Evaluation of energy values of various oil sources when fed to poultry (Update)

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INTRODUCTION

Dietary energy has become an increasingly important component of least cost feed formulation, due to recent volatility of the crude oil market (USDA, 2011). Historically, starch (specifically corn starch) has been the primary energy source for poultry diets in the United States. As ethanol continues to divert increasing quantities of corn away from traditional animal feed markets, alternatives to dietary starch are needed (USDA, 2011). One viable option is to use supplemental fats and oils to increase the dietary energy content. There are several sources of lipids that can be utilized by the poultry industry, ranging from high quality (soybean oil, lard, tallow, etc.) to lower quality sources (crude corn oil, yellow grease, etc.), 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 poultry rations, these data were generated 25 to 50 years ago (Sibbald, et al., 1962; Huyghebaert, et al., 1988). Not only have fat sources changed over this time, poultry have also undergone significant genetic progress. Therefore reliable and current ME data on these fat sources will allow for precision formulation of the energy content of poultry diets. The objective of these experiments was to determine the metabolizable energy of various oils and fats in both broiler and laying chickens. The second objective was to build predictive equations that can be used to estimate the ME values of the oils and fats for formulation purposes, based on composition (i.e., fatty acid profile, free fatty acid level and moisture, etc.) and quality (i.e., peroxide value).

MATERIALS AND METHODS

General Procedure

Birds were sourced from local facilities and transferred to ISU poultry farm. They were fed a corn-SBM basal diet for 2 wks, which met or exceeded the NRC requirements (NRC, 1994). On day 15, birds were individually weighed, sorted and randomly allocated to the experimental units (EU) using a completely randomized design, with 6 EU per treatment. The allocation was based on the bodyweight to keep the average bodyweight of all the treatment groups similar at the initiation of experiment. A total of nine oils and fats were evaluated resulting in 28 treatments; a basal diet without supplemental oil and 3 concentrations of oil for each of the sources. Experimental diets were fed from d 15 to 21, while feed and water were provided *ad-libitum*. Birds were monitored twice daily with mortality removed from the pens as they occurred. After 5 d adjustment period, clean excreta trays were placed under the pens to allow for a 48 h excreta collection. All animal procedures were approved by the Institutional Animal Care and Use Committee (IACUC) of Iowa State University before the start of the experiment.

Oils were sourced from local sources when possible, but poultry fat was a broiler source from Mississippi. AV blended fats were from commercial feed mills.

Table 1: Design

		Broiler Chicks		Laying hens	
Oil Source	**Reps**	**Oil Inclusion %**	**Birds**	**Oil Inclusion %**	**Birds**
None (Basal)	6	None	24	None	12
Soy Oil	6	3, 6, 9	72	2, 4, 6	36
Corn Oil	6	3, 6, 9	72	2, 4, 6	36
CWG^	6	3, 6, 9	72	2, 4, 6	36
Poultry Fat	6	3, 6, 9	72	2, 4, 6	36
Crude Corn Oil	6	3, 6, 9	72	2, 4, 6	36
Purified Corn Oil	6	3, 6, 9	72	2, 4, 6	36
AV Blend 1[#]	6	3, 6, 9	72	2, 4, 6	36
AV Blend 2	6	3, 6, 9	72	2, 4, 6	36
AV Blend 3	6	3, 6, 9	72	2, 4, 6	36

[#] AV Blend: Animal and vegetable blended oils.
[^] CWG: Choice White Grease.

Experiment 1

A total of 672 day-old, male Ross 308 chicks were used in this experiment. Each of the oil sources were used at 3, 6, and 9% inclusion in the basal diet (Table 1). Four chicks were allocated to each battery, which was serving as an EU providing 762 sq. cm per chick. The chicks were maintained at 31ºC and the light was provided at 23L:1D during d 15 to 21.

Experiment 2

A total of 336 58 wk old Hy-line W36 first-cycle laying hens were used in this experiment. Each of the oil sources were used at 2, 4, and 6% inclusion levels on the basal diet (Table 2). 2 hens were allocated to each cage, which was serving as an EU providing 96 sq. inches per hen. The hens were maintained at 25ºC and light was provided at 16L:8D.

Laboratory Procedure

Excreta samples were frozen at -20ºC before they were oven dried at 65ºC for 3 days. The feed samples were also corrected to the dry matter basis by measuring 5.0g of each sample and drying them in an oven at 100ºC for 24hrs and calculating the ratio between the dry weight and pre-dry weight. The feed and excreta samples were then ground through a 1-mm screen while the feed samples were ground 0.5-mm screen. The samples were assayed for the nitrogen corrected apparent metabolizable energy (AME_n) by determining the gross energy using adiabatic oxygen bomb calorimeter and nitrogen concentration using a Kjeltech 1028 distilling unit. Titanium dioxide was determined (Leone, 1973) in the excreta and feed samples to calculate the AME_n (Scott, et al., 1982) for each diet. The oil sources were analyzed for the proximate principles (crude fat, moisture, insolubles and unsaponifiables) and fatty acid composition. Oil ME_n were estimated as the difference between the basal diet and the oil supplemented diet (Sell, et al., 1986). An equation for the slope of the regression line was formulated based on the AME_n digestibility of the oil sources at 0 (basal), 3, 6, and 9% inclusion rates (Sibbald, et al., 1962).

RESULTS

The fatty acid profile of the oil sources used in these experiments is reported in Table 3. Figure 1 is an example graph for the calculation of the ME of the fat source. The AME_n values, for each oil source, are reported in Table 4. Missing values are equations that did not result in a four point curve or are still under evaluation.

