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Effects of Lysolecithin and Sodium Stearoyl-2-lactylate on Growth Performance and Nutrient Digestibility in Broilers

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ABSTRACT We investigated the effects of supplementing low energy diets with lysolecithin and sodium stearoyl-2-lactylate on growth performance and nutrient digestibility in broilers. A total of 768 1-d-old Ross 308, mixed gender broiler chicks with an average initial body weight of 44.3 g, were used in a 35-d feeding trial. Broiler chicks were sorted into pens with 16 birds per pen and every treatment consisted of 12 pens (192 chickens per treatment). Treatments were: 1) PC: basal diet, 2) NC: PC-100 kcal, 3) T1: NC+ 0.08% lysolecithin, and, 4) T2: NC + 0.04% sodium stearoyl-2-lactylate. Body weight gain (BWG), feed intake (FI) and feed conversion ratio (FCR) were measured on a weekly basis. Chromium oxide was added to the diets at 0.2% on the last week of the experiment, as a marker for digestibility. Dietary treatments had no effect on growth performance for days 1 to 21. Low energy diet supplemented with lysolecithin and sodium stearoyl-2-lactylate in phase 2 (d 21 to 35) improved body weight gain (P<0.05). Addition of lysolecithin and sodium stearoyl-2-lactylate to the diets improved the digestibility of energy and nitrogen (P<0.05), but digestibility of dry matter was not affected. Overall, addition of an emulsifier to the diet of broiler chickens in the late growth phase enhanced growth performance and digestibility of energy and nitrogen.

(Key words : broiler, growth performance, lysolecithin, stearoyl-2-lactylate)

INTRODUCTION

The new commercial strains of broiler chickens used in the poultry industry are genetically improved to reach marketing weight at shorter periods. Meeting the rapid growth potential of chickens requires a well balanced diet. Dietary energy level is one of the most important nutrient considerations in diet formulation. Oils are one of the main sources of required energy levels in broiler diets (Adrizal et al., 2002), especially in young chickens and piglets, where the digestive tract is incompletely developed with relatively low levels of natural lipase production for efficient absorption and digestion of high levels of dietary oils (Krogdahl, 1985). Fat globules are not easily subjected to enzymatic digestion thus remaining a problem within the digestive tract. Fat is emulsified by bile salts and hydrolyzed by lipase. Therefore, addition of an emulsifier to the diet such as phospholipids, lecithin and lysolecithin can effectively decrease the size of fat globules and increase the total available surface for enzymatic digestion (Polin, 1980; Krogdahl 1985; Jones, et al., 1992; Al-Marzooqi and Leeson, 1999; Soares and Lopez-Bote 2002; Gu and Li 2003). Sodium stearoyl-2-lactylate (E 481 SSL) is a mixture of sodium salts of stearoyl lactylic acids and minor proportions of other salts of related acids, formed by the esterification of commercial stearic acid with lactic acid, and neutralized to sodium salts. It is applied as emulsifier, whipping agent, and conditioning agent to a wide range of advanced food processing technologies (Armero et al., 1998; Kelly et al., 1999; Manohar et al., 1999; Gomez et al., 2004). Previous studies reported that addition of an emulsifier to the diet of rats and chickens improved fat digestibility. However, these studies focused on one type of emulsifiers and didn't test effects of emulsifiers in animals provided with different dietary energy levels (Augur et al., 1947; Polin 1980). There is a need to evaluate if emulsifiers yield the same effects in animals with low energy diets. Therefore, the aim of this study was to determine the effects of lysolecithin and stearoyl-2-lactylateon supplemented with low energy diets on growth performance and nutrient digestibility in broiler chickens.

MATERIALS AND METHODS

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1. Animals, Diets and Facilities

The Animal Care and Use Committee of Dankook University approved the broiler chicken study procedures. A total of 768 1-d-old Ross 308, mixed gender broiler chicks with an average initial body weight of 44.3 g were used in a 35-d feeding trial to investigate the effects of 2 different emulsifiers, lysolecithin (Lipidol®, Easybio Co. Cheonan, Korea) and sodium stearoyl-2-lactylate (Prosol®, Ilshinwells, Seoul, South Korea), on growth performance and nutrient digestibility. Broiler chicks were allocated to pens with 16 birds/pen and 12 pens/treatment. Treatments were: 1) PC (basal diet), 2) NC (basal diet-100 kcal/kg down spec.), 3) T1 (NC+0.08% lysolecithin), and 4) T2 (NC+0.04% sodium stearoyl-2-lactylate). 0.08% lysolecithin and 0.04% sodium stearoyl-2-lactylate were used according to manufacturers' instructions. Birds were housed in 3 floor battery cages in an environmentally controlled room (24 to 32℃ and 65% relative humidity) with a free access to feed and water during the experimental period. The diets were formulated to meet or exceed the nutrient concentration recommended by the National Research Council (NRC, 1994). Ingredients and calculated nutrient composition of the PC and NC diets were presented in Table 1.

2. Sampling and Measurements

The chickens and remnant feed in feeders (pen basis) were weighed on d 5, 19 and 33 to calculate feed intake (FI), body weight gain (BWG) and feed conversion ratio (FCR).

