48 | 1.41 | 0.07 | 0.00 | \*\* |
| 1-4 | 1.60 | 1.55 | 1.50 | 0.06 | 0.00 | \*\* |

SEM = Standard error of mean, NS= Non Significant, \*\*= Significant at 1% level

Table 4.4.2 represents the cumulative feed conversion (CFC) of broilers on different treatment groups. It can be noted that along the whole experimental period CFC was highly significant (P<0.01) at 3rd and 4th weeks of age among different treatment groups. Improved CFC was found in T1 & T2 groups comparing to the control group (T0). Among the treatment groups, T2 showed better results than T1 and control group.

**4.5. Effect of commercial emulsifiers on carcass characteristics of broilers**

The following tables (4.5.1 and 4.5.2) represent the effect of commercial emulsifiers on carcass characteristics of broilers.

**Table 4.5.1:** Initial body weight of broiler before slaughtering, eviscerated weight and dressing percentage of broiler among different dietary treatment groups at 28th day of age

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Traits** | **Mean** | | | **SEM** | **P value** | **Level of sig.** |
| **T0**  **(Control)** | **T1**  **(Lysolecithin)** | **T2**  **(Lecithin)** |
| **Initial body weight (gm)** | 1451.00 | 1643.00 | 1660.00 | 22.15 | 0.10 | NS |
| **Eviscerated weight (gm)** | 843.40 | 1027.20 | 1054.60 | 25.77 | 0.01 | \* |
| **Dressing %** | 58.18 | 62.52 | 63.60 | 1.34 | 0.00 | \*\* |

SEM = Standard error of mean, NS = Non significant at 5% level, \* = Significant at 5% level, \*\* = Significant at 1% level

From the table 4.5.1, it was found that T1 and T2 group were higher in initial body weight of broiler than control group (T0) before slaughtering. The difference in initial body weight among three groups was non-significant (P>0.05). T2 group was higher in initial weight than T1 group and control group (T0) gained less initial weight than others two groups.

Eviscerated body weight of broilers was different among three treatment groups. T1 and T2 groups were higher in eviscerated weight after slaughtering than control group (T0). The difference of eviscerated weight among three groups were significant (P<0.05). T2 group was higher in eviscerated body weight than T1 group. Control group (T0) showed lower eviscerated weight than others two groups (table 4.5.1).

Dressing percentage (%) of slaughtered broilers among three treatment groups were slightly variable (table 4.5.1) and the difference of dressing percentage (%) among three groups were highly significant (P<0.01). T1 and T2 groups were higher in dressing percentage (%) than control group (T0). Dressing percentage (%) in T2 group was higher than T1 group.

**Table 4.5.2:** Weight of primal parts and internal edible offal of broiler among different dietary treatment groups at 28th day of age

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Traits** | **Mean (gm)** | | | | **SEM** | **P value** | **Level of sig.** |
| **T0**  **(Control)** | **T1**  **(Lysolecithin)** | **T2**  **(Lecithin)** | |
| **Primal Parts** | | | | | | | |
| **Drumstick** | 53.80 | 66.20 | 68.80 | | 4.49 | 0.01 | \* |
| **Thigh** | 77.80 | 76.80 | 83.60 | | 13.40 | 0.83 | NS |
| **Breast** | 311.60 | 361.80 | 362.00 | | 20.74 | 0.20 | NS |
| **Back** | 145.00 | 187.60 | 194.20 | | 12.39 | 0.00 | \*\* |
| **Neck** | 31.80 | 38.40 | 34.40 | | 3.32 | 0.11 | NS |
| **Wing** | 32.80 | 46.20 | 45.00 | | 4.00 | 0.00 | \*\* |
| **Feet** | 58.40 | 71.60 | 71.40 | | 5.11 | 0.02 | \* |
| **Internal Edible Offal** | | | | | | | |
| **Liver** | 34.60 | 42.00 | | 42.20 | 4.29 | 0.12 | NS |
| **Heart** | 7.40 | 8.60 | | 8.80 | 0.80 | 0.11 | NS |
| **Abdominal Fat** | 28.80 | 27.00 | | 22.00 | 8.20 | 0.06 | NS |
| **Neck Fat** | 6.40 | 5.20 | | 5.10 | 1.94 | 0.85 | NS |

