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Effect of exogenous emulsifier (Glycerol polyethylene glycol ricinoleate) in energy reduced diet on carcass characteristics and visceral organ weight in broilers

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Abstract
The study examined the impact of exogenous emulsifier on carcass characteristics. One hundred twenty eight day-old broiler chicks were divided into four groups: a control group (T_1) fed a standard diet prepared following Bureau of Indian Standards (2007) [2] and three experimental groups receiving 350 ppm of exogenous emulsifier with energy reduced basal diet with energy reduced (- 60 kcal), (- 90 kcal), (- 120 kcal) in T_2, T_3 and T_4 respectively and each treatment was divided into four replicates containing eight birds each. Results showed significant enhancements in dressing percentage, breast yield, drumstick yield and abdominal fat and no significant enhancement was observed in thigh yield and no significant difference in relative weight of heart, liver, proventriculus and gizzard.

Keywords: Exogenous emulsifier, carcass characteristics, breast yield, drumstick yield, broilers

Introduction

Fats provide two times more energy as compared to carbohydrates and proteins in broiler production. Oils improve feed intake by adding flavor, palatability and help the intestines absorb fat-soluble vitamins (Siyal *et al*., 2017) [10]. Growing interest has arisen in optimizing the use of supplementary fats because energy costs are on the rise. Increased dietary energy density is the goal of poultry nutritionists in order to meet broiler requirements (Srinivasan *et al*., 2020) [12].

Vegetable oils and animal fats are both used in commercial broiler diets to increase growth rates and feed efficiency. Fats are not completely digested and energy is lost when emulsifier levels fall below ideal diet-related values. The bile salts act as emulsifiers naturally. Although poultry creates emulsifiers in the form of bile salts, these can occasionally be insufficient due to increased levels of additional fats and oils. Because of their limited ability to generate and secrete lipase and bile salts until their gastrointestinal tracts mature at 10–14 days of age, young birds exhibit poor utilization of dietary fats (Siyal *et al*., 2017) [10].

Emulsifiers are surface-active substances that work on the interface between two immiscible media, such as water and oil (Tan *et al*., 2016) [9]. Animals dietary lipids are insoluble in the watery environment of their gastrointestinal tracts and must be broken down by the enzymes lipase and bile (Siyal *et al*., 2017) [10]. Emulsifiers work by raising fat molecules active surface area, which permits lipase to break down triglyceride molecules into monoglycerides and fatty acids.

Emulsion droplets, which create high levels of monoglycerides in the colon, induce the production of micelles, decrease surface tension and facilitate the nutrient transport through the membrane (Melegy *et al*., 2010) [5]. An emulsifier breaks the fat globules into small micelles, which are easily digested, absorbed and assimilate into the system, resulting in availability of extra metabolizable energy to the birds.

Emulsifier addition have improved growth performance, feed efficiency, lipid absorption and blood lipid composition in chicken diets (Udomprasert and Rukkwamsuk, 2006) [13]. Adding fat emulsifier to broiler diets into vegetable oil boosted weight gain. The natural emulsifiers are bile salts. Exogenous bile salt supply enhanced growth performance, intestinal tract enzyme activity, metabolizable energy and reduced plasma cholesterol in broiler chickens (Kussaibati *et al*., 1982) [4].

The commercially available emulsifiers in the feed industry can be divided into two groups: synthetic and natural emulsifiers. Synthetic emulsifiers are modified emulsifiers like lysolecithin or lysophosphatidylcholine (Zhang *et al*., 2011) [14], whereas natural emulsifiers are those made in the animal body like phospholids and bile, as well as those derived from food materials like soylecithin (Soares and Lopez-Bote, 2002) [11].

Adding synthetic emulsifiers to poultry diets, such as sodium stearoyl-2-lactylate and Glycerol polyethylene glycol ricinoleate, improves body weight, feed intake, and the efficiency with which fat, protein and metabolizable energy are utilized (Roy *et al*., 2010) [8]. Hence exogenous emulsifiers can be employed to increase energy efficiency and fat digestibility. A diet that includes an efficient emulsifier can make up for a decrease in dietary energy. Because of this, it is possible to create lower-energy diets for birds without sacrificing their performance, which lowers feed costs and promotes more sustainable and cost-effective production (Siyal *et al*., 2017) [10].

Materials and Methods

In this study, a total of one hundred and twenty eight day-old commercial broiler chicks were acquired from Venkateshwara Hatcheries Pvt. Ltd. Upon procurement, the chicks underwent initial assessment based on weight, after which they were randomly allocated into four experimental groups. Each group consisted of four replicates, with each replicate comprising eight chicks. The basal diet (T_1) was formulated in accordance with the specifications outlined by the Bureau of Indian Standards (BIS) in 2007 [2]. For the formulation of Treatment 2 (T_2), Basal diet with energy reduced (- 60 kcal) + 350 ppm exogenous emulsifier. For Treatment 3 (T_3), Basal diet with energy reduced (- 90 kcal) + 350 ppm exogenous emulsifier. For Treatment 4 (T_4), Basal diet with energy reduced (- 120 kcal) + 350 ppm exogenous emulsifier. The chicks were reared in deep litter system and was maintained under standard managemental practices till six weeks of age. Standard vaccination schedule was followed for immunizing the birds. Feed and water were provided ad libitum throughout the experimental period.

