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Fatty-Acid Composition of Free-Choice Starter Broiler Diets

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ABSTRACT

Two experiments were carried out to evaluate the inclusion of vegetable oils with different fatty acid content in starter and pre-starter broiler diets. In Experiment I 480 1- to 9-day-old male Ross 308 broilers were fed diets containing corn oil (CO), acid corn oil (ACO), linseed oil (LO) or coconut fat (CoF). Chicks were distributed according to a factorial 2x2x2arrangement (2 free fatty acids - FFA) x (2 n6:n3 ratios) x (2 medium-chain fatty acids levels - AGMC). Performance responses and dry matter (DMM), crude protein (CPM), and crude fat (CFM) metabolizability were evaluated. In Experiment II, 480 1- to 20-day-old male Ross 308 broilers were offered the free choice of 2 different diets: with no fat addition, or with 10% addition of the following fat sources: CO, LO, CoF, soybean soapstock (SBS), acid soybean oil (ASO), or acid cottonseed oil (ACtO). Performance responses and diet selection were evaluated. In experiment I, there were no significant effects of the diets on performance, DMM, or CPM; however, the inclusion of FFA depressed CFM. In experiment II, there was a marked preference of birds of the diets with fat inclusion, leading to the selection of diets with more than 3100 kcal/kg ME in the period of 1 to 20 days, independently of fat source. The broilers selected the high fat and energy diets since the first days of age, which resulted in better bird performance.

INTRODUCTION

The inclusion of fats in feeds positively influences broiler performance (Vieira *et al*., 2002; Pucci *et al*., 2003), and enhances feed palatability (NRC, 1994). The composition of the fatty acids added to diets affects body fat composition in broilers (Waldroup & Waldroup, 2005), and therefore body fat growth pattern can be modified by dietary fat (Crespo & Esteve-Garcia, 2002).

Birds fed diets with high saturated fatty acids from animal origin deposit relatively more mesenteric and abdominal fat as compared to other sites of the body (Crespo & Esteve-Garcia, 2002). The increase in the proportion of saturated fatty acids in broiler diets causes weight gain depression and worse feed conversion ratio, as well as reductions in fat and fatty acids digestibility and energy metabolizability (Zollitsch *et al*., 1997; Dänicke *et al*., 2000). On the other hand, diets with high polyunsaturated fatty acid content promote lower body fat deposition (Crespo & Esteve-Garcia, 2002).

The physiological capacity of birds during the first post-hatching days limits fat absorption (Carew *et al*., 1972), and the limited fat digestion seems to be caused by insufficient secretion of bile salts and lipase (Krogdahl *et al*., 1985). Fat digestibility in chicks is 6% lower than that of adult roosters (Freitas *et al*., 2005). In general, apparent fat metabolizability decreases as the proportion of dietary saturated fatty acids increases (Zollistsch *et al*., 1997).

Young broilers are capable of digesting and absorbing fats rich in polyunsaturated fatty acids, whereas fats with high saturated fatty acid content are poorly utilized (Wiseman, 1984). In addition, increasing saturation of fat sources and free fatty levels in the diet results in linear reductions in metabolizable energy (ME) in young broilers (Wiseman & Salvador, 1991). It is known that pre-starter broiler performance is positively influenced by feeds containing 3000 kcal ME/kg (Vieira *et al*., 2006); however, high ME values during this stage also promote an increase in carcass fat deposition (Zanusso *et al*., 1999).

This study aimed at studying the effects of the inclusion of vegetable oils with different fatty acid composition in pre-starter broiler diets on live performance and nutrient metabolizability, as well as to determine adequate dietary metabolizable energy level for the starter phase using free-choice feeding.

MATERIALS AND METHODS

Two experiments were carried out with male broilers in the pre-starter and starter phases. Experiment I evaluated the inclusion of different types of vegetable oils and their mixtures in pre-starter diets. Experiment II evaluated bird preference for diets including or not different types of vegetable oils in the starter phase.