SEM = Standard error of mean, NS = Non significant at 5% level, \* = Significant at 5% level, \*\* = Significant at 1% level

From the table 4.5.2, it was observed that the weights of drumstick of dressed broilers were significantly different (P<0.05). T1 and T2 groups were higher in weight of drumstick than control group (T0). T2 group revealed higher weight than T1 group.

Weights of thigh, breast and neck of dressed broilers were found non-significant (P>0.05) among three treatment groups that is presented at table 4.5.2 where T2 group was numerically higher in weight of thigh and breast than those of other two groups and in case of weight of neck, T1 group was numerically higher than those of other two groups.

In case of the weights of wing and back of dressed broilers, there were highly significant (P<0.01) difference among three treatment groups (Table 4.5.2). Mean weight of back region in T2 group was higher than that of T1 and T0 groups. On the other hand, T2 group showed lower weight than T1 group, but higher weight than control group (T0) in case of weight of wing.

Table 4.5.2 also indicates different weights of feet of dressed broilers among three treatment groups. T1 and T2 groups were higher in weight of feet than T0 group. The difference in weight of wing among three groups were significant (P<0.05). Weight of T2 group was slightly lower than T1 group, but higher than control group.

The difference of weight of liver, heart, abdominal fat and neck fat of dressed broilers were non-significant (P>0.05) among three treatment groups (Table 4.5.2). In weights of liver and heart, T2 group were numerically higher than T1 group and control group (T0). However, T2 group showed lowest fat deposition at abdomen and neck region than those of T1 and T0 groups but it was statistically non significant.

**4.6. Effect of commercial emulsifiers on cost benefit analysis of broiler**

**Table 4.6.1:** Cost of production and returns of broilers in different treatment groups

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Cost items** | | | | | |
| **Parameter** | **T0**  **(Control)** | **T1**  **(Lysolecithin)** | **T2**  **(Lecithin)** | **SEM** | **Level of sig.** |
| **Mean** | **Mean** | **Mean** |
| Chick cost (Tk./chick) | 40.00 | 40.00 | 40.00 | **-** | **NS** |
| Emulsifier cost (Tk./kg) | **-** | 2000.00 | 1200.00 | **-** | **-** |
| Total feed cost (Tk./kg) | 37.35 | 38.15 | 38.77 | 0.32 | **NS** |
| Management cost (Tk./broiler) | 13.00 | 13.00 | 13.00 | **-** | **NS** |
| Total feed cost (Tk./broiler) | 80.88 | 82.33 | 83.40 | 0.03 | \* |
| Total cost (Tk./broiler) | 135.88 | 137.33 | 138.40 | 0.03 | \* |
| Total cost  (Tk./kg live broiler) | 123.41 | 120.74 | 120.32 | 0.15 | \* |
| **Income** | | | | | |
| Market sale price (Tk./kg broiler) | 130.00 | 130.00 | 130.00 | **-** | **NS** |
| Total sale price (Tk./broiler) | 158.47 | 162.51 | 168.84 | 0.25 | \* |
| Net Profit (Tk./broiler) | 22.59 | 25.17 | 30.43 | 0.24 | \* |
| Net Profit  (Tk./kg live broiler) | 6.59 | 9.26 | 9.68 | 0.15 | \* |

**N.B.** SEM = Standard error of mean, NS = Non significant at 5% level, \* = Significant at 5% level. Total feed cost included to feed raw materials cost and growth promoter cost; Management cost included vaccination cost, labour cost, electricity cost, disinfectant cost and litter material’s cost.1 US $=78 Taka (approx.)

