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Effect of Emulsifier Supplementation on Production Performance of Broilers in Grower Phase (0–21 days)

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Abstract

This trial was performed to investigate the impact of supplementation of emulsifier on broiler production parameters, nutrient digestibility, and carcass characteristics during the grower phase. To execute the trial, day-old ($n=240$) broiler chicks (Ross-308) were classified into 4 dietary treatments (LS0, LS15, LS30, and LS45) at random, with 6 replicates and 10 birds per replicate. Dietary treatment LS0 included a basal diet without any emulsifier; LS15 contained 150 g/ton emulsifier, LS30 contained 300 g/ton emulsifier, and LS45 contained 450 g/ton emulsifier. Weekly feed consumption and weight gain (WG) records were kept to calculate the feed conversion ratio (FCR). Birds' feces were sampled replicate-wise on the 21st day to measure nutrient digestibility by adding Celite® as an external marker. On the 21st day, two birds from each replicate were slaughtered to evaluate carcass characteristics (percentage of dressing, carcass, and relative organ weight). During week 1, no significant ($p > .05$) difference in feed intake (FI) was observed among all the treatments. During the second and third weeks, the highest ($p < .05$) FI was observed in birds fed the LS0 diet. Birds fed LS45 showed significantly higher ($p < .05$) WG during all 3 weeks. During the first week, birds fed LS30 and LS45 showed similar FCRs. During the second and third weeks, better ($p < .05$) FCR was seen in birds fed the LS45 diets. The findings showed the highest ($p < .05$) crude protein, dry matter, and ether extract digestibility in birds given diet LS45. Moreover, the dressing, carcass, thigh yield, and relative heart and liver weight percentages were higher ($p < .05$) in birds fed LS45 diets than in other dietary treatments. Birds fed the LS0 diet showed the highest ($p < .05$) relative gizzard weight percentage compared to other treatments. However, breast yield and abdominal fat weight percentages were unaffected ($p > .05$) due to dietary treatments. Overall, based on the outcomes of this investigation, it is suggested that supplementing the diet with emulsifier at 450 g/ton optimizes the growth performance, carcass parameters, and nutrient digestibility of nutrients of broilers throughout the grower phase (0–21 days).

Keywords: Broiler, carcass characteristics, emulsifier, fat digestibility, growth performance, nutrient digestibility

What is already known on this topic?

- *While emulsifier supplementation has been extensively studied for its effects during the starter (0–10 days) and finisher (22–35 days) phases of broiler production, limited research has focused on its impact during the grower phase (11-21 days).*

What this study adds on this topic?

- *In this study, a novel emulsifier, specifically formulated to enhance fat metabolism and improve energy utilization was used. This formulation was designed based on the characteristics of leading emulsifier products currently available in the market.*

Introduction

Poultry mostly obtains its energy from fats and oils, which are also known as lipids. For many years, the poultry sector has been incorporating fat into birds' diets to promote carcass development and quality, higher feed efficiency, and improved performance. Fat also aids in reducing the amount of dust in the feed and improves its palatability (Fébel et al., 2008; Firman et al., 2008).

In addition to cereal grains, fats are the densest energy sources for the birds and improve their productivity. Additionally, they supply vital fatty acids and act as a transport for vitamins that are lipid soluble (Rossi et al., 2010). Improving fat digestibility allows for lower levels of additional lipids to be included in broiler chicken diets, lowering feed production costs while maintaining performance (Ahmadi-Sefat et al., 2022). However, bile salts and pancreatic lipase are required to emulsify the digestion of fat in the gastrointestinal tract due to their chemical ability to be not soluble in water. It has been noted that many factors, such as age, genetic strain, enzyme activity, and diet composition, may influence lipid digestion (Zampiga et al., 2016).

Additionally, there is an age-related decline in the ability of newly hatched birds to efficiently use fats, especially animal fats, which may be due to the underdeveloped gastrointestinal tract of young birds prior to 10–14 days of age (Ravindran & Abdollahi, 2021). As the chick grows, its secretion of lipase increases with the development of its proventriculus and pancreas (Hakansson, 1974; Noy & Sklan, 1995). Therefore, emulsifier supplementation in their diet is more necessary at the initial phase of life (Sell & Hodgson, 1962).

