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Short Communication

A Note Comparing the Apparent Metabolisable Energy of Three Oil Sources and their Combination in Broiler Chickens

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ABSTRACT

Apparent metabolisable energy (AME) of palm oil (PO), soybean oil (SO), linseed oil (LO) and blend oil (BO) in a ratio of 4:1:1 were evaluated. A total of 75, 21-day-old birds were fed corn-soy basal diet and the four test diets containing different oil sources (PO, SO, LO and BO), that were developed by replacing 60 g/kg of the basal diet for eight days. Differences in the apparent metabolisable energy were found ($P<0.05$), with the higher values for broiler-fed BO. This study affirmed that BO increases AME of oil enriched with saturated fatty acid in poultry diets.

Keywords: Broiler chicken, blend oil, linseed oil, metabolisable energy, palm oil, soybean oil

INTRODUCTION

Broiler diets are supplemented with vegetable oils and animal fats to increase energy concentration and to improve productivity (Lopez-Bote et al., 1997). This is because the apparent metabolisable energy (AME) content in oil is thrice higher than that of other feedstuff (Mateos & Sell, 1981). Thus, oil is a vital component in compounding of high-energy broiler diets. As feeding cost accounts for about 65% of total production

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cost, dietary oils may well be used as a way in which broiler chicken production might enhance growth performance and improve meat yield at a reasonably cheaper price (Corzo et al., 2005). Other advantages of using fats include increased palatability, reduced dustiness and improved feed texture (Baião & Lara, 2005; Ayed et al., 2015). Among all vegetable oils, soybean oil and oil palm are widely used in the feed industry. Abdulla et al. (2015, 2016a,b) observed differences in dietary sources of palm oil, soybean oil and linseed oil and their effect on growth performance, gut morphology, composition of fatty acid, oxidative stability and cholesterol content of breast muscle in broiler chicken. Although previous findings have shown the influence of supplementing different kinds of oils on metabolism of fats, growth performance in broiler birds as well as the apparent metabolisable energy (AME), the information are still not consistent. For instance, Tancharoenrat et al. (2013) states that the use of soybean oil, palm oil and poultry fat had lower ($P<0.05$) apparent metabolisable energy than tallow while the differences were absent in poultry fat, soybean oil and palm oil. Kavouridou et al. (2008) found that the birds consuming linseed oil had a significantly higher percentage of apparent metabolisable energy matched with birds fed a diet containing palm oil but there was no significant difference from birds fed a diet supplemented with soybean and coconut oil. Although previous works have described the metabolisable energy (ME) of different sources of oil that have been typically used in broiler diets, those data were recorded 25 to 50 years ago. Not only have oil sources changed since then (composition and quality indices), broilers have also gone through major heritable change. Consequently, consistent and current AME data on these sources of oil will allow for accurate formulation of the energy content in broiler feeds. Thus, the current study was aimed at assessing the AME in different sources of oils: Palm oil (PO), soybean oil (SO) and linseed oil (LO) when fed to broiler chicks. Also, the study aimed to examine the probable synergism of combination PO, SO and LO in a ratio of 4:1:1.

MATERIALS AND METHODS

Ethical Note

This study was conducted in accordance with the animal ethics guidelines of the Research Policy of University Putra Malaysia.

Birds, Husbandry and Experimental Procedure

One hundred one-day-old Cobb 550 broiler birds bought from a commercial farm were fed starter diets (22% crude protein) for 21 days. During the first week, their temperature was maintained at 35 ^{o}C and then reduced steadily to about 28 ^{o}C until the conclusion of the experiment. The birds were vaccinated against Newcastle disease (ND) and infectious bronchitis (IB) live vaccine (MyVac, Kuala Lumpur, Malaysia) through the intraocular route on day 7 and 14 of the raising period. The infectious bursal disease vaccine (IBD) (MyVac, Kuala Lumpur, Malaysia) was administered on day

