Effects of Dietary Soy Inclusion on Broiler Chick Performance and Metabolizable Energy

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Summary and Implications

Soybean protein is the major source of protein and amino acids in poultry diets, although soy contains several indigestible and anti-nutritional components that might negatively affect broiler chick performance. Two experimental diets were formulated to contain high soy, combination of toasted full fat soybeans and soybean meal 48, and low soy, soy protein reduced and replaced with dried distillers grains with solubles, canola meal, meat and bone meal and synthetic lysine. From these two diets, three concentrations of dietary soy inclusion were generated including low (20% soy products), middle (28% soy products), and high (35% soy products) by using either 100% or a 50/50 mixture of the two diets. Experimental diets were fed to broilers from day 10 to 21. Nitrogen corrected apparent metabolizable energy (AMEn), feed intake, feed conversion ratio (FCR), and body weight gain data were collected. High soy inclusion significantly reduced feed intake in comparison to the both low and middle soy inclusions. Body weight gain, FCR and AMEn were not negatively affected.

Introduction

The objective of this research was to determine the effect of dietary soy inclusion on broiler performance parameters and metabolizable energy. Traditionally soy has been vastly utilized in poultry and other monogastric diets within the United States. Nutritionally soy is a good source of protein and when utilized with corn protein can provide a well-balanced amino-acid profile. A concern with feeding soy to poultry is the indigestible and anti-nutritional components and their effects on performance and digestibility. Some of the anti-nutrients in soy include non-starch polysaccharides, phytates, raffinose, stachiose, and β-mannans.

Materials and Methods

Male Ross 708 broiler chicks were fed a corn-soybean meal based starter diet (including 5% toasted full fat soy) for ten days prior to feeding of experimental diets. Birds were weighed into groups to help minimize differences between final cage weights once all birds were assigned to cages. In total 576 birds were selected and grouped into an experimental unit (EU) consisting of 8 birds. Each of the three treatments was replicated 24 times in Pettersime battery cages. Experimental chamber temperature was maintained at 85^{0}F, at the start of chick housing, and was decreased 5^{0}F each week until reaching a final temperature of 70^{0}F. Supplemental heat was offered at one end of the battery cages allowing chicks to select a thermo-neutral temperature. Light was provided continuously and birds were monitored twice daily with mortality recorded and removed as it occurred.

Three experimental diets were provided containing three different inclusion levels of full fat soybean meal and toasted soy. Inclusions of soy products were 20%, 28%, and 35% (Table 1). Both experimental diets and water were provided *ad libitum* throughout the experimental period (day 10 to 21).

All birds were individually weighed at the start and completion of the experimental period and the difference was used to calculate body weight gain. Body weight gain was reported for the 10-21 day period. Feed intake was determined for each cage by calculating the difference between the amount of feed offered and the amount of feed refused and reported for the 10-21 day period. Feed conversion ratio (FCR) was calculated from day 10-21 using the ratio of body weight gain and feed intake. Clean excreta samples were collected from pans below each cage for AMEn determination after a 2 day collection period. All samples were immediately transported to the laboratory and frozen at -20^{0}C until analysis.

Excreta and feed samples were oven dried. After drying, excreta samples were ground through a Whiley 1.0-mm screen and feed samples were ground through a 0.5-mm screen. Titanium dioxide concentration was determined for feed and excreta samples. Gross energy (GE) for excreta and feed samples was determined using an adiabatic oxygen bomb calorimeter. Nitrogen content of excreta and feed samples was established using LECO Trumac N. Dietary AMEn values for each diet were calculated as follows:

AMEn = dietary GE - [excreta GE × dietary Ti/excreta Ti - 8.22 × (dietary N - excreta N × dietary Ti/excreta Ti)]

Data were analyzed using ANOVA and students T-test to separate means if significance was detected, with significance determined at ($P \leq 0.05$).

Results and Discussions

In the current experiment dietary soy inclusion rate was varied from a high concentration of soy (35% of the diet from soy products) to low (20% of the diet from soy products) with an intermediate diet (28% of the diet from soy products). After feeding from 10 to 21 d, body weight gain and FCR were not different (Table 2). However feed intake was significantly reduced in birds fed the high soy (35%) treatment in comparison to middle and low soy diets. These data may indicate birds fed high soy diets reduced feed consumption with the high concentrations of soy. This might partially be explained due to the high concentration of indigestible or anti-nutrients found in soy causing the birds to reduce feed consumption. In this case there were no negative effects on bird AMEn values generated from these diets, suggesting energy utilization is not affected or is accounted for with current formulation values. In conclusion, high concentrations of soy did not affect growth or energy utilization of growing broilers, but did reduce feed intake suggesting soy might limit feed intake, possibly due to anti-nutrient or non-digestible components of soy.

Table 1. Dietary formulations for corn-soybean meal based starter diet and three experimental treatments with varying inclusions of soy products at 20%, 28%, and 35%.

Ingredient	Starter	High Soy (35%)	Middle Soy (28%)	Low Soy (20%)
Corn	51.83	50.52	51.18	51.85
DDGS	10.00	9.95	12.48	15.00
Meat/bone meal	4.13	0.00	1.45	2.90
Rapeseed Solv Ext	2.39	0.00	2.73	5.47
Soybean meal 48	23.38	25.00	22.50	20.00
Soybeans - Full Fat	5.00	10.00	5.00	0.00
Soy oil	0.50	0.50	1.16	1.82
Salt	0.31	0.39	0.35	0.30
DL Methionine	0.29	0.22	0.21	0.20
Threonine	0.05	0.02	0.01	0.00
Bio-Lys	0.47	0.21	0.30	0.40
Limestone	0.92	1.11	0.97	0.84
Dicalcium Phosphorus	0.00	0.86	0.43	0.00
Choline chloride 60	0.10	0.10	0.10	0.10
Vitamin premix	0.63	0.63	0.63	0.63
TiO2	0.00	0.50	0.50	0.50
Crude protein %	23.45	22.75	22.25	21.75
Poultry ME kcal/kg	2960	2960	2960	2960
Calcium %	0.89	0.74	0.74	0.74
Phosphorus %	0.63	0.60	0.59	0.58
Avail Phos %	0.35	0.30	0.30	0.30
Fat %	5.07	5.49	5.64	5.78
Fibre %	3.38	3.31	3.49	3.68
Met %	0.66	0.58	0.57	0.56
Cys %	0.38	0.38	0.38	0.37
Met+Cys %	1.04	0.96	0.94	0.93
Lys %	1.40	1.27	1.24	1.21

Table 2. Statistical analysis of chick nitrogen corrected apparent metabolizable energy (AMEn), body weight gain (BWG), feed intake (FI), feed efficiency (FE), and feed conversion ratio (FCR).

Soy Inclusion	AMEn (kcal/kg)	BWG (g/ck)	FI (g/chick)	FE (g/kg)	FCR (g/g)
Low (20%)	3131	462	721[a]	755	1.358
Middle (28%)	3119	477	709[ab]	784	1.296
High (35%)	3155	462	684[b]	785	1.294
Pooled SEM	17.8	7.5	10.3	21.9	0.0380
P-value	0.35	0.24	**0.05**	0.54	0.40