Replacing of Beef Tallow by Krabok Fat and Soybean Oil on Growth Performance and Energy Balance in Broiler Diets

S. Wongsuthavas, C. Yuangklang, K. Vasupen and M. Wanapat*

Faculty of Natural Resources, Rajamangala University of Technology Isan,
Sakon Nakhon Campus 47160 Thailand
*Department of Animal Science, Faculty of Agriculture,
Khon Kaen University, 40002 Thailand

ABSTRACT

A total of 45 7-d-old males Arbor Acres broiler commercial chicks were randomly distributed in to 15 birds per group. They were kept in individual cages and fed from 7 to 28 d of age with isocaloric and isonitrogenous diets. Three sources of fat (Beef tallow; BT, Soybean oil; SO, and Krabok fat; KF) containing 3.0% fat and 18% crude protein. Experimental treatments were subjected to a completely randomized design (CRD). Energy intake, energy excretion and energy in carcass of SO diets showed lower than BT and KF diets (3,884, 4,427 and 4,419 kcal/kg; 812, 1,263 and 1,171 kcal/kg; (P<0.01) and 363, 528 and 497kcal/kg; (P<0.05), respectively). Moreover, broilers fed BT and KF presented lower energy expenditure percentage of energy intake when compared with SO diets (61.25, 62.17 and 69.18% of energy intake, respectively) (P=0.046). Abdominal fat deposition were on significantly (1.20, 1.19 and 1.23% of live weight, respectively) (P=0.695). These results could be concluded that unsaturated fatty acid from soybean oil produced higher energy expenditure more than beef tallow and krabok fat.

Keywords: Medium Chain Fatty Acid, Growth Performance, Energy Balance

Introduction

The mechanism of PUFA versus SFA is preferentially oxidized (Beynen and Katan, 1985) and thereby yields 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 energy. 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 energy 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) (Wongsuthavas et al., 2007a). In the light of the above-mentioned, we hypothesized that the consumption of krabok oil by broiler chickens would lower the deposition of energy. 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 energy balance, we also determined growth performance.

Materials and Methods

Forty-five male 1-d-old Arbor Acres broiler chicks were housed in groups and they were offered commercial diet for 7 days before commencement of the experiment. Then, birds were randomly distributed into 15 birds per group and birds were kept in individual cages. Feed was provided ad *libitum* in form of meal. Birds were freely to clean water. The experimental diets were formulated to contain three sources of fat (tallow, soybean oil and krabok oil) as shown in Table 1. The experiment was evaluated in a Completely Randomized Design, which there are three sources of fat (tallow (T), soybean oil (SBO) and krabok oil (KO).

Table 1. Ingredients and chemical composition of experimental diets

	Fat sources		
Ingredients composition	**Tallow**	**Soybean oil**	**Krabok oil**
Tallow	3.00	-	-
Soybean oil	-	3.00	-
Krabok oil	-	-	3.00
Tapioca starch	46.02	46.02	46.02
Soybean meal	41.05	41.05	41.05
Rice bran hull	4.00	4.00	4.00
Dicalcium phosphate	3.87	3.87	3.87
DL-methionine	0.30	0.30	0.30
L-lysine	0.25	0.25	0.25
Sodium chloride	0.51	0.51	0.51
Premix	1.00	1.00	1.00
Total	**100.00**	**100.00**	**100.00**
Chemical composition			
Dry matter	89.83	89.59	89.67
MEn (kcal/kg) calculated	3,535	3,551	3,553
Crude protein (N*6.25)	17.98	18.12	18.06
Protein : Energy Ratio	196.61	195.97	196.73
Crude fat, %	3.61	3.33	3.61

Energy Balance Analysis

The experimental diets were analyzed for dry matter, ash, crude fat, crude fiber and crude protein (AOAC, 1990). Bomb calorimetry analysis was done to determine gross energy in diets, homogenised whole carcass and excreta. Carcass and excreta were dried prior to energy measurement at 60 $_{o}$C for 72 h in a forced-hot air oven. An adiabatic bomb calorimeter was used with benzoic acid as thermochemical standard. The total amount of energy that was lost as heat (energy expenditure) was calculated with the formula: energy lost as heat = energy intake – energy in excreta – energy stored in body. Energy stored in the body was determined as energy in whole carcass at the end of the 21-days feeding period minus the baseline energy content in the whole body. To determine baseline body energy content, 10 seven-day old chickens were used and their values were averaged.

Calculations and Statistical Analysis

The data was performed by ANOVA (SPSS/PC Statistic, SPSS. Inc., Chicago, IL). The level of statistical significance was pre-set at $P<0.05$.

Results and Discussion

Growth performance

Growth performance was enhanced significantly by dietary krabok fat (Final BW, ADFI, and ADG). However, FCR was no significant different between treatments. The decreased in ADFI in broiler chickens fed a diet high in PUFA has been reported earlier (Huang et al., 1990), but the effect does not appear to be consistent (Skrivan et al., 2000). The lower feed intake by birds fed a PUFA-rich could be explained by the higher digestibility of the fat component (Brue and Latshaw, 1985), implying a higher dietary content of metabolizable energy and thus less feed needed to meet the energy requirement.

