**Chapter-1: Introduction**

The poultry farming has now turned into one of the most important division of agriculture throughout the world. It is expanding rapidly as a dynamic industry in South Asian countries. Poultry is basically a source of economical, palatable and healthy food protein for human consumption (Mahesar et al., 2010).

Poultry industry is an important part of agriculture in our country. It has established its position on faster growing segment in the agriculture sector. Poultry, predominantly chickens, are extensively used as a protein source throughout the world (Perry et al.,2002; Kingorietal, 2010). It is reported that most of the developing nations in the world are facing complications in providing adequate food for public (Zafar and Idrees, 2005). Moreover, protein plays a vital function in human diet. There are two major sources of proteins i.e. plant and animal. Normal requirement of animal protein as meat for a man is about 62.5 gm/day, while people of our country get only 6.90 gm/day (Jabbar and Green, 1983). High quality proteins and micro-nutrients are present in broiler meat which has beneficial effect for human health and nutrition (Barroetoa, 2007). It also provides cash income and creates employment opportunity for small and landless farmers.

Broilers require energy and numbers of other nutrients including proteins, minerals, vitamins for their proper body maintenance, growth & production (Neto et al., 2011). Fats and oils are usually added to broiler diet as dietary energy-yielding ingredients to improve productivity, thus efficient fat digestion is crucial for chicken growth (Blanch et al. 1996). Besides the obvious advantages of being high in caloric density, fat has also been observed to exert an extra caloric effect. Fat may improve the physical characteristic and palatability of the diet to an extent which promotes increased feed consumption (Dale and Fuller, 1979). Furthermore, fat slows down the rate of feed passage through the digestive tract, allowing more time for better digestion and absorption of nutrients (NRC, 1994).

In young birds, the assimilation of dietary fat is limited because they have a reduced capacity to produce & secret bile salts and lipase until their gastrointestinal tracts matures (Noy and Sklan, 1995). This limitation causes an inability to form mixed micelles in the intestinal lumen which further decrease fat digestion & absorption of nutrients (Leeson & Atteh, 1995). Fats were not efficiently used until lipase activity reached its maximum level (Krogdahl and Sell, 1989). 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 (Polin et al., 1980; Kussaibati et al., 1982). It is reported that the emulsifier have considerable ability to lower surface tension (Harper et al., 1979). This enables them to emulsify fats in the intestine and dissolve fatty acids and water insoluble soaps. Emulsifier is also 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).

Glyceryl polyethylene glycol ricinoleate (GPEGR) is a nutritional emulsifier derived from castor oil (Roy et al., 2012). It is hydrophilic, naturally biodegrades, non toxic and reduces the viscosity (Arnouts & Lippens, 2006). 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 food elements (Sreedevi et al., 2012). Several studies reported about the beneficial results of using GPEGR as exogenous emulsifier on digestibility, live weight, FCR and abdominal fat in broiler chicks (Udomprasert and Rukkwamsuk, 2006 and Roy et al., 2010)

Lysolecithin are derived from lysophosphatidyl cholines and acts as a membrane fluidity modulator (Soares et al., 2002). Liver lysolecithins have been found to contain the saturated acids palmitic and stearic, and the unsaturated acids oleic, linoleic, and arachidonic (Latif et al., 2014). Lysolecithin forms the liposomes that can be filled with useful substrates and help in rapid absorption of nutrients (Gatlin et al., 2005). It is an excellent emulsifying agent which improves the digestion of fat and enters into the structure of living cells (Aguilar et al., 2013). Neto et al., (2011) reported that birds fed diets containing soybean oil and supplemented with lysolecithin presented better (p<0.05) body weight, weight gain & feed conversion ratio and similar findings were found at Zhang et al., (2011); Alzaqwari et al., (2010); and Maertens et al., (2013).

Since emulsification is required for micelle formation and absorption of fat, exogenous emulsifiers may enhance fat utilization by broilers supplied high-fat diets. However, other author reported that supplementation of emulsifier increases digestibility of nutrients, but has less effect on growth performance and carcass traits (Jones et al., 1992; Aguilar et al., 2013). The reason for inconsistent results remains unclear. So, the current study was undertaken with emulsifiers, one of which contains lysolecithin and other contain glyceryl polyethylene glycol ricinoleate (GPEGR**)** to investigate the effect on broilers performance.

**Objectives of the study:**

1. to compare the effect of commercial emulsifiers supplementation to the diets of broiler chickens on feed intake, body weight gain and feed conversion of chicks;
2. to select an appropriate type of emulsifier in rations for optimum productivity of the broiler chicks; and
3. to estimate the cost benefit ratio among the treatment groups;

**Chapter-2: Review of Literature**

The process of fat emulsification is the most important step in achieving 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 (Krogdahl and Sell, 1989). To assure that these added fats are absorbed efficiently by the bird’s digestive system one should add emulsifiers.

The literature related to the current study is reviewed in this chapter under the following headings:

**2.1 Nutritional emulsifier**

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 (Neto et al., 2011).

According to Cox et al., (2002) 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) (Griffin, 1954). 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 (Griffin, 1949). When feeding poultry, a higher number would be desirable because the content of the gut is more watery.

Momoh et al., (2008) reported that 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 (Guess et al., 1981)**.**

**2.2 Importance of Emulsifier**

The use of emulsifiers in birds and pigs diets have also increased of lipids absorption, growth performance and feed efficiency and modified the blood lipids (Momoh et al., 2008). 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 (Malegy et al., 2001).

