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Authors' Affiliation:
1. Institute of Animal and Dairy Sciences, Faculty of Animal Husbandry, University of Agriculture Faisalabad - Pakistan
2. Poultry Research Institute, Murree Road, Shamsabad, Rawalpindi -Pakistan
3. University of Agriculture, Faisalabad (Sub-Campus Toba Tek Singh) - Pakistan

***Corresponding Author:**
Sohail Hassan Khan
Email: sohailhassan64@gmail.com

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Impact of supplemental exogenous lysolecithin on performance, fat digestibility, and lipid metabolites responses in broilers

Faizan Mahmood[1], Haq Nawaz[1], Sohail Hassan Khan[2]*, Muhammad Yousaf[1], Javid Iqbal[3]

Abstract

Background: The production and secretion of lipase and bile salt are restricted particularly in young chicks, resulting in a feeble metabolism of lipids as well as oils. Addition of exogenous lysolecithin in the poultry rations may be incorporated as better option to control such constraint.

Methods: In total, 120 day-old Hubbard broiler chickens assigned at random to four nutritional treatments for period of 42d trial. The broiler's rations (0-28d and 29-42d) were added with 0, 0.050, 0.075 and 0.10% exogenous emulsifier with1.0% soybean oil. The data relating performance, carcass traits, fat digestibility and blood fat profiles in chickens was obtained during experiment.

Results: During days 1-21 and 1-42, chickens fed diets with high levels (0.075 or 0.100%) of emulsifier with soybean oil resulted significantly ($p<0.05$) better weight gain and feed: gain ratio than without emulsifier. The broilers on emulsifier diets fed substantially ($p<0.05$) less feed intake and considerable ($p<0.05$) decreased feed: gain ratio as compared to without emulsifier at 1-21d. The relative weight of the breast or leg meat yield, and liver significantly ($p<0.05$) increased in broilers given exogenous emulsifier rations. On day 21 and 42, the digestibility of fat in birds offered with emulsifier diets were substantially ($p<0.05$) increased than that of control group. Lipid profile was not influenced by exogenous emulsifier supplementation in broiler's diet.

Conclusion: This study envisaged that exogenous emulsifier supplementation (0.05 to 0.10%) in broiler's diet improved the performance, meat yield and fat digestibility without affecting on cholesterol profile in broilers.

Introduction

Viable broilers possess a crouch yield cycle and enormous obligation for energy. Thus, the need to include fats or oils in the broiler's ration is unavoidable. Lipids and vegetable oils have maximum energy level amongst nutrients as well as mostly supply the calories density for poultry [1]. Literature showed that addition of lipids and oils in poultry diet be able to enhance the performance of growth as well as assist toward accomplish production values in commercial broilers [2]. Presently, employ of various basis of lipid, for instance vegetable oils (canola oil, soybean oil, corn oil, and sunflower oil), fat of black soldier fly larvae, and animal fat, are regular energy-based ingredients in poultry diets [3, 4]. The chemical process of fat in day-old broiler altered noticeably, from egg yolk-based fat provide to the source of external carbohydrate-based diet [2]. Though, production & secretion of lipase enzyme as well as bile salt be restricted particularly in newly hatched chicks, resulting in meager metabolism of fats and oils [5]. Supplementation of lysolecithin in the poultry rations may be employed as an appropriate mode to eradicate such constraint.

Lysolecithin is a usual fat like material [phospholipid namely lysophosphatidylcholine (19-21%), phosphatidylethanolamine (8-20%) and phosphatidylinositol (20-21%)] exist in numerous food substances, like whole grain, soyabean, and yolk of egg [6]. Moreover, lysolecithin as a main energy supplier, as well play an important role as an emulsifier through fortifying or connecting phospholipid fragments [7]. Emulsifiers comprise hydrophilic and hydrophobic particles that may circulate oil globules equally in the emulsion. Under these circumstances, emulsifiers may boost up the metabolism of fats [8].

According to Food and Drug Administration, USA, lysolecithin as emulsifier has been accepted as protected commodity for human use. Similarly, as per European Union under the number EE322, this product has also been documented as food supplement [9]. Though physiological aspects of emulsifying action have already been demonstrated but its impact on production remain questionable. Previous studies showed that specific impacts on consumption and nutrients digestibility in broilers [10] and rabbits [11] with the supplementation of lecithin as emulsifier. Studies exploring impact of lysolecithin on bird's growth performance are meager as well as inadequate.