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Consequently, one possibility to address the issue of fat digestion in broiler diets is to include exogenous emulsifiers. Emulsifiers work by separating fat globules and increasing the fats' active surface area, which improves the activity of enzymes that hydrolyze glycerides into fatty acids and promotes the production of micelles made up of lipolysis derivatives. By producing a diffusion gradient, this significantly increases the absorption of lipids (Haetinger et al. 2021). According to several studies, broiler chicken performance may be enhanced by adding exogenous emulsifiers to their diet (Guerreiro Neto et al., 2011; Melegy et al., 2010; Roy et al., 2010; Zhang et al., 2011). Supplementation of exogenous emulsifiers to feed may help in emulsification, thereby aiding in fat absorption and digestion (Mendoza & Van Heugten, 2014). The addition of emulsifiers at 0.05% and 0.10% (lysolecithin) into diets of broilers having low energy increased body weight gain (BWG) during the 1–28 days (Mohammadigheisar et al., 2018). The addition of synthetic emulsifiers at multiple levels (1 g/kg, 0.5 g/kg, and 0.75 g/kg) in broiler diets increased body weight (BW) from day 12–22 than the control (Bontempo et al., 2018). Supplementation of blends of emulsifiers (Sodium Stearoyl-2-Lactylate and 1,3-Diacylglycerol) in broiler feed with various energy levels enhanced feed conversion ratio (FCR) at various phases and overall period than the control (Liu et al., 2020). The supplementation of 0.05% emulsifier in low dietary energy (40 kcal, 60 kcal, and 80 kcal) was found to increase fat digestibility in broilers than the basal diet with no emulsifier addition (Serpunja & Kim, 2019).

It was hypothesized that the supplementation of exogenous emulsifier would aid in fat digestibility, which could increase live weight gain (WG), FCR, nutrient digestibility, and carcass parameters. Therefore, the main purpose of the trial was to check the impact of emulsifier supplementation on broiler growth parameters, nutrient digestibility, and carcass characteristics of broiler birds during the grower phase (0–21 days).

Method

The present investigation was performed at Raja Muhammad Akram Nutrition Research Center, Directorate of Farms, University of Agriculture, Faisalabad. This study was carried out after the animal experiment was permitted by the Graduate Studies & Research Board, University of Agriculture, Faisalabad (Approval no: 24509-12, Date: July 5, 2023).

Experimental Plan

To execute the research, 240-day-old broiler (Ross-308) birds were obtained from a commercial hatchery. Then, birds were randomly classified into 4 dietary treatments (LS0, LS15, LS30, and LS45), each with 6 replicates having 10 birds per replicate. Dietary treatment LS0 was a basal diet without any emulsifier; LS15 contained 150 g/ton emulsifier, LS30 contained 300 g/ton emulsifier, and LS45 contained 450 g/ton emulsifier. Table 1 shows the composition of the experimental diets. All nutrients in the diets were formulated according to the nutrient requirements recommended by Council & Nutrition (NRC, 1994), except metabolizable energy (ME), which was 100 kcal/kg lower than the recommendations.

Emulsifier Composition

A bio-surfactant-based energy booster, designed to optimize fat digestibility and absorption, thus improving energy utilization by

Table 1.

Dietary Composition and Nutrient Content of Broiler Diet (0–21 Days)

Ingredients (%)	LS0	LS15	LS30	LS45
Corn	54.24	54.22	54.21	54.19
Rice polishing	8.00	8.00	8.00	8.00
Soybean meal	26.79	26.79	26.79	26.79
Canola meal	8.00	8.00	8.00	8.00
Calcium carbonate	1.13	1.13	1.13	1.13
MCP	0.51	0.51	0.51	0.51
NaCl	0.15	0.15	0.15	0.15
Sodium bicarbonate	0.33	0.33	0.33	0.33
Lysine sulphate, 55%	0.33	0.33	0.33	0.33
DL-Methionine, 99.5%	0.25	0.25	0.25	0.25
L-Threonine, 99%	0.05	0.05	0.05	0.05
L-Isoleucine	0.015	0.015	0.015	0.015
L-Valine	0.005	0.005	0.005	0.005
*Vitamin premix	0.1	0.1	0.1	0.1
**Mineral premix	0.1	0.1	0.1	0.1
†Winzyme HTR®	0.005	0.005	0.005	0.005
††LipidSolve®	–	0.015	0.03	0.045
Total	**100**	**100**	**100**	**100**
Nutrient composition				
Nutrients				**%**
Dry matter				89.79
Metabolizable energy (Kcal/kg)				2900
Crude protein				21.55
Ether extract				4.00
Crude fiber				4.08
Calcium				0.85
Available Phosphorus				0.42
Phytic Phosphorus				0.32
Sodium				0.23
Chloride				0.19
Lysine, digestible				1.18
Methionine + Cystine, digestible				0.90
Threonine, digestible				0.79
Tryptophan, digestible				0.25
Arginine, digestible				1.29
Valine, digestible				0.89
Leucine, digestible				1.58
Isoleucine, digestible				0.8