While animals have natural emulsifiers that help digest fats, these are not well developed in young birds (Krogdahl and Sell, 1989). Because the majority of the contents of a bird's stomach are water, bile salt acts as a natural emulsifier that binds fat and water together, allowing for increased digestion. Young birds have low levels of lipase and bile salt production. This can be corrected by adding emulsifiers to feed.

The amount of bile salts excreted by the gall bladder is one of the key factors influencing lipid digestibility in animals and broilers (Rauof, 2007). The emulsifying properties of bile salts enhance fat digestion by reducing the size of the large fat globules derived from the fatty part of the feed. The efficacy of the lipase released in the small intestine increases with decreasing fat particle size. Furthermore, bile salts enhance the formation of a micellar phase in the small intestine which enhances fatty acid digestibility in dry diets (Bayler and Lewis, 1963). This micelle phase transports the end products of the fat digestion through the small intestine's membrane (Gurr and James, 1971).

When a shortage of emulsifying molecules such as bile salts appears, fat digestibility will significantly decrease. Freeman et al., (1968) reported that in young pigs, the capacity of the small intestine to absorb micellar lipid exceeds normal influx into the gut. Therefore, entry of fatty acids into the micellar phase limits fatty acid digestibility (Bayler and Lewis, 1963). Emulsifying agents promote the incorporation of fatty acids into micelles. Augur et al., (1974) and Polin (1980) reported increased digestibility of fat when an emulsifier was mixed with the fat before it was fed to rats and chicks.

**2.3 Emulsifier substances**

**2.3.1 Glyceryl polyethylene glycol ricinoleate (GPEGR)**

According to Roy et al., (2012), 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 & 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. Saraf, (2012) reported that it acts as good lubricant which helps in producing better pellet quality.

Sreedevi et al., (2012) reported that 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. It prevents paresis in poultry.

**2.3.2 Lysolecithin (Lysophosphatidylcholine)**

Lysolecithin are derived from lysophosphatidyl cholines, are class of chemical compounds which are derived from phosphatidyl cholines 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. Lysolecithin forms the liposome that can be filled with useful substrates (Gatlin et al., 2005). It is estimated that lysolecithin is at least 7-9 times better efficient than lecithin (Hertrampf, 2001).

Liver lysolecithins have been found to contain the saturated acids palmitic and stearic, and the unsaturated acids oleic, linoleic, and arachidonic (Latif et al., 2014). 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 (West et al., 1968)**.**

Soares et al., (2002) reported that 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. 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.

**2.3.3 Lecithin**

Herslof (1990) reported that lecithin is 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., 2005). The isoelectric pH of a pure lecithin is usually components give rise to different lecithins (Latif et al., 2014). Pena et al., (2014) reported that a lecithin containing stearic and oleicacids is different from one containing palmitic and oleic acids. They had presented that various combinations of saturated and unsaturated acids occur in lecithin. Many contain both saturated and unsaturated acids.

Schaible, (1970) reported that accompanying 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.

Azmanand and Ciftci (2004) reported that 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.

**2.3.4 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 (Haslewood, 1955). 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 (West et al., 1968). West et al., (1968) 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 enable 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, 2003). These bile salt-lipid complexes are the micelles, so important to fat absorption.

Rauf, (2007) noted that 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 (Al-Marzooqi and Leeson, 1999).

Harper et al., (1979) reported that 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).

**2.4 Effect of emulsifiers in high fat diet on broilers**

**2.4.1 Effect on fat absorption**

Fat are insoluble in water and do not solubilise in the intestinal tract of birds. So, it is necessary to emulsifying before they can be digested by lipolytic enzymes. The process of emulsification depends on the characteristics of fat such chain length position of fatty acid on triglycerides and fat saturation (Gu & Li, 2003). 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 (Azman and Ciftci , 2004).

Emulsifier also plays a role in overcoming the inadequacies of naturally bile and recirculation in young birds. The maturation of the mechanism involved in the absorption of saturated fats partly appears to involve the availability of bile acids. Serafin and Nesheim (1967) indicated that young chicks are unable to replenish bile salts lost by excretion as readily as older birds.Alzawqari et al., (2010) obtained an increase in the absorption of TLW from 47 to 69% by the addition of 0.5% ox bile to chick diets containing 20% beef TLW. Edwards (1962) and Eyssen et al., (1965) also had some positive response using bile salts. Garlich and Nesheim (1965) reported that 3 and 6 % of a bile salt improved fat absorption of chicks fed unheated soybean meal. Stamp and Jenkins (2008) reported that both apparent absorption of fat and ME were improved for several lipids by 0.2% cholic acid diets for young chicks.

Crespo and Esteve-Garcia (2003), feeding purified type diets, showed that the absorption of tallow was improved 15 to 20% in chicks 4 to 7 days of age by adding to the diets either cholic acid, chenodeoxycholic acid, or sodium taurocholate (NaT). Polin et al., (1980**)** noted that 0.04% cholic acid or chenodeoxycholic acid significantly improved, while (NaT) caused only atrend for an improvement, in tallow’s absorption by chicks fed practical type diets. Katongole and March (1980) also substantiated that NaT enhanced significantly the absorption of tallow in chicks 3 weeks of age. They noted it was most effective in light and broiler type breeds and only partially effective in a medium type breed.

Polin et al., (1980) reported that the cholic acid improved the absorption of tallow but not significantly; chenodeoxycholic acid significantly improved tallow absorption during days 0 to 7 but decreased it during days 14 to 21. The bile acid, dehydrocholic acid, deoxycholic acid and sodium taurocholate had no significant effect on absorption of tallow.

Kussaibati et al., (1982a) reported that 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 was increased. In addition, metabolizable energy was significantly improved (P<.01) by the addition of bile salts when the dietary intake level increased to the adlibitum level.