In experiment I, 480 1- to 9-day-old Ross broilers were housed in metal cages, kept in an environmentally-controlled room under a 24-h lighting program, and supplied water and feed ad libitum. The experimental diets were formulated to supply the recommended levels (Rostagno *et al*., 2005), and contained equal protein and energy levels, but different types and mixtures of vegetable oils. Eight diets were manufactured taking into consideration: (1) the presence or absence of free fatty acids (corn oil or acid corn oil, respectively), (2) two n6:n3 ratios (high: > 40:1 and low: < 5:1), and (3) two levels of medium-chain fatty acids (addition or not of coconut fat), as described in Table 1. Fatty acid profiles were calculated from the analyzed values of the four oil sources (corn, acid corn oil, linseed, and coconut), and ether extract levels of corn and soybean meals were estimated.

A completely randomized experimental design, with a 2 x 2 x 2 factorial arrangement (presence or absence

Table 1 - Pre-starter diet composition in Experiment I.

Ingredients (%)	T1	T2	T3	T4	T5	T6	T7	T8
Corn	53.52	53.52	53.52	53.52	53.52	53.52	53.52	53.52
Soybean meal 46.5%	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9
Corn oil 4.0	2.67	2.67	1.34	-	-	-	-	
Acid corn oil	-	-	-	-	4.0	2.67	2.67	1.34
Linseed oil -	-	1.33	1.33	-	-	1.33	1.33	
Coconut fat	-	1.33	-	1.33	-	1.33	-	1.33
Dicalcium phosphate 20%	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Calcitic limestone	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24
Sodium chloride (salt)	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51
DL-Methionine	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27
L-Lysine 0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	
Choline 0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	
Mineral premix[1]	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Vitamin premix[2]	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
L-Threonine	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Monensin 20%	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Total	100	100	100	100	100	100	100	100
Calculated composition								
Total CF* (%)	6.31	6.31	6.31	6.31	6.31	6.31	6.31	6.31
Saturated FA* (% CF)	12.79	25.95	12.78	25.94	14.86	27.33	14.16	26.63
Unsaturated FA* (% CF)	83.70	69.98	84.48	70.75	80.63	67.93	82.43	69.72
Total n 6 (% CF)	58.52	46.71	48.86	37.05	49.47	40.67	42.82	34.01
Total n 3 (% CF)	1.23	0.94	10.72	10.59	1.05	0.93	10.71	10.58
MCFA* (% CF)	0.00	10.17	0.00	10.17	0.00	10.17	0.00	10.17
n6:n3 ratio	47.39	49.80	4.56	3.50	47.22	43.95	4.00	3.21
Crude protein (%)	22	22	22	22	22	22	22	22
Metabolizable energy (kcal/kg)	3100	3100	3100	3100	3100	3100	3100	3100
Calcium (%)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Available phosphorus (%)	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Dig. methionine (%)	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Dig. methionine + dig. cystine (%)	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Dig. lysine (%)	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20

1 - Addition per kg feed: selenium 0.3 mg; iodine 0.7 mg; iron 50 mg; copper 12 mg; zinc 80 mg; manganese 80 mg; 2 - Addition per kg feed: Vit A 10,000 IU; Vit D3 2,500 IU; Vit E 35 mg; Vit K 2 mg; Vit B1 2 mg; Vit B2 6 mg; Vit B6 2.5 mg; Vit B12 0.012 mg; biotin 0.08 mg; pantothenic acid 15 mg; niacin 35 mg; folic acid 1 mg; * CF = crude fat, FA = fatty acids, MCFA = medium-chain fatty acids.

of free fatty acids, high or low n6:n3 ratio, and inclusion or not of medium-chain fatty acids) was applied, with a total of 8 treatments of 5 replicates of 12 birds each.

In experiment I, performance (weight gain, feed intake, and feed conversion ratio) and dry matter (DMM), crude protein (CPM), and crude fat (CFM) metabolizability, which was determined by total excreta collection from 4 to 9 days of age, were evaluated.

In the second experiment, 480 male Ross 308 broilers were maintained in an environmentally-controlled room under a 24-h lighting program from 1 to 20 days of age. Seven starter diets containing different vegetable oils were compared. Birds were provided free choice between a diet with no fat inclusion and a diet containing 10% of the tested fat (Table 2). The side where the feeders were placed was changed daily to precent any possible behavioral bias.

Table 2 - Combination of the free-choice diets supplied in experiment II.

