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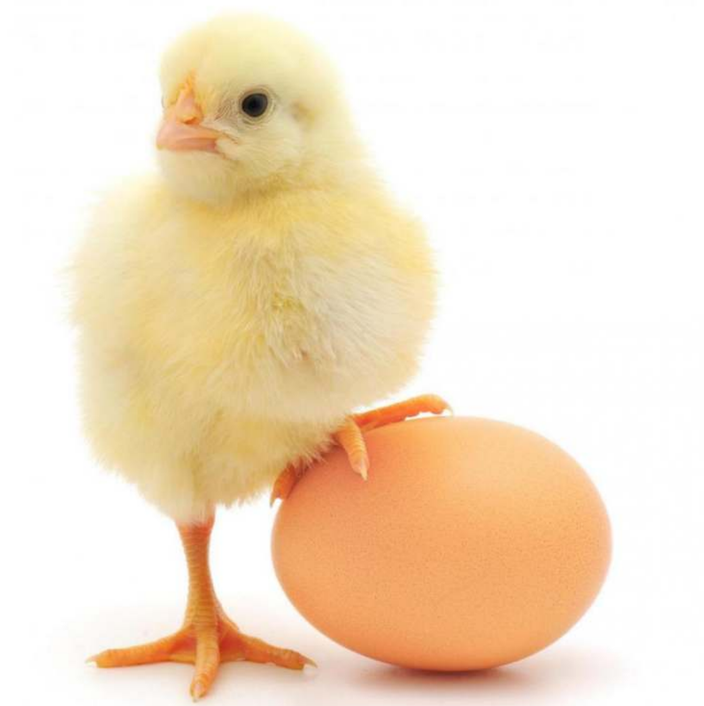

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Dietary Soybean Oil, but Not Krabok Oil, Diminishes Abdominal Fat Deposition in Broiler Chickens

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Abstract: In broiler chickens we tested the hypothesis that dietary fats rich in medium-chain triacylglycerols (MCT) would diminish abdominal fat deposition as do fats rich in polyunsaturated fatty acids (PUFA). Broiler chickens were fed on diets containing either tallow, which is rich in Saturated Fatty Acids (SFA), soybean oil, which is rich in PUFA, or krabok oil, which is rich in MCT. Krabok oil was isolated from the seeds of a tree (*Irvingia malayana*) grown widely in tropical and subtropical areas. Growth performance was not significantly affected by the type of dietary fat. Possibly, the production of krabok oil for use in broiler rations may become economically relevant. The diets containing either soybean oil or krabok oil showed a significantly higher apparent fat digestibility than did the diet containing tallow. In keeping with earlier investigations, dietary soybean oil versus tallow significantly lowered abdominal fat deposition, the lowering being 21%. The feeding of krabok oil instead of tallow did not affect the weight of abdominal fat, which would lead to rejection of our hypothesis.

Key words: Tallow, soybean oil, krabok oil, broiler chicken, feed intake, abdominal fat deposition

Introduction

It has been observed frequently that the addition to the diet of an oil rich in polyunsaturated fatty acids (PUFA) at the expense of long-chain Saturated Fatty Acids (SFA) reduces the amount of abdominal fat in broiler chickens (Sanz *et al*., 1999, 2000a; Crespo and Esteve-Garcia, 2002a; Newman *et al*., 2002; Pinchasov and Nir, 1992; Villaverde *et al*., 2005; Zollitsch *et al*., 1997, Wongsuthavas *et al*., 2007). The metabolic basis for the diminishing effect of PUFA on abdominal fat mass is poorly understood (Sanz *et al*., 2000b; Crespo and Esteve-Garcia, 2002b,c; 2003; Newman *et al*., 2002; Villaverde *et al*., 2005). One possible mechanism could be that PUFA versus SFA are preferentially oxidized (Beynen and Katan, 1985) and thereby yield ATP so that carbohydrates are shifted from the oxidative into the lipogenic pathway. The conversion of glucose into triglycerides is less efficient in terms of energy deposition than is the conversion of fatty acids into triglycerides (Newsholme and Leech, 1994). Consequently, the feeding of PUFA instead of SFA acids may lead to less deposition of abdominal fat. Analogous to PUFA, saturated fatty acids with medium-chain length are also preferentially oxidized (Bach and Babayan, 1982). Thus, it could be hypothesized that dietary fats rich in medium-chain triacylglycerols (MCT) would diminish abdominal fat deposition in broiler chickens.
Krabok (*Irvingia malayana*, Oliv. ex. A. Benn.) is a tree grown widely in tropical and subtropical areas. In Thailand, the krabok tree is commonly used for wood and charcoal production, whereas the seeds, after peeling, are consumed by people. Krabok seed oil is rich in lauric (C12:0) and myristic acid (C14:0) (Peangpra, 1977). In the light of the above-mentioned, we hypothesized that the consumption of krabok oil by broiler chickens would lower the deposition of abdominal fat. To test the hypothesis, broiler chickens were fed on diets containing either tallow, which is rich in SFA, soybean oil, which is rich in PUFA, or krabok oil, which is rich in MCT. Apart from abdominal fat weight, we also determined apparent fat digestibility.

