Journal of
Animal Health and Behavioural Science

Research Article Open Access

Effect of Dietary Supplementation of Lysophospholipids and Phospholipids Blend on Performance and Carcass Quality Traits of Broilers Fed Energy Deficient Diet

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Abstract

This study was conducted to evaluate productive performance and carcass quality traits of broiler chickens fed diets supplemented with an exogenous emulsifier based on lysophospholipids and Phospholipids. Two hundred and forty, newly hatched male chicks of a commercial strain (ARBOR ACRES PLUS) were randomly divided into four treatment groups. Each treatment group had6 replicateswith10 birds in each group. Birds were reared in separate pens as an experimental unit. Two basal diets were formulated; one with full energy diet which served as positive control (PC) and another was 80 Kcal/ kg less as compare to PC at each phase of diet which served as negative control (NC). Each of the diet was supplemented with 250 gm /ton of Lysophospholipids & Phospholipids blend emulsifier (JubiDOL plus) and fed to birds from 0 to 35 days of age. At the end of the trial (35 d), birds that received the Lysophospholipids & Phospholipids blend emulsifier had a statistically significant ($p<0.05$) higher body weight, lower feed conversion rate and better EEF as compared to the negative control. While mortality and feed intake was similar amongst control and treatment the groups. There was no statistically significant effect of the emulsifier on carcass traits and incidence of foot pad dermatitis.This study concluded that the use of an emulsifier based on Lysophospholipids & Phospholipids blend improved the performance and feed efficiency while there were limited effects on carcass quality traits of broilers.

Keywords: Broiler; Emulsifier; Lysophospholipids; Phospholipids; Performance

Introduction

Lipids are water-insoluble compounds and their digestion is due to the synergic action of bile salts and pancreatic lipase. Lipid digestion takes place in an aqueous environment in small intestine where bile salts ensure emulsification of dietary fats allowing pancreatic lipase to hydrolyse the triglycerides present on water–oil interface, with production of 2-monoglycerides and free fatty acids [1]. Furthermore, bile salts play a key role in the formation of mixed micelles which are subsequently absorbed by the mucus producing cells of the small intestine [2]. Broilers are reared in intensive production systems and require an adequate dietary source of energy and protein to express their genetic potential. In order to achieve these requirements, large amounts of animal fats and vegetable oils are added to their diets to increase the energy content [3]. However, several factors can affect lipids digestion such as, age [2,4], bird strain [5], secretion and activity of digestive enzymes [6-8], gut microbiota [9], and to the diet composition such as type of fat used as lipid supplement[10], ratio of unsaturated to saturated fatty acids in the diet [11], presence of pentosans [12] and dietary fiber [13]. Synthesis and recirculation of bile salts is low in young chickens [14] and literature suggests that the bile salts added to diets reportedly improved fat absorption in young chickens [15]. Therefore, use of exogenous emulsifiers may support bile salts in both emulsion and micelle formation process, determining a positive effect on lipids digestibility and productive performance. Lysophospholipids are mono-acyl derivatives of phospholipids resulting from the action of phospholipase, which hydrolyze the ester bond [16]. These compounds are characterized by higher hydrophilic-lipophilic balance and thus a better oil–water emulsification capacity than the corresponding phospholipids [17]. Lysophospholipids show a lower critical micelle concentration than bile salts and lecithin to form smaller micelles compared to phospholipids [18]. On the other hand, previous literature suggest that lysophospholipids improved gut permeability to macromolecules like proteins and dextrans [19], regulate the activity of several enzymes [19,20], and cause epithelial cells hypertrophy in broiler duodenum [21]. Previous reports also suggested positive or partially positive effects of lysophospholipids in broilers [17, 22-24] and pigs [25,26]. There is no clear indication about their efficacy, due to the different composition of the basal diet used. Furthermore there is little information regarding the guidelines for the inclusion of lysophospholipids according to the different energy levels in the diet. Therefore, a trial was conducted to evaluate the effects of lysophospholipids and phospholipids supplemented at a constant dose or at variable energy level in diets on productive performance and carcass quality traits of broiler chickens.

Materials and Methods

Animal care

The experimental procedure was approved by the Institutional Animal Care and Use Committee at Bangkok Animal Research Center, Thailand.