Pullen and Polin (1984**)** reported that neither practical –type nor purified type diets, saturated (tallow) nor unsaturated (corn oil) fats at 8% of the diet significantly influenced lipid retention in chickens with cannulated ducts. In these chickens' percent dry matter retained of the purified diet was 81%, a significantly higher value than the 62% retained of the practical type diet.

**2.4.2 Effect on broiler performance**

Daghir and Balloun (1961) reported that 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 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 receiving soybean oil.

Roy et al., (2010) conducted an experiment in cob-500 broiler chicks and reported that the effect of a synthetic emulsifier, glyceryl polyethylene glycol ricinoleate (GPEGR**)** supplemented in incremental dose levels. The report showed that live weight and live weight gain in 39 days was higher (*P < .*07) in the emulsifier supplemented dietary group containing 2% level. Cumulative feed consumption was similar across the dietary treatments (P>0.1) although, during the grower phase the dietary group containing 2% level of fat birds consumed less food for each unit of live weight gain relative to the control group.

Udomprasert and Rukkwamsuk, (2006) studied an experiment on 300 male broiler chicks (Ross 308). Results revealed that birds in a negative control group that fed on a lower nutrient density diets only (lower in added oil and in synthetic amino acids) without glyceryl polyethylene glycol ricinoleate (GPEGR**)**, showed a significant (P < 0.05) lowest final body weight, lowest weight gain, poorest FCR and highest feed

consumption in comparison to the positive control and the GPEGR supplemented groups.

Malegy et al., (2010) conducted an experiment and observed that birds received experimental diet recorded more feed intake and best feed conversion than control. With 8% fat feed intake was decreased and feed conversion was improved when lysolecithin in the diet increased. But with 12% fat most feed consumption was recovered by group received low emulsifiers level, but the best feed conversion was recorded by group received high level of lysolecithin.

Neto et al., (2011) reported that birds fed diets containing soybean oil and supplemented with emulsifier presented better (p<0.05) body weight, weight gain and feed conversion ratio and similar findings were found at Zhang et al., (2011); Alzaqwari et al., (2010) and Maertens et al., (2013).

Huang et al., 2007 conducted a study on 240 arbor acres chicks and demonstrated that the performance of birds fed with 0.5% lysolecithin and 1.5% soy-oil (SOL1) was better than other groups, while the birds fed with 2% lysolecithin (SL) showed poorer performance (p<0.05). During the starter period (from 1st to 21st day), broilers fed with 2% lysolecithin (SL) had the lowest average daily gain (ADG), feed intake (ADFI) and its FCE was the worse compared with other groups (p<0.05).

Several investigations conducted in poultry have reported only the effects of dietary lysolecithin on absorption of animal fats (Summers and Leeson, 1981; Donaldson and Ward, 1988). However, little information is available on dietary phospholipids in relation to lipid and lipoprotein metabolism.

**2.5 Effect of emulsifiers on different species**

Emulsifier such as has been widely used in animal diets, such as sheep (Jenkins and Fotouhi, 1990), lambs (Lough et al., 1991), horses (Holland et al., 1998), fish and crustacean larviculture (Coutteau et al., 1997; Liu et al., 2004), swine (Overland et al., 1994; Soares and Lopez-Bote, 2002).

In European and American countries emulsifiers are widely used in pigs and aquatic fishes. Danek and Rozkot (2008) reported that effect of emulsifier such as Polyethylene glycol ricinoleate in pigs after weaning has increase weight gains and improve feed conversion, ileal digestibility of fat and fatty acids which is similar to the results of Desouza et al., (1995); Danek et al., (2005); Heugton and odle (2000). Various researches were conducted on finisher swine on effect of lysolecithin in lipid digestibility and triglyceride level and show the increased digestibility of fat and desirable level of triglyceride (Cera et al., 1988; Danek and Rozkot (2008).

Emulsifiers are now used for growth and weight enhancer and better FCR in aquatic monogastric animals. Lysoecithin from various sources has commonly been used for dietary supplementation of phospholipids for fish, which show improved growth, feed conversion, survival rate, body composition and lipid mobilization in response to dietary lecithin (Ketola, 1976; Hung and Lutes, 1988; Poston, 1991 and Hasan et al., 2009).

The use of emulsifiers in birds and pigs diets have also increased of lipids absorption, growth performance and feed efficiency (Momoh et al., 2008). When a shortage of emulsifying molecules appears, fat digestibility will significantly decrease. Freeman et al., (1968) reported that in young birds, the capacity of the small intestine to absorb micellar lipid exceeds normal influx into the gut. Therefore, entry of fatty acids into the micellar phase limits fatty acid digestibility (Bayler and Lewis, 1963). Emulsifying agents promote the incorporation of fatty acids into micelles. Augur et al., (1974) and Polin (1980) reported increased digestibility of fat when an emulsifier was mixed with the diet in chicks.

**Chapter-3: Materials and Methods**

**3.1 Location of the experiment**

The current experiment was conducted to study the effect of two different commercials emulsifiers on growth performance in broiler chickens from October to November 2014, at the Department of Animal Science and Nutrition experimental Farm and Field Research Laboratory of Chittagong Veterinary and Animal Sciences University (CVASU), Khulshi, Chittagong, Bangladesh.

**3.2 Preparation of poultry shed for the experiment**

At first, the selected broiler shed was thoroughly washed and cleaned up by using tap water with caustic soda. Brooding boxes and broiler cages were also cleaned by using tap water with caustic soda. Then copper sulphate solution was used as sprayer 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 one week for drying. All windows were opened for proper ventilation. After one-week lime was spread on the floor and around the shed for bio-security.

