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Emulsifier in Broiler Diets Containing Different Fat Sources

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Digestibility, pancreatic lipase, performance, poultry offal fat, serum lipids, soybean oil.

ABSTRACT

This present study aimed at evaluating the effect of the addition of an emulsifier to diets containing soybean oil, poultry fat or their blend, on the performance, carcass traits, serum lipid levels, pancreatic lipase concentration and nutrient digestibility of broilers. A randomized block design was applied using a 3 x 2 factorial arrangement, with three fat sources (soybean oil, poultry fat, and a blend of 50% soybean oil and 50% poultry fat) and the addition or not of an emulsifier. In experiment I, broiler performance, carcass traits, serum cholesterol, HDL, and triglyceride levels, and pancreatic lipase activity in 42-day-old broilers were evaluated. In experiment II, dry matter (DM), ether extract (EE), crude protein (CP) and crude fiber (CF) coefficients of digestibility were analyzed. Broilers fed the diet containing soybean oil and emulsifier presented higher body weight, weight gain and better feed conversion ratio. When birds were fed poultry fat and the fat blend (soybean oil and poultry fat) and the emulsifier was added to the diets, pancreatic lipase concentration increased. It was concluded that the use of soybean oil, poultry fat and their blend does no in the diet does not influence the performance, carcass traits, or serum cholesterol, HDL and triglyceride levels of 42-day-old broilers. The addition of emulsifiers to diets containing poultry fat improves ether extract digestibility and increases the production and secretion of pancreatic lipase.

INTRODUCTION

The continuous genetic improvement of broiler genetic lines result in continuous changes in their nutritional requirements, demanding improvements in feed formulation and manufacturing in order to supply these requirements. The addition of fat sources increases dietary energy levels, and consequently, feed efficiency. However, it must be considered that fat absorption increases with bird age, as young broilers have a physiological limitation to absorb that nutrient (Jeason & Kellog, 1992; Nir *et al*., 1993; Lima *et al*., 2003).

Those physiological limitations of the digestive system of poultry may be overcome using endogenous and/or exogenous strategies to maximize feed digestion and absorption. The addition of synthetic emulsifier to broiler diets is a recent practice as compared to other dietary supplements. The mode of action of emulsifiers is to increase the active surface of fats, allowing the action of lipase, which hydrolyze triglyceride molecules into fatty acids and monoglycerides and favor the formation of micelles consisting of lipolysis products. This is an essential step for lipid absorption, as its creates a diffusion gradient that increases absorption.

Among emulsifiers, casein has become an important feed additive which are heterogeneous protein aggregates, which are the most important components involved in the emulsification of beta-casein, presenting proline residues (Araújo, 1999).

There are many studies on the influence of age on the use of vegetable oils and animal fats. Young poultry present lower fat digestion capacity as compared to older birds and are not physiological capable of responding to the energy levels included in pre-starter and starter diets (Carew Jr. *et al*., 1972; Krogdhal, 1985; Sell *et al*., 1986; Jeason & Kellog, 1992; Nir *et al*., 1993; Lima *et al*., 2003).

The objective of the present study was to evaluate the effect of the addition of a commercial emulsifier composed by casein to broiler diets containing soybean oil, poultry fat and their combination on broiler performance, carcass traits, blood cholesterol, triglycerides and HDL-cholesterol levels, pancreatic lipase concentration, and nutrient digestibility.

MATERIALS AND METHODS

Two experiments were carried out at the Poultry Nutrition Lab of the School of Veterinary Medicine and Animal Science, Univ. Estadual Paulista (UNESP), Botucatu, Brazil.

In experiment I, 720 one-day-old male Cobb broilers were used. Chicks were vaccinated in the hatchery against infectious bursal disease, Marek's disease, and fowl pox. Birds were housed in 24 pens measuring 2.5 m^2 in a conventional broiler house equipped with trough feeders and bell drinkers. Brooding was provided by infrared lamps. House temperature and ventilation were manually controlled to maintain broiler comfort temperature, according to the genetic line manual. A 24h of light lighting program was adopted.

A randomized block design was applied using a 3 x 2 factorial arrangement, with three fat sources (soybean oil (SO), poultry fat (PF), and a blend of 50% soybean oil and 50% poultry fat (SOPF) and the addition or not of an emulsifier, totaling six treatments, with four replicates of 30 birds each.