Birds and poultry house

Two hundred and forty (240) newly hatched male chicks of a commercial strain (ARBOR ACRES PLUS) were allocated to four treatment groups with 6 replications with10 birds per replicate in

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Received January 01, 2019; **Accepted** February 19, 2019; **Published** February 27, 2019

Citation: Chauhan S, Priyadarshi A, Gautam B, Saikhlai K (2019) Effect of Dietary Supplementation of Lysophospholipids and Phospholipids Blend on Performance and Carcass Quality Traits of Broilers Fed Energy Deficient Diet. J Anim Health Behav Sci 3: 115.

individual pen. The experiment was conducted in a tunnel ventilated shed with evaporative cooling system. Shed had a solid-concrete-floor and rice hull was used as bedding material for birds. Birds had adlib access to feed and water. Three phases feeding, 0-10, 10-24 and 24-35 days protocol was adopted. Two basal diets were formulated, one with full energy (2950, 3050, 3150 Kcal/Kg) at each phase in diet which served as positive control (PC) and another was 80 Kcal/ kg less (2870, 2970, 3070 Kcal/Kg) as compare to PC, at each phase of diet and served as negative control (NC). The details of 4 different dietary treatments are given in Table 1. The above diets were supplemented with 250 gm/ ton of Lysophospholipids & Phospholipids blend emulsifier (JubiDOL plus, Jubilant life sciences, Noida, India) in the respective treatments. By adding blend emulsifier, it is proposed, that there will be 2.5-3% improvement in digestibility of oil. Thus corresponding reduction of 80 Kcal (2.6%) was taken as negative control. The details of phase wise composition of ration offered to different treatment groups are presented in Table 2.

Productive performance

At housing and at the end of each feeding phase (10, 24 and 35d), weight of all birds from each pen and the weight of residual feed was recorded. Daily mortality was also recorded during the trial. Feed conversion rate, cumulative feed conversion rate and European Efficiency Index were calculated.

Carcass traits

At 35 days of age, 4 birds per pen with body weight close to the pen mean were slaughtered for carcass characteristic evaluation (live weight, carcass weight, breast meat, thigh, drumstick, wing & abdominal fat) and internal organ measurements (weight of liver, gizzard, heart and spleen). Foot pad dermatitis was also measured by scoring (foot pad score; 0=good no lesion, 1=Mild lesion, 2=Severe lesion) as suggested by earlier [27].

Statistical analysis

Data was analysed with ANOVA of variance as a 2 x 2 factoriel in randomise complète block design. Pen means were used as the experimental unit for the analysis. Differences among treatments were tested for significance by using the Duncan's multiple range tests at 5% significance level. Statistical software IBM, SPSS version 20.0 was used for statistical studies.

Results

The birds remained healthy and consumed their daily feed throughout the experiment. In this experiment, mortality percentage was very low in all the experimental groups and no significant difference among the groups was noted. The data of performance of broilers from different treatment groups is presented in Table 3. There was steady weight gain in broilers from all the treatment groups. Birds that received feed supplemented with lysophospholipids and phospholipids blend had significantly higher live weight and weight gain (p=< .05) compared to the positive control group. However the group that did not receive emulsifier in the diet but received full energy was comparable with the

Groups	Energy	Emulsifier in diet
1	Positive control	Not supplemented
2	Negative control	Not supplemented
3	Positive control	Supplemented (250 g/ton)
4	Negative control	Supplemented (250 g/ton)

Table 1: Details of the different dietary treatments.