Addition of emulsifiers in poultry ration with fat from vegetable source was recently documented to improve overall performance, energy digestibility as well as meat quality in broilers [12]. Similarly, Abbas and coworkers [13] observed that dietary supplementation of fat emulsifier, increased overall body weight and fat digestibility in broiler chicks. However, Cantor and coworkers [14] tested soybean-lecithin (emulsifier) as an alternate of mixed vegetable-animal fat in broiler rations. They reported that two levels of this emulsifier (2.5 and 5.0%) did not show significant effect on finished body weight, feed consumption and feed: gain ratio.

Therefore, the objective of this trial was to investigate the potential of lysolecithin (Lipidol®) with respect to improve the utilization of soybean oil in broilers regarding overall performance, meat yield, fat digestibility and blood cholesterol profile.

Methods

Investigational Chicks and Management

A total 120, day-old broilers having 46.0 g±3g average body weight were procured from a local hatchery. The trial was carried out with the permission of the Animal Welfare and Ethics Committee, University of Agriculture, Faisalabad, Pakistan. Birds were distributed at random into 12 apportioned floor pens (each 10′ × 15′) each containing 10 birds and three pens as replicates/ treatment following a completely randomized design. Chicks were given with *ad libitum* approach to diet and drinking water. Health protection and supervision of broiler chicks followed to the established guiding principle [15]. These chicks were reared under accepted temperature schedule, that steadily reduced from 32 degree to 24 degree centigrade within 23L: 1D cycle.

Broiler Rations

There were 2-stages rationing schedule, from 1 to 21 days (starter ration) and from 22 to 42 days (finisher ration). These rations were prepared following the recommendations of National Research Council [16]. First stage rations contained metabolizable energy 2780 Kcal/kg and crude protein 20% whereas second-stage rations hold metabolizable energy 2880 Kcal/kg and crude protein 18%. Both stages rations of broiler chicks were added with 0, or 0.050, 0.075 and 0.10% exogenous emulsifier product (Lipidol® contains lysolecithin, Easybio Co., Korea) with1.0% soybean oil. Table-1 showed the layout of rations used in experiment for broiler chicks.

Variables studied

The record of broiler's performance including body weight gain (BWG), feed consumption and feed: gain ratio was collected at 2-week periods. Data of mortality was also noted throughout study. Broilers were examined two times every day and dead birds' weight were considered to regulate for feed intake. Feed: gain ratio was workout as the ratio of grams of diet to grams of BWG.

On last day of experiment, six broiler chicks from each treatment were sacrificed to examine broilers carcass characteristics (dressing percentage, breast meat yield, legs meat yield, wings meat yield, abdominal fat pad, intestinal weight, liver weight, heart weight, gizzard weight as well as shanks weight).

Ingredients	0-28 d	29-42 d
Corn	500.00	600.00
Rice broken	50.00	-
Corn gluten meal (60%)	20.00	20.00
Canola meal	80.00	64.00
Soybean meal (47.5%)	300.00	240.00
Vegetable oil	-	30.00
Molasses	30.00	30.00
Marble chips	5.00	5.00
Dicalcium Phosphate	10.00	5.00
Vitamin premix[1]	2.00	2.00
Trace mineral mix[2]	1.00	1.00
Choline Cl (60%)[3]	1.00	1.00
L-Lys HCl (98%)	1.00	2.00
Total	**1,000.00**	**1,000.00**
Analyses		
ME, kcal/kg	2895.65	3155.90
CP, %	22.80	20.13
CF, %	3.75	3.39
Ash, %	7.17	6.39
Available Phosphorus (%)	0.40	0.40
Lysine, %	1.27	1.08
Methionine, %	0.50	0.42
Met + Cys, %	0.84	0.72
Sodium, %	0.21	0.21
Chloride, %	0.28	0.29
Lino , %	1.16	3.04

Table 1: Composition (%) and calculated nutrient content of basal rations.