**3.3 Experimental design**

The experiment was carried out for 28 days where starter period was 0 to 14 days and grower period was 15 to 28 days. In experiment, total 90 birds were allocated to three treatment groups with three replicates each. Chicks were equally and randomly divided and distributed in three dietary treatment groups (T0, T1 and T2) with three replications. There were 30 birds per treatment group and 10 birds per replication. 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/replications** | | **Total no. of broilers per treatments** |
| To(Basal diet- control) | R1 | 10 | 30 |
| R2 | 10 |
| R3 | 10 |
| T1(Basal diet+0.08%Lysolecithin, in both starter & grower ration) | R1 | 10 | 30 |
| R2 | 10 |
| R3 | 10 |
| T2 (Basal diet + 0.08% Glyceryl polyethylene glycol ricinoleate (GPEGR), in starter & grower ration ) | R1 | 10 | 30 |
| R2 | 10 |
| R3 | 10 |
| Grand total = | | | 90 |

**3.4 Collection of experimental broiler chicks**

A total of 90 day-old chicks (Cobb 500 strain) of mixed sex were purchased from an agent of Nahar Agro Complex Limited, Jhautala Bazar, Khulshi, Chittagong, Bangladesh on October 2014. During purchasing all chicks were examined for any kind of abnormality and uniform size.

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**Photo 3.1: Day old chicks**

**3.5 Collection of emulsifiers**

Different types of emulsifiers are available in the market. For this research work commercial emulsifiers such as AVI-MUL TOP (Sevecom Spa, Italy) which contain mainly Glyceryl polyethylene glycol ricinoleate (GPEGR) 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 followed in the experiment was that of 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-energetic and Iso-nitrogenous. Feeds were supplied ad-libitum along with fresh clean drinking water for all the time.

**3.7 Feed formulation and feeding diets**

The birds were supplied 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. Emulsifiers were supplied from 1st day to 28th day with other feed ingredients. Feed was supplied ad-libitum along with fresh clean drinking water. 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 Ingredients and nutritive composition of the experimental broiler starter diets**

|  |  |
| --- | --- |
| **Ingredients (kg/100kg)** | **Starter ration (0-14 days)** |
| Maize | 50 |
| Auto Rice Polish | 4.2 |
| Soybean Meal | 35.5 |
| Full fat Soya | 4.5 |
| Soybean oil | 2.0 |
| Molasses | 0.5 |
| Limestone | 1.5 |
| Salt | 0.3 |
| Vitamin mineral premix | 0.25 |
| DCP | 0.9 |
| L-lysine | 0.1 |
| DL-Methionine | 0.2 |
| Maduramycin | 0.06 |
| Enzyme | 0.025 |
| Antioxidant | 0.012 |
| Total | 100 |
| **Estimated chemical composition (DM basis)** | |
| Metabolizable Energy (Kcal/kg) | 2920 |
| Crude Protein (gm/100gm) | 22.79 |
| Crude Fiber (gm/100gm) | 4.07 |
| Calcium (gm/100gm) | 0.94 |
| Phosphorous (gm/100gm) | 0.68 |
| Lysine (gm/100gm) | 1.38 |
| DL Methionine (gm/100gm) | 0.53 |

**N.B:** 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 Ingredients and nutritive composition of the experimental broiler grower diets**

|  |  |
| --- | --- |
| **Ingredients (kg/100kg)** | **Grower ration (15-28 days)** |
| Maize | 53 |
| Auto Rice Polish | 2.283 |
| Soybean Meal | 33.45 |
| Full fat Soya | 4.5 |
| Soybean oil | 3.0 |
| Molasses | 0.5 |
| Limestone | 1.35 |
| Salt | 0.3 |
| Vitamin mineral premix | 0.25 |
| DCP | 0.9 |
| L-lysine | 0.07 |
| DL-Methionine | 0.2 |
| Toxi mold | 0.05 |
| Maduramycin | 0.05 |
| Enzyme | 0.06 |
| Antioxidant | 0.025 |
| Total | 100 |
| **Estimated chemical composition (DM basis)** | |
| Metabolizable Energy (Kcal/kg) | 3009 |
| Crude Protein (gm/100gm) | 21.92 |
| Crude Fiber (gm/100gm) | 3.79 |
| Calcium (gm/100gm) | 0.87 |
| Phosphorous (gm/100gm) | 0.66 |
| Lysine (gm/100gm) | 1.29 |
| DL Methionine (gm/100gm) | 0.52 |

**N.B:** 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.



**Photo 3.2: Preparation of mash feed**

**3.8 Management Procedure**

The following management procedures were followed during the whole experimental periods and the uniformity in the management practices were maintained as much as possible.

**3.8.1 Brooding of the chicks**

After proper cleaning and drying, the brooding boxes were ready for broiler chicks rearing under strict hygienic conditions. The experiment was conducted in winter season. As a result during experiment ambient temperature was very low from the normal environmental temperature. Dry and clean newspaper was also placed in the brooding box. Newspaper was changed two times a day from the floor of the brooding box. This is continued for seven days. After seven days fresh dried rice husk litter materials was spread on the floor of the brooding box at a depth of about 3-4 inches. 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.



**Photo 3.3: Box brooding of baby chicks**

**3.8.2 Maintaining room temperature**

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 were used to maintaining the temperature. Temperature was maintained according to Table 3.4.