Ingredient	Starter (0-10 d)		Grower (10-24 d)		Finisher (24-35 d)	
	PC	NC	PC	NC	PC	NC
Corn 8.0% lot.170108	49	50.97	50.6	52.57	53.03	54.99
Soybean meal (dh) 48.5%	35.16	34.82	31.19	30.86	25.88	25.55
DDGS 27%	4	4	5	5	6	6
Rice bran,full fat 13%	3	3	4	4	5	5
Palm oil (8300)	3.44	1.8	4.63	2.99	5.83	4.19
MDCP 16.8/21.3 lot.161217	2.186	2.182	1.918	1.913	1.686	1.681
Limestone 39.9% Ca	1.109	1.112	1.021	1.023	0.953	0.956
Pellet binder (Pelex Dry)	0.3	0.3	0.3	0.3	0.3	0.3
DL-Methionine	0.324	0.321	0.272	0.269	0.244	0.241
L-Lysine HCL	0.285	0.291	0.238	0.243	0.246	0.252
L-Threonine	0.14	0.14	0.097	0.097	0.084	0.084
Salt	0.085	0.081	0.215	0.212	0.208	0.205
Sodium Bicarbonate	0.643	0.647	0.189	0.193	0.193	0.115
Vit/Min premix	0.2	0.2	0.2	0.2	0.2	0.2
Choline chloride 60%	0.087	0.087	0.084	0.084	0.098	0.098
Salinomycin (Sacox)	0.05	0.05	0.05	0.05	0.05	0.05
Total	**100**	**100**	**100**	**100**	**100**	**100**
Unit						
Weight	1	1	1	1	1	1
Dry matter	88.19	87.97	88.28	88.05	88.41	88.19
ME for poultry	2950	2870	3050	2970	3150	3070
Crude protein	23	23	21.5	21.5	19.5	19.5
Crude fat	6.57	5.02	8	6.44	9.45	7.89
Linoleic acid	1.79	1.65	1.99	1.85	2.21	2.07
Crude fiber	2.93	2.96	2.95	2.98	2.94	2.97

Table 2: Details of feed composition of two main treatment groups.

emulsifier supplemented groups. Cumulative feed consumption was similar across the dietary treatment groups that received emulsifier in diet and received full energy in the diet. However, the in a group of broilers that received energy deficient diet without supplementation of emulsifier in a diet had low feed consumption. When FCR was compared, the results were similar to the body weight gain. FCR was did not differ significantly between treated and positive control group; while FCR was significantly lower (p<0.0001) as compared to the group that received energy deficit diet and without supplementation of emulsifier in a diet. As European Efficiency Index (EEF) is overall index of performance of broilers, EEF was calculated for all treatment groups and we observed that EEF of emulsifier supplemented group is far better than non-supplemented groups especially when compared with energy deficient and with supplementation group.

Supplementation of lysophospholipids and phospholipids blend in diet and energy levels in diet did not affect the gross carcass traits (Table 4). Mean values of different treatment groups did not differ significantly with other. The abdominal fat deposition and mean foot pad lesions score was better in both emulsifiers supplemented groups as compare to non-supplemented groups. Effect of emulsifier supplementation on internal organ weight was studied and data is presented in Table 5. The addition of emulsifier has no significant effect on organ weight (g/kg BW) of gizzard, heart and spleen. The liver weight (g/kg BW) of both emulsifier supplemented group was significantly (P<0.05) higher as compare to non-supplemented groups.

Discussion

Previous research suggested that the supplementation of emulsifier enhanced the utilization of dietary fat [25, 28] and improved live weight gain and feed conversion in pigs. Conforming to the postulation, this