LS0 Basal diet without emulsifier. LS15 Basal diet containing 150 g/ton emulsifier. LS30 Basal diet containing 300 g/ton emulsifier. LS45 Basal diet containing 450 g/ton emulsifier. *Vitamin premix provides Vitamin D3, 5400 KIU; Vitamin B1, 4000 mg; Vitamin B2, 9000 mg; Vitamin B6, 7600 mg; Vitamin A, 20 000 KIU; Vitamin E, 48,000 mg; pantothenic acid, 20,000 mg; folic acid, 1600 mg; biotin, 200 mg; Vitamin K3, 4000 mg; Vitamin B12, 20 mg; niacin, 60,000 mg/kg of diet. **Mineral premix provides, zinc, 120,000 mg; iron, 10,000 mg; copper, 12,000 mg; iodine, 1800 mg; cobalt, 400 mg; manganese, 140,000 mg; and selenium, 360 mg/kg of diet. †Winzyme HTR® is a phytase with activity 20,000 FTU/g phytase. ††Lipid Solve® is a commercially synthesized exogenous emulsifier.

fats and oils incorporated in animal feed. It contains surfactin, the most powerful bio-surfactant, and a lipopeptide-type biosurfactant that is produced by *Bacillus subtilis*, Glyceryl monostearate, and polyacrylate.

Growth Performance

Birds' BWs were measured weekly until the end of the study. The BW and feed intake (FI) were checked at the end of each week throughout the entire growth period to determine BWG, FCR, and average feed consumption. On the 21st day, two birds per replication were picked randomly and then slaughtered for carcass parameters.

Mortality (%): Mortality was monitored daily, and postmortems were undertaken in the event of any disease lesions. The mortality record was maintained daily. Dead birds were weighed and used to adjust the BWG and FCR.

To determine the average FI weekly, the amount of feed rejected each week was deducted from the total amount of feed provided.

Feed intake per bird = (Feed offered − Feed refused)/Total no. of birds per replicate.

The average FI and BWG data were used to calculate FCR every week, using the following equation:

FCR = Feed intake (g)/Weight gain (g)

Nutrient Digestibility

Digestibility was calculated by the indirect marker method. For this reason, Celite® (acid-insoluble ash) was mixed into the diet of birds at 1% on the 18th day, and feces were collected every 24 hours for 3 days to determine nutrient digestibility. Feces were collected replicate-wise by spreading polyethylene sheets on the floor. After collecting feces for 3 days, all the fecal samples were mixed homogeneously replicate-wise. Then these fecal samples were kept in airtight plastic bags at −20°C until analyzed for Acid Insoluble Ash (AIA) and proximate analysis (Shabir et al., 2019). As stated in the literature (Muhammad et al., 2016; Niu et al., 2017) feed and fecal moisture and fat content were analyzed using (AOAC, 2006) procedures. Fat content was measured using the Soxhlet device. AIA was determined by ashing the specimens and subjecting them to scorching hydrochloric acid (Viveros et al., 2002). The digestion technique was followed as reported in previous investigations (Massuquetto et al., 2019).

Carcass Parameters

On the 21st day of the trial, two birds from each replication were picked at random as a sample for determining carcass characteristics by slaughtering. All the visceral organs, head, shanks, and feathers were removed, and carcass yield percentage was calculated. The percentages of dressing, thigh, abdominal fat, and breast were determined. The dressing percentage was obtained by dividing the carcass weight, including internal organs such as the gizzard, heart, and liver, by the live weight in grams.

Statistical Analysis

Statistics 8.0 was used to analyze the results of recorded data using Analysis of Variance (ANOVA) under a completely randomized design by using Tukey's test for the comparison of the mean (Steel & Torrie, 1997).