Materials and Methods

Krabok seed oil extraction: Krabok seeds were purchased from a local market. The seeds were dehulled and ground through pass a 1-mm screen sieve of a grinding machine. Then, the meal was extracted by the Sohxlet method using hexane (AOAC, 1975). The hexane was evaporated and the residual krabok oil was used for diet formulation.

Broiler chickens and diets: Forty-five 7-day-old Arbor Acres broiler chicks were used. They were randomly allocated to three groups of 15 birds each and kept in individual cages. Feed was provided ad libitum in the form of meal. Birds had free access to water. The

Table 1: Ingredient and analyzed composition of the experimental diets

Ingredient composition (%)	Fat source: Tallow	Soybean oil	Krabok oil
Tallow	2.87	0.00	-
Soybean oil	0.13	3.00	-
Krabok oil	-	-	3.00
Constant components	97.00	97.00	97.00
Analyzed composition (%)			
Dry matter	92.0	92.0	91.9
Crude protein	18.0	18.0	18.0
Crude fat	3.4	3.3	4.4
Crude fiber	3.2	3.2	3.2
Ash	4.3	4.3	4.3

The constant components consisted of (g/100 g diet): tapioca starch, 46.02; soybean meal, 41.05; rice bran hulls, 4; dicalcium phosphate, 3.87; D,L-methionine, 0.3; L-lysine, 0.25; sodium chloride, 0.51; premix, 1. The premix supplied per kg of diet: vitamin A, 1,650 IU; vitamin D, 330 IU; vitamin E, 11 IU; vitamin K, 0.55 mg; thiamine, 198 mg; riboflavin, 3.96 mg; niacin, 3.30 mg; pyridoxine, 3.85 mg; vitamin B_{12}, 0.01 mg; calcium pantothenic acid, 10 mg; folacin, 0.61 mg; biotin, 0.17 mg; choline, 1,430 mg; manganese, 65.99 mg; iodine, 0.39 mg; potassium, 330 mg; zinc, 43.97 mg; copper, 8.80 mg; ferrous, 87.59 mg; selenium, 0.17 mg

Table 2: Fatty acid profile of dietary fat source in broiler rations

Fatty acid	Beef tallow	Soybean oil	Krabok oil
10:0	0.0	0.0	1.8
12:0	0.0	0.0	44.4
14:0	2.0	0.2	43.7
16:0	19.8	12.9	4.5
16:1	0.9	0.1	0.6
18:0	38.1	4.6	0.4
18:1 n-9c	22.0	22.7	3.6
18:2 n-6c	0.8	53.1	0.5
18:3 n-6	0.4	0.0	0.0
18:3 n-3	0.3	3.6	0.0
20:0	0.4	1.4	0.0
20:1 n-9	0.4	1.1	0.0
SFA	63.0	19.3	95.0
MUFA	23.7	24.0	4.2
PUFA	1.6	56.7	0.5

Table 3: Effect of dietary fat source on growth performance and apparent digestibility of dry matter and crude fat

Growth performance	Fat source: Tallow	Soybean oil	Krabok oil	Pooled SEM
Initial BW, g	184	182	178	0.71
Final BW, g	655	647	660	4.11
ADFI, g/d	45.4	41.8	46.6	0.35
ADG, g/d	22.4	23.0	23.0	0.21
FCR (feed intake: weight gain)	2.08	1.97	2.07	0.02
Digestibility, % of intake				
Dry matter	95.1	95.5	96.1	2.51
Crude fat	76.3[b]	82.0[a]	81.7[a]	2.52

Results are for 15 birds per treatment. Values with different superscript letter differ significantly (p<0.01)

experimental diets contained tallow, soybean oil or krabok oil. The ingredient and calculated composition of the diets is shown in Table 1.

Data collection: Feed intake of the birds was recorded daily and body weight was measured weekly. Excreta were collected quantitatively during the entire experimental period. At the end of experiment (28 days of age), the birds were stunned and slaughtered at a local slaughterhouse. Five birds per treatment were randomly chosen for measurement of organ weights. The abdominal adipose tissue (from the proventriculus surrounding the gizzard down to the cloaca), breast, thigh, liver, spleen, heart, gizzard, small intestine and large intestine from each broiler were collected and weighed. Intestines were weighed without contents. The length of small and large intestine were measured.