Feeds were based on corn and soybean meal, and formulated according to the nutritional recommendations of Rostagno *et al*. (2005). A 3-phase feeding program was adopted: starter (1 – 21 days), grower (22 – 35 days) and finisher (36 – 42 days) (Table 1). Feed and water were provided *ad libitum* during the entire experimental period. The

Table 1 – Ingredient and calculated composition of the experimental diets.

Ingredients	Starter			Grower			Finisher		
	SO	PF	SOPF	SO	PF	SOPF	SO	PF	SOPF
Ground corn	54.56	54.76	54.32	59.49	60.93	60.16	62.82	64.07	63.40
Soybean oil	3.50	-	1.75	4.00	-	2.00	4.50	-	2.25
Poultry fat	-	3.50	1.75	-	4.00	2.00	-	4.50	2.25
Soybean meal	37.90	37.80	38.20	32.70	31.10	32.00	29.30	28.01	28.70
Inert material[1]	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Salt	0.50	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Limestone	1.10	1.10	1.15	1.05	1.00	1.05	1.05	1.00	1.00
Dicalcium phosp.	1.80	1.80	1.80	1.65	1.80	1.65	1.55	1.60	1.60
DL-methionine	0.17	0.17	0.17	0.15	0.16	0.16	0.12	0.12	0.12
L-lysine HCl	0.07	0.07	0.06	0.15	0.16	0.13	0.01	0.05	0.03
Vit./Min. Suppl.[2]	0.40	0.40	0.40	0.40	0.40	0.40	0.20	0.20	0.20
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calculated values									
Crude protein, %	21.79	21.76	21.91	19.80	19.18	19.53	18.50	18.00	18.27
AME, kcal/kg	3.055	3.049	3.051	3.150	3.148	3.148	3.223	3.220	3.220
Methionine, %	0.49	0.49	0.50	0.46	0.45	0.40	0.40	0.40	0.41
Met.+Cys., %	0.86	0.86	0.87	0.79	0.78	0.79	0.73	0.72	0.72
Lysine, %	1.28	1.27	1.28	1.16	1.16	1.17	0.99	1.00	0.99
Calcium, %	0.98	0.98	1.00	0.91	0.92	0.91	0.88	0.87	0.87
Total phosp., %	0.68	0.68	0.68	0.64	0.66	0.64	0.61	0.62	0.62
Ether extract, %	5.82	5.79	5.79	6.45	6.46	6.46	7.05	7.05	7.02

*SO = soybean oil; PF = poultry offal fat; SOPF = 50% soybean oil and 50% poultry fat. 1 - Replacement of inert material by AVILAC-E® (NUTRIFEED) in the corresponding treatments. 2 - Vitamin and mineral supplement made by the company Vaccinar Nutrição and Saúde Animal (levels/kg feed): vitamins A, 12,000 IU; D3, 2400 IU; K3, 3.2 mg; B1, 2.4 mg; B2, 4.8 mg; B6, 4.8 mg; B12, 24 mcg; niacin, 256 mg; pantothenic acid, 12 mg; biotin, 0.096 mg;

emulsifier used in the present study consisted of milk-derived casein.

Performance parameters were evaluated for the cumulative periods of 1 to 7, 1 to 14 and 1 to 42 days of age. Body weight was obtained by weighing together of all birds of each experimental unit at housing and at 7, 14 and 42 days of age; weight gain was calculated as the difference between body weight at the end of period and weight at housing. Feed intake was calculated as to difference between the total amount of feed supplied and feed residues at the end of each period. Feed conversion ratio was calculated as the ratio between total feed supplied and weight gain in each period and corrected for the weight of birds that died during that period. Mortality was daily recorded and expressed as a percentage of the ratio of the number of dead birds during each period to the number of birds housed. Production factor was calculated as by dividing daily weight gain (kg) times livability (%) by feed conversion ratio and multiplied by 100.

At the end of the experimental period, five birds per experimental unit (20 birds per treatment) were randomly chosen and submitted to 8h fasting and weighed. These birds were then stunned, bled, de-feathered, eviscerated, and their abdominal fat pad was removed. Carcasses with no feet, head and neck were weighed to determine carcass yield relative to live slaughter weight, and subsequently cut up and de-boned to obtain the following parts yield relative to carcass weight: breast, breast meat, breast bones, breast skin, leg (thighs+drumsticks), back, and wings. Feet, head+neck, abdominal fat pad, and gizzard yields were determined relative to live weight before slaughter (Sartori *et al*., 1997).