Results

Growth Performance

Feed Intake

The total amount of feed consumed by the birds every week is presented in Table 2. During the first week of the trial, no significant ($p > .05$) difference was seen in FI. During week 2, the highest ($p < .05$) FI was seen in birds offered LS0 diets while the lowest ($p < .05$) FI was seen in birds fed LS45 diet. During the third week, birds fed the LS0 diet had the highest ($p < .05$) FI, while those fed the LS15 diet had the lowest ($p < .05$) FI.

Body Weight Gain

The live WG of all experimental groups recorded weekly is shown in Table 3. During week 1, birds fed the LS45 dietary treatment showed higher ($p < .05$) BWG while birds fed the LS15 diets showed lower ($p < .05$) WG. During the second week, higher ($p < .05$) BWG was observed in birds offered LS45 diets, while lower ($p < .05$) BWG was noticed in birds fed LS0 diets. During the third week, higher ($p < .05$) BWG was found in birds given the LS45 diets, while birds fed the control diet showed the lowest ($p < .05$) WG.

Feed Conversion Ratio

The results of mean values for FCR are mentioned in Table 4. During the first week, birds offered dietary treatments LS30 and LS45 showed better ($p < .05$) FCR compared to other treatments. During the secondandthird weeks, better ($p < .05$) FCR was observed in birds fed a diet supplemented with 450 g/ton emulsifier while birds fed a control diet showed poor ($p < .05$) FCR.

Overall Period (0–21 days)

Overall growth performance from days 0–21 is shown in Table 5. During the overall grower phase, birds fed the control diet showed higher ($p < .05$) FI while birds fed LS15 diets showed lower ($p < .05$) FI. Birds fed LS45 diets had higher ($p < .05$) BWG while birds fed LS0 diets showed lower ($p < .05$) BWG. Birds fed LS45 diets showed better ($p < .05$) FCR than other dietary treatments. Mortality remained unaffected ($p > .05$) due to dietary treatments during the overall growth period from (0–21) days.

Nutrient Digestibility

At day 21, birds kept on a diet supplemented with 450 g/ton emulsifier showed significantly higher ($p < .05$) digestibility of crude protein (CP), ether extract (EE), and dry matter (DM), while birds fed the LS0 diet showed significantly lower ($p < .05$) digestibility of CP, EE, and DM (Table 6).

Table 2.
Effect of Dietary Supplementation of Different Levels of Emulsifier on Weekly Feed Intake of Broiler Chicken

Week	LS0	LS15	LS30	LS45	SEM	*p*
Week 1	140.27	135.72	137.63	138.66	1.71	.324
Week 2	374.62^{a}	369.54^{a,b}	361.58^{b,c}	360.66^{c}	2.05	.0002
Week 3	591.27^{a}	553.83^{c}	566.67^{b}	585.51^{a}	3.19	.0001

LS0 Basal diet without emulsifier.
LS15 Basal diet containing 150 g/ton emulsifier.
LS30 Basal diet containing 300 g/ton emulsifier.
LS45 Basal diet containing 450 g/ton emulsifier.
$^{a–c}$Means with different superscripts within a row differ significantly ($p < .05$).

Table 3.
Effect of Dietary Supplementation of Different Levels Emulsifier on Weekly Body Weight Gain of Broiler Chicken

Week	LS0	LS15	LS30	LS45	SEM	*p*
Week 1	131.20^{b}	122.13^{c}	136.85^{a}	137.72^{a}	0.82	.0001
Week 2	271.65^{c}	285.72^{b}	286.94^{b}	296.55^{a}	2.59	.0001
Week 3	345.24^{c}	354.98^{b}	362.66^{b}	389.82^{a}	2.59	.0001

LS0 Basal diet without emulsifier.
LS15 Basal diet containing 150 g/ton emulsifier.
LS30 Basal diet containing 300 g/ton emulsifier.
LS45 Basal diet containing 450 g/ton emulsifier.
$^{a-c}$Means with different superscripts within a row differ significantly ($p < .05$).