Carcass traits

Carcass characteristics such as dressing percentage, drumstick yield, thigh yield, abdominal fat and the weights of visceral organs including the heart, liver, gizzard and proventriculus were documented. This was accomplished by euthanizing two birds from each replicate at the conclusion of the experiment. The findings were presented in terms of grams per hundred grams (g/100 g).

Prior to slaughter, the birds underwent a 12-hour fasting period with access only to ad-libitum drinking water. Their live weights were recorded, and humane slaughter methods were utilized. This entailed cutting the jugular vein and carotid artery on one side of the neck, allowing bleeding for 1-2 minutes, scalding at 54 °C for two minutes, mechanical defeathering for 30-60 seconds, and dressing at the atlanto-occipital joint with legs at the hock joint. Evisceration involved making an incision at the abdominal area to remove the gastrointestinal tract, separable fat, and both edible and non-edible organs. Dressing percentage was determined as a proportion of live body weight. Specifically, it was calculated by multiplying the weight of the eviscerated carcass in grams by 100 and then dividing by the pre-slaughter live weight in grams.

The weight of the drumstick portion from each slaughtered bird across all treatments was measured to evaluate the influence of exogenous emulsifier. Drumstick yield percentage, indicating the proportion of drumstick weight to pre-slaughter live weight, was calculated by multiplying the drumstick weight in grams by 100 and then dividing by the pre-slaughter live weight in grams. Similarly, the weights of the thigh and breast, separated at their respective joints, were measured to compute thigh yield percentage and breast yield percentage, respectively.

Abdominal fat, encompassing fat surrounding various internal organs, was recorded and expressed as a percentage of the live weight of the corresponding bird. The abdominal fat percentage was determined by multiplying the weight of abdominal fat in grams by 100 and then dividing by the pre-slaughter live weight in grams.

Relative visceral organ weights

At the end of experiment, two birds from each replication across all treatment groups were euthanized and expressed in term of percent to examine the impact of supplementing exogenous emulsifier. The average weights of the heart, liver, gizzard, and proventriculus, excluding certain contents, were determined, and the results were presented as percentages of the average live body weight. The heart weight percentage, indicating the proportion of heart weight to pre-slaughter live weight, was calculated by multiplying the heart weight in grams by 100 and then dividing by the pre-slaughter live weight in grams. Similarly, the liver weight percentage was computed by multiplying the liver weight in grams by 100 and then dividing by the pre-slaughter live weight in grams. The gizzard weight percentage, representing the proportion of gizzard weight to pre-slaughter live weight, was determined using the same method. Likewise, the proventriculus weight percentage was calculated by multiplying the proventriculus weight in grams by 100 and then dividing by the pre-slaughter live weight in grams.

Statistical evaluation

The experimental design utilized in this study followed a completely randomized design (CRD) with one-way analysis. Data pertaining to various parameters of the biological trial were analysed using the standard methodology outlined by Snedecor and Cochran (1994), and statistical analysis was conducted using SPSS 20 software. Mean differences among treatments were assessed using Tukey's Range Test, with significance set at $p \leq 0.05$.

Results

At the end of the experiment, the mean dressing percentage T_1, T_2, T_3 and T_4 were 71.34, 72.98, 74.41 and 74.75 per cent, respectively. The group T_3 and T_4 recorded the highest dressing percentage and were significantly ($p \leq 0.05$) higher compared to T_1 group. However, there was no significant ($p > 0.05$) difference in the dressing percentage between the treatments T_2, T_3 and T_4 and also among the T_1 and T_2.

The yield of breast (%) in T_1, T_2, T_3 and T_4 at the end of the experiment were 22.68, 28.81, 28.59 and 28.77, respectively. Statistical analysis revealed significant ($p \leq 0.05$) difference in yield of breast between the treatments. The treatments T_2, T_3 and T_4 recorded the highest breast yield and were significantly ($p \leq 0.05$) different from T_1. However, no significant ($p > 0.05$) difference was observed in the breast yield in the T_2, T_3 and T_4.

The yield of thigh (%) T_1, T_2, T_3 and T_4 at the end of the experiment were 9.42, 10.14, 10.06 and 10.15, respectively. Statistical analysis revealed no significant ($p > 0.05$) difference in yield of thigh between the treatments.