The table 4.6.1 shows the cost-benefit analysis between three different treatment groups. Significant (P<0.05) differences were observed in total feed cost, total cost, total sale price and net profit among the dietary treatment groups. The total feed cost (Tk./broiler) was higher in lecithin supplemented diet group than that of other groups. On the other hand, the total cost (Tk./kg live broiler) was lowest in lecithin supplemented diet group. From the economic perspective, the lecithin supplemented diet group (T2) earned more profit (P<0.05) than that of other two dietary groups (T1, T0).

**Chapter- 5: Discussion**

**5.1. Effect of emulsifiers on weekly feed consumption of broilers**

The feed consumption among the treatment groups at 1st and 2nd weeks was higher supplemented with lecithin group (T2) and lower feed intake was found in both lysolecithin supplemented diet group (T1) and control group (T0). In 3rd week, the feed intake was closely similar in different groups and difference was not significant (P>0.05). Although in previous weeks (1st to 2nd week), control group (T0) showed less amount of feed consumption other than two experimental diet groups. Difference in feed consumption was highly significant (P<0.01) in different treatment groups. Cumulative feed consumption of broilers at 2nd, 3rd and 4th weeks of age was higher in T1 and T2 groups, but T0 group showed lowest feed consumption among the groups. The result of feed intake was similar with the result of lecithin supplemented diet group (Yun-he, 2013) and also for lysolecithin supplemented diet group (Xing et al., 2004; Raju et al., 2011).They all reported that lecithin and lysolecithin has positive effect on feed intake in broilers. However, inconsistent result was observed by Aguilar et al., (2013). They reported that supplementation of lysolecithin in broilers diet did not affect the feed intake. They conducted the study on male Ross 308 broilers. The possible reason for inconsistency was sex and strain variation (Ferket et al., 2006).

**5.2. Effect of emulsifiers on body weight of broilers**

Along the whole experimental period, increased body weight was observed in both lysolecithin (T1) and lecithin (T2) supplemented groups in comparison with the control group (T0). The highest body weight was observed in lecithin supplemented group (T2) and the lowest body weight was observed on the control group (T0). Body weight in lysolecithin supplemented group (T1) showed better result than that of control group. But T2 gave consistently higher body weight than T1 and T0 groups. Emulsifier supplemented diet groups (T1 and T2) showed improved cumulative body weight than control group (T0). The highest cumulative body weight was observed in T2 group and lowest in control group (T0). The results of body weight in broilers supplemented diet with lecithin were agreeable with the findings of Sreedevi et al., (2012). Aguilar et al., (2013) reported that lecithin increases the body weight of broilers in comparison with control group (T0) which are not treated with any emulsifier. Increased body weight was also observed in lysolecithin supplemented diet group T1 compared to control group. The results were also in agreements with the results of some researchers (Dan at el., 2013; Liu et al., 2012). But research investigating the effect on body weight of broilers was inconsistent with Nini et al., (2013). The primary reason for inconsistency was attributable to the fat sources. They used animal fats, were less digestible than vegetable oils (Azman and Ciftci, 2004).

Although both lecithin (T2) and lysolecithin (T1) supplemented diet group showed improved body weight than control group (T0), this study found better result in lecithin supplemented boilers diet than lysolecithin supplemented broilers.

**5.3. Effect of emulsifiers on body weight gain of broilers**

The supplementation of lysolecithin and lecithin emulsifier diet in groups T1 and T2 showed increased weekly body weight gain of broiler than control group (T0). The highest body weight gain was observed on the emulsifier supplemented group (T2) and the lowest body weight gain was observed on the control group (T0). Improved cumulative body weight gain was found in T1 and T2 groups than that of control group. But along the whole period of experiment, increased body weight gain was observed in T2 group compared to T1 and control group (T0).