Table 2 Effect of dietary fat source on growth performance

Growth performance	Fat source			P-value
	Tallow	Soybean oil	Krabok oil	
Initial BW, g	150.03	150.03	149.83	0.9985
Final BW, g	802.00[b]	750.60[b]	839.47[a]	0.0173
ADFI, g/d	59.61[a]	49.67[b]	58.37[a]	0.0003
ADG, g/d	31.05[a]	28.60[b]	32.84[a]	0.0119
FCR (feed intake:weight gain)	1.93	1.75	1.79	0.0799

Results are for 15 birds per treatment.
[ab] P<0.01

Energy balance, energy digestibility and abdominal fat deposition

Indeed, we found that the energy digestibility of soybean oil diet trended to digest more efficiently than that of the diet with tallow and krabok fat (Table 3). However, krabok oil also trended to digest better than tallow. There was no significant diet effect on the percentage of energy stored in the body.

Table 3. Influence of fat sources on fat utilization and whole carcass fat deposition

Items	Fat sources			P-Value
	Tallow	**Soybean oil**	**Krabok fat**	
Energy balance, kcal/kg				
Energy intake	4,427[a]	3,884[b]	4,419[a]	0.007
Energy excretion	1,263[a]	812[b]	1,171[a]	0.007
Energy stored in body	528[a]	363[b]	497[a]	0.043
Energy expenditure	2,837	2,709	2,752	0.857
% of intake				
Energy in excreta	27.27	26.65	21.85	0.170
Energy stored in body	11.49	11.28	8.97	0.234
Energy expenditure	61.25[b]	69.18[a]	62.07[ab]	0.046
Energy digestibility	72.73	78.15	73.35	0.170
Fat deposition, % of carcass weight				
Abdominal fat	1.20	1.19	1.23	0.695

Results are for 10 birds per treatment.

The energy balance data did show that reducing intakes of soybean oil were associated with decreasing amounts of energy in the fat fraction of excreta. This effect can be explained by the fact that soybean oil is digested more efficiently by broilers than is tallow (Mossab et al., 2000) and substantiates the lower energy intakes with high levels of PUFA.

The hypothesis tested in this study was that replacement of dietary tallow by krabok and soybean oil would increase energy expenditure. Table 3 shows that calculated energy expenditure, either expressed as absolute amount or as percentage of intake, enhance energy expenditure was systematically related to soybean oil and krabok fat in the diet. Studies in humans have shown that diets with a high PUFA may increase energy expenditure. The diet with a high PUFA ration was increased the thermogenic effect food compared with a diet with a low PUFA. Furthermore, the results of these studies suggest that with a high intake of PUFA there is an increased contribution of fat oxidation to the thermogenic effect of food whereas the contribution of carbohydrates is decreased. BMR was not affected by the fat type (Jones and Schoeller, 1988), but in another study polyunsaturated fat increased BMR (Van Marken Lichtenbelt et al., 1997). However, abdominal fat in broiler chickens was no significant difference (P>0.05)

Conclusion

In broiler nutrition, fat sources are most important to increase energy intake and to improve carcass quality. Plant oil, particularly soybean oil, is increasingly used in broiler nutrition to replace animal fat. While krabok oil is locally plant oil which it can be used as energy source for broiler chicken without any affect on growth performance.

Acknowledgements

The authors with to express their thanks to Thailand Research fund (TRF) and Rajamangala University of Technology I-San for financial and facilities supports.

References

AOAC. 1990. Official Methods of Analysis. Washington, DC: Association of Official Analysis Chemists.

Bach, A.C., and Babayan, V.K., 1982. Medium-chain triglycerides: an update. The Amer. J. Clinical Nutr. 36, 950-962

Beynen, A.C. and Katan., M.B., 1985: Why do polyunsaturated fatty acids lower serum cholesterol?. Amer. J. Clinical Nutr. 42, 560-563.

Brue, N.R., and Latshaw, J.D. (1985). Energy utilization by the broiler chicken as affected by various fats and fat levels. Poultry Science, 64: 2,119-2,130.

Huang, Z.B., Leibovitz, H., Lee, C.M., and Millar, R., 1990. Effects of dietary fish oil on ω3 fatty acid level in chicken eggs, and thigh flesh. J. Agric. Food Chem. 38, 743-747.

Jones, P.J.H. and D. R. Schoeller. 1988. Polyunsaturated:saturated ratio of diet fat influences energy substrate utilization in the human. Metabolism 37, 145-151.

Mossab, A., Hallouis, J.M., and Lessire, M., 2000. Utilization of soybean oil and tallow in young turkeys compared with young chickens. Poultry Sci. 79, 1326-1331.

Newsholme and Leech, 1994)

Skrivan, M., V. Skrivanova. M. Marounek, E. Tumova, and J. Wolf. 2000. Influence of dietary fat source and copper supplementation on broiler performance, fatty acid profile of meat and depot fat, and on cholesterol content in meat. . Br. Poultry Sci. 41, 608-614.

Van Marken Lichtenbelt, W.D., R. P. Mensink, and K. R. Westerterp. 1997: The effect of fat composition of the diet on energy metabolism. Z. Ernaehrungswiss 36, 303-305.

Wongsuthavas, S., C. Yuangklang, S. Wittayakun, K. Vasupen, J. Mitchaothai, P. Srenanul and A. C. Beynen. 2007a. Dietary soybean oil, but not krabok oil, diminishes abdominal fat deposition in broiler chickens. International Journal of Poultry Science. 6 (11): 792-795.