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

|  |  |
| --- | --- |
| Week | Temperature °F |
| 1st | 95 |
| 2nd | 90 |
| 3rd | 85 |
| 4th | 80 |

**3.8.3 Brooder and cage space**

Each box brooder having 2.38 ft. X 2.08 ft. was allocated for 30 birds. After 14 days later broiler birds were transferred to cage having 3.5 ft. X 1.63 ft. for 10 birds. Therefore, floor space for each bird in the brooding box was 0.17 sq. ft. and cage was 0.57 sq. ft. respectively.

**3.8.4 Feeder and drinker spaces**

In the early stage of brooding feed and water were given to birds on paper and small waterer. Feeding and watering were performed by using one small round plastic feeder and one round waterer 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 waterer with a capacity of three liters was used for feeding and drinking.

**3.8.5 Method of feeding, watering and lighting**

Formulated mash feed and fresh clean drinking water was supplied ad-libitum to the birds throughout the experimental period. Feed and drinking water were given three times a day. Starter ration was supplied for 0 to 14 days and grower ration for 15 to 28 days. During the early stage of growth feed and water were given to birds on paper and small drinkers. The birds were exposed to a continuous lighting of 24 hours of photoperiod.

**3.8.6 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.

**3.8.7 Vaccination**

All birds were vaccinated properly against Newcastle disease on the 4th days and booster dose again on 14th day according to the following schedule:

**Table 3. 5 Schedule of vaccination**

|  |  |  |  |
| --- | --- | --- | --- |
| **Age of birds** | **Name of diseases** | **Name of the vaccines** | **Route of administration** |
| 4th days | New Castle Disease | BCRDV (Live) | One drop in one eye |
| 14th days | Infectious Bursal Disease | IBD (Live) | Do |

# DSC05206.JPG

**Photos 3.4: Vaccination of broiler chick**

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, details of which are given below:

**Table 3.6 Schedule of chemo prophylaxis/medication**

|  |  |
| --- | --- |
| **Age of the birds (days)** | **Drugs used through water** |
| 1-7 | Rena-WS +Electrolyte |
| 10-17 | Rena-WS +Electrolyte |
| 18-28 | Rena-WS +Electrolyte |

**3.8.9 Bio-security/Sanitation**

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**

Following parameters were recorded throughout the experimental period.

**3.9.1 Body weight**

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.

 

**Initial weight**

**Final weight**

**Photo 3.5 Weighing of broilers using electric balance**

**3.9.2 Feed intake**

Weekly feed intake was calculated by deducting the left over feeds from the total amount of supplied feed to the broilers.

**3.9.3 Mortality**

Mortality was recorded throughout the experimental period when death occurred in any replication.

**3.10 Calculation of data**

**3.10.1 Body weight gain:**

The body weight gain was calculated by deducting initial body weight from the final body weight of the birds.

Body weight gain= Final body weight-Initial body weigh

**3.10.2 Feed intake:**

Quantity of offered feed was weighed weekly. Refusal feed was recorded to determine the feed intake per week. Feed intake was calculated weekly as gm/bird.

**3.10.3 Feed conversion (FC):**

The amount of feed intake per unit of weight gain is the feed conversion (FC). This was calculated by using following formula.

Feed intake (kg)

FC =

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 expressed in percent.

**3.10.5 Study Design & Statistical Analysis**

Completely randomized design (C.R.D) was used as study design. Statistical analyses were conducted with the Statistical Package for Social Science (SPSS for Windows Version 16; SPSS Inc.233 South Wackier Drive, Chicago, USA) to determine if variables differed among between treatment groups. Results are expressed as means ± SE. The body weight, body weight gain, feed intake and feed conversion were compared among the groups by 1-way ANOVA and subsequent Duncan’s Multiple Range Tests (DMRT). The level of significance was set less than 0.05 (P<0.05).

**Chapter-4: Results and Discussion**

**4.1 Effect of emulsifiers on body weight of broilers**

The body weight of broiler birds on energy base diet, containing commercial emulsifier at different age are presented in table 4.1. There was no significant (P>0.05) difference in body weight of broilers among the experimental treatment groups in day1. However, significant differences (P<0.05) were evident from 2nd, 3rd and 4th weeks of age. Along the whole experimental period, increased body weight was observed in lysolecithin and glyceryl polyethylene glycol ricinoleate (GPEGR) supplemented group T1 and T2 in compared with the control group. The highest body weight was observed on glyceryl polyethylene glycol ricinoleate (GPEGR) 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 can be noted that among the supplemented groups, T2 gave consistently higher body weight than T1 and T0 group.

**Table 4.1 Weekly body weight (gm/broiler) of broiler on different treatment groups**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Age** | **Dietary treatment groups** | | | **P -value** | **Level of significance** |
| **T0**  **Mean ± SE** | **T1**  **Mean ± SE** | **T2**  **Mean ± SE** |
| Day 1 | 40±0.02 | 40.12±0.02 | 40.57±0.03 | 0.29 | NS |
| 1stweek | 134.23a±0.79 | 142.20b±0.94 | 154.40c±1.21 | 0.00 | \* |
| 2nd week | 332.00a±0.47 | 349.20b±0.56 | 369.93c±0.63 | 0.00 | \* |
| 3rd week | 676.76a±1.58 | 705.00b±3.05 | 740.14c±2.10 | 0.00 | \* |
| 4th week | 1186.9a±6.24 | 1217.3b±3.14 | 1256.8c±5.52 | 0.00 | \* |

Mean values having uncommon superscripts differ significantly. SE=Standard error, NS= Non significant at 5% level, \*= Significant at 5% level.