1	Diet with no oil inclusion (NO)
2	Free choice between the NO diet and diet with 10% soybean oil
3	Free choice between the NO diet and diet with 10% corn oil
4	Free choice between the NO diet and diet with 10% acid soybean oil
5	Free choice between the NO diet and diet with 10% coconut fat
6	Free choice between the NO diet and diet with 10% acid cottonseed oil
7	Free choice between the NO diet and diet with 10% linseed oil

The experimental diets were formulated to supply the recommended nutritional requirements (Rostagno *et al*., 2005), and were different only as to ME level and type of vegetable oil included (Table 3). The experimental diets were based on a single basal diet, to which the different oils and fats were added.

Performance parameters (weight gain, feed intake, and feed conversion ratio) and feed preference were evaluated. A completely randomized experimental design with 7 treatments of 5 replicates of one cage each (12 birds per cage) was applied in experiment II.

The statistical models of experiments I and II were analyzed by analysis of variance using the Generalized Least Square procedure of Statgraphics plus 4.1 software program (Manugistics, 1999). The means of the main factors were compared by the test of Tukey at 5% de probability.

Table 3 - Starter diet composition in experiment II

Ingredients (%)	No oil	With oil
Corn 58.39	46.25	
Soybean meal 45%	37.44	39.57
Vegetable oil	-	10.00*
Dicalcium phosphate 20%	1.87	1.91
Calcitic limestone	1.21	1.18
Sodium chloride (salt)	0.48	0.49
DL-Methionine	0.19	0.22
L-Lysine 0.18	0.14	
Choline 0.04	0.04	
Mineral premix[1]	0.10	0.10
Vitamin premix[2]	0.05	0.05
Monensin 20%	0.05	0.05
Total	100	100
Calculated composition		
Crude protein (%)	21	21
Metabolizable energy (kcal/kg)	2843	3360
Crude fat (%)	2.69	12.28
Calcium (%)	0.96	1.0
Available phosphorus (%)	0.45	0.50
Dig. methionine (%)	0.60	0.60
Dig. methionine + dig. cystine (%)	0.80	0.94
Dig. lysine (%)	1.20	1.26

* T2 soybean oil, T3 corn oil, T4 acid soybean oil, T5 coconut fat, T6 acid cottonseed oil, T7 linseed oil. 1 - Addition per kg feed: selenium 0.3 mg; iodine 0.7 mg; iron 50 mg; copper 12 mg; zinc 80 mg; manganese 80 mg; 2 - Addition per kg feed: Vit A 10,000 IU; Vit D3 2,500 IU; Vit E 35 mg; Vit K 2 mg; Vit B1 2 mg; Vit B2 6 mg; Vit B6 2.5 mg; Vit B12 0.012 mg; biotin 0.08 mg; pantothenic acid 15 mg; niacin 35 mg; folic acid 1 mg;

RESULTS AND DISCUSSION

Table 4 shows bird performance results in experiment I. Feed intake increased when medium-chain fatty acids were included in the diet ($p \leq 0.07$), but was not affected by the other evaluated factors. There was no effect of the experimental treatments on weight gain or feed conversion ratio in experiment I, indicating the lack of influence of dietary fatty acid composition on the performance of broilers at this age. Similar results were found with the use of different fatty-acid profiles added to broiler diets (Crespo & Esteve-Garcia, 2002). On the other hand, Newman *et al*. (2002) observed that the dietary inclusion of polyunsaturated fatty acids (n-3 and n-6 sources) improved the feed conversion ratio of broilers; however, at an older age (3 weeks).

Table 5 shows dry matter (DMM), crude protein (CPM), and crude fat (CFM) metabolizability results for the period of 4 to 9 days. No significant differences were observed in DMM or CPM; however, CFM decreased when broilers were fed free fatty acids derived from acid corn oil. The action of free fatty acids on fat absorption was described by Wiseman & Salvador (1991), who observed that fat metabolizability decreased as FFA content increased in the diet of young broilers. This is explained by the fact that bile salt concentration in the intestine of broilers during the first week of life is not sufficient to allow efficient micella formation with the fatty acids (Katangole & March, 1980).

Table 4 - Effect of dietary fatty acid composition on feed intake (FI), weight gain (WG), and feed conversion ratio (FCR) of 1- to 9-day-old male broilers (experiment I).