21 through intraocular route. The birds were given feed and water *ad-libitum*. On day 21, birds of similar body weight were picked at random and allocated to experimental units. Three birds per unit (cage) and five replicate units were randomly allocated to a basal diet and each of the four test diets: Palm oil (PO), soybean oil (SO), linseed oil (LO) and blend oil (BO). The blend oil was a combination of PO, SO and LO in a ratio of 4:1:1. The classic total excreta method was used to measure the AME test. The birds were fed in mash form for a period of eight days, with the first four days as an adaptation period. During the last four days, feed intake (FI) of each unit was recorded, and the chicks' faeces was collected on a daily basis, collected and weighed within a cage. Faeces collected was thoroughly mixed, and typical samples were obtained and freeze-dried (Model 0610, Cuddon Engineering, Blenheim, New Zealand). Dried fecal samples were crushed to pass through a 0.5 mm sieve and kept in airtight plastic containers at −4 °C for further analyses. Dry matter (DM) and gross energy (GE) of the feeds and fecal samples were analysed.

Determination of Fatty Acid Composition of Oil Sources

The total fatty acids were extracted from the different oils following the protocol of Folch et al. (1957), modified by Ebrahimi et al. (2014) and described by Abdulla et al. (2015).

Apparent Metabolisable Energy Assay

The AME for PO, SO, LO and blend oil (BO) were determined following the procedures of Nalle et al. (2011). According to the procedure, the corn-soybean basal diet was compounded as shown in Table 1 and the test diets, each containing a different oil sample, were prepared by substituting 60 g/kg of the basal diet with a different oil.

The DM of samples was determined following the standard guidelines of AOAC (2007). Prior to oven drying, the weight of all the samples was taken and later placed in an oven dryer for a period of 24 hours at a temperature of 105 °C and the weights were recorded again after half an hour of cooling in a desiccator. To determine the GE an adiabatic bomb calorimeter (Gallenkamp Autobomb, UK) standardised with benzoic acid was used.

The AME was calculated for both the basal and test diets (different oils) applying the following formula:

AME of diet (kcal/kg)
= [(FI × GE diet) – (Excreta output × GE excreta)] ÷ FI

AME of oil (kcal/kg) =
[(AME of test diet) – (AME basal diet × 0.94)] ÷ 0.06

(Ravindran et al., 2014)

Table 1
The Basal Diet Compositions (g/kg, as Fed Basis) Used in the AME Digestibility Assays

Ingredient (%)	AME assay[1]
Corn	65.40
Soybean meal	30.38
Mono di calcium phosphate 21%	1.35
Calcium carbonate	1.55
Salt	0.30
L-Lysine	0.30
DL-Methionine	0.20
Vitamin premix[2]	0.10
Choline chloride	0.10
Toxin binder[3]	0.15
Anti-oxidant[4]	0.02
Mineral premix[5]	0.15
Total, kg	100.00
Calculated Analysis	
ME (kcal/kg)	2887.00
Crude protein (%)	19.00
Fat (%)	2.66
ME/CP	151.95
Fibre (%)	3.76
Calcium (%)	0.92
Total Phosphorus (%)	0.64
Avail. P for Poultry (%)	0.36
L-Lysine (%)	1.21
DL-Methionine (%)	0.50

[1]Test diets were prepared by substituting 60 g/kg of the basal diet with palm oil, soybean oil and linseed oil. [2] Supplied per kg diet: Vitamin A 11,494 IU; vitamin D 1,725 IU; vitamin E 40 IU; vitamin K3 2.29 mg; cobalamin 0.05 mg, thiamine 1.43 mg, riboflavin 3.44 mg, folic acid 0.56 mg, biotin 0.05 mg, panthothenic acid 6.46 mg, niacin 40.17 mg, pyridoxine 2.29 mg. [3]Toxin binder contains natural hydrated sodium calcium aluminium silicates (HSCAS). [4]Antioxidant contains butylated hydroxyanisole (BHA). [5]Supplied per kg diet: Fe 120 mg, Mn 150 mg, Cu 15 mg, Zn 120 mg, I 1.5 mg, Se 0.3 mg, Co 0.4 mg.

STATISTICAL ANALYSIS

Data obtained were subjected to one-way ANOVA testing and analysed using the general linear model of SAS (SAS, 2007). The significant differences among the treatment means were compared using Duncan's multiple range tests while the Alpha level used for assessment of significance for all the analyses was set at 0.05.

