Ciência Rural, Santa Maria, v.38, n.4, p.1099-1104, jul, 2008
ISSN 0103-8478

Energy and oil levels in broiler starter diets

Níveis de energia e de óleo vegetal em dietas iniciais de frangos de corte

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ABSTRACT

The feed intake and performance of the broilers fed with different levels of dietary energy in the starter diet to 21 days of age were evaluated. In Experiment 1 it was evaluated the performance of birds fed to 2,900 and 3,200kcal ME kg^{-1} diets, and the results show that ME intake was highest for birds 3,200kcal ME kg^{-1} on the 7th day of age. Feed intake (FI), weight gain (WG), and feed conversion (FC) were not affected by dietary energy level on the 7th and 14th day of age, but on the 21st day of age, WG and FC were better for 3,200kcal ME kg^{-1} diets. In the experiment 2, isocaloric diets (2,900kcal ME kg^{-1}) were formulated with four different oil levels (0, 1, 2, and 3%), in order to observe diet preference. Between 6 and 10 days of age, a quadratic response in FI for oil level was observed ($Y=47.6+49.8x–13.4x^2$, $R^2=0.98$). Between 11 to 15, and 16 to 20 days of age, birds preferred to eat the diet with the highest level of oil ($Y=16.6+52.85x$, $R^2=0.97$ and $Y=19.30+59.05x$, $R^2=0.98$, respectively). Experiment 3 evaluated the performance and the pancreatic Lipase and Amylase activities of birds. On the 11th day of age, a linear response to WG and FC dietary oil level occurred. No differences were found in pancreatic lipase and amylase enzyme levels at 5 days of age. The diets with higher levels of energy and/or oil, during the first days of age, did not influence dietary preference, pancreatic lipase and amylase level or the performance of broilers. The results of this study show that diets with high levels of energy derived from lipids may not be interesting for young broilers, as they do not result in better performance (FI, WG, and FC).

Key words: *chicks, feed intake, free choice, palatability.*

RESUMO

Foram avaliados o comportamento ingestivo e o desempenho de frangos de corte alimentados com diferentes níveis de energia e inclusões de óleo vegetal na dieta inicial. No Experimento 1, foi comparado o desempenho de frangos alimentados com dietas contendo 2.900 ou 3.200kcal EM kg^{-1} de ração, e a ingestão de EM foi maior nas aves alimentadas com 3.200Kcal EM kg^{-1} na primeira semana de idade. O consumo de ração (CR), o ganho de peso (GP) e a conversão alimentar (CA) não foram influenciados pelo nível de energia aos sete e aos 14 dias, entretanto, aos 21 dias de idade, GP e CA foram melhores paras aves alimentadas com dietas com 3.200Kcal de EM kg^{-1}. No Experimento 2, foram formuladas dietas isocalóricas (2.900 Kcal EM kg^{-1}) com diferentes níveis de óleo (0, 1, 2 e 3%). Entre o sexto e o décimo dia de idade houve aumento no CR, concomitantemente à inclusão de óleo ($Y=47,6+49,8x–13,4x^2$, $R^2=0,98$). Entre o décimo e o décimo quinto dia e também entre o décimo quinto e vigésimo dia de idade, houve preferência pela ingestão de rações com maior nível de óleo ($Y=16,6+52,85x$, $R^2=0,97$ e $Y= 9,3+59,05x$, $R^2=0,98$ respectivamente). No experimento 3, foi avaliado o desempenho e a atividade da lipase e amilase pancreáticas. No décimo primeiro dia de idade, houve aumento linear em GP e CR com o aumento no nível de óleo. Não houve alteração nos níveis de enzimas estudados. Dietas com altos níveis de energia e/ou óleo não alteram o desempenho ou a produção de lipase e amilase em frangos nos primeiros dias de idade. Os resultados deste estudo mostram que altos níveis de energia proveniente de lipídios não são interessantes para frangos de corte, por não alterarem o seu desempenho (consumo de ração, ganho de peso ou conversão alimentar).