	FI (g)	WG (g)	FCR
Free fatty acids (FFA)			
Presence	176	161	1.094
Absence	174	158	1.097
n6:n3 ratio			
High	175	159	1.101
Low	175	161	1.090
Medium-chain fatty acids (MCFA)			
With	174	159	1.092
With no	177	161	1.099
Probability (P ≤ F)			
FFA	0.14	0.13	0.73
n6:n3	0.73	0.24	0.28
MCFA	0.07	0.29	0.48
FFA x n6:n3	0.75	0.32	0.12
FFA x MCFA	0.44	0.63	0.84
n6:n3 x MCFA	0.41	0.18	0.43
FFA x n6:n3 x MCFA	0.71	0.51	0.67
CV (%)	2.58	1.90	1.92

In experiment II, birds generally preferred the diets with fat addition since the first week of life (Table 6), except for those fed acid soybean oil or acid cottonseed oil. The birds seemed to prefer the diets containing soybean oil, corn oil, and coconut fat. This preference was maintained during the entire experimental period. The largest preference differences were observed between 1 to 4 days of age, when birds showed lower preference for the diets containing free fatty acids. During the following period (4 to 12 days), birds started to eat these diets twice as much as compared to the first period, reaching similar feed intakes as the birds fed the diets with the addition of the other oils. The preference for soybean oil, corn oil, and coconut fat during the total period resulted in higher crude fat and ME intake (Table 7).

Table 5 - Effect of dietary fatty acid composition on dry matter (DMM), crude protein (CPM), and crude fat (CFM) metabolizability 4- to 9-day-old male broilers (experiment I).

	DMM (%)	CPM (%)	CFM (%)
Free fatty acids (FFA)			
Presence	64	58	68a*
Absence	65	59	63b
n6:n3 ratio			
High	64	58	64
Low	65	59	66
Medium-chain fatty acids (MCFA)			
Wtih	65	59	65
With no	64	58	65
Probability (P ≤ F)			
FFA	0.57	0.37	0.01
n6:n3	0.22	0.27	0.26
MCFA	0.16	0.16	0.93
FFA x n6:n3	0.85	0.14	0.12
FFA x MCFA	0.65	0.99	0.93
n6:n3 x MCFA	0.74	0.54	0.95
FFA x n6:n3 x MCFA	0.13	0.08	0.39
CV (%)	2.67	4.32	5.35

*Means in the same column followed by different letters are significantly different by the test of Tukey at 5%.

In all free-choice treatments, during the period of 1 to 20 days of age, more than 50% of bird feed intake consisted of the fat-rich diets, leading to higher average crude fat and ME intake levels than those recommended for this rearing stage (less than 7% crude fat and AME lower than 3050 kcal/kg) (Rostagno *et al*., 2005).

It was observed that the birds did not adjust their feed intake as a function of the possibility of selection, as shown by the lack of significant differences in average feed intake among the different fat sources (Table 8). The chicks fed the low-energy diet (no oil inclusion) did not increase their feed intake to achieve the same calorie intake as the birds submitted to the free-choice treatments.

The capacity of digesting and absorbing lipids improves as broilers grow (Katangole & March, 1980). In the present study, weight gain started to be clearly influenced by dietary fat source after 4 days of age (Table 9). The lower energy intake caused by the low-energy diet resulted in worse bird performance. The broilers fed the fat-supplemented diets presented

Table 6 - Effect of different types of vegetable oils on the selection (% of the test diet) of diets containing 10% fat by male broilers (experiment II).

Oil	1 to 4 days	4 to 12 days	12 to 20 days	1 to 12 days	1 to 20 days
Soybean soapstock	67.4 c*	67.6 ab	68.9 b	67.5 b	68.5 b
Corn oil	67.3 c	69.6 b	72.6 b	69.4 b	71.6 b
Acid soybean oil	25.3 a	60.2 a	58.7 a	56.4 a	58.1 a
Coconut fat	61.3 c	70.3 b	69.8 b	69.2 b	69.7 b
Acid cottonseed oil	29.3 ab	59.3 a	57.4 a	55.7 a	56.9 a
Linseed oil	43.8 b	64.9 ab	65.3 ab	62.6 ab	64.5 ab
P (< F)	0.000	0.001	0.001	0.000	0.000
CV (%)	16.52	4.71	4.81	4.38	4.66

*Means in the same column followed by different letters are significantly different by the test of Tukey at 5%

Table 7. Crude fat and metabolizable energy composition of the selected diets (experiment II).