Chemical analysis: The experimental diets were analyzed for dry matter, ash, crude fat, crude fiber and crude protein (AOAC, 1975). In excreta dry matter and crude fat were determined. The dietary fat sources were saponified and methylated according to the procedure of Metcalfe *et al.* (1966) followed by gas chromatography to determine fatty acid composition (Javadi *et al.*, 2004).

Statistical analysis: Average Daily Feed Intake (ADFI), Average Daily Gain (ADG), Feed Conversion Ratio (FCR) and apparent digestibilities for dry matter and crude fat were calculated. Data were subjected to Duncan's multiple range test (Steel and Torries, 1980) using a computer program (SPSS for windows 9.0, SPSS Inc., Chicago, IL, 1998). The level of statistical significance was pre-set at $p<0.05$.

Results

Chemical and fatty acids composition in experimental diets: Table 1 shows that the analyzed proximate composition of the diets was similar. As would be expected, the tallow used was rich in SFA and soybean oil rich in PUFA (Table 2). The krabok oil was high in SFA, but this fraction consisted mainly of C12:0 and C14:0.

Growth performance, fat digestibility and abdominal fat deposition: Growth performance was not significantly affected by the type of dietary fat. However, ADFI and FCR tended to lowered by feeding soybean oil. Indeed, we found that the fat component of the diet containing soybean oil was digested more efficiently than that of the diet with tallow (Table 3). However, krabok oil also was digested better than tallow, but the birds fed the diet with krabok oil did not display a tendency towards a lower ADFI. It would thus appear that the digestibility of the fat component of the diet is not a major determinant of ADFI by broiler chickens with ad libitum access to feed (Table 3).

Table 4: Effect of dietary fat source on organ weights

	Fat source			
Organ weight, % of body weight	Tallow	Soybean oil	Krabok oil	Pooled SEM
Breast meat	10.17	10.15	10.19	0.33
Thigh meat	5.79	5.29	6.03	0.21
Abdominal fat	1.19^{ab}	0.94^{b}	1.38^{a}	0.07
Liver	2.84^{ab}	3.22^{a}	2.38^{b}	0.14
Heart	0.75	0.75	0.69	0.04
Spleen	0.13	0.12	0.12	0.01
Gizzard	3.01	3.06	2.54	0.19
Intestine (small and large)	8.18^{b}	9.94^{a}	7.92^{b}	0.31
Intestinal length, cm per 100 g of body weight				
Small intestine	16.6	20.4	19.0	1.02
Large intestine	2.5	3.4	2.8	0.22
Intestinal length (cm)				
Small intestine	124	130	123	2.84
Large intestine	19	22	18	1.04

Results are for 5 birds per treatment; [ab]Values in the same row with the different superscripts differ significantly ($p<0.05$)

Organ weight: The weights of other organs were not influenced, pointing at a rather specific effect of soybean oil on abdominal fat. Contrary to our expectation, the feeding of krabok oil instead of tallow did not affect the weight of abdominal fat (Table 4).

Discussion

Feed intake: A decrease in ADFI in broiler chickens fed a diet high in PUFA has been reported earlier (Atteh *et al.*, 1983; Sklan and Ayal, 1989; Huang *et al.*, 1990), but the effect does not appear to be consistent (Skrivan *et al.*, 2000; Wongsuthavas *et al.*, 2007). A lower feed intake by birds fed a PUFA-rich could be explained by the higher digestibility of the fat component (Corino *et al.*, 1980; Brue and Latshaw, 1985), implying a higher dietary content of metabolizable energy and thus less feed needed to meet the energy requirement.

Fat digestibility, liver and intestine weight: Krabok oil was digested better than tallow. It has been reported earlier that MCT-rich fats are digested more efficiently by broiler chickens than are fats high in SFA (Young *et al.*, 1963; Zheng *et al.*, 2006). In keeping with earlier investigations (Keren-Zvi *et al.*, 1990; Mossab *et al.*, 2000; Wongsuthavas *et al.*, 2007), dietary soybean oil versus tallow was found to significantly lower abdominal fat deposition, the lowering being 21%.

An interesting finding emerged in that krabok oil versus soybean oil significantly diminished the relative weight of liver and intestine as shown in Table 4. The basis and impact of this observation are not known.

Conclusions: In conclusion, the observation that the feeding of krabok oil versus tallow did not lower abdominal fat leads to rejection of our hypothesis. It would appear that the presence in dietary fat of fatty acids that are preferentially oxidized is not a determinant of abdominal fat deposition in broiler chickens. The data do indicate that krabok oil can be used as energy source for broiler chickens without a negative affect on growth performance. Possibly, the production of krabok oil for use in broiler rations may become economically relevant.

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