A digestibility trial was conducted on 19-21d as well as 40-42d old (2 broiler chicks from each replicate). Celite (source of Acid Insoluble Ash) was incorporated in broilers ration at the rate of one percent then offered to experimental chicks. The acceptation duration of 3d was offered to chicks. Birds were placed on polythene sheets for collection of fecal samples Fecal samples were composited replicate wise and were kept at -10°C till analyzed for determination of nutrient digestibility i.e. ether extract as described by AOAC [17]. Digestibility was worked out through the formula as given below.

$$\text{Digestibility (\%)} = 100 - \{100(\frac{\text{marker in ration}}{\text{marker in feces}} \times \frac{\text{nutrient in feces}}{\text{nutrient in ration}})\}$$

At the end of trial, samples of blood were obtained from nine birds as per treatment to explore blood serum cholesterol, triglyceride, high-density lipoprotein (HDL) and low density lipoprotein (LDL). The bird's blood was assembled in a test tube to attain serum. These assembled blood samples were centrifuged at 3000g for ten minutes then serum was poured into autoclaved vials then preserved at -20°C for determining of cholesterol. Serum cholesterol, triglyceride, HDL and LDL were determined through employing diagnostic kits (Sigma Diagnostics, Catalog No. 352, Sigma Chemical Co., St. Louis, MO 63178-9916) as well as equipment i.e., spectrophotometer.

Analytical process

The recorded information was examined through applying the SPSS version 11 for analytical procedure. The p-value (<0.05) was measured a substantial variation within all treatments then evaluation of means was done applying Duncan's Multiple Range Test [18].

Results

Performance parameters

Table 2 showed an impact of exogenous emulsifier on growth performance. At starting stage (0 to 21d) as well as overall period (0 to 42d) of chickens given diets at high levels (0.075 or 0.100%) of emulsifier with soybean oil resulted substantially ($p<0.05$) better body weight gain as well as feed: gain ratio than without emulsifier. These results showed that chickens fed less ($p<0.05$) feed consumption resulted in better ($p<0.05$) feed: gain ratio than that of without emulsifier at starting stage. However, BWG, feed consumption as well as feed: gain ratio remained unaffected ($p>0.05$) among different treatments from days 22-42 (growing stage). Furthermore, feed intake did not affect among the various treatments during the overall phase.

Carcass characteristics

Exogenous emulsifier addition exhibited did not affect ($p>0.05$) on relative weights of dressing percentage, wing meat yield, abdominal fat pad, intestine, gizzard, heart, and shank (Table 3). However, the relative weight of the breast meat, leg meat yield as well as liver increased ($p<0.05$) in chicks given exogenous emulsifier diets (Table 3).

Fat digestibility

On day 21 and 42, the digestibility of ether extract (EE) in birds given emulsifier diets were enhanced ($p<0.05$) than without emulsifier group (Table 4).

Blood lipid profile

Serum cholesterol, triglyceride, HDL as well as LDL contents did not affect with exogenous emulsifier included in broiler's diet (Table 5).

Discussion

In recent years, the price of cereal grains (as energy source) is continuing to increase due to which the insertion of lipid in broiler ration preparations has developed into well known. Though, only endogenous emulsifiers may not be maintained suitable lipid metabolism in birds [19]. However, exogenous emulsifiers are proficient for increasing lipid metabolis

Treatments	Body weight gain (g)			Feed intake (g)			Feed:gain ratio		
	0-21d	22-42d	0-42d	0-21d	22-42d	0-42d	0-21d	22-42d	0-42d
Control	830.11[a]	1502.7	2272.8[a]	1215.93[a]	2699.3	3931.9	1.46a	1.79	1.72[a]
0.050%	804.66[a]	1641.6	2446.3[ab]	1075.95[b]	2828.2	3904.1	1.33[ab]	1.72	1.59[ab]
0.075%	901.44[b]	1609.7	2534.4[b]	1099.66[b]	2728.3	3732.3	1.22[b]	1.69	1.47[b]
0.100%	865.55[ab]	1499.2	2364.7[ab]	1089.75[b]	2733.3	3823.06	1.26[b]	1.82	1.61[ab]
SEM	18.31	26.78	39.13	26.54	39.09	53.61	0.025	0.05	0.03

[a-b]Means with different letters in column differ significantly (p 0.05)
SEM = Standard error mean
Table 2: Average body weight gain (g), feed intake (g) and feed: gain ratio per bird fed diets containing various levels of exogenous emulsifier and 1% soybean oil during different phases.