Treatment			Initial body weight (g)	Final weight gain (g)	Body weight gain (g)	Feed intake (g)	FCR	EEF	Livability (%)
Group	Diet	Emulsifier							
0-10 days of age									
1	PC	-	41	257[a]	216[a]	245	1.132[b]	227.36[a]	100
2	NC	-	41	243[b]	202[b]	243	1.201[a]	199.14[b]	98.33
3	PC	+	41	263[a]	222[a]	252	1.136[b]	227.53[a]	98.33
4	NC	+	41	258[a]	216[a]	246	1.138[b]	222.64[a]	98.33
		Pooled SEM		3.494	3.48	4.991	0.007	0.013	1.179
		CV%		3.33	3.94	4.97	1.45	2.69	2.91
		Source	df	p-value					
		Treatment diet	7	0.0007	0.0007	0.0663	<0.0001	<0.0001	0.774
		Emulsifier (A)	3	0.0018	0.0017	0.0598	<0.0001	7E-04	0.5782
		Diet (B)	1	0.8018	0.8271	0.2551	<0.0001	0.002	0.3242
		A x B	3	0.005	0.0051	0.1641	<0.0001	0.002	0.8013
11-24 days of age									
1	PC	-	257[a]	1317[a]	1060	1328	1.253	738.6	98.33
2	NC	-	243[b]	1276[b]	1036	1327	1.283	700.3	98.33
3	PC	+	263[a]	1309[a]	1046	1322	1.263	728.3	98.33
4	NC	+	258[a]	1308[a]	1051	1328	1.265	725.4	98.15
		Pooled SEM		3.494	11.776	10.883	16.707	0.013	0.015
		CV %		3.33	2.21	2.54	3.1	2.45	2.95
		Source	df	p-value					
		Treatment diet	7	0.0007	0.0417	0.4115	0.4306	0.356	0.5777
		Emulsifier (A)	3	0.0018	0.0665	0.3768	0.1947	0.262	0.5774
		Diet (B)	1	0.8018	0.781	0.8804	0.2848	0.124	0.2259
		A x B	3	0.005	0.0471	0.2613	0.7917	0.709	0.5367
25-35 days of age									
1	PC	-	1317[a]	2468[b]	1151[b]	1815	1.578[b]	1423.11[b]	100
2	NC	-	1276[b]	2370[c]	1094[c]	1803	1.650[a]	1306.31[c]	100
3	PC	+	1309[a]	2464[b]	1155[b]	1798	1.557[b]	1438.92[b]	100
4	NC	+	1308[a]	2511[a]	1202[a]	1845	1.534[b]	1487.98[a]	100
		Pooled SEM		11.776	24.425	20.681	30.595	0.014	0.014
		CV%		2.21	2.44	4.44	4.16	2.111	2.111
		Source	df	p-value					
		Treatment diet	7	0.0007	0.0417	0.4115	0.4306	0.356	0.5777
		Emulsifier (A)	3	0.0018	0.0665	0.3768	0.1947	0.262	0.5774
		Diet (B)	1	0.8018	0.781	0.8804	0.2848	0.124	0.2259
		A x B	3	0.005	0.0471	0.2613	0.7917	0.709	0.5367
0-35 days of age									
1	PC	-	41	2468[a]	2427[a]	3387	1.395[b]	497.1	98.33
2	NC	-	41	2370[c]	2329[c]	3370	1.447[a]	452.3	96.67
3	PC	+	41	2464[a]	2423[a]	3369	1.391[b]	489	96.67
4	NC	+	41	2511[a]	2470[a]	3418	1.384[b]	500.6	96.67

	Pooled SEM		24.425	24.451	40.708	0.009	0.01	2.51
	CV %		2.44	2.49	2.96	1.55	1.74	6.4
	Source	df	p-value					
	Treatment diet	7	0.0035	0.0037	0.1561	<0.0001	<0.0001	0.9708
	Emulsifier (A)	3	0.0609	0.0625	0.1093	<0.0001	3E-04	0.6874
	Diet (B)	1	0.4524	0.4543	0.3569	0.0046	0.011	0.8158
	A x B	3	0.0021	0.0021	0.267	0.0116	0.011	0.9827
	Means within column with no common superscript differ significantly (p<0.05) with in that particular stage.							
	Feed conversion ratio uncorrected for mortality and culls.							
	European Efficiency Index = ((Body weight (kg) x Livability (%)) / (Age (d) x FCR)) x 100							

Table 3: The effect of various dietary supplementations on growth performance of broiler.

Treatment			Dressing with hock* (%)	Breast Meat** (%)	Thigh*** (%)	Drum stick*** (%)	Wing*** (%)	Abdominal fat (%)	Footpad dermatitis core****
Group	Diet	Emulsifier							
1	PC	-	75.77	29.51	19	13.07	9.78	2.25	0.11
2	NC	-	75.73	29.85	19	13.49	9.87	2.04	0.11
3	PC	+	75.69	30.15	19.03	12.87	9.53	2.03	0.06
4	NC	+	76.14	29.77	18.83	12.99	9.82	1.9	0.08
Pooled SEM			0.22	0.381	0.185	0.176	0.092	0.085	0.026
C.V%			0.71	3.13	2.4	3.29	2.31	10.15	6.22
Source		df	p-value						
Treatment diet		7	0.6389	0.9118	0.5482	0.3565	0.1059	0.1905	0.9014
Emulsifier (A)		3	0.5041	0.8188	0.6381	0.2323	0.111	0.184	0.5865
Diet (B)		1	0.2186	0.8038	0.4242	0.3858	0.0328	0.0327	0.4765
A x B		3	0.747	0.6577	0.319	0.4384	0.6535	0.8884	0.9671
***Thigh, drumstick and wing with bone and abdominal fat as percent of carcass weight.									
****Foot pad score; 0=Good no lesion, 1=Mild lesion, 2=Severe lesion.									