Palavras-chave: *consumo de ração, energia, frango de corte, palatabilidade.*

INTRODUCTION

In poultry, during embryo development, the nutrients are supplied by the egg, and after hatching, the birds start to use nutrients from complex diets and

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Received 08.25.06 Approved 09.19.07

chick gastrointestinal tract requires a period of adaptation, which usually takes two to three weeks after hatched (MORAN, 1999). This is particularly important when lipids are considered. Approximately 80% of these components come from the yolk sac during the last 7 days before hatching, showing that lipids are the main energy source for the embryo during incubation. Nevertheless, in young birds, the gastrointestinal tract (TGI) is not able to digest and absorb efficiently some feed components, such as fats and oils (SEEL, 1996). The storage of pancreatic enzymes of newly hatched birds is not sufficient to hydrolyse these substrates, and rapidly reduce their levels few days after hatched (NITSAN et al., 1991). In addition, MAIORKA et al. (1997) observed that dietary energy influences feed intake and feed conversion of broilers, starting on the second week of age. It is known that fats increase diet palatability, and therefore they could be used to increase feed intake and to improve performance. However, this is not been proved for birds yet. Research suggests that palatability is not important for birds, as the number of taste receptors in the tongue is very small as compared to other animals – the number of taste receptors in the mouth of birds is approximately 350 (SAITO, 1966), whereas it is 15,000 in pigs (MONCRIEFF, 1951). In this context, the objective of the present study was to evaluate performance and feed preference of broilers fed diets with different levels of energy and/or oil during the first 21 days of life.

MATERIALS AND METHODS

In the Experiment 1, total of 160 day-old male Cobb broilers were housed in 16 cages (10 birds/cage) in an experimental poultry house. The birds were distributed in a completely randomized experimental design with two diet treatments differing in energy level where: T1 diet with 2,900kcal ME kg^{-1}, and T2 diet with 3,200kcal ME kg^{-1}. The diets were isonitrogenous and the differences in energy levels were obtained by the inclusion of soybean oil or an inert material (sand) in the diet – first experiment, and in the experiment 2 and 3 were used the combination between soybean oil and starch to obtain the isocaloric diets (Table 1). Feed (mash) and water were offered *ad libitum* for 21 days. During the experimental period, feed intake (FI), metabolizable energy intake (MEI), weight gain (WG) and feed conversion (FC) were determined weekly. Data were analyzed by analysis of variance using the general linear model procedure of SAS software (SAS, 1996).

In the second Experiment, twenty Cobb broilers were randomly assigned to individual cages on the day of the hatching and were reared from 21 days of age. Each cage was equipped with four feeders, to allow the birds free choice of the diets. Each feeder was considered a treatment of the following 4 treatments (1) 0% of oil in the diet; (2) 1% of oil in the diet; (3) 2% of oil in the diet and (4) 3% of oil in the diet (Table 1). All diets were isocaloric (2,900kcal EM/kg), and offered in mash form. The feeders were weighed on 5, 10, 15, and 20 days of age for feed intake measured to determine diet preference. A completely randomized experimental design was used (4 treatments and 20 replicates – the feeders of each 20 cages were considered a replicate), and data were submitted to regression polynomial analysis (P <0.05) (SAS, 1996).

The Experiment 3 was carried out to evaluate performance and pancreatic enzymes activity of broilers fed diets with different levels of oil, but with the same metabolizable energy level. Birds were distributed in completely at random experimental design, with 4 treatments (the same treatments as the experiment 2) with 5 replicates (Table 1). All diets were isocaloric (2,900kcal EM kg^{-1}), and offered in mash form. Two hundred Cobb™ broilers were randomly assigned to 20 cages on hatching day and were reared from 1 to 21 days of age. Each cage with 10 birds was considered an experimental unit, and feed and water were offered *ad libitum*. During the experimental period, FI, WG and FC were evaluated on 5, 10, 15, and 20 days of age.