Table 5.
Impact of Dietary Supplementation of Different Levels of Emulsifier on Overall Growth Performance of Broiler Chicken (Day 0–21)

Items	LS0	LS15	LS30	LS45	SEM	*p*
FI (g)	1106.2^{a}	1059.1^{c}	1065.9^{c}	1084.8^{b}	3.74	.0001
BWG (g)	748.09^{b}	762.83^{c}	786.45^{b}	824.09^{a}	3.93	.0001
FCR	1.3862^{a}	1.3887^{a}	1.3554^{b}	1.3164^{c}	8.56	.0001
Mortality %	1.41	0.92	1.32	0.74	0.34	.5712

LS0 Basal diet without emulsifier. LS15 Basal diet containing 150 g/ton emulsifier. LS30 Basal diet containing 300 g/ton emulsifier. LS45 Basal diet containing 450 g/ton emulsifier. BWG, body weight gain; FCR, feed conversion ratio; FI, feed intake. $^{a-c}$Means with different superscripts within a row differ significantly ($p < .05$).

Carcass Characteristics

In comparison with the other dietary treatments, birds offered LS45 diets showed higher ($p < .05$) while the LS0 group showed lower ($p < .05$) dressing percentages. Birds fed LS45 diets showed higher ($p < .05$) while birds offered LS15 diets showed lower ($p < .05$) carcass percentages. Birds fed LS45 diets showed higher ($p < .05$) while birds fed LS15 diets showed lower ($p < .05$) thigh yield percentages. Birds fed LS45 diets showed higher ($p < .05$) while the LS0 group showed lower ($p < .05$) relative heart and liver weight percentages. Birds fed LS0 diets had higher ($p < .05$) relative gizzard weight percentages than birds offered diets enriched with emulsifiers. Breast yield and abdominal fat weight percentages remained unaffected ($p > .05$) due to dietary treatments (Table 7).

Discussion

Growth Performance

Dietary lipids contain the highest calorific value among all other nutrients and are ideal for meeting the body requirements and energy balance of high-performing birds. During week 1, FI was unaffected ($p > .05$) by dietary treatments. These findings agreed with the study performed by Park et al. (2018), who found that adding lysolecithin to low-energy diets did not affect FI in broilers. Our findings are consistent with Abbas et al. (2016) found that the inclusion of different levels of fat (1%, 2%, and 3%) with or without 350 mg/kg emulsifier did not affect FI in broilers during starter, finisher, and overall periods compared to diets without emulsifier. This may be due to the improved digestibility of nutrients with the supplementation of emulsifiers that meet the caloric demands of the birds and the birds could not eat more feed (Mathlouthi et al., 2003). During week 2, the highest ($p < .05$) FI was seen in birds offered the control diet compared to birds fed the treatment diets, and the lowest ($p < .05$) FI was seen in birds fed the LS45 diet. During the third week, dietary treatment LS0 showed higher ($p < .05$) FI while birds fed LS15 diet showed lower ($p < .05$) FI. Our findings contradict Mohammadigheisar et al. (2018) found that adding 0.05% and 0.10% lysolecithin to low-energy diets did not influence FI in broilers during the 0–28-day period. Similarly, our outcomes are in agreement with Roy et al. (2010) who stated that lowering the dietary energy levels and supplementing the diets with an emulsifier might improve FCR by reducing FI.

Table 4.
Effect of Dietary Supplementation of Different Levels Emulsifier on Weekly Feed Conversion Ratio of Broiler Chicken

Weeks	LS0	LS15	LS30	LS45	SEM	*p*
Week 1	1.07^{a}	1.11^{a}	1.00^{b}	1.00^{b}	0.01	.0001
Week 2	1.38^{a}	1.29^{b}	1.26^{b,c}	1.21^{c}	0.01	.0001
Week 3	1.71^{a}	1.56^{b}	1.56^{b}	1.50^{c}	0.01	.0001

LS0 Basal diet without emulsifier. LS15 Basal diet containing 150 g/ton emulsifier. LS30 Basal diet containing 300 g/ton emulsifier. LS45 Basal diet containing 450 g/ton emulsifier. $^{a-c}$Means with different superscripts within a row differ significantly ($p < .05$).

During week 1, birds fed LS30 and LS45 dietary treatment showed higher ($p < .05$) BWG. Our results are in agreement with the outcomes of Bontempo et al. (2018), who stated that BWG was more enhanced in broilers given multiple levels of synthetic emulsifier diet during the starter phase than in the control group. This might be due to the supplementation of emulsifiers at high concentrations that can increase the absorption of fat, producing higher energy. Hence, the birds gained more weight compared to the other dietary treatments. During the second and third weeks, higher ($p < .05$) BWG was seen in birds given a diet supplemented with 450 g/ton emulsifier. These findings are in line with Zaefarian et al. (2015) investigated the effects of lysolecithin emulsifiers within broiler diets and reported that BWG increased in broilers by adding lysolecithin to a soybean-based diet during 1–21 days. This gain in weight might be due to the high emulsifying activity of the emulsifier used in the study.