At the end of the experiment, the drumstick yield (%) in T_1, T_2, T_3 and T_4 were 8.19, 9.21, 9.15 and 9.23 respectively. Statistical analysis revealed significant ($p \leq 0.05$) difference in the drumstick yield between the treatments (T_2, T_3 and T_4) and control (T_1). no significant ($p > 0.05$) difference in drumstick yield between treatments T_2, T_3 and T_4.

The percent abdominal fat (%) at the end of the experiment were 1.111, 0.941, 0.933 and 0.896 in T_1, T_2, T_3 and T_4 at the end of the experiment. Statistical analysis revealed significant ($p \leq 0.05$) difference was observed in the abdominal fat percentage between treatments (T_2, T_3 and T_4) and control (T_1) and no significant difference was observed between the treatments T_2, T_3 and T_4.

The heart weight (% live weight) in different treatment groups were 0.541 (T_1), 0.540 (T_2), 0.545 (T_3) and 0.580 (T_4) there was no significant difference ($p > 0.05$) in the heart weight among all the treatment groups and control.

The liver weight (% live weight) in different treatment groups were 1.60 (T_1), 1.59 (T_2), 1.62 (T_3) and 1.66 (T_4) and there was no significant difference ($p > 0.05$) in the liver weight among all the treatment groups and control.

The proventriculus weight (% live weight) in different treatment groups were 0.421 (T_1), 0.406 (T_2), 0.403 (T_3) and 0.473 (T_4) and there was no significant difference ($p > 0.05$) in the proventriculus weight among all the groups compared to control group.

The gizzard weight (% live weight) in different treatment groups were 1.82 (T_1), 1.77 (T_2), 1.81 (T_3) and 1.76 (T_4) and there was no significant difference ($p > 0.05$) in the relative weight of gizzard among all the groups compared to control group.

Discussion

There was significant difference ($p \leq 0.05$) in dressing per centage, breast yield, abdominal fat, drumstick yield and no significant difference in thigh yield, relative weight of heart, liver, proventriculus and gizzard of birds in the groups supplemented with exogenous emulsifier (Glycerol Polyethylene Glycol Ricinoleate) in energy reduced diet compared to the control at the end of the experiment (42nd day).

The findings of present study were in agreement with Roy *et al*. (2010) [8] they conducted a research aiming to enhance productivity in broilers using a nutritional emulsifier. The diet was supplemented with a synthetic emulsifier at a dose rate of 2 % of added fat. Their findings indicated that in an increase of nearly 6 % in carcass weight and more than an 8 % increase in breast meat yield compared to the non-supplemented group.

The findings of present study were in agreement with Nagargoje *et al*. (2016) [7] they conducted an experiment to evaluate the effect of crude soy lecithin with or without lipase on carcass traits and keeping quality of meat of broiler chickens. The edible carcass yield percent was found significantly higher in lecithin alone or lipase enzyme supplemented groups.

The findings of present study were in agreement with Movagharnejad *et al.* (2020) [6] showed that how various treatments affect the relative weights of carcass weights and immune organs in broiler chickens. Broiler chickens fed with a restricted energy (150 kcal/kg diet lower than control) and the inclusion of lysophospholipids and lysolecithin had greatest breast weight than control. The relative abdominal fat was higher in control than in other treatments. This may be due to enhanced absorption and utilization of dietary lipids. This improved lipid utilization could contribute to better nutrient absorption and utilization in the broiler chickens, potentially leading to increased muscle development.

The findings of present study were in disagreement with Guerreiro Neto *et al*. (2011) [3] they investigated the impact of incorporating an emulsifier into diets containing soybean oil, poultry fat, or a mixture of both, on the performance, carcass characteristics. This study involved using three fat sources soybean oil, poultry fat, and a 50 % blend of soybean oil and poultry fat alongside the inclusion or exclusion of an emulsifier. Their findings revealed that the presence of soybean oil, poultry fat, or their combination in the diet did not exert any influence on carcass traits.

The findings of present study were in disagreement with Aguilar *et al*. (2013) [1] determined the carcass traits of broiler chicks fed with an increasing level of energy provided by palm oil (12.13, 12.80, 12.38, 13.05, 12.64 and 13.51 MJ/kg) and the supplementation of an exogenous emulsifier at liquid dose of 0.5 g/ton on broilers. The treatments did not influenced on the carcass, breast and abdominal fat weight and yield, breast meat color. Thus, the exogenous emulsifier had no effect on carcass traits in broilers.

Conclusion

Based on the above results it was concluded that inclusion of 350 ppm of exogenous emulsifier to the basal diet with energy reduced by 60 kcal, 90 kcal and 120 kcal could improve the dressing per centage, breast yield, abdominal fat, drumstick yield and there is no improvement or adverse effect on thigh yield, heart, liver, gizzard and proventriculus of the birds at the end of the experiment (42nd day).

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