At five days of age, one bird per treatment was chosen at random, sacrificed by cervical dislocation and the pancreas was collected, immediately frozen in liquid nitrogen, and stored at -70°C. Later, the pancreas was removed from frozen storage, and mixed with $CaCl_2$ 50mM buffer, pH 8.0 (1:20 dilution). A crude extract was centrifuged at 14,000rpm for 30 min, at 4°C, filtered through a glass filter, and stored at -20°C until enzyme analyses.

Lipase analysis was performed according to SARDA & DESNUELLE (1958). Olive oil was utilised as substrate in sodium taurodeoxicolate 6mM, NaCl 0.15M, $CaCl_2$ 1mM, Tris (hydroxymethyl) aminomethane buffer 0.2mol L^{-1} pH 8.0 and partially purified broiler colipase (BROCKMAN, 1981).

The analysis of pancreatic α-amylase was determinated at 37°C according to BERNFELD (1955) and performed in triplicate. Protein analysis was conducted according HARTREE (1972). Data were submitted to polynomial regression analysis (P<0.05) (SAS, 1996).

RESULTS AND DISCUSSION

Experiment 1

Throughout the experimental period, the birds fed with 3,200kcal ME kg^{-1} showed higher ME

Table 1 - Calculate composition of experimental diets.

	Experiment 1		Experiments 2 and 3			
Ingredients (%)	1	2	1	2	3	4
Yellow corn	54.28	54.28	48.48	48.48	48.48	48.48
Soybean meal	28.99	28.99	34.32	34.32	34.32	34.32
Gluten meal	7.50	7.50	4.50	4.50	4.50	4.50
Soybean Oil	1.17	4.58	0.00	1.00	2.00	3.00
Starch	-	-	8.02	5.58	3.14	0.70
Dicalcium phosphate	1.70	1.70	1.64	1.64	1.64	1.64
Limestone	1.43	1.43	1.42	1.42	1.42	1.42
Vitamin and trace mineral mix[a]	0.80	0.80	0,80	0,80	0.80	0.80
Salt (NaCl)	0,45	0.45	0.45	0.45	0.45	0.45
DL-Methionine	0.17	0.17	0.20	0.20	0.20	0.20
L-Lysine	0.10	0.10	0.17	0.17	0.17	0.17
Sand	3.41	-	0.0	1.44	2.88	4.32
			Calculated analysis			
ME, kcal/kg	2.900	3.200	2.900	2.900	2.900	2.900
Crude protein, %	22.00	22.00	22.00	22.00	22.00	22.00
Total oil, %	3.72	7.10	2.32	3.32	4.32	5.29
Calcium, %	1.00	1.00	1.00	1.00	1.00	1.00
P Available, %	0.45	0.45	0.45	0.45	0.45	0.45
Sodium, %	0.20	0.20	0.20	0.20	0.20	0.20
Methionine + Cystine, %	0.88	0.88	0.92	0.92	0.92	0.92
Lysine, %	1.10	1.10	1.25	1.25	1.25	1.25

[a] Provided per kilogram of diet: vitamin A (11,250IU); vitamin D_3 (2,250IU); vitamin E (9.00IU); vitamin K_3 (1.8mg); thiamine (1,1mg); riboflavin (9mg); Pyridoxine (1,8mg); vitamin B_{12} (0,02mg); biotin (0.15mg); pantothenic acid (9,9mg); niacin (38.25mg); folic acid (0.9mg); choline (680mg) selenium (0,18mg); iodine (1,2mg); iron (70mg); copper (10mg); zinc (60mg); manganese (70mg).

intake (P<0.05) than those fed with 2,900kcal ME kg^{-1} (Table 2). This biggest ME intake has probably relation to the biggest feed intake of the 3,200kcal ME kg^{-1} ration. Although the 3,200kcal ME kg^{-1} ration feed intake has not been statistical superior than 2,900kcal ME kg^{-1}, it had 7% more consumption of this ration, that reflects on the superior ME intake. However, there is no statistical difference on FI, WG, or FC on 14-day-old birds (Table 2). It prevails some years the idea that birds feed intake is regulated to satisfy the energy requirements, overlapping to other control mechanisms determined for the amino acids, triglyceride, vitamins and minerals necessity (GONZALES, 2002). The attendance system of the metabolic requirements that is reflected of the animal physiological state and the environment conditions is co-ordinated by a detector system in hypothalamus. However the maximum control activity of this system is reached after approximately 15 days in birds (GONZALES, 2002).