	1-4 d	4-12 d	12-20 d	1-12 d	1-20 d
Selected crude fat (%)					
No oil	2.69	2.69	2.69	2.69	2.69
Soybean soapstock	9.16 c	9.17 ab	9.30 b	9.17 b	9.26 b
Corn oil	9.15 c	9.37 b	9.65 b	9.34 b	9.56 b
Acid soybean oil	5.12 a	8.46 a	8.32 a	8.10 a	8.26 a
Coconut fat	8.56 c	9.43 b	9.39 b	9.33 b	9.37 b
Acid cottonseed oil	5.50 ab	8.38 a	8.20 a	8.04 a	8.15 a
Linseed oil	6.89 b	8.92 ab	8.95 ab	8.69 ab	8.88 ab
P (< F)	0.000	0.001	0.001	0.000	0.000
CV (%)	7.94	3.26	3.32	2.99	3.21
Selected metabolizable energy (kcal/kg)*					
No oil	2843	2843	2843	2843	2843
Soybean soapstock	3191 c	3191 d	3198 c	3191 c	3196 c
Corn oil	3183 c	3195 d	3210 c	3194 c	3205 c
Acid soybean oil	2956 a	3115 ab	3104 a	3094 a	3102 a
Coconut fat	3110 b	3149 bc	3147 b	3144 b	3146 b
Acid cottonseed oil	2970 a	3101 a	3093 a	3086 a	3091 a
Linseed oil	3065 b	3172 cd	3179 bc	3160 bc	3173 bc
P (< F)	0.000	0.000	0.000	0.000	0.000
CV (%)	0.72	0.39	0.41	0.34	0.39

Means in the same column followed by different letters are significantly different by the test of Tukey at 5%. * Calculated using the following.

Table 8 - Effect of different dietary vegetable oils on the feed intake (g) of male broilers fed diets containing or not 10% oil (experiment II).

Oil type	1 to 4 days	4 to 12 days	12 to 20 days	1 to 12 days	1 to 20 days
No oil	42	335	756	374	1130
Soybean soapstock	43	345	847	388	1236
Corn oil	44	334	823	377	1201
Acid soybean oil	42	347	805	389	1194
Coconut fat	43	337	781	381	1162
Acid cottonseed oil	44	341	814	386	1200
Linseed oil	43	345	805	388	1194
P (< F)	0.270	0.550	0.094	0.467	0.117
CV (%)	2.85	2.52	3.77	2.40	3.08

Table 9 - Effect of different dietary vegetable oils on the weight gain (g) of male broilers fed diets containing or not 10% oil (experiment II).

Oil type	1 to 4 days	4 to 12 days	12 to 20 days	1 to 12 days	1 to 20 days
No oil	47 a	236 a*	440 a	283 a	723 a
Soybean soapstock	51 a	267 b	524 b	318 b	842 b
Corn oil	49 a	264 b	521 b	313 b	835 b
Acid soybean oil	46 a	263 ab	487 ab	309 ab	795 ab
Coconut fat	48 a	268 b	485 ab	316 b	801 ab
Acid cottonseed oil	48 a	256 ab	525 b	304 ab	829 b
Linseed oil	46 a	273 b	534 b	320 b	836 b
P (< F)	0.102	0.005	0.002	0.004	0.001
CV (%)	3.90	3.70	5.08	3.17	3.58

*Means in the same column followed by different letters are significantly different by the test of Tukey at 5%.ME values (kcal/kg) for the fat sources: soybean soapstock = 8800; corn oil = 8700; acid soybean oil = 8100; coconut fat = 8000; acid cottonseed oil= 8000; linseed oil = 8800.

higher weight gain as compared to those fed diets with no fat addition, independently of fat source, for the total experimental period. The addition of fat to the diets promoted higher weight gain, and consequent improvement in feed conversion ratio. These responses were also verified by Pucci *et al*. (2003), who observed that broiler performance improved as dietary fat levels increased from 0 to 7.5%.

The best numerical response in terms of weight gain was observed when soybean oil, corn oil, and linseed oil were supplemented; however, means were not statistically different at 5% probability level. Other authors also did not detect differences in the performance of broilers fed different oil sources (Crespo & Esteve-Garcia, 2002; Vieira *et al*., 2002).

Dietary ME content positively influenced broiler weight gain, which was also observed by Oliveira *et al*. (2000) and Zanusso *et al*. (1999). Considering that the other nutrients supplied the birds' nutritional requirements, it can be inferred that weight gain increased due to the higher metabolizable energy intake resulting from the diets with oil addition as compared to the control diet with no oil. Therefore, the increase in weight gain verified in the present study can be related to a possible improvement in the energy:protein ratio in the feeds.