At 42 days of age, one bird per experimental unit was randomly selected for the collection of 5mL of blood by brachial vein puncture, and the obtained serum was analyzed for total cholesterol total, triglycerides and high-density lipoprotein (HDL) by colorimetric enzymatic method using a commercial kit (Celm®), with reading at 505nm in spectrophometer, according to the method of Lumeij (1997). The results were expressed in mg/dL. These birds were then sacrificed, and had their pancreas removed for the analysis of pancreatic lipase (Sarda & Desnuele, 1958) using a commercial kit (In vitro Diagnóstica - Renylab®) with reading at 412nm absorbance in spectrophotometer. The results were expressed in IU/kg pancreas.

In experiment II, 72 one-day-old male Cobb broilers were used. Chicks were vaccinated in the hatchery fowl pox. Birds were housed in 24 galvanized iron cages (0.50m high, 0.50m wide, 0.60m deep).

A randomized block design was applied using a 3 x 2 factorial arrangement, with three fat sources (soybean oil (SO), poultry fat (PF), and a blend of 50% soybean oil and 50% poultry fat (SOPF) and the addition or not of an emulsifier, totaling six treatments with four replicates of three birds each. The experimental diets used in this experiment had the same ingredient and calculated compositions as those used in experiment I.

In order to determine dietary nutrient digestibility, excreta samples were collected every 12 hours for three consecutive days after day 21. Excreta were placed in plastic bags and stored at -20 °C. At the end of the collection period, excreta samples were thawed, homogenized, and pre-dried in a forced-ventilation oven at 55 °C for 72 hours, after which they were ground for subsequent analyses. Dry matter (DM), ether extract (EE), crude protein (CP) and crude fiber (CF) contents were determined according to the methodology recommended by the AOAC (1990) and the coefficients of digestibility were calculated according to the method proposed by Matterson *et al*. (1965).

At the end of the excreta collection period (24 days of age), one bird/cage was sacrificed to determine the activity of pancreatic lipase. The collection and analysis procedures were the same as those used in experiment I.

Data were submitted to analysis of variance using the General Linear Model procedure of SAS software package (1996). Means were compared by the test of Tukey at 5% probability.

RESULTS AND DISCUSSION

There was no effect of fat source or of the addition of the emulsifier on the performance of 7-day-old broilers (Table 2). These results are consistent with the findings of Vieira *et al*. (2002), who added 4% soybean soapstock to broiler diets and did not observe any differences in performance. Gaiotto (2004) also did not find any differences in the performance of 7-day-old broilers fed soybean oil or poultry fat at 3.98 and 4.19% inclusion levels, respectively, which were similar to the 3.5% levels used in the present study. The use of an emulsifier did not improve the performance of 7-day-old broilers possibly due to their low lipase activity during this period (Jeason & Kellog, 1992; Nir *et al*., 1993).

At 14 days of age there was significant effect

Table 2 - Mean initial weight (IW), body weight (BW), weight gain (WG), feed intake (FI), feed conversion ratio (FCR), mortality (MO) and production factor (PF) of broilers fed diets with different fat sources and with or with no addition of an emulsifier.

Parameter	Emulsifier (E)		Fat source (F)			Probability			CV (%)[3]
	Without	With	SO[1]	PF[1]	SOPF[1]	E	F	ExF	
IW, g	46	46	46	45	46	ns	ns	ns	0.60
7 days of age									
BW, g	179	181	179	180	180	ns	ns	ns	1.83
WG, g	133	135	133	135	135	ns	ns	ns	2.50
FI, g	148	148	148	146	149	ns	ns	ns	3.68
FCR	1.11	1.10	1.12	1.09	1.10	ns	ns	ns	4.21
MO[2], %	0.27	0.27	0.83	0.00	0.00	ns	ns	ns	42.99
14 days of age									
BW, g	491	500	489	499	500	p<0.05	p<0.05	p<0.05	1.40
WG, g	445	454	442	453	454	p<0.05	p<0.05	p<0.05	1.55
FI, g	547	544	544	546	547	ns	ns	ns	1.55
FCR	1.23	1.20	1.23	1.21	1.20	p<0.05	p<0.05	p<0.05	1.50
MO[2], %	0.55	1.39	1.66	0.83	0.42	ns	ns	ns	57.95
42 days of age									
BW, g	2673	2711	2699	2687	2691	ns	ns	ns	2.58
WG, g	2673	2711	2653	2641	2645	ns	ns	ns	2.63
FI, g	4281	4266	4274	4304	4243	ns	ns	ns	2.22
FCR	1.65	1.64	1.64	1.65	1.64	ns	ns	ns	1.22
MO[2], %	6.94	10.28	8.33	7.50	10.00	ns	ns	ns	46.55
PF	353	347	353	532	346	ns	ns	ns	7.33