RESULTS

Table 2 shows the composition of the fatty acids of the different oil sources. According to the results, the concentration of oleic (C18:1n-9) and palmitic acid (C16:0) in PO

Table 2
The Composition of Fatty Acids (% of Total Identified Fatty Acids) of Different Oils[1]

Fatty acid	Palm oil	Soybean oil	Linseed oil	Blend oil	SEM[8]
C12:0	0.34[a]	0[c]	0[c]	0.23[b]	0.06
C14:0	1.00[a]	0.09[c]	0[d]	0.68[b]	0.16
C16:0	37.45[a]	10.80[c]	5.25[d]	27.64[b]	4.97
C16:1 n-7	0.21[a]	0.08[b]	0.05[b]	0.16[a]	0.03
C18:0	4.10[b]	4.40[a]	3.83[c]	4.11[b]	0.08
C18:1n-9	44.37[a]	25.38[c]	20.02[d]	37.14[b]	3.69
C18:2n-6	12.01[d]	52.45[a]	15.98[c]	19.41[b]	6.43
C18:3n-3	0.24[d]	6.44[c]	54.48[a]	10.31[b]	8.57
SFA[2]	42.66[a]	15.00[c]	9.00[d]	32.66[b]	5.18
USFA[3]	56.84[d]	84.35[b]	90.53[a]	67.02[c]	5.18
MUSFA[4]	44.57[a]	25.46[c]	20.06[d]	37.30[b]	3.72
PUFAn-3[5]	0.24[d]	6.44[c]	54.48[a]	10.31[b]	8.57
PUFAn-6[6]	12.01[d]	52.45[a]	15.98[c]	19.41[b]	6.43
n-6: n-3 ratio[7]	48.75[a]	8.14[b]	0.29[d]	1.88[c]	7.52
USFA: SFA	1.32[d]	5.51[b]	9.96[a]	2.05[c]	1.25
PUFA: SFA	0.28[d]	3.84[b]	7.75[a]	0.90[c]	1.08

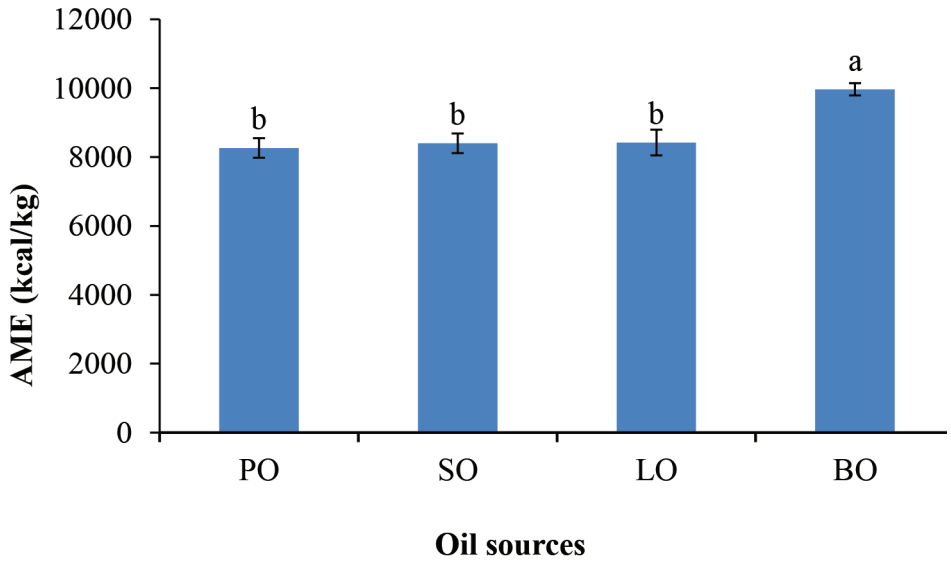
[1]The data are expressed as the percentage of identified fatty acids. [2]Total saturated fatty acid= sum of C12:0+C14:0+ C16:0+C18:0. [3]Total unsaturated fatty acid= sum of C16:1n-7+ C18:1n-9+ C18:2n-6+C18:3n-3+C20:4n-6+C20:5n-3 +C22:5n-3+C22:6n-3. [4]Total monounsaturated fatty acid = sum of C16:1n-7+C18:1n-9. [5] polyunsaturated fatty acid n-3 = sum of C18:3n-3+C20:5n-3+C22:5 n-3+C22:6n-3. [6] polyunsaturated fatty acid n-6 = sum of C18:2n-6+C18:3n-6+C20:4n-6. [7] polyunsaturated fatty acid n-6: polyunsaturated fatty acid n-3= (C18:2n-6+C18:3n-6+C20:4n-6) ÷ (C18:3n-3 + C20:5n-3 + C22:5n-3 + C22:6n-3). [8]SEM: Standard error of means.