During the first week, birds fed dietary treatments LS30 and LS45 showed better ($p < .05$) FCR. These findings align with the outcomes of Liu et al. (2020) studies that the addition of emulsifier blends in a broiler diet with various energy contents improved FCR during the starter phase compared to the control diet. The broilers' improved FCR could be attributed to better fatty acid and nutrient digestibility (Zhang et al., 2011). During the second and third weeks, better ($p < .05$) FCR was observed in birds fed a diet supplemented with 450 g/ton emulsifier while birds fed a control diet showed poor ($p < .05$) FCR. Our findings are in close agreement with Upadhaya et al. (2017) showed that adding different levels of 1, 3-diacylglycerol emulsifier in the broiler diet improved FCR only during the grower phase compared to the control diet. This improvement might be due to dietary supplementation of emulsifier that improved BWG mainly during the grower phase due to the high emulsifying activity of bile acid and emulsifier that resulted in better utilization of energy by the broiler birds. Improved high-energy content resulted in improved FCR in birds (Ge et al., 2019; Lai et al., 2018; Parsaie et al., 2007).

Nutrient Digestibility

The findings of the current investigation showed that birds fed a diet supplemented with 450 g/ton emulsifier showed better ($p < .05$) digestibility of EE and CP. This might be because adding an exogenous emulsifier to the diet helped the birds' bodies to better emulsify, digest, and absorb fat (Maisonnier et al., 2003). Increased fat digestibility in our study may contribute to the increased average total tract digestibility of DM and CP observed. These findings are similar to the results of Hu et al. (2019), who suggested that adding bile acid increased the fat digestibility of broiler chickens. Likewise, Alzawqari et al. (2011) stated that the digestibility of fat improved ($p < .05$) with the addition of bile during the starter phase. In contrast with our study, Dierick and Decuypere (2004) reported that the addition of lipase and lysoforte did not produce any significant improvement in fat digestibility while there was an improvement in the digestibility of some minor fatty acids.

The increased digestibility of EE in our study might be attributed to the growth of lipase secretions, bile salts, and digestive organs, which create tiny droplets of lipid micelles and hence improve fat digestion (Wiseman, 2013). Our results are in line with Zavareie and Toghyani (2018) who found that emulsifier addition in the diet enhanced EE digestibility on the 21st day of the study. Likewise, Hosseini et al. (2018) demonstrated that supplementing broiler diets with lysolecithin emulsifier improved the digestibility of DM, CP, and EE. The digestibility of EE and CP in broilers was improved by the supplementation of fat source blends (soybean oil and poultry oil) with emulsifiers in the diet, compared to a diet with no emulsifier (Guerreiro Neto et al., 2011). The addition of a 0.05% emulsifier in low-energy diets (40 kcal, 60 kcal, and 80 kcal) was found to increase fat digestibility in broilers compared to the basal diet with no emulsifier supplementation (Serpunja & Kim, 2019). Similarly, the impact of supplementing young broilers' diet with an emulsifier improved the digestibility of EE and DM (Abbas et al., 2016). Additionally, Drażbo et al. (2019) reported that fat digestibility was increased by the inclusion of a commercial emulsifier (at 500 mg/kg) in the diet of broilers.