The results of body weight in broilers supplemented with glyceryl polyethylene glycol ricinoleate (GPEGR) diet were also in agreement with the findings of Udomprasert and Rukkwamsuk, (2006) and Roy et al., (2010). They reported that GPEGR increases the body weight of broilers in compare to control group. Increased body weight was also observed lysolecithin supplemented diets group T1 in compared with control group. The results were in agreements with the results of Melegy et al., (2001); Xing et al., (2004); Raju et al., (2011). But Research investigating the effect on body weight of broilers was inconsistent with Jones et al., 1992. The primary reason for inconsistency was attributable to the fat sources. They used animal fats, were less digestible than vegetable oils (Azman et al., 2004).

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

**4.2 Effect of emulsifiers on body weight gain of broilers**

The responses of commercial emulsifiers on weekly body weight gain of broilers are presented in table 4.2. Tabular results showed significant (P<0.05) differences among the treatment groups at 1st, 2nd & 3rd weeks of age. But no significant (P>0.05) difference was observed at 4th week of age. The supplementation of lysolecithin and GPEGR emulsifier diet in group 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). It can be noted that increased body weight gain was consistent in T2 group. Along the whole period, body weight gain was higher in T1 supplemented group than control group but lower than T2. It is interesting to note that at 4th week of age there was no deviation in weight gains compared to those of broilers at earlier stages of growth.

**Table 4.2 Weekly body weight gain (gm/broiler) of broiler on different treatment groups**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Age**  **(weeks)** | **Dietary treatment groups** | | | **P -value** | **Level of significance** |
| **T0**  **Mean ± SE** | **T1**  **Mean ± SE** | **T2**  **Mean ± SE** |
| 1 | 94.23a±0.79 | 102.07b±1.13 | 113.83c±.930 | 0.00 | \* |
| 2 | 198.07a±0.41 | 207.00b±0.95 | 217.53c±0.63 | 0.00 | \* |
| 3 | 344.77a±1.18 | 357.80b±3.38 | 370.20c±1.50 | 0.00 | \* |
| 4 | 511.16±6.46 | 512.30±5.80 | 516.66±3.43 | 0.75 | NS |

Mean values having uncommon superscripts differ significantly. SE=Standard error, NS= Non significant at 5% level, \*= Significant at 5% level.

The cumulative body weight gain of broilers on energy based diets containing commercial emulsifiers at different ages are presented in table 4.3. Among the whole treatment groups significant (P<0.05) 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. But along the whole period of experiment, increased body weight gain was observed in T2 group in compared with T1 and control group. However, T1 group showed improved body weight than control group but not as T2 group. The highest cumulative body weight gain was observed in T2 group and lowest in control group.

**Table 4.3 Cumulative body weight gain (gm/broiler) of broiler on different treatment groups**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Age**  **(weeks)** | **Dietary treatment groups** | | | **P -value** | **Level of significance** |
| **T0**  **Mean ± SE** | **T1**  **Mean ± SE** | **T2**  **Mean ± SE** |
| 1-2 | 292.0a±0.59 | 309.07b±0.58 | 330.37c±0.34 | 0.00 | \* |
| 1-3 | 635.77a±1.57 | 664.87b±3.21 | 700.47c±1.91 | 0.00 | \* |
| 1-4 | 1146.9a±6.01 | 1177.2b±3.08 | 1217.1c±5.33 | 0.00 | \* |

Mean values having uncommon superscripts differ significantly. SE=Standard error, NS= Non significant at 5% level, \*= Significant at 5% level.

According to the present study the higher body weight gain was observed in both lysolecithin and GPEGR supplemented group comparing to the control group. These results were in agreement with earlier studies for lysolecithin emulsifier (Melegy et al., 2001; Raju et al., 2011; Zhang et al., 2011; Aguilar et al., 2013) and also for GPEGR emulsifier (Soede, 2005; Udomprasert and Rukkwamsuk, 2006 and Roy et al., (2010). They reported that lysolecithin and GPEGR increases the body weight of broiler 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 increases digestibility of nutrients but has minimal effect on growth performance in weanling pigs. The possible causes of inconsistency may be due to species variation. Katongole and March, (1980) reported that feed digestibility and average BWG vary due to species variation.

The present study shows improved body weight gain in both lysolecithin and GPEGR supplemented diet group comparing with the control group. But it can be noted that GPEGR showed more effective results than lysolecithin supplemented broilers.

**4.3 Effect of emulsifiers on feed intake of broilers**

Supplementation of commercial emulsify base energy diet on weekly feed intake of broiler is presented in table 4.4. According to the tabular value, there were presence significant (P>0.05) differences were observed among the treatment groups at 1st, 2nd and 3rd weeks with increased amount of feed intake. After the end of 4th week of age, there was no significant (P>0.05) difference observed. From the tabular value it can be stated that in 1st week increased feed intake was found in GPEGR supplemented group T2 and lower feed intake was found in both lysolecithin supplemented diet group and control group. In 2nd week, higher feed intake was observed in emulsifier supplemented groups T1 & T2 and lower feed intake was observed in control group. In 2nd and 3rd week the feed intake was closely similar in T1 & T2 group. Although in previous weeks, control group showed less amount of feed intake other than two experimental diets but in 4th week feed intake was higher in control group than other experimental diet groups.

**Table 4.4 Weekly feed intake (gm/broiler) of broiler on different treatment groups**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Age**  **(weeks)** | **Dietary treatment groups** | | | **P -value** | **Level of significance** |
| **T0**  **Mean ± SE** | **T1**  **Mean ± SE** | **T2**  **Mean ± SE** |
| 1 | 109.95a±2.25 | 112.57a±0.79 | 121.09b±0.46 | 0.00 | \* |
| 2 | 264.40a±0.52 | 272.93b±0.62 | 273.47b±1.02 | 0.00 | \* |
| 3 | 538.93a±2.79 | 550.10b±0.78 | 553b±4.81 | 0.03 | \* |
| 4 | 898.57a±7.25 | 876.63a±7.34 | 865.54b±5.82 | 0.02 | \* |

Mean values having uncommon superscripts differ significantly. SE=Standard error, NS= Non significant at 5% level, \*= Significant at 5% level.