ns: not significant (p≥0.05). 1 - SO: soybean oil; PF: poultry fat; SOPF: 50% soybean oil and 50% poultry fat. 2 - Mortality data were submitted to square-root transformation (X+0.5). 3 - CV: coefficient of variation.

emulsifier addition on body weight, weight gain and feed conversion ratio (Table 3). As to the effect of emulsifier addition, birds fed diets with no emulsifier presented better body weight, weight gain and feed conversion ratio when poultry fat and the fat blend were present in the diet. This result indicates that there was a synergistic effect between fat sources.

Table 3 – Details of the effects of the interactions between fat source and emulsifier on body weight, weight gain and feed conversion ratio of 14-day-old broilers.

Parameter	Emulsifier	Fat source			Mean
		SO[1]	PF[1]	SOPF[1]	
Body weight, g	Without	474 Bb	499 a	501 a	491
	With	502 A	499	499	500
	Mean	488	499	500	
Weight gain, g	Without	428 Bb	453 a	455 a	445
	With	456 A	453	453	454
	Mean	442	453	454	
Feed conversion ratio, g	Without	1.28 Aa	1.21 b	1.20 b	1.23
	With	1.19 B	1.20	1.21	1.20
	Mean	1.23	1.21	1.20	

1 - SO: soybean oil; PF: poultry fat; SOPF: 50% soybean oil and 50% poultry fat. a,b - Means followed by different small letters in the same row are significantly different by the test of Tukey (p<0.05). A,B - Means followed by different capital letters in the same row are significantly different by the F test (p<0.05).

As to the effect of fat source, birds fed diets emulsifier presented better (p<0.05) body weight, weight gain and feed conversion ratio results. The inclusion of the emulsifier did not influence these parameters when poultry fat or the fat blend were used (Table 3). The better body weight and feed conversion ratio of the birds fed the diets with soybean oil and emulsifier may be related to the fatty-acid composition of this fat source and its effects on fat digestion ad absorption. According to Ketels & DeGroote (1989), the utilization of dietary fat by broilers increases when the ratio between insaturated and saturated fatty acids increased from 0.0 to 2.5.

At 42 days of age, fat sources and the addition of the emulsifier had no influence on broiler performance (Table 2), which agrees with the results of Ferreira *et al*. (2005), who did not observe performance differences among broilers fed different ratios of soybean oil and tallow, as well as with Sanz *et al*. (2000), using sunflower oil and a blend of tallow and lard, and with Manilla *et al*. (1999) and Andreotti *et al*. (2004), who did not find any differences among soybean oil levels in the diet.

The results of the present study, however, disagree with the findings of Zollistsch *et al*. (1997), who found better feed conversion ratio and higher weight gain in 43-day-old broilers fed a diet with soybean oil as fat. Gaiotto *et al*. (2000) verified better performance of 42-day-old broilers fed a blend of equal parts of soybean oil and tallow.

There was no influence of fat sources or of emulsifier addition on carcass traits (Table 4). These results are consistent with those of Andreotti *et al*. (2004), Ferreira *et al*. (2005) and Lara *et al*. (2006), who also did not observe any differences in carcass and parts yields or in abdominal fat percentage in broilers fed different fat sources.

Total cholesterol, HDL or triglyceride levels were not affected by dietary fat sources or emulsifier addition (Table 5), as observed by Silva *et al*. (2001) and Fascina *et al*. (2009), who did not find any HDL differences between broilers fed vegetable oils or animal fat. Ozdogan & Aksit (2003) also did not observe any differences in triglyceride levels in broilers fed vegetable oil or tallow, whereas Fascina *et al*. (2009) observed lower triglyceride levels in broilers fed soybean oil as compared to those fed tallow.