At 21 days of age, WG and FC were influenced (P < 0.05) by dietary energy level, with the birds fed with 3,200kcal ME kg^{-1} were heavier and showed better FC than those fed with 2,900kcal ME kg^{-1}.

Experiment 2

During the first 5 days of age, no differences were observed among experimental treatments (Table 3). Between 6 and 10 days of age, broilers showed a quadratic response in terms of FI to dietary oils levels, as shown by equation: $Y = 47.52 + 49.78x – 13.37x^2$, R^2:0.98. From 11 to 20 days of age, it was observed that birds preferred diets with higher oil levels ($Y = 16.6 + 52.85x$, R^2:0.97 and $Y = 19.3 + 59.05x$, R^2:0.98, for 11 to 15 days, and 16 to 20 days, respectively). The National Research Council (NRC, 1994) detaches some benefits caused by the oil inclusion in poultry diets, like the palatability improvement, resulting in increase of the feed intake. This increase in the ingestion, beyond to supply the energy requirement basically, seems also to supply the essential fat acid, necessary to the animal growth. To attend the fad acid requirement, after the vitelline sac absorption, it can probably be one of the explanations of the increase of the FI following the increase of the oil inclusion.

Experiment 3

From 1 to 5, and 6 to 10 days of age, there

Table 2 - Feed intake (FI), ME intake (MEI), weight gain (WG) and feed conversion (FC) of broilers from 1 to 7, 8 to 14 and 15 to 21 days of age (Experiment 1).

Energy level (kcal ME/kg)	FI (g)	MEI (kcal)	WG (g)	FC (g g^{-1})
		1-7 days		
2.900	136	394^b	105	1.280
3.200	143	458^a	111	1.284
		8-14 days		
2.900	375	$1{,}088^b$	274	1.368
3.200	379	$1{,}212^a$	282	1.343
		15-21 days		
2.900	685^a	$1{,}986^b$	339^b	2.020^a
3.200	653^b	$2{,}090^a$	380^a	1.718^b

[a,b] different letters in the column are different by T test ($P < 0.05$).

were no statistical differences in terms of FI, WG, and FC among the different treatments (Table 4). In addition, no differences were found in pancreatic lipase and amylase enzyme level at 5 days of age (Table 5). However, between 11 and 15 days of age, there were linear responses in WG and FC, as shown by the equations (Y=171.58+0.47x, R^2:0.88 and Y=1.62- 0.004x, R^2:0.95, respectively). Between 16 and 20 days of age of birds, linear responses in FI, WG and FC were also observed (Y= 42.8+1.98x, R^2: 0.97; Y=216.2+1.57x, R^2:0.95 and Y=1.61-0.003x, R^2:0.82, respectively).

The intestinal tract of young birds is not physiologically prepared to digest and absorb the different nutrients supplied in the diet. In particular, lipid digestion and absorption is very inefficient in young birds (SEEL, 1996). This could explain the results observed in the present study (Experiment 1 and 3), where the different energy or oil levels did not affect WG and FC of birds until two weeks of age. The digestion and absorption of lipids require several factors, such as the presence of bile salts, pancreatic lipase, colipase, and fatty acid binding protein. In the early period after hatching, the bird entero-hepatic circulation is still immature, and this causes the accumulation of taurocholate in ileum (JEANSON & KELLOGG, 1992). This immature entero-hepatic circulation can negatively affect the digestion of lipids, as it reduces fat emulsification (SERAFIN & NESHEIM, 1970). The activity of pancreatic lipase increases as the bird ages, but fat digestion also requires bile salts (KROGDAHL & SELL 1989). Moreover, enzyme activity is induced by the presence of substrate (MORAN, 1985), which means that higher amounts of substrate in intestinal tract induce higher enzyme activity. However, the results in table 5 show that, although treatments contained increasing levels of oil in Experiment 3, no increase in pancreatic lipase activity was observed, suggesting that young birds are not physiologically adapted to respond to substrate.

