Evaluation of Energy Values of Various Oil Sources when Fed to Broiler Chicks

A.S. Leaflet R2804

G. Raj Murugesan, Graduate Research Assistant, Department of Animal Science;
Brian J. Kerr, Animal Scientist, USDA-ARS NLAE;
Michael E. Persia, Assistant Professor, Department of Animal Science

Summary and Implications

The nitrogen-corrected apparent metabolizable energy (AMEn) values of seven different oil and fat sources used in broiler diets, primarily across the Midwestern US, were determined in a digestibility experiment. Fifteen days old, Ross 308 male broiler chicks were fed diets containing each oil or fat source at 0%, 3%, 6%, and 9% inclusion levels for 7 days before excreta samples were collected to analyze AMEn on day 21. The AMEn was calculated using 2 different methods, including a linear equation slope method as well as calculating the difference between basal diet and oil containing diets. The AMEn values determined by linear equation slope method for the oil and fat sources were generally in line with historic data. Differences in animal-vegetable blended fats were observed and care should be given when using these sources in feed formulations. Direct comparison of the excess energy contributed by the 3% diets provided an average of 69% increase over the energy value derived from the equations. This increase in estimated energy can be attributed to an extra caloric effect of the additional fat due to increased digesta transit time and absorption rate of dietary energy.

Introduction

The increased cost and volatility of the crude oil market has led to dietary energy becoming an increasingly important component of least cost feed formulation for broiler. Historically, starch has been the primary energy source for broiler diets in the United States. As ethanol continues to divert increasing quantities of corn starch away from traditional animal feed markets, the dietary energy requirements of livestock species have had to adjust to a reduced reliance on starch. Lipids available to the broiler industry range from highly refined (soybean oil, lard, tallow, etc.) to less pure sources (crude corn oil, yellow grease, etc.), along with a variety of blended oils. Although classical research has characterized the metabolizable energy (ME) of different fat sources that have been typically utilized in broiler rations, these data were generated 25 to 50 years ago. Not only have fat sources changed over this time (composition and quality indices), broilers have also undergone significant genetic change. Therefore reliable and current ME data on these fat sources will allow for precision formulation of the energy content of broiler diets. The objective of this experiment was to determine the apparent ME of various oils and fats when fed to broiler chicks.

Materials and Methods

To allow for the maturation of the digestive system of the birds with regards to fat digestion, male Ross 308 chicks were fed a corn-soybean meal basal diet for 2 wk before experimental diets were fed. On day 15, 456 birds were individually weighed, sorted, and randomly allocated to experimental units (EU) using a completely randomized design. Each experimental diet was fed to 6 EU with 4 birds per EU (762 cm^2 per chick). The allocation was based on the body weight to keep the average body weight of all the treatment groups similar. A total of 6 oils and fats were evaluated, resulting in 19 dietary treatments; a basal diet without supplemental oil and 3 inclusion levels (3, 6, and 9%) for each of the 7 oil sources (Table 1). Fat sources used included purified soy oil, crude corn oil, poultry fat, methyl soyate esters, and 2 different types of animal-vegetable blends. Experimental diets were offered at the start of the experimental period (day 15). After 5 days of adjustment period, excreta trays were placed under the pens to allow for a 48 h excreta collection.

Table 1. Experimental design to evaluate the energy values of various oil sources when fed to broiler chicks.

Oil Source	Oil Inclusion %	Birds[1]
None (Basal)	None	24
Soy Oil	3, 6, 9	72
Corn Oil	3, 6, 9	72
Poultry Fat	3, 6, 9	72
Methyl Soyate	3, 6, 9	72
Animal and Vegetable (AV)Blend 1	3, 6, 9	72
Animal and Vegetable (AV) Blend 2	3, 6, 9	72

[1]Each treatment consisted of one oil source fed at 3, 6, or 9% to 6 replicate pens of 4 chickens, resulting in 24 total chickens fed per treatment.

Excreta samples were frozen at -20ºC before they were oven dried at 65ºC and ground through a 1-mm screen, while the feed samples were ground to pass through a 0.5-mm screen. Samples were assayed for nitrogen corrected apparent metabolizable energy (AMEn) by determining gross energy (GE) using Parr's adiabatic oxygen bomb calorimeter and nitrogen (N) concentration using a Kjeltech 1028 distilling unit. Titanium dioxide (Ti) was added to the diet and subsequently determined in the excreta and feed samples. Dietary AMEn values for each diet were as follows:

$$\text{AMEn} = \text{dietary GE} - [\text{excreta GE} \times \text{dietary Ti}/\text{excreta Ti} - 8.22 \times (\text{dietary N} - \text{excreta N} \times \text{dietary Ti}/\text{excreta Ti})]$$

Oil AMEn Calculations

There are two differing methods of calculating AMEn of the oil fed in these diets, including a linear equation slope method and calculating AMEn in the oil by difference between the basal diet and the oil containing diets.

