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Influence of dietary fat sources and lysolecithin on growth performance, visceral organ size, and histological intestinal alteration in broiler chickens

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ABSTRACT

The aim of this study was to investigate the influence of dietary fat sources and lysolecithin on growth performance, visceral organ size, and histological intestinal alterations in broiler chickens. Ninety-six 7-d-old male broiler chickens were assigned to 8 treatments in a 2 × 4 factorial arrangement of treatments with 2 levels of lysolecithin (0 and 145 mg/kg) and 4 different fat sources [poultry fat (PF), yellow grease from Kagoshima (YG1), yellow grease from Kashima (YG2), and yellow grease from Hachinohe (YG3)]. Each treatment had 4 replicates of 3 broiler chickens per cage until 49 d of age. There was no difference in BW gain due to fat sources, lysolecithin, or lysolecithin × fat source interaction throughout the experiment. By feeding lysolecithin, feed efficiency increased ($P < 0.05$) during the growth period of 7 to 21 d of age, and the weights of the duodenum, ileum, and total intestine decreased ($P < 0.05$). Intestinal villus height, villus area, and cell area were not different among treatment groups, except that ileal villus height tended to decrease and ileal cell area tended to increase ($P = 0.077$) by feeding lysolecithin. Increased duodenal cell mitosis and decreased jejunal tunica muscularis thickness were observed ($P < 0.05$) by feeding lysolecithin. Furthermore, on the villus apical surface, more protuberated cells, cell clusters, and deeper cells at the sites of recently exfoliated cells were observed by feeding lysolecithin. However, the protuberant cells were not different among treatment groups. The Integrated Fluorescence Density Values of Anti-Cluster of Differentiation 36 reaction in the jejunum were significantly greater in the lysolecithin-fed groups, except YG2. These results indicate that feeding lysolecithin improves feed efficiency during 7 to 21 d of age regardless of the fat type, and causes epithelial hypertrophy.

1. Introduction

Dietary fats, including recycled fat such as yellow grease (YG), are mainly energy sources in livestock feed. In addition to vegetable oils and poultry fat, YG is low cost and it does not negatively affect on growth performance in animal (Firman et al., 2008; Ouart et al., 1992).

After dietary fat enters the gastrointestinal tract, bile salt plays an important role as an emulsifier to break the fat into small droplets in an aqueous environment. The emulsified fats are hydrolyzed by lipase and the products aggregate with bile salts to form micelles. However, the limited ability of young chicks to secrete bile salt (Krogdahl, 1985) causes inefficient diet fat utilization. However, using synthetic bile salt in feed results high poultry production costs. Therefore,

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Table 1
Feed formulation, energy and nutrients of experimental diet.

Item	Period (d of age)			
	1 to 7	7 to 21	21 to 39	39 to 49
Ingredient (%, as-fed basis)				
Corn	49.40	49.40	60.30	62.90
Soybean meal	41.94	42.03	31.12	28.68
Fat	5.60	5.60	5.60	5.60
$CaCO_3$	0.78	0.88	0.88	0.73
Tricalcium phosphate	1.58	1.41	1.42	1.45
NaCl	0.23	0.25	0.25	0.24
DL-Met	0.23	0.23	0.22	0.21
L-Lys.HCl	0.04	0.04	0.02	0.03
Choline chloride	0.08	0.08	0.08	0.08
Vitamin and trace mineral premix[a]	0.12	0.12	0.12	0.07
Calculated composition (as-fed basis)				
ME (kcal/kg)	3108	3109	3205	3232
Crude protein (%)	22.10	22.10	18.00	17.10
Crude fat (%)	7.60	7.60	7.70	7.80
Crude fiber (%)	4.40	4.40	3.90	3.80
Ash (%)	5.80	5.70	5.20	4.90
Met (%)	0.58	0.58	0.52	1.04
Met+Cys (%)	0.97	0.97	0.86	1.38
Lys (%)	1.37	1.34	1.06	1.01
Ca (%)	0.96	0.94	0.90	0.84
Available P (%)	0.66	0.63	0.59	0.59
Na (%)	0.20	0.20	0.20	0.20

[a] These ingredients were proprietary formulations of a company.

Table 2
Chemical properties and fatty acid content of fat sources[a].

Item	PF	YG 1	YG 2	YG 3
Free fatty acid (%)	4.90	4.40	4.60	8.80
Iodine value (g/100 g)	72.80	63.78	72.80	70.63
Fatty acid (% of total fatty acid)				
Lauric acid, C12:0	ND[b]	ND	0.99	ND
Myristic acid, C14:0	0.93	1.81	1.97	1.11
Palmitic, C16:0	26.51	25.62	25.60	26.55
Palmitoleic acid, C16:1 (n-7)	7.30	4.32	2.73	6.12
Stearic acid, C18:0	8.49	14.22	12.22	9.16
Oleic acid, C18:1	39.40	42.84	42.01	41.60
Linoleic acid, C18:2	14.64	11.19	14.48	12.85
Eicosatrienoic acid, C20:3 (n-3)	2.73	ND	ND	ND
Docosadienoic acid, C22:2 (n-6)	ND	ND	ND	2.61
Total acid (%)	100.00	100.00	100.00	100.00
Saturated (%)	35.93	41.65	40.78	40.78
Unsaturated (%)	64.07	58.35	59.22	59.22
unsaturated/saturated	1.78	1.40	1.45	1.45

[a] Poultry fat (PF), yellow grease from the Kagoshima (YG1), Kashima (YG2) and Hachinohe (YG3) areas.
[b] Not detected.

to find exogenous emulsifiers is an alternative way to solve this problem. Several studies report that exogenous emulsifier could improve growth performance in broiler chicken (Guerreiro Neto et al., 2011; Melegy et al., 2010; Roy et al., 2010; Zhang et al., 2011).

Lysolecithin, the product of hydrolyzed soy lecithin by the enzyme phospholipase A 2, is known to be an effective emulsifier in food industry (Van Nieuwenhuyzen, 1981). Lysolecithin has one mole fatty acid per molecule that increases the hydrophilic properties. Although feeding lysolecithin was recently reported to increase egg weight and feed efficiency in laying hens (Han et al., 2010), and to improve growth performance of broiler chickens in the starter period caused by increased fatty acid digestibility (Zhang et al., 2011), histological intestinal alterations induced by feeding lysolecithin have not been studied so far in detail.

The intestinal crypt region produces enterocytes which migrate from the villus base to the tip to replace older cells, with the older cells sloughed into the intestinal lumen (Uni et al., 2001). As cell turnover of these epithelial cells from proliferation to extrusion is a few days.