Parameters (%)	Treatments				SEM
	Control	0.050%	0.075%	0.100%	
Dressing percentage	60.42	59.61	62.55	61.43	3.51
Breast meat yield	39.28[b]	41.39[a]	41.89[a]	41.25[a]	2.38
Legs meat yield	15.19[b]	16.76[a]	16.62[a]	16.34[a]	1.63
Wings meat yield	9.73	9.71	9.29	9.73	0.74
Abdominal fat pad	1.75	1.71	1.70	1.68	0.25
Intestinal weight	5.40	5.66	4.95	5.99	0.60
Liver weight	2.04[b]	2.49[a]	2.55[a]	2.61[a]	0.43
Heart weight	0.43	0.52	0.49	0.46	0.12
Gizzard weight	1.95	1.86	2.08	1.87	0.31
Shank weight	4.86	4.59	4.63	4.70	0.67

[a-b]Means sharing similar superscripts in a row are statistically non-significant (P>0.05)
SEM = Standard error mean
Table 3: Average values of relative dressing percentage, meat yields, abdominal fat pad and different organ weights (g organ wt. /100g body wt.) of birds fed diets containing various levels of exogenous emulsifier and 1.0% soybean oil during cumulative phase (0-42 days).

Parameter	Treatments				SEM
	Control	0.050%	0.075%	0.10%	
1-21d					
Digestibility (%)	71.61[b]	78.55[a]	79.09[a]	78.90[a]	2.15
40-42d					
Digestibility (%)	75.22[b]	82.59[a]	84.90[a]	85.09[a]	4.69

[a-b]Means sharing similar superscripts in a row are statistically non-significant (P>0.05)
SEM = Standard error mean
Table 4: Average fat digestibility per bird fed diets containing various exogenous emulsifier levels and 1.0% soybean oil (during 19-21 and 40-42 days of age).

Parameters (mg/dL)	Treatments				SEM
	Control	0.050%	0.075%	0.100%	
Cholesterol	158.0	141.33	147.33	158.33	9.85
Triglycerides	114.33	114.00	123.67	104.00	6.99
HDL	49.67	48.33	48.33	47.67	2.36
LDL	85.67	77.00	101.33	89.67	5.15

HDL: High density lipoprotein; LDL: Low density lipoprotein
SEM = Standard error mean
Table 5: Average values of cholesterol, triglycerides, HDL and LDL per bird fed diets containing various exogenous emulsifier levels and 1.0% soybean oil during cumulative phase (0-42 days).

-m then supporting/increasing broiler's performance given low caloric ration [20]. Results of current trial were similar with findings of recent study [21] which elucidated that during 0-19d, the broilers fed diets containing 0.1 or 0.2% exogenous emulsifier showed significantly improved BWG. Moreover, feed: gain ratio also improved in broilers fed diet containing 0.1% emulsifier. Recently, Wealleans and coworkers [22] employed particulars from a great fundamental record to explain regarding lysolecithin supplementation with 0.0125% or more in broiler rations may perhaps constantly increase broiler performance over scope of husbandry circumstances, basal grains as well as lipid origin. In another study, dietary supplementation of exogenous emulsifier (lysophosphatidylcholine, 0.1%) in rations of broilers increased BWG as well as improved feed: gain ratio (i.e. 5.9%) values during 0-42d of age [10]. Likewise, more recent studies [23-26] found advancement in BWG and better feed: gain ratio by supplementation of emulsifiers (0.025 to 0.100%) in rations of broiler and duck. Better bird's performance adding emulsifier possibly recognized to the better lipid digestibility that may be increased growth of chicks proceeding to superior effectiveness of ration consumption. Addition of exogenous emulsifier apparently increased lipid consumption to little birds owing to less lipase concentration constraint the digestion and intestinal absorption of lipid in little chicks [27]. Such results could be accredited to the activity of lysolecithin as lipid emulsifier that alongwith

enhanced hydrolysis of lipids, ends in high concentrations of micelle creation and metabolism of lipids [28]. In contrast, emulsifiers displayed non-significant influence on the broilers' production with regard to BWG and feed: gain ratio at both 21 and 35d of age [29]. The conflicting findings in respect of growth performance possibly because of variations in the forms and quantities of nutritional lipid origins like different oil sources of palm, soybean, tallow, poultry fat as well as main constituent of emulsifying agent such as lysophosphatidylcholine, soybean lecithin, glyceryl-polyethylene or glycol ricinoleate. In this study, lysolecithin was added as emulsifier to the broiler's diet which efficiently reduced the dimension of lipid droplets or enhanced the dynamic outside area of lipids for enzymatic action [30]. Consequently, lipid droplets are not simply chemically assimilated as well as maintain like indigestible leftovers inside the intestinal region.