Cumulative feed intake of broilers on different treatment groups are given in table 4.5. There was presence significant (P<0.05) differences among the treatment groups in 2nd and 3rd week. But no significant (P>0.05) differences were observed in 4th week. Cumulative feed intake was higher in both T1 & T2 group comparing with the control group. However, in 4th week feed intake was relatively similar among the treatment groups. It indicated that the effect of emulsifiers were presents upto 3rd week of ages.

**Table 4.5 Cumulative feed intake (gm/broiler) of broiler on different treatment groups**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Age**  **(weeks)** | **Dietary treatment groups** | | | **P -value** | **Level of significance** |
| **T0**  **Mean ± SE** | **T1**  **Mean ± SE** | **T2**  **Mean ± SE** |
| 1-2 | 374.35a± 1.99 | 383.50 b± 0.75 | 394.57c±0.56 | 0.00 | \* |
| 1-3 | 912.28a±0.99 | 933.60b±0.53 | 947.33c± 4.60 | 0.00 | \* |
| 1-4 | 1809.8±7.33 | 1810.23± 4.76 | 1811.8± 7.79 | 0.97 | NS |

Mean values having uncommon superscripts differ significantly. SE=Standard error, NS= Non significant at 5% level, \*= Significant at 5% level.

The result of feed intake was similar with the results for GPEGR supplemented diet group (Udomprasert and Rukkwamsuk, 2006; Roy et al., 2010) and also for lysolecithin supplemented diet group (Melegy et al., 2001; Xing et al., (2004); Raju et al., (2011). They all reported that GPEGR and lysolecithin has positive effect on feed intake in broilers. However, inconsistent result was observed with Aguilar et al., (2013). They reported that supplementation of lysolecithin in broilers diet do 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).

**4.4 Effect of emulsifiers on feed conversion (FC) of broiler**

The feed conversion (FC) of broilers during different weeks of age under different dietary groups on energy base diet is given in table 4.6. There were significant (<0.05) difference observed among the whole treatment groups upto 4th weeks of ages. In 1st week feed conversion was higher in control group in comparison with other groups. But in 2nd, 3rd and 4th weeks, FC was significantly (P<0.05) lower in T2 group compared to other groups. Along the whole period highest FC was seen in control group and lowest in T2 group. It can be noted that FC was similar in emulsifier supplemented group T1 and T2 at 1st week of age. In 2nd week, decreased FC was observed in T2 group in comparison with other groups. But in 3rd and 4th weeks, FC was similar in T1 and control group other than T2 group. Improved FC was seen in T2 group but T1 group showed slightly improved FC than control group.

**Table 4.6 Weekly feed conversion (FC) of broiler on different treatment groups**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Age**  **(weeks)** | **Dietary treatment groups** | | | **P -value** | **Level of significance** |
| **T0**  **Mean ± SE** | **T1**  **Mean ± SE** | **T2**  **Mean ± SE** |
| 1 | 1.17b±0.01 | 1.09a±0.01 | 1.07a±0.00 | 0.00 | \* |
| 2 | 1.33c±0.00 | 1.31b±0.00 | 1.26a±0.00 | 0.00 | \* |
| 3 | 1.56b±0.01 | 1.54b±0.01 | 1.49a±0.01 | 0.02 | \* |
| 4 | 1.76b±0.01 | 1.73b±0.01 | 1.67a±0.00 | 0.00 | \* |

Mean values having uncommon superscripts differ significantly. SE=Standard error, NS= Non significant at 5% level, \*= Significant at 5% level.

The cumulative feed conversion (CFC) of broilers on different treatment groups is given in following table 4.7. It can be noted that along the whole experimental period CFC was significant (P<0.05) among all the treatment groups. Improved CFC was found in T1 & T2 groups comparing to the control group. But among the treatment groups, T2 showed better results than T1 and control group.

**Table 4.7 Cumulative feed conversion (CFC) of broiler on different treatment groups (T0, T1 and T2).**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Age**  **(weeks)** | **Dietary treatment groups** | | | **P -value** | **Level of significance** |
| **T0**  **Mean ± SE** | **T1**  **Mean ± SE** | **T2**  **Mean ± SE** |
| 1-2 | 1.27c±0.00 | 1.23b±0.00 | 1.19a±0.00 | 0.00 | \* |
| 1-3 | 1.43c±0.01 | 1.40b±0.01 | 1.35a± 0.01 | 0.00 | \* |
| 1-4 | 1.58c±0.00 | 1.53b± 0.00 | 1.48a±0.01 | 0.00 | \* |

Mean values having uncommon superscripts differ significantly. SE=Standard error, NS= Non significant at 5% level, \*= Significant at 5% level.

In the present study, improved CFC was found in both lysolecithin & GPEGR supplemented diet group than the control group. The result of improved CFC for GPEGR supplemented diet group was in agreement with the findings of Udomprasert and Rukkwamsuk, 2006; Roy et al., (2010). However, similar consistent result of improved CFC for lysolecithin supplemented diet group was observed by various researchers (Melegy et al., 2001; Raju et al., 2011; Zhang et al., 2011, Jansen et al., 2013).

Although lysolecithin and GPEGR supplemented diet group showed better result than control group, CFC was more effective in GPEGR supplemented group than lysolecithin supplemented diet group.