Chromium oxide at 0.2% was added to the diets on the last week of the experimental period, as a marker for apparent digestibility of dry matter (DM), nitrogen and energy. Fresh fecal and feed samples were collected from each pen at the end of the experiment, after feeding the chickens for 1 week. Fecal samples were ground and screened with a 1 mm screen subsequent to drying at 70℃ for 72 hours. Digestibility of DM, nitrogen and energy were determined according to the methods established by AOAC (2003) and chromium levels were determined via UV absorption spectrophotometry (Shimadzu, UV-1201, Japan).

3. Statistical Analysis

Data were analyzed by completely randomized design, with the pen of birds as the experimental unit. Orthogonal contrasts were used to test the overall effect of lysolecithin and sodium stearoyl-2-lactylate supplementation (PC vs. NC; PC vs. T1+T2; NC vs. T1+T2). Variability in the data was expressed as pooled SEM, and $P<0.05$ was considered statistically significant.

Table 1. Basal diet composition (as-fed basis)

Item	Phase 1 (0 to 19d)		Phase 2 (19 to 33d)	
	NC	PC	NC	PC
Ingredients (%)				
Corn	59.75	56.95	60.37	60.44
Soybean meal (CP 45%)	28.90	29.25	30.80	25.33
Corn gluten meal (CP 60%)	4.38	4.44	-	3.83
Tallow	1.23	3.61	3.90	5.00
Limestone	0.91	0.91	1.00	1.02
Dicalcium phosphate	2.07	2.07	1.89	1.93
Salt	0.31	0.32	0.37	0.37
Methionine (99%)	0.33	0.33	0.41	0.37
Lysine-HCl (24%)	1.68	1.68	0.85	1.28
Threonine (98.5%)	0.18	0.18	0.16	0.18
Vitamin premix[1]	0.06	0.06	0.05	0.05
Trace mineral premix[2]	0.10	0.10	0.10	0.10
Choline (50%)	0.10	0.10	0.10	0.10
Calculated values				
ME (kcal/kg)	2,950	3,050	3,100	3,200
CP (%)	21.00	21.00	19.00	19.00
Lys (%)	1.40	1.40	1.20	1.20
Ca (%)	0.90	0.90	0.90	0.90
P (%)	0.71	0.71	0.66	0.66

[1] Provided per kilogram of diet: 15,000 IU of vitamin A, 3,750 IU of vitamin D_3, 37.5 mg of vitamin E, 2.55 mg of vitamin K_3, 3 mg of thiamin, 7.5 mg of riboflavin, 4.5 mg of vitamin B_6, 24 μg of vitamin B_{12}, 51 mg of niacin, 1.5 mg of folic acid, 0.2 mg of biotin, and 13.5 mg of Pantothenic acid.

[2] Provided per kilogram of diet: 37.5 mg of Zn, 37.5 mg of Mn, 37.5 mg of Fe, 3.75 mg of Cu, 0.83 mg of I, 62.5 mg of S and 0.23 mg of Se.

RESULTS AND DISCUSSION

1. Growth Performance

The results (Table 2) demonstrated that dietary treatments did not affect growth performance on d 0 to 7. The results were in agreement with earlier reports (Jeason & Kellog, 1992; Nir et al., 1993). We speculated that emulsifier additives did not improve the broiler chicken performance due to low lipase activity. We observed that chickens fed on diets of lower energy and supplemented with an emulsifier on d 21 to 35 and 0 to 35, responded with significantly less efficient FCR (P<0.05). The data showed that feeding chickens with a low energy diet (NC group) on d 7 to 21 significantly increased FI (P<0.05), but addition of an emulsifier (either lysolecithin or sodium stearoyl-2-lactylate) decreased (P=0.07) FI and significantly improved FCR (P<0.05), as compared to NC group. The low energy diet on d 21 to 35 and the overall experimental period resulted in higher FI and FCR in the NC group, as compared to the PC and T1 groups. The results demonstrated that there were no significant differences between PC and low energy diets supplemented with lysolecithin or sodium stearoyl-2-lactylate (T1 and T2). These results indicated that BWG was unaffected during the entire experimental period. Previously, researchers reported that chickens fed on low energy diets showed higher FI (Leeson et al., 1996; Azman and Ciftci 2004; Cho et al., 2012). Thus, emulsifier additives to low energy diets alleviated the negative effects and improved FCR by reducing FI and increasing feed efficiency.