Carcass Characteristics

In comparison with the other dietary treatments, birds fed LS45 diets showed higher ($p < .05$) dressing percentages, while the LS0 group had lower ($p < .05$) dressing percentages. Carcass percentage was better ($p < .05$) in birds given a diet supplemented with 450 g/ton emulsifier. An increase in carcass weight following emulsifier supplementation appears to be linked to improved lipid facilitation (Han YungKeun et al., 2010). The thigh yield percentage was higher ($p < .05$) in birds fed LS45 diets, while it was lower ($p < .05$) in birds offered LS15 diets. Our results contradict Kamran et al. (2019), who concluded that different fat sources and emulsifier levels did not influence thigh yield percentage in broiler chickens. No significant ($p > .05$) difference was observed in the breast yield percentage among birds fed all dietary treatments. Our findings are in tune with Bontempo et al. (2018), who found that the addition of synthetic emulsifiers in the broiler's diet did not significantly affect breast weight. In the current study, there was no significant ($p > .05$) variation in the percentage of bird abdominal fat among all treatments. Our results are consistent with those of Liu et al. (2020) who stated that the inclusion of emulsifiers in the broiler diet did not have any impact on the weight of breast muscles and abdominal fat when compared to the control diet. In contrast with our study, Mohammadigheisar et al. (2018) found that the inclusion of 0.05% emulsifier (lysolecithin) in the diet improved the weight of breast muscles. In the current experiment, birds fed diets LS30 and LS45 showed higher ($p < .05$) relative heart and liver weight percentages. Our results are in line with (Siyal et al. 2017), who concluded that the supplementation of emulsifier in the broiler diet resulted in increased liver weight at 21 days of age compared to the control. The possible reason might be an increase or decrease in the relative weight of the liver can be related to the synthesis and circulation of lipids in the bloodstream (Aguilar et al., 2013). In the present research trial, a higher ($p < .05$) heart weight percentage was seen in birds fed the LS45 diet as compared to other dietary treatments. These findings are comparable to Saleh et al. (2009), who investigated that birds that consumed dietary emulsifiers may have had larger carcass and organ weights as a result of increased fat utilization, which may have resulted in higher ME values.

Table 6.

Impact of Dietary Supplementation of Different Levels of Emulsifier on Nutrient Digestibility of Broiler Chicken at Day 21

Digestibility (%)	LS0	LS15	LS30	LS45	SEM	*p*
Dry matter	70.06^{c}	70.14^{c}	71.41^{b}	72.30^{a}	0.03	.0001
Crude protein	72.49^{c}	72.51^{c}	72.90^{b}	73.49^{a}	0.02	.0001
Ether extract	79.07^{d}	80.66^{c}	81.50^{b}	82.73^{a}	0.02	.0001

LS0 Basal diet without emulsifier.LS15 Basal diet containing 150 g/ton emulsifier. LS30 Basal diet containing 300 g/ton emulsifier. LS45 Basal diet containing 450 g/ton emulsifier. $^{a–d}$Means with different superscripts within a row differ significantly ($p < .05$).

Table 7.

Impact of Dietary Supplementation of Different Levels Emulsifier on Carcass Parameters of Broiler Chicken on Day 21

Carcass Characteristics (%)	LS0	LS15	LS30	LS45	SEM	*p*
Dressing	74.77^{b}	77.29^{b}	78.18^{a}	79.88^{a}	12.84	.0001
Carcass	$65.91^{a,b}$	64.30^{b}	$66.31^{a,b}$	68.90^{a}	9.11	.0006
Breast yield**	31.62	31.28	31.18	29.87	4.76	.1165
Thigh yield**	$25.86^{a,b}$	24.82^{b}	$26.10^{a,b}$	27.12^{a}	3.82	.0134
Liver weight¶	2.73^{b}	2.84^{b}	$2.92^{a,b}$	3.11^{a}	1.31	.0015
Heart weight¶	0.59^{b}	$0.61^{a,b}$	$0.62^{a,b}$	0.63^{a}	0.26	.0040
Gizzard weight¶	2.50^{a}	2.03^{b}	2.00^{b}	2.07^{ab}	0.80	.0004
Abdominal fat weight¶	2.29	2.13	2.23	2.21	0.88	.4450

LS0 Basal diet without emulsifier. LS15 Basal diet containing 150 g/ton emulsifier. LS30 Basal diet containing 300 g/ton emulsifier. LS45 Basal diet containing 450 g/ton emulsifier. $^{a-b}$Means with different superscripts within a row differ significantly ($p < .05$). **Breast and thigh yield (% to carcass weight). ¶Relative organ (liver, gizzard, and heart) weight and abdominal fat (% to live weight).

Conclusion and Recommendations

It can be concluded that various levels of emulsifier improved the growth performance of birds. The pronounced impact was noticed in birds offered diets enriched with 450 g/ton emulsifier. Hence, the addition of an emulsifier at a higher dose significantly improved the birds' performance during the grower phase (0–21 days).

Data Availability Statement: The data that support the findings of this study are available on request from the corresponding author.

Ethics Committee Approval: This study was carried out after the animal experiment was permitted by the Graduate Studies & Research Board, University of Agriculture Faisalabad (Approval no: 24509-12, Date: July 5, 2023).

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