In accordance with the performed study, these results were agreed with earlier studies for lysolecithin emulsifier by some researchers (Raju et al., 2011; Aguilar et al., 2013). Concordant result was also observed for lecithin emulsifier by previous researchers (Huang et al., 2007; Yun-he, 2013). They all reported that lecithin and lysolecithin increases the body weight of broilers than the control group. But the results of BWG in lysolecithin were inconsistent with the findings of Jones et al., (1992). They reported that addition of lysolecithin increased digestibility of nutrients but had minimal effect on growth performance at market age. There were no significant interactions between fat sources and the addition of lysolecithin which indicated that lysolecithin supplementation could improve body weight gain of broiler chickens in the starter period (Zhang et al., 2011). The possible causes of inconsistency may be due to species variation. The study shows improved body weight gain in both lecithin and lysolecithin supplemented diet group comparing with the control group. But it can be noted that lecithin showed more effective results than lysolecithin supplemented diets.

**5.4. Effect of emulsifiers on feed conversion (FC) of broilers**

In this study, improved FC was found in both lecithin (T2) & lysolecithin (T1) supplemented diet groups than the control group (T0). Improved cumulative FC was found in T1 & T2 groups comparing to the control group (T0). The result of improved FC for lecithin supplemented diet group was in agreement with the findings of (Kim et al., 2008; Huang et al., 2007). However, concordant result of improved FC for lysolecithin supplemented diet group was observed by various researchers (Raju et al., 2011; Zhang et al., 2011, Jansen et al., 2015; Aguilar et al., 2013).Although lecithin and lysolecithin supplemented diet groups showed better result than control group, FC was more effective in lecithin supplemented group than lysolecithin supplemented diet group.

**5.5. Effect of commercial emulsifiers on carcass characteristics of broilers**

**5.5.1. Initial body weight before slaughter and eviscerated body weight of broilers**

Initial body weight before slaughtering as well as eviscerated body weight in T1 and T2 groups were higher than control group (T0). The difference of initial body weight among three groups was non-significant (P>0.05). T2 group was with higher initial weight than T1 group and control group (T0) was less in initial weight than other two groups. In the present study, the result of improved body weight and for lecithin supplemented diet group was in agreement with the findings of (Yun-he, 2013).

**5.5.2. Dressing percentage (%) of slaughtered broilers**

Dressing percentage (%) of slaughtered broilers in T1 and T2 groups were higher than that of control group (T0). Dressing percentage (%) in T2 group was higher than T1 group and control group showed lowest percentage than others two groups.In the present study, the results showed similarity with some authors, such as lecithin improved the growth performance as well as dressing percentage (%) of broilers (Kim et al., 2008). It was recorded that the low and mid-level addition of concentrated soybean lecithin could enhance the slaughter rate and carcass quality of broilers (Yun-he, 2013).

**5.5.3. Weight of drumstick, thigh and breast muscle of dressed broilers**

In comparison with control group, the weight of broiler drumstick (gm) was significantly higher (P<0.05) in lecithin and lysolecithin supplemented treatment groups in this study. Weights of thigh (gm) and breast muscle (gm) were not significantly (P>0.05) affected by diets with supplemented emulsifiers. Previous study revealed that the difference of weight of breast muscle and thigh muscle among the three groups were not significant, but in case of drumstick, it was significant (Chen and Zhou, 2012). Drumstick, thigh muscle and breast muscle were higher in weight than control group with emulsifier containing diet in some studies of previous researches (Yue-ping et al., 2015; Dan et al., 2013). It was also observed that different emulsifiers in different treatments also did not influence on the carcass, drumstick, thigh and breast muscle (Aguilar et al., 2013).

**5.5.4. Weight of back region and neck region**

The weights of back region of dressed broilers in T1 and T2 groups were higher in weight than control group (T0). The difference in weight of back region among three groups was highly significant (P<0.01). Control group (T0) gained lowest weight than other two groups. While studying weights of neck region, it was observed that T1 and T2 groups were numerically higher in weight than T0 group but the difference in weight of neck region among three groups were found non-significant (P>0.05). In the present study, weight of back and neck region were higher than control group with lysolecithin supplementation diets (Dan et al., 2013). Lecithin supplementation diets showed higher return than lysolecithin and control group. In previous studies, the weight of back and neck region were significantly higher than that of control group (T0) (Yun-he, 2013). But Aguilar et al., (2013) reported that the treatments with emulsifiers did not influence on the carcass quality such as back and neck region muscle.