The performance results observed in Experiment 1 and 3 may be explained by the report of CAREW et al. (1972), that verified that, during the first days of life, birds were not able to digest well the corn oil or animal fat from diet. MAIORKA et al. (1997) also observed that, at 7 days of age, birds did not regulate feed intake according to dietary energy level, but after 14 days of age dietary energy level had a significant effect on feed intake, weight gain and feed conversion. The results observed in experiment 2, agree with MAIORKA et al. (1997), in which the oil level in the diet did not affect feed intake until five days of age

Table 3 - Feed intake (g) of broilers during the experimental period (Experiment 2).

Oil level (%)	1-5 days	6-10 days	11-15 days	16-20 days
0.0	15.0	46.5	27.5	29.5
1.0	25.0	87.0	55.5	61.0
2.0	24.0	90.5	117.5	141.5
3.0	25.0	77.5	183.0	199.5
Polynomial regression	NS	$Y = 47.52+49.78x-13.37x^2$ $R^2 = 0.98$	$Y = 16.6+52.85x$ $R^2 = 0.97$	$Y = 19.3+59.05x$ $R^2 = 0.98$

Table 4 - Feed intake (FI), weight gain (WG) and feed conversion (FC) of broilers during the experimental period (Experiment 3).

Oil level (%)	FI (g)	WG (g)	FC (g g^{-1})
		1-5 days	
0.0	87.0	71.8	1.217
1.0	92.6	73.8	1.254
2.0	88.8	73.6	1.217
3.0	89.4	75.8	1.178
Polynomial regression	NS	NS	NS
		6-10 days	
0.0	158.4	109	1.453
10	157.0	110	1.427
2.0	158.0	109	1.449
3.0	159.0	111	1.420
Polynomial regression	NS	NS	NS
		11-15 days	
0.0	274.8	169.8	1.623
1.0	281.6	179.4	1.572
2.0	273.4	180.0	1.523
3.0	279.6	185.0	1.509
Polynomial regression	NS	Y = 171.58+0.47x $R^2 = 0.88$	Y =1.62-0.004x $R^2 = 0.95$
		16-20 days	
0.0	341.4	212.0	1.636
1.0	367.6	239.0	1.552
2.0	376.6	245.0	1.541
3.0	404.4	263.2	1.538
Polynomial regression	Y =342.8+1.98x $R^2 = 0.97$	Y =216.2+1.57x $R^2 = 0.95$	Y =1.61–0.003x $R^2 = 0.82$

(Table 3), but caused a quadratic response from 6 to 10 days of age. These data suggest that birds prefer diets with high oil levels as the gastrointestinal tract physiologically matures and becomes able to digest and to absorb lipids.

The analyses of the data of the present study show that the regulation of feed intake according to the dietary energy or oil level is related to the broiler age. Adult birds are more adapted to digest and absorb lipids, and thus may have a better regulation of feed intake according to these factors, whereas young birds are still not able to fully use this mechanism of feed regulation.

Table 5 - Pancreatic lipase and amylase activity of broilers at 5 days of age (Experiment 3).

Oil level (%)	Lipase	Amylase
0.0	13.21 ± 1.06	0.096 ± 0.01
1.0	14.81 ± 0.97	0.084 ± 0.02
2.0	14.55 ± 1.91	0.098 ± 0.02
3.0	14.51 ± 1.51	0.086 ± 0.03
Polynomial regression	NS	NS

μMol $minute^{-1}$ mg^{-1} of protein (specific activity).

CONCLUSION

The results of this study show that diets with high levels of energy derived from lipids may not be interesting for young broilers for the first two weeks, as they do not result in better performance (FI, WG, and FC).

ACKNOWLEDGEMENTS

The authors thank Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP) for financial support (Proc. 98/11304-9).

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