was significantly (P<0.05) higher than that in SO, LO and BO, while LO and SO were significantly higher in terms of α-linolenic acid and linoleic acid, respectively in comparison with PO. The ranking of n-6:n-3 ratios was in the order of PO>SO>BO>LO. The proportion of total saturated (SFA) and total mono-unsaturated fatty acids (MUSFA) of PO was higher (P<0.05), while total unsaturated fatty acid (USFA) content was lower (P<0.05) compared to those of SO, LO and BO.

The apparent metabolisable energy of different sources of oil in broiler chicken is summarised in Figure 1. The result showed that the BO had the highest (P<0.05) value (9413 kcal/kg) of AME in comparison with PO (8277 kcal/kg), SO (8401 kcal/kg) and LO (8423 kcal/kg). On the other hand, there was no significant difference (P>0.05) between PO, SO and LO.

DISCUSSION

The values of ME in oils is mainly influenced by their ingestion, which is influenced by a myriad of factors such as the absence or presence of ester bonds (free fatty acids or tryglycerides), number of double bonds, stretch of the carbonic chain, the type and amount of the triglycerides augmented in the diets, free fatty acid compositions, detailed arrangement of SFA and USFA on



PO: Palm oil, SO: Soybean oil, LO: Linseed oil, BO: Blend of palm, soybean and linseed oil in a ratio of 4:1:1.
[a,b] indicate significant differences ($p<0.05$) between different oil sources.
Values are means ± 1 standard error.

Figure 1. Apparent metabolisable energy (AME) for various sources of oil in broiler chicken.

the backbone of glycerol, age, sex and the intestinal flora of birds (Garrett & Young, 1975; Ketels & De Groote, 1989; Leeson & Summers, 2001; Nascif et al., 2004). In the present study, although PO had a higher ratio of USFA to SFA compared to that of SO and LO, the AME in LO and SO was seen to be similar to that of PO. The similarity in the AME of the PO, SO and LO could be due to the low concentration of stearic acid (C18:0) in the oils. Stearic acid stops the activity of lipase (Van Kuiken & Behnke, 1994). Thus, similar concentration of acids such as stearic acid in oils may have similar activity on lipase, resulting in a similar AME. This statement agrees with the report of Tancharoenrat et al. (2013), who reported that the AME of PO was similar to that of SO. However, the present results contradict the findings of Kavouridou et al. (2008), who reported that birds fed a diet supplemented with LO had significantly higher AME compared with birds fed a diet supplemented with PO but this was not significantly different from birds fed SO. The highest AME in BO could be due to the utilisation of SFA and this may be improved by the presence of USFA. These results are in agreement with the findings of Garrett and Young (1975). This interaction is triggered by the excellent blending abilities in USFA (Garrett & Young, 1975). This interaction affects the absorption of SFA. However, the utilisation of USFA was not influenced by changing the USFA:SFA ratio (Garrett & Young, 1975). Ketels and De Groote (1989) reported that oil was used at the bird's maximal capacity if the ratio exceeded

four. Diets containing saturated fat resulted in less feed gain ratio than those containing poly unsaturated fats (Zollitsch et al., 1997). Also, Sanz et al. (2000) posited that the rate of saturation in broiler chickens of dietary oils was affected by their accumulation of fats and metabolic use.

CONCLUSION

Based on the current results, it appears that the AME of PO, SO and LO in broiler chickens was similar despite differences in the fatty acid composition of the oils. In addition, the present evaluation showed that blend oil is an attractive way to increase the AME of oil that is rich with SFA for poultry by adding oil rich with USFA.

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