**5.5.5. Weight of abdominal fat and neck regional fat**

In the performed study, abdominal fat and neck regional fat were observed carefully and found that fat deposition was numerically higher in control group than that of lecithin and lysolecithin supplemented dietary groups but the result was not proved statistically significant (P>0.05). The findings of this study were supported by the findings of Chen and Zhou (2012); Aguilar et al., (2013) and Dan et al., (2013). Dan et al., (2013) said that dietary lysolecithin has anti-fatty liver and carcass fat repartition effects and enhances the removal of body cholesterol in broilers.

**5.5.6. Weight of liver and heart**

In this study, weight of liver and heart were compared to each other groups. Lecithin fortified treatment group was numerically higher in weight than other two groups but not been statistically significant (P>0.05) which is consistent with Huang et al., (2007) and Lomas (2012) said that it promoted fat absorption in the liver and increases energy efficiency of feed**.** Aguilar et al., (2013) also commented that the exogenous emulsifier increased the liver weight and yield.

**5.6. Effect of commercial emulsifiers on cost benefit analysis of broiler**

There were no significant (P>0.05) differences observed for cost items like chick cost (Tk./Chick), total feed cost (Tk./Kg), management cost (Tk./broiler) and for sale items including market sale price (Tk./Kg broiler). On the other hand, significant (P<0.05) differences were observed in total feed cost (Tk./broiler), total cost (Tk./broiler) and total cost (Tk./Kg live broiler) in between T2 and others. In terms of income, significant (P<0.05) differences were observed in total sale price (Tk./broiler), net Profit (Tk./broiler) and net profit (Tk./Kg live broiler) in T2 group with other two groups. Tabular data showed that total cost (Tk./broiler) was higher in lecithin supplemented diet group (T2 ) comparing to the lysolecithin supplemented diet group (T1) and control group. But total cost (Tk./Kg live broiler) was highest in control group and lowest in (T2) group. In case of income, total sale price (Tk./broiler), net profit (Tk./broiler) and net profit (Tk./Kg live broiler) was increased in lecithin and lysolecithin supplemented diet groups than control group. Though net profit (Tk/broiler), net profit (Tk/Kg live broiler) was increased in both lecithin and lysolecithin supplemented groups, lecithin supplemented diet group showed maximum income.

**Chapter-6: Conclusions**

The study was conducted from July to August 2015, at the Department of Animal Science and Nutrition experimental farm and Field Research Laboratory of Chittagong Veterinary and Animal Sciences University to investigate the effect of lecithin and lysolecithin supplemented diet on growth performance and carcass quality of broiler.

The experiment showed that increased body weight in lecithin and lysolecithin supplemented diet groups than that of control group. The highest body weight was predicted in lecithin supplemented diet group. Along the whole experimental period, body weight gain was highest in lecithin supplemented diet group than that of the lysolecithin supplemented diet group and control group. The improved feed conversion was found in lecithin and lysolecithin supplemented diet group in comparing to control group. However, more effective FC was observed in lecithin supplemented diet group.

Among the carcass parameters; eviscerated body weight, dressing percentage (%) as well as weight of drumstick, thigh and breast muscle, back and neck region, feet, liver and heart were visibly higher in lecithin supplemented diet group than either lysotecithin supplemented diet group or control group. Abdominal fat and neck regional fat weights were found slightly lower in lecithin supplemented diet group in comparison with other groups.

In cost items, Maximum total cost (Tk/Kg live broiler) was observed in control group and minimum total cost (Tk/Kg live broiler) was in lecithin supplemented diet group.