The total cholesterol results obtained in the present study are different from those obtained by Crespo & Esteve-Garcia (2003) and Fascina *et al*. (2009), who verified higher total cholesterol in broilers fed diets containing animal fat relative to those fed vegetable oils.

Pancreatic lipase levels were influenced by fat sources and emulsifier addition, which effects interacted ($p<0.05$) when broilers were 24 and 42 days of age (Table 6). At these two evaluated ages, independently of the addition of emulsifier, fat sources did not significantly affect pancreatic lipase secretion. However, within the factor fat sources, 24-day-old broilers fed poultry offal fat presented higher lipase concentration when the diet did not contain emulsifier, and the lowest lipase levels were obtained when broilers were fed the diet containing the fat blend and the emulsifier. In 42-day-old broilers, lípase concentration was higher when diets were supplemented with emulsifier.

Table 5 – Serum levels of total cholesterol, HDL and triglycerides of 42-day-old broilers as a function of fat source and emulsifier inclusion.

Parameter	Total cholesterol mg/dL	HDL mg/dL	Triglycerides mg/dL
Fat source (F)	**ns**	**ns**	**ns**
SO[1]	185.18	79.08	30.07
PF[1]	179.34	80.93	29.13
SOPF[1]	151.02	50.85	25.90
Emulsifier (E)	**ns**	**ns**	**ns**
Without	169.48	73.85	26.11
With	174.21	66.72	30.62
F x E	ns	ns	ns
CV[2] (%)	23.20	25.00	29.27

ns: not significant. 1 - SO: soybean oil; PF: poultry fat; SOPF: 50% soybean oil and 50% poultry offal fat. 2 - CV: coefficient of variation.

The results of the present study show that there was an increase in the serum levels of pancreatic lipase between 24 and 42 days of age, particularly when the emulsifier was added, which is consistent with the reports of Nir *et al*. (1993), Noy & Sklan (1995) and Lima *et al*. (2003), who verified that pancreatic lipase levels increased with bird age. Jeason & Kellog (1992) mentioned that the lower concentration of that enzyme found in chicks is lower because their enterohepatic circulation is immature, independently from substrate. On the other hand, Krogdhal (1985) argues that pancreatic lipase activity increases with lipid intake.

Table 4 – Carcass traits of 42-day-old broilers as a function of fat source and emulsifier inclusion.

Parameter	Emulsifier (E)		Fat source (F)			Probability			CV[2] (%)
	Without	With	SO[1]	PF[1]	SOPF[1]	E	F	ExF	
Carc[3], %	72.43	72.15	72.75	72.27	72.85	ns	ns	ns	2.21
Head+neck[3], %	5.66	5.51	5.50	5.67	5.59	ns	ns	ns	6.89
Feet[3], %	3.98	3.86	3.92	3.89	3.82	ns	ns	ns	6.85
Ab. fat[3], %	1.83	1.66	1.66	1.78	1.79	ns	ns	ns	24.64
Back[3], %	20.68	21.11	21.15	20.57	20.97	ns	ns	ns	7.93
Leg[3], %	32.64	31.82	32.05	32.65	31.97	ns	ns	ns	5.62
Breast[3], %	35.12	35.10	34.95	35.03	35.35	ns	ns	ns	4.74
Wings[3], %	11.14	11.37	11.38	11.19	11.20	ns	ns	ns	6.86
Br. meat[3], %	26.11	25.99	26.03	25.83	26.29	ns	ns	ns	5.59
Br. bone[3], %	5.58	5.52	5.55	5.66	5.44	ns	ns	ns	8.97
Br. skin[3], %	3.26	3.31	3.24	3.26	3.36	ns	ns	ns	18.03

1 - SO: soybean oil; PF: poultry fat; SOPF: 50% soybean oil and 50% poultry fat. 2 - CV: coefficient of variation; ns: not significant. 3 - Carc.: carcass yield; head+neck: head and neck yield; feet: feed yield; Ab.