**4.5 Effect of Commercial Emulsifiers on cost benefit analysis of broiler**

The data on cost benefit analysis are presented in table 4.8. According to the table there were no significant (P>0.05) differences observed for cost items in chick cost (Tk/Chick), total feed cost (Tk/Kg), total feed cost (Tk/broiler), management cost (Tk/broiler) and for sale items market sale price (Tk/Kg broiler). On the other hand, significant (P<0.05) differences were observed in 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), net profit (Tk/Kg live broiler) in T2 group with other two groups. Tabular data showed that total cost (Tk/broiler) was higher in GPEGR 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), net profit (Tk/Kg live broiler) was increased in GPEGR and lysolecithin supplemented diet group than control group. Net profit (Tk/broiler), net profit (Tk/Kg live broiler)was maximum in T2 group followed by T1 and minimum in control group. Though net profit (Tk/broiler), net profit (Tk/Kg live broiler) was increased in both GPEGR and lysolecithin supplemented group, GPEGR supplemented diet group showed maximum income.

**Table 4.8 Cost of production and returns of broilers in different treatment groups (T0, T1 and T2).**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Cost items** | | | | |
| **Parameter** | **T0**  **Mean ± SE** | **T1**  **Mean ± SE** | **T2**  **Mean ± SE** | **Level of significance** |
| Chick cost (Tk./Chick) | 25 | 25 | 25 | NS |
| Emulsifier cost(Tk./Kg) | **--** | 800 | 1500 | -- |
| Growth promoter cost (Tk./bird) | **--** | 1.15 | 2.16 | -- |
| Total feed cost (Tk./Kg) | 38.7 | 38.7 | 38.7 | NS |
| Management cost (Tk./broiler) | 47 | 47 | 47 | NS |
| Total feed cost (Tk./broiler) | 69.79±0.34 | 69.59± 0.35 | 70.05±0.23 | NS |
| Total cost(Tk./broiler) | 141.80a±0.32 | 144.03a±0.62 | 144.21b±0.23 | \* |
| Total cost(Tk./Kg live broiler) | 119.15b±0.13 | 118.32b±0.86 | 114.45a±0.48 | \* |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Income** | | | | |
| Market sale price (Tk./Kg broiler) | 138 | 138 | 138 | NS |
| Total sale price (Tk./broiler) | 163.77a±0.88 | 167.98a±2.12 | 173.45b±0.76 | \* |
| Net Profit (Tk./broiler) | 21.97a±0.56 | 23.95a±1.46 | 29.2667b±0.68 | \* |
| Net Profit (Tk./Kg live broiler) | 18.50a±0.41 | 19.66a±0.53 | 23.23b±0.43 | \* |

Mean values having uncommon superscripts differ significantly. NS = Non significant at 5% level, \* = Significant at 5% level.

**N.B.** Total feed cost included to feed raw materials cost and growth promoter cost; Management cost included vaccination cost, labor cost, electricity cost, disinfectant cost and litter material’s cost. (1 US $=78 Taka)

**Chapter-5: Conclusions**

The study was conducted from October to December 2014, at the Department of Animal Science and Nutrition experimental farm and Field Research Laboratory of Chittagong Veterinary and Animal Sciences University (CVASU), Khulshi, Chittagong, Bangladesh. The aim of experiment was to investigate the effect of lysolecithin and glyceryl polyethylene glycol ricinoleate (GPEGR) supplemented diet on broilers growth performance. A total of 90 day-old chicks (Cobb-500) were weighted and randomly distributed to the three treatment groups. The birds were given three test diets such as basal diet, lysolecithin and GPEGR supplemented diet according to different treatment groups as well as replication groups.

The present study showed that increased body weight was occurred in lysolecithin and GPEGR supplemented diet group comparing with control group. The highest body weight was predicted in GPEGR supplemented diet group and lowest in control group. In case of body weight gain, GPEGR and lysolecithin supplemented diet group showed effective results than control group. Along the whole experimental period, BWG was highest in GPEGR supplemented diet group comparing to the other two supplemented diet groups. It can be noted that feed intake was significantly (P<0.05) differed among the treatment groups in whole experimental period. During the study period improved feed conversion was in GPEGR and lysolecithin supplemented diet group in comparing to control group. However, more effective FC was observed in GPEGR supplemented diet group.

In cost items, chick cost (Tk/Chick), total feed cost (Tk/Kg), total feed cost (Tk/broiler), management cost (Tk/live broiler) and in income, market sale price (Tk/Kg live broiler) was similar among the treatment groups. Total cost (Tk/Kg live broiler) was lower in lysolecithin and GPEGR supplemented diet group in comparing to control group. Maximum total cost (Tk/Kg live broiler) was observed in control group and minimum total cost (Tk/Kg live broiler) was in GPEGR supplemented diet group. In terms of profit, net profit (Tk/ kg live broiler), net profit (Tk/Kg live broiler) was increased in GPEGR and lysolecithin supplemented diet group in comparing to control group. Net profit (Tk/ live broiler), net profit (Tk/Kg live broiler) was maximum in T2 group and minimum in control group. Therefore, it can be concluded that GPEGR demonstrated the good effect for growth performance in broilers.Hence, Avi-multop that contains mainly GPEGR may be suggested to the broiler farmers for their betterment in income.

# Chapter-6: Recommendations

It is a pilot study, and further study may be done on dietary level of emulsifiers and similar work to make a concrete remarks. The study may be done on different strain and sex of broilers. However, based on the overall conclusion it may be recommended that the farmer should use exogenous emulsifier based diet in broiler ration and GPEGR may be considered as inevitable emulsifier in term of improved broiler performance and economically benefited ration.

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**Brief Biography of the Student**

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