On the other hand, the lecithin supplemented diet group was found to gain more profit in broilers. Finally, it can be concluded that lecithin supplementation in broiler diet may be a wise decision in terms of better growth performance as well as carcass quality of broiler and also for generating more income.

# Chapter-7: Recommendations and future perspectives

Being a pilot study, further researches may be done on dietary level of emulsifiers to make a concrete remark for a field level. The studies may be done on different strains, sex and age of broilers with different environmental conditions considering temperature and humidity. More experiments can be done with different types of emulsifiers with variable dosing parameter other than lecithin and lysolecithin on performance of broilers. However, based on the overall results it may be recommended that the farmers should use exogenous emulsifier based diet in broiler ration and lecithin may be considered as an inevitable emulsifier in terms of improved broiler performance, carcass quality as well as economically benefited ration.

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**APPENDICES**

**Appendix A.** Ingredients and calculated nutritive composition of the experimental broiler diets on different treatment groups

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Ingredients (kg/100kg)** | **Starter ration (0-14 days)** | | | | **Grower ration (15-28 days)** | | |
| **T0** | **T1** | **T2** | | **T0** | **T1** | **T2** |
| Maize | 53.5 | 53.44 | 53.3 | | 55 | 54.94 | 54.80 |
| Molasses | 0.85 | 0.85 | 0.85 | | 0.635 | 0.635 | 0.635 |
| Soya meal | 35 | 35 | 35 | | 33.75 | 33.75 | 33.75 |
| Protein con | 1.5 | 1.5 | 1.5 | | 0.8 | 0.8 | 0.8 |
| Rice polish | 3.7 | 3.7 | 3.7 | | 3.5 | 3.5 | 3.5 |
| Salt | 0.25 | 0.25 | 0.25 | | 0.25 | 0.25 | 0.25 |
| Methionine | 0.2 | 0.2 | 0.2 | | 0.1 | 0.1 | 0.1 |
| Lysine | 0.1 | 0.1 | 0.1 | | 0.233 | 0.233 | 0.233 |
| Vit-min Premix | 0.25 | 0.25 | 0.25 | | 0.25 | 0.25 | 0.25 |
| Feed Enzyme | 0.025 | 0.025 | 0.025 | | 0.025 | 0.025 | 0.025 |
| Soya oil | 2.5 | 2.5 | 2.5 | | 3.5 | 3.5 | 3.5 |
| Lime stone | 1.103 | 1.103 | 1.103 | | 1.35 | 1.35 | 1.35 |
| Maduramycin | 0.06 | 0.06 | 0.06 | | 0.06 | 0.06 | 0.06 |
| Antioxidant | 0.012 | 0.012 | 0.012 | | 0.012 | 0.012 | 0.012 |
| D.C.P | 0.95 | 0.95 | 0.95 | | 0.535 | 0.535 | 0.535 |
| **Lysolecithin** | **0.00** | **0.06** | **0.00** | | **0.00** | **0.06** | **0.00** |
| **Lecithin** | **0.00** | **0.00** | **0.2** | | **0.00** | **0.00** | **0.2** |
| **Total** | **100** | **100** | **100** | | **100** | **100** | **100** |
| **Parameters** | **Estimated chemical composition (DM basis)** | | | | | | |
| ME  (Kcal/kg) | 2939.40 | 2937.40 | | 2933.00 | 3014.69 | 3012.70 | 3008.07 |
| CP  (gm/100gm) | 22.04 | 22.03 | | 22.01 | 21.16 | 21.16 | 21.14 |
| CF  (gm/100gm) | 3.51 | 3.50 | | 3.50 | 3.44 | 3.44 | 3.44 |
| EE  (gm/100gm) | 3.08 | 3.08 | | 3.08 | 3.1 | 3.1 | 3.1 |
| Ca  (gm/100gm) | 0.95 | 0.72 | | 0.90 | 0.87 | 0.86 | 0.82 |
| P  (gm/100gm) | 0.62 | 0.50 | | 0.62 | 0.52 | 0.52 | 0.52 |
| Lysine (gm/100gm) | 1.20 | 1.20 | | 1.20 | 1.24 | 1.24 | 1.24 |
| Methionine (gm/100gm) | 0.90 | 0.89 | | 0.89 | 0.77 | 0.77 | 0.76 |

**N.B:** T0 = control, T1 = 0.06% Lysolecithin with a dose of 60g/100kg of feed, T2 = 0.2% Lecithin with a dose of 2g/kg of feed.