Gomez & Polin (1976) observed better fat absorption when bile salts were added to diets. Freeman (1984) mentioned that bile salts emulsify fats, creating smaller particles, thereby favoring the action of lipase, and therefore it may be inferred that, in the present study, the emulsifier increased the availability of lower fat particles, consequently increasing the demand of lipase production (Table 6) and improving ether

Table 6 - Pancreatic lipase levels (UI/g pancreas) of 24-day-old broilers (Exp. 2) and 42-day-old broilers (Exp. 1), as a function of fat source and emulsifier inclusion.

Age (days)	Emulsifier (E)	Source (F)			Mean	Probability			CV² (%)
		SO¹	PF¹	SOPF¹		E	F	E x F	
24	Without	19.49	20.01A	13.12B	17.54				
	With	15.48	14.85B	32.09A	20.80	<0.05	<0.05	<0.05	24.06
	Mean	17.48	17.43	22.60					
42	Without	25.91	33.58B	19.81B	26.43				
	With	33.82	51.20A	48.75A	44.59	<0.05	<0.05	<0.05	4.51
	Mean	29,.86	42.39	34.28					

1 - SO: soybean oil; PF: poultry fat; SOPF: 50% soybean oil and 50% poultry fat. 2 - CV:coefficient of variation. A,B - Means followed by different capital letters in the same row are significantly different by the F test (p<0.05).

There was no effect of fat source or of emulsifier on the digestibility of dietary dry matter or crude fiber; however, there was effect of the interaction (p<0.05) between fat source and emulsifier addition on crude protein and ether extract digestibility (Table 7).

Table 7 - Coefficients de apparent digestibility of dry matter (DM), crude protein (CP), crude fiber (CF) and ether extract (EE) of 21- to 23-day-old broilers de 21 a 23 days of age, as a function of fat source and emulsifier inclusion.

Source	DM, %	CP, %	CF, %	EE, %
Fat source (F)	**ns**	**p<0.05**	**ns**	**P<0.05**
SO¹	75.01	64.10	43.26	93.31
PF¹	75.04	65.68	44.32	92.72
SOPF¹	75.81	66.52	47.70	94.98
Emulsifier (E)	**ns**	**p<0.05**	**ns**	**p<0.05**
Without	75.67	69.92	47.64	92.59
With	74.90	60.95	42.54	94.74
F x E	ns	p<0.05	ns	p<0.05
CV², (%)	4.52	9.58	19.54	1.77

ns: not significant. 1 - SO: soybean oil; PF: poultry fat; SOPF: 50% soybean oil and 50% poultry offal fat. 2 - CV: coefficient of variation.

Broilers fed diets containing soybean oil and poultry offal fat presented better crude protein digestibility (p<0.05) when the emulsifier was not added to the diet (Table 8). As to ether extract digestibility, birds fed the diet with poultry offal fat and supplemented with the emulsifier presented better (p<0.05) digestibility (Table 8).

Table 8 – Details of the effects of the interactions between fat sources and emulsifier on crude protein and ether extract digestibility.

Coefficient de digestibility, %	Emulsifier	Fat source			Mean
		SO¹	PF¹	SOPF¹	
Crude protein	Without	73.92 A	67.04 A	68.80	69.92
	With	54.29 B	64.31 B	64.25	60.95
	Mean	64.10	65.68	66.52	
Ether extract	Without	92.53	90.43 B	94.82	92.59
	With	94.08	95.00 A	95.14	94.74
	Mean	93.31	92.71	94.98	

1 - SO: soybean oil; PF: poultry fat; SOPF: 50% soybean oil and 50% poultry fat; A,B Means followed by different capital letters in the same

Polin & Hussein (1982) observed an increase in lipid retention in 7-day-old broilers when bile salts (sodium taurocholate at 0.4%) in the diets, whereas the absence of bile salt supplementation reduced fat utilization in 25% as seven days of age as compared to 14 and 21 days of age. Kussaibati *et al*. (1982) showed that the supplementation of bile salts in broiler diets increased the digestibility of less saturated fats, such as the blends of animal and vegetable fats. This result is consistent with the better fat digestibility of the diet containing poultry offal fat and emulsifier obtained in the present study.

CONCLUSIONS

The use of soybean oil, poultry fat and their blend in the diet does not influence the performance, carcass traits, or serum cholesterol, HDL and triglyceride levels of 42-day-old broilers. The addition of emulsifiers to diets containing poultry offal fat improves ether extract digestibility and increases the production and secretion of pancreatic lipase.

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