The better feed conversion results for the total experimental period (Table 10) were verified in birds fed the diets containing linseed oil and corn oil, but there were no differences in the period of 1 to 4 days of age. Better feed conversion during the period of 1 to 21 days of age when higher ME was fed to broilers was also observed by Zanusso *et al*. (1999), Oliveira *et al*. (2000), and Pucci *et al*. (2003).

The calorie ratios (kcal ME intake/kg weight gain) of the experimental treatments for each phase are presented in Table 11. The calorie ratio contrast between the dietary inclusion or not of oil was only significant for the period of 1 to 4 days of age (orthogonal contrast: T1x T2+T3+T4+T5+T6+T7; $p<0.01$). No relevant differences were observed among fat sources. This means that, during that period, broilers are not able to store large amounts of body fat when selecting higher energy diets. On the other hand, birds fed the control diet, i.e., with lower metabolizable energy level, gained less weight. The decrease in metabolizable energy intake as dietary ME is reduced was also found by Longo *et al*. (2006), who verified increasing energy requirements for weight gain (calorie ratio) as a function of bird age. Similarly, Mendes *et al*. (2004) observed that increasing dietary energy levels promoted a linear decrease in feed intake, and had a quadratic influence on the weight gain of 1- to 21-day-old broilers.

Current practical tables work with low energy assumptions for the starter phases: 2960 kcal/kg from 1 to 7 days, and 3050 kcal/kg from 8 to 21 days (Rostagno *et al*., 2005). However, in the present study, independently of the type of vegetable oil added to the feeds, broilers selected diets containing much higher fat and energy levels than those recommended in the tables. The values of the basal diet, with no fat addition and 2843 kcal ME/kg, were the closest to those recommended by Rostagno *et al*. (2005). The birds selected the diets containing 3200 kcal/kg since the first days of age, with a more marked effect after 12 days of age, resulting in better performance results.

Based on the results of the present study, it can be concluded that diets containing different levels of free fatty acids, medium-chain fatty acids, and different n6:n3 ratios affected crude fat metabolizability, but did not influence the performance of 1- to 9-day-old broilers. Moreover, broilers selected diets containing high fat, and consequently high ME levels, at a very

Table 10 - Effect of different dietary vegetable oils on the feed conversion ratio (g) of male broilers fed diets containing or not 10% oil (experiment II).

Oil type	1 to 4 days	4 to 12 days	12 to 20 days	1 to 12 days	1 to 20 days
No oil	0.901	1.422 b*	1.723 b	1.325 b	1.566 b
Soybean soapstock	0.855	1.298 ab	1.616 ab	1.226 ab	1.467 ab
Corn oil	0.887	1.265 a	1.581 ab	1.206 a	1.439 a
Acid soybean oil	0.908	1.325 ab	1.663 ab	1.263 ab	1.505 ab
Coconut fat	0.912	1.259 a	1.612 ab	1.206 a	1.451 ab
Acid cottonseed oil	0.926	1.344 ab	1.554 a	1.276 ab	1.452 ab
Linseed oil	0.933	1.263 a	1.509 a	1.215 ab	1.399 a
P (< F)	0.285	0.014	0.012	0.027	0.007
CV (%)	3.41	3.36	3.67	3.00	2.90

*Means in the same column followed by different letters are significantly different by the test of Tukey at 5%.

Table 11 - Dietary calorie ratios (kcal ME intake/kg weight gain) during the studied phases (experiment II).

Oil type	1 to 4 days	4 to 12 days	12 to 20 days	1 to 12 days	1 to 20 days
No oil	2560	4043	4897	3764	4451
Soybean soapstock	2730	4143	5169	3913	4689
Corn oil	2824	4043	5074	3851	4615
Acid soybean oil	2683	4123	5165	3908	4669
Coconut fat	2835	3966	5073	3791	4566
Acid cottonseed oil	2751	4167	4806	3908	4486
Linseed oil	2860	4007	4798	3840	4440
P (< F)	0.051	0.765	0.127	0.693	0.211
CV (%)	3.37	3.33	3.75	3.00	2.97

young age. The intake of pre-starter and starter diets containing high energy levels since the first days of age had a positive effect on the performance of broilers during this period.

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