Table 4: The effect of various dietary supplementations on carcass quality and footpad dermatitis of broiler at 35th day of age.

Treatment			Liver (g/kg BW)	Gizzard (g/kg BW)	Heart (g/kg BW)	Spleen (g/kg BW)
Group	Diet	Emulsifier				
1	PC	-	21.11 ^{bc}	12.11	4.49	0.87
2	NC	-	20.90 ^{c}	12.01	4.6	0.86
3	PC	+	22.39 ^{a}	11.92	4.65	0.95
4	NC	+	21.54 ^{ab}	11.49	4.56	1.03
Pooled SEM			0.674	0.386	0.141	0.068
C.V.%			7.43	7.87	7.47	17.36
Source		df	p-value			
Treatment diet		7	0.0444	0.8925	0.3866	0.0596
Emulsifier (A)		3	0.0072	0.6093	0.3381	0.163
Diet (B)		1	0.9171	0.845	0.5077	0.9863
A x B		3	0.5209	0.8131	0.3072	0.0318
^{a,b,c} Means within column with no common superscript differ significantly (p<0.05)						

Table 5: The effect of various dietary supplementations on internal organs of broiler at 35th day of age.

trial suggested that there was a significant improvement in live weight of birds when fed with emulsifier supplemented feed. Improved feed efficiency in the emulsifier supplemented birds during the all three growing phases, possibility due to the positive effects of the emulsifier on digestion and absorption of fat as well as other nutrients. We recorded this positive effect of emulsifier when diet was compromised by 80 Kcal per kg of feed. The inclusion of an emulsifier in broiler diet is critical during the early growth phase [29] because lipase activity in chickens is at peak between 40 and 56 days of age [30]. Moreover, synthesis and recirculation of bile salts is at a much lower level in young chickens [14]. Addition of bile salts improved fat absorption in young chickens [15] and augmented productive performance in chickens and pigs [25,28,31]. The results of this study demonstrated the benefits of dietary supplementation of emulsifiers in grower phase (0-35 days of

age). The positive effect of emulsifiers on digestibility of nutrients and ultimately on performance is documented in broilers [32]. Our results are in agreement with previous findings [22]. This could be related to the better emulsifying ability of lysophospholipids by forming small liposomes that are absorbed with high efficiency [33].

During earlier experiments, the addition of lysophospholipids caused mortality in broilers [22]. On other hand, many studies reported no effect of feeding emulsifier on livability of broilers [32, 34]. In this study we did not observe significant effect of emulsifier feeding on carcass traits of the broilers. Similar findings were recorded in broilers after feeding graded levels of emulsifier in diets [32,34]. Although not significant, we found reduced deposition of abdominal fat in emulsifier supplemented groups which could be an indication of a better utilization of fat for energy requirement of a body. The foot pad lesion score was also reduced by supplementation of emulsifier in diet. Earlier, addition of emulsifier in the diet has been shown to reduce the pasty vent conditions in broilers [32]. Footpad lesions score is an indicator of litter condition or enteric infections in broilers. It is widely known that nitrogen and fat excretion tend to reduce litter quality and increase the incidence of footpad lesions. Although there was no significant reduction of foot pad lesions in treated group in this study, the use of an emulsifier may improve the retention of dietary fats, proteins and reduce the incidence of foot pad lesions, however, further studies are required to investigate this hypothesis.

Conclusion

In conclusion, lysophospholipids and phospholipids blend was effective emulsifiers for broiler chickens, when added at concentrations of 250 gm/ton of feed in low energy fed broilers. At this concentration the emulsifier significantly increased the live weight and improved feed conversion efficiency. However, the effects on carcass traits were not significant. The abdominal fat and incidence of foot pad lesion score was reduced. Results from this study suggested that the use of lysophospholipids and phospholipids blend could be the potential solution for improving production and feed efficiency of broiler chickens, when fed with energy deficient diets.

Conflict of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

Acknowledgements

The authors express their sincere thanks to Bangkok Animal Research Center, Thailand for providing facility to conduct experiment.

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