To calculate the linear equation, the AMEn values for the diets were plotted against supplemental oil concentration (0, 3, 6, and 9%) within source to generate a four point curve. Linear equations were generated for each oil source, including slope, intercept and the R^2. The slope of this equation is the estimated ME of the oil source (Figure 1).

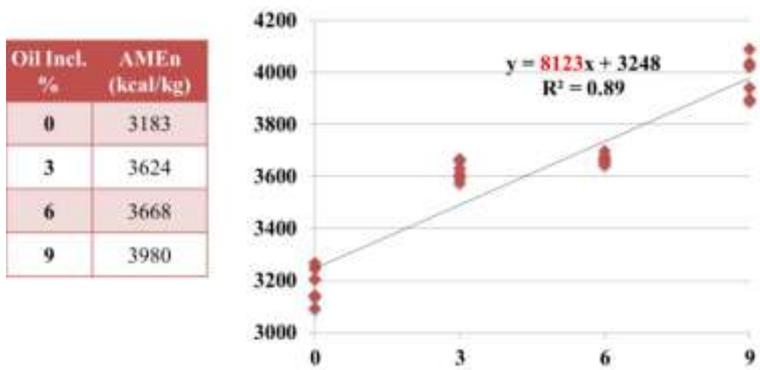

Figure 1: Graphical example of linear equation derivation for soy oil (Y axis is dietary AMEn, kcal/kg; and X axis is dietary oil concentration, %).

A second method of Oil AMEn determination was estimated as the difference between the basal diet and the oil supplemented diets at 3, 6 and 9% using the following equation:

$$\text{AMEn for 3\% oil diet} \times (\text{AMEn for 0\% oil diet} \times 0.97) / 0.03$$

Results and Discussion

The AMEn values for each oil sources calculated by linear equation or difference and the percentage changes between the two calculations are shown in Table 2.

Table 2. AME_n values determined by the linear slope as well as calculated by the difference for each oil source when fed to broiler chicks.

Oil Source	Predictive Oil AMEn	AMEn calculated by difference	% Overage b/w std. curve & difference
Soy Oil	8,123	13,735	69
Crude Corn Oil	7,803	11,622	49
Poultry Fat	7,829	9,979	27
Methyl Esters	7,977	10,499	32
AV Blend 1	8,094	12,567	55
AV Blend 2	7,482	14,664	96

Comparison of AMEn as calculated by the difference method versus determination by the slope method resulted in an overestimate of oil AMEn by 69%, 49% and 35% for the 3, 6, and 9% inclusion rates, respectively. This increase in estimated energy can be attributed to an extra-caloric effect from increased utilization of other components of the diet and not from the fat itself. The extra caloric effect decreased as inclusion level increased, but still resulted in oil AMEn values greater than the gross energy associated with the oil sources. Various reasons have been researched and purported to be the mechanisms behind the extra-caloric effect and they are, (i) decreased rate of passage and thus improved digestion and intestinal absorption; (ii) synergistic enhancement of saturated fatty acid absorption in the presence of unsaturated fatty acids of the basal diet; and (iii) lowered heat increment of the supplemented diet resulting in improved utilization of ME.

The vegetable oils were fairly consistent, although the pure soy oil resulted in slightly higher AMEn than the crude corn oil. The poultry fat resulted in an AMEn value lower than the vegetable oils, in line with previous reports for fat of this nature. The soy methyl esters resulted in significantly higher dietary energy, resulting in an AMEn value slightly higher than the corn oil. One point to note is the variability in the energy content of the AV blended oils. This variability suggests that care must be taken in selecting AV blended oils due to energy content and quality.

Conclusions

- The AMEn values determined by linear equation slope method for various oil and fat sources were generally in line with historic data, suggesting that poultry maintain the ability to use oil as an energy source.
- Major differences in AV-blended fats were observed and care should be given when using these sources in feed formulations.
- The extra-caloric effect of dietary fat was demonstrated and should be considered when determining AMEn of oil sources in poultry diets.

Acknowledgements

We would like to acknowledge the Midwest Poultry Research Program and USDA for funding this experiment, Evonik Degussa Corporation for providing Bio-lys and DL-Methionine, Cargill and Feed Energy Company for fat, Lincoln Way Energy LLC for DDGS, and ILC Resources for limestone. We recognize the care for the birds provided by W. Larson, J. Tjelta, W. Rogers, and R. Holbrooke of Iowa State University poultry research center; and also like to thank N. Nachtrieb, M. Higgins and J. Green for assistance.