In relation to carcass characteristics, two studies [31, 32] indicated so as addition of lysolecithin to broiler rations displayed maximum yield of breast and thigh muscle than control. It is consistent with present study and showed that lysolecithin may increase the distribution of fats within the bird's carcass, thus advancing the feature of muscle. The considerable reducing influence of abdominal fat did not observe in the current trial. The possible reason perhaps the emulsifier modifies the accessibility of fat as well as protein particles in the dissemination in favor of alteration into the muscles instead of abdominal fat accumulation thus ultimately influences fatty acid and amino acid accumulations in the flesh [33]. Although, several aspects can add in the consumption of auxiliary lipid like, constitution of the added lipid, physical appearance of lipid or amount of the emulsifiers [26]. Moreover, emulsifier has also potential of antioxidant and observed the greater oxidative stability of the cooked broiler muscle resulting from birds fed the high emulsifier supplemented diets [34]. In poultry, liver is primary organ implicated to fat digestion and absorption in the body that considers about 95% of a new fatty acid production [20]. Present findings were harmony with the earlier study [35] which explained better liver weight observed through supplementing soy-lecithin as emulsifier to broiler's ration. As a result, increased liver weight probably linked to the fortified fat digestion and absorption in the liver. The trend of fat digestibility increased in broiler chicks offered diets enriched with exogenous emulsifier during starter and finishing phases. Ether extract digestibility is restricted in immature chicks whilst discharge of lipase enzyme is not sufficient. Actually, immature broiler chicks possess little capability for digestion of lipid than grown-up broilers. But, addition of exogenous emulsifier to the rations of broiler chicken improved lipid metabolism in immature chicks [36]. In present study, the digestibility of fat enhanced at 21d, whereas maximum consumption of fat was recorded in the birds given emulsifiers diets than that of control diet. The similar findings were observed in another study in which utilization of fat increased in birds offered rations supplemented with soy-lecithin as emulsifiers (0.05 to 0.10%) during 19-21 day [20]. Literature indicated that a positive correlation noted between exogenous emulsifier in the broiler's ration as well as ether extract digestibility [37]. Improvement in broiler performance in this trial was owing to enhancing the ether extract digestibility with supplementation of emulsifier. Blood profile is generally linked with physical condition as its values are excellent signals of dietary condition of poultry. This trial showed that there was non-significant effect on serum cholesterol, triglyceride, HDL and LDL contents with addition of emulsification. Preceding research trials on the impact of emulsifiers on serum fat status in meat-type birds are inadequate. Moreover, findings of trials in respect of fat profile with addition of nutritional emulsifier are contradictory. Two studies [38, 39] found in the support of the current study so as to serum cholesterol, triglyceride and HDL- cholesterol contents in birds given with rations including oil from vegetable source or tallow did not influence through emulsifier inclusion i.e. glyceryl polyethylene glycol ricinoleate and lysolicithin. On the contrary, another study showed birds offered to ration consisting 0.05% emulsifier (sodium stearoyl-2-lactylate) recorded lesser serum triglycerides as compared to birds given with high-caloric rations without emulsifier [28].

Supplemental exogenous emulsifier in broiler's ration improved the BWG, feed: gain ratio, yields of leg & breast meat as well as fat digestibility without affecting on cholesterol profile in broilers. Moreover, supplementation of lysolecithin (0.05 to 0.10%) in basal ration included 1.0% soybean oil indicated somewhat better performance as compared to control diet in broilers. Supplemental emulsifiers in altering fat metabolic process in broilers requires to be more inspected.

Competing interest

The authors certify that they have no conflict of interest to declare in the subject matter or materials discussed in this manuscript.

Authors' Contribution

FM, HN and MY designed the experiments and supervised the research. SHK and JI participated in the analyses and provided consultation. SHK, HN and FM

wrote the paper. All authors have read and approved the manuscript.

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