Graphical Example

Soy Oil

Oil Incl. %	AMEn (kcal/kg)
0	3183
3	3624
6	3668
9	3980

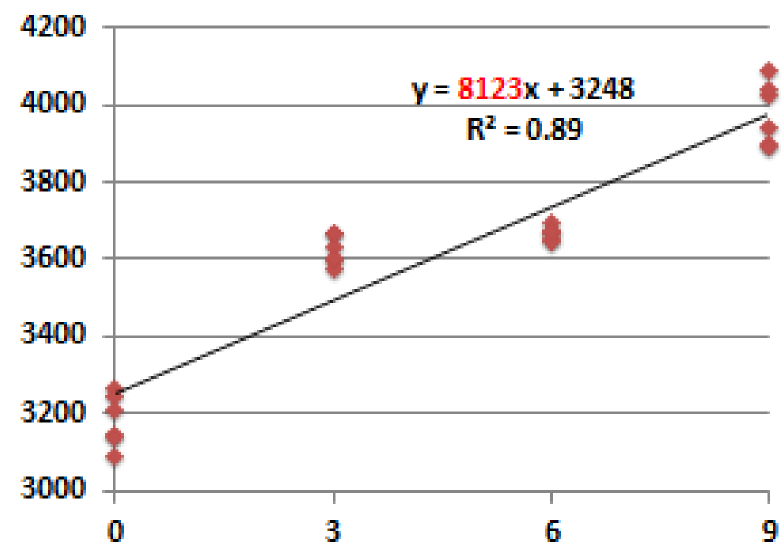

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Table 3. Fatty acid profile for oil sources

	Soy	Corn	CWG	Poultry	Crude Corn	Pure Corn	AV 1	AV 2	AV 3
C14:0	0.09	0.08	1.42	0.69	0.10	0.08	1.53	1.79	0.72
C14:1	0	0	0	0.23	0	0	0.25	0.05	0.06
C15:0	0	0	0	0.09	0	0	0.22	0.07	0.13
C16:0	10.72	12.79	25.36	22.36	12.95	13.46	19.74	15.62	16.73
C16:1	0.08	0.11	1.98	7.27	0.11	0.11	2.11	1.14	0.77
C17:0	0.11	0.08	0.30	0.15	0.08	0.08	0.62	0.20	0.29
C17:1	0.06	0	0.23	0.11	0	0.04	0.39	0.16	0.16
C18:0	4.13	2.04	16.47	5.22	2.04	2.10	12.28	8.85	7.39
C18:1 *t9*	0	0	0.40	0.49	0.05	0.10	3.49	1.40	2.60
C18:1 *n9*	21.08	28.14	37.98	41.89	26.52	27.65	36.55	36.67	28.60
C18:2	54.22	54.27	12.61	17.97	55.55	49.16	17.16	26.24	36.40
C18:3 ω	7.45	1.30	0.53	0.71	1.26	0.30	1.37	1.71	2.93
C18:4 ω	0	0	0	0.09	0.00	0.26	0.17	0.13	0.28
C20:0	0.33	0.41	0.22	0.08	0.40	0.40	0.22	0.53	0.29
C20:1 *n9*	0.30	0.31	0.71	0.39	0.31	0.34	0.65	0.67	0.53
C20:3 ω3	0	0	0.07	0	0	0	0	0	0
C20:4 *n6*	0	0	0.31	0.34	0	0	0.17	0.21	0.09
C22:0	0.36	0.15	0.09	0.17	0.15	0.14	0.17	0.27	0.34
C22:6 ω3	0	0	0	0	0	0	0	0.05	0.05
C24:0	0.11	0.19	0	0.00	0.21	0.20	0	0.29	0.21
C24:1 *n9*	0	0	0.14	0.10	0	0	0.09	0.08	0.05

DISCUSSION

Direct comparison of the excess energy contributed by the 3% oil diets against the energy determined through the slope of the regression line equations, for each of the oil sources fed to broilers, provided an average of 69% increase over the energy value derived from the equations. The comparison of the 2% oil diets fed to the first-cycle

Table 4. AME_n values for each oil source when fed to broiler and layer chickens

	Broiler chicks (20-21 days)		**Layer hens (first cycle)**	
Oil Source	**AME_n (kcal/kg)**	**Predictive Equations**	**AME_n (kcal/kg)**	**Predictive Equations**
Soy Oil	8121	8121X + 3248	8771	8771X + 3316
Corn Oil	7801	7801X + 3199	…	…
Choice White Grease	…	…	8249	8249X + 3346
Poultry Fat	7827	7827X + 3149	6824	6824X + 3326
Crude Corn Oil	…	…	8034	8034X + 3354
Purified Corn Oil	…	…	8062	8062X + 3318
AV Blend 1	8092	8092X + 3222	…	…
AV Blend 2	7480	7480X + 3306	…	…
AV Blend 3	9150	9150X + 3238	…	…

laying hens provided an average of 51% increase. This increase in estimated energy by difference in comparison to slope-regression analysis can be attributed to an extra caloric effect of the additional fat due to increased digesta transit time and absorption rate of dietary energy (Sibbald, et al., 1962). This extra energy comes from increased utilization of other components of the diet and not from the fat itself, but must be removed from the calculations to accurately determine the energy value of the various fat and oil sources.

Although there are some differences in the utilization of these fats between layer and broiler species (soy oil and poultry fat), the results generally fall within the accepted historic values for these fats and oils. One point to note is the variability in the energy content of the AV blended oils and suggests that care must be taken in selecting AV blended oil due to possible variable energy content and quality.

In conclusion, dietary fat continues to be a valuable method to increase chicken dietary energy. The extra-caloric effect of dietary fat was validated and we are currently working with the data to generate predictive equations for these fat sources.

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