Table 2. Effects of supplementation lysolecithin and sodium stearoyl-2-lactylate on growth performance in broilers[1]

Items	PC	NC	T1	T2	SE[2]	*P*-value			
						PC vs. NC	PC vs. T1 & T2	T1 vs. T2	NC vs. T1 & T2
d 0 to 7									
BWG[3] (g/bird)	135	132	138	134	2.7	0.339	0.854	0.289	0.201
FI[4] (g/bird)	165	166	165	165	3.4	0.861	0.909	0.981	0.929
FCR[5]	1.22	1.26	1.2	1.23	0.03	0.448	0.881	0.416	0.307
d 7 to 21									
BWG (g/bird)	806	795	816	813	11.3	0.530	0.530	0.891	0.181
FI (g/bird)	1,116	1,128	1,119	1,120	3.9	0.040	0.548	0.865	0.072
FCR	1.39	1.42	1.37	1.38	0.02	0.195	0.561	0.840	0.042
d 21 to 35									
BWG (g/bird)	829	816	834	843	5.8	0.120	0.203	0.288	0.004
FI (g/bird)	1,270	1,309	1,272	1,273	14.1	0.055	0.884	0.950	0.039
FCR	1.53	1.6	1.52	1.51	0.02	0.028	0.623	0.624	0.003
Overall									
BWG (g/bird)	1,770	1,743	1,788	1,790	12.4	0.135	0.227	0.881	0.005
FI (g/bird)	2,551	2,603	2,556	2,558	16.04	0.028	0.765	0.919	0.025
FCR	1.44	1.49	1.43	1.43	0.01	0.006	0.438	0.962	0.0002

[1] Abbreviation: PC, basal diet; NC, PC-100kcal; T1, NC + 0.08% lysolecithin; T2, NC + 0.04 % sodium stearoyl-2-lactylate.
[2] Standard error.
[3] Body weight gain.
[4] Feed intake.
[5] Feed conversion ratio.
The analysis was based on the average measurement of 12 replicates.

2. Nutrient Digestibility

The results presented in Table 3 indicated that supplementing low energy level diets with lysolecithin or sodium stearoyl-2-lactylate significantly enhanced digestibility of nitrogen and energy (P<0.05). The results demonstrated that reducing the dietary energy level had a negative impact on digestibility of energy (P=0.056), but emulsifier supplementation of low energy diets improved (P=0.003) the digestibility of energy in chickens with low dietary energy level diet. Digestibility of dry matter was unaffected by dietary treatments; however it was slightly lower in the NC group, as compared to the PC, T1 and T2 groups. Studies investigating the effects of dietary lysolecithin and sodium stearoyl-2-lactylate on nutrient digestibility in broiler chickens are limited. Jones et al. (1992) reported that addition of emulsifiers to the diet increased the digestibility of nutrients.

SUMMARY

The findings of our study indicated that reducing dietary energy level had adverse effects on growth performance of broiler chickens and supplementing the low energy diets with emulsifiers could alleviate the negative effects and improve chickens performance. Also it was concluded that inclusion of an emulsifier in broiler chickens diet could improve digestibility of nitrogen and energy.

초 록

본 연구는 저 에너지 사료 내 lysolecithin과 sodium stearoyl-2-lactylate의 첨가가 육계의 생산성 및 영양소 소화율에 미치는 영향을 규명하였다. 본 시험은 1일령 ROSS 308(♂, ♀) 768수를 공시하였고, 시험 개시 체중은 44.3 g으로 35일간 진행하였으며, 시험설계는 1) PC(basal diet), 2) NC(PC-100 kcal), 3) T1(NC+ 0.08% lysolecithin) and 4) T2(NC + 0.04% sodium stearoyl-2-lactylate)로 4개 처리를 하여 처리당 12반복, 반복당 16수씩 완전 임의 배치하였다. 증체량(body weight gain: BWG), 사료섭취량(feed intake: FI) 및 사료요구율(feed conversion ratio: FCR)은 매주 측정하였다. 산화크롬(Cr_2O_3)을 표시물로서 0.2% 첨가하여 실험 실험종료 7일전에 급여하였다. 1~21일차 생산성에 있어 처리구간 유의적인 차이가 나타나지 않았고(P>0.05), 21~35일차 증체량에 있어서 T1 처리구 및 T2 처리구가 대조구와 비교하였을 때 유의적으로 높게 나타났다(P<0.05). 영양소 소화율에 있어 T1 처리구 및 T2 처리구가 대조구와 비교하였을 때 유의적으로 효과가 있었다(P<0.05). 그러나 건물 소화율에 있어서는 처리구간 유의적인 차이를 나타내지 않았다(P>0.05). 종합적으로, 육계 사료 내 유화제의 첨가가 후반 성장 단계에서 생산성, 에너지 소화율 및 질소 소화율을 향상시켰다.

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Table 3. Effects of supplementation lysolecithin and sodium stearoyl-2-lactylate on nutrient digestibility in broilers[1]

Items (%)	PC	NC	T1	T2	SE[2]	*P*-value			
						PC vs. NC	PC vs. T1&T2	T1 vs. T2	NC vs. T1&T2
Dry matter	78.33	78.16	78.73	78.83	0.36	0.740	0.322	0.853	0.176
Nitrogen	65.64	64.09	66.06	67.56	0.62	0.092	0.142	0.103	0.002
Energy	78.84	77.67	79.29	79.43	0.41	0.056	0.305	0.816	0.003

[1] Abbreviation: PC, basal diet; NC, PC-100kcal; T1, NC + 0.08% lysolecithin; T2, NC + 0.04 % sodium stearoyl-2-lactylate.
[2] Standard error.
[3] Body weight gain.
[4] Feed intake.
[5] Feed conversion ratio.
The analysis was based on the average measurement of 8 replicates.

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