**Appendix Table B.** Cost of different items with return among treatment groups

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Cost Parameters** | | | | | | | | | | |
|  |  | **Chick cost (Tk/b)** | **Emulsifier cost (Tk./Kg)** | | **Total feed cost (Tk./kg)** | **Total feed cost (Tk./b)** | | **Management cost (Tk./b)** | | **Total cost (Tk./b)** |
| **T0** | **R1** | 40 | - | | 37.35 | 80.82 | | 15 | | 135.82 |
| **R2** | 40 | - | | 37.35 | 80.90 | | 15 | | 135.90 |
| **R3** | 40 | - | | 37.35 | 80.92 | | 15 | | 135.92 |
| **T1** | **R1** | 40 | 2000 | | 38.15 | 82.51 | | 15 | | 137.51 |
| **R2** | 40 | 2000 | | 38.15 | 82.05 | | 15 | | 137.05 |
| **R3** | 40 | 2000 | | 38.15 | 82.44 | | 15 | | 137.44 |
| **T2** | **R1** | 40 | 1200 | | 38.77 | 83.52 | | 15 | | 138.52 |
| **R2** | 40 | 1200 | | 38.77 | 83.49 | | 15 | | 138.39 |
| **R3** | 40 | 1200 | | 38.77 | 83.20 | | 15 | | 138.20 |
| **Income Parameters** | | | | | | | | | | |
|  |  | **Total sale price (Tk./Kg broiler)** | | **Final body wt. (gm/broiler)** | | | **Total sale (Tk./broiler)** | | **Net Profit (Tk./broiler)** | |
| **T0** | **R1** | 130 | | 1212 | | | 157.56 | | 21.74 | |
| **R2** | 130 | | 1231.60 | | | 160.11 | | 24.21 | |
| **R3** | 130 | | 1213.30 | | | 157.73 | | 21.81 | |
| **T1** | **R1** | 130 | | 1262.20 | | | 164.09 | | 26.58 | |
| **R2** | 130 | | 1238 | | | 160.94 | | 23.89 | |
| **R3** | 130 | | 1249.90 | | | 162.49 | | 25.05 | |
| **T2** | **R1** | 130 | | 1301.30 | | | 169.16 | | 30.64 | |
| **R2** | 130 | | 1289.70 | | | 167.66 | | 29.17 | |
| **R3** | 130 | | 1305.30 | | | 169.69 | | 31.49 | |

**N.B:** T0 = control, T1 = 0.06% Lysolecithin with a dose of 60g/100kg of feed, T2 = 0.2% Lecithin with a dose of 2g/kg of feed.

**Brief biography of the author**

Tapash Kumar Paulcompleted his graduation degree on Doctor of Veterinary Medicine (DVM) from Chittagong Veterinary and Animal Sciences University (CVASU), Bangladesh. As an intern student he received clinical training from Madras Veterinary College and Research Institute of Tamilnadu Veterinary and Animal Sciences University, India. Tapash has a great interest in research and has done some epidemiological research works. In order to detect prevalence and associated risk factors of FMD in cattle, he has performed a survey and also biochemical tests during his internship at Upazilla Veterinary Hospital, Harirampur, Manikgang. He had worked in a project of pure RCC farming and breeding under the NGO, IDF at Satkania in the district of Chittagong. He wants to do more research work on poultry feed. His ambition is to develop skill in processing and technology of poultry feed.