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Determination of Metabolizable Energy in Soybean, Sunflower and Canola Meals Using Caecectomised and Intact Adult Cockerels

[1]Ali Nouri-Emamzadeh, [2]A. Yaghobfar, [1]A.A. Sadeghi, [2]S.A. Mirhadi and [1]M. Chamani
[1]Department of Animal Science, Science and Research Branch, Islamic Azad University, Tehran, Iran
[2]Animal Science Research Institute, P.O. Box 31585-1483, Karaj-I.R., Iran

Abstract: The experiment was conducted to determine metabolizable energy contents of Soybean (SBM), Canola (CM) and Sunflower (SFM) meals by Conventional Addition Method (CAM) included with intact and caecectomized adult cockerels for 7 day: A 3 day pre-experiment and a 4 day experiment period. The values of SBM and CM obtained using intact cockerels were approximately 11 and 5% higher ($p<0.05$) than those used cecectomized cockerels, respectively. There was no significant effect of caecectomy on the measured values for SFM ($p>0.05$). Therefore, the effect of caecectomy on ME values in adult cockerels is dependent on the compositions of the meal assayed. However, caecetomised and intact cockerels had not differences for amount of EEL and ENL excretion.

Key words: Metabolizable Energy, Soybean (SBM), Canola (CM), Sunflower Meals (SFM), Conventional Addition Method (CAM), EEL, ENL

INTRODUCTION

Soybean (SBM), Canola (CM) and Sunflower (SFM) Meals have been shown to be a valuable source of protein and energy in poultry diets. The majority of published Metabolizable Energy (ME) contents of these meals are derived from measurements based on excreta from intact birds (Parsons *et al*., 2000; Parsons, 1985). Some researcher reported that amount of MEn content of SBM, CM, SFM are 2362, 1980 and 1820 kcal kg^{-1}, respectively (Lee *et al*., 1995; Jiang, 2003 and Vilamide and San Juan, 1998). However, the usefulness of these values has often been questioned, because of unknown and variable influence of microflora in the hindgut (McNab, 1973; Ragland *et al*., 1999). Caecectomy has been used by several workers to minimize the hindgut microflora effects, but information concerning the effect of caecectomy on ME values in SBM, CM and SFM are limited (Parsons *et al*., 2000; Ragland *et al*., 1999; Coon *et al*., 1990) and about other feedstuffs produced variable results (Ragland, 1999, Longstaff *et al*., 1990). Caecectomy significantly decreased dry matter digestibility and TMEn values of SBM in roosters (Parsons *et al*., 2000). Coon reported substantial digestion of SBM hemicelluloses in the ceca and colon of conventional roosters. Longstaff *et al*. (1991) reported no effect of caecectomy on true metabolizable energy and digestion of protein, starch and lipid of field bean in adult cockerels. Intact ducks exhibited greater ability to utilize the energy in SBM and wheat middling, but lower the ability in corn (Ragland, 1999). Bird type, feeding method and experimental procedure are responsible dietary factors for the observed variations within measured ME values for a feedstuff. The major dietary factors include amount of intake, heat process extent, chemical composition of feedstuff especially fiber, Nonstarch Polysaccharides (NSP) contents and Antinutritional Factors (ANF) (Bell, 1993; Karr-Lilienthal *et al*., 2005; Slominski and Campbell, 1990; Parsons *et al*., 2000).

Coon reported substantial oligosaccharides of SBM in the ceca and colon of intact adult roosters. So, a important part of difference in the energy content of SBM or CM or SFM determined in same intact birds may be due to differences in rate of population and activity of bacteria degrading carbohydrates in lower intestinal tract especially cecum (Parsons *et al*., 2000).

The objectives of the experiment were to determine metabolizable energy content of SBM, CM and SFM and Endogenous Energy Loss (EEL) and Endogenous Nitrogen Loss (ENL) with using intact and caecectomy adult cockerels.

MATERIALS AND METHODS

The experiment was conducted to determine metabolizable energy contents of Soybean (SBM), Canola (CM) and Sunflower (SFM) meals with adult Rhode Island Red (RIR) cockerels. Thirty two (16 intact

Corresponding Author: Ali Nouri-Emamzadeh, Department of Animal Science, Science and Research Branch, Islamic Azad University, Tehran, Iran

and 16 caecectomized) RIR cockerels were placed in individual metabolic cages (0.66×0.66 m) with fixed aluminum trays for separately excreta collection. The experiment was carried out on the basis of a completely randomized design with 4 replicates; with using Conventional Addition Method (CAM) included 3 day adaptation and 4 day experiment period. The adult cockerels were caecectomized as procedure described by Green *et al*. (1987). Four intact and 4 caecectomized adult cockerels were given no feed as negative controls to provide a measure of the FE_m and UE_e (the EEL). The average temperature in the experiment house was 24±2°C with a lighting cycle of 16:8 h (light: dark). The samples of droppings avoided during the 72 h period were collected, weighted and frozen. The frozen samples were removed from the freezer and placed in an oven to be dried at 80°C overnight. Gross energy of the meals and excreta samples were determined by adiabatic oxygen bomb calorimeter using a Parr4 Model 1241 Calorimeter. Crude protein was calculated as total nitrogen×6.25, total nitrogen being analyzed by an automated Kjeldahl procedure. (Association of Analytical Chemists, 1990). Nitrogen correction was carried out using a factor 8.73 kcal per nitrogen retained. Using these values, AME, AMEn, TME and TMEn was determined using the calculations of Sibbald (1979):

$$AME\left(kcal\ kg^{-1}\right) = \frac{GE_f - GE_e}{F_i}$$

$$AME_n\left(kcal\ kg^{-1}\right) = AME - \frac{8.73 \times NR}{F_i}$$

$$TME\left(kcal\ kg^{-1}\right) = AME + \frac{EEL}{F_i}$$

$$TME_n\left(kcal\ kg^{-1}\right) = AME_n + \frac{EEL + 8.73 \times NR_0}{F_i}$$

$$Nr_0 = (FmEn+UmEn+UeEn)$$

Where appropriate, the energy voided as excreta (FE+UE) was corrected to zero nitrogen balance (FEn+UEn) by assuming that excreta nitrogen, resulting from tissue nitrogen catabolism, has an energy of 8.73 kcal g^{-1} (energy value of 1 g of urinary nitrogen of tissue origin).

RESULTS

Chemical composition of oil meals as soybean, sunflower and canola meals were shown in Table 1. Mean values of CP, CF, Ash and EE for soybean, canola and sunflower were 44.99, 39.58 and 31.81; 7.1, 14.70 and 25; 6.91, 7.20 and 8.07; 1.31, 3.53 and 0.5 (%), respectively.

The mean values of AME, AMEn, TME and TMEn (kcal kg^{-1}) contents SBM, CM and SFM in intact and caecectomized adult cockerels presented in Table 2. Intact cockerels exhibited greater ($p<0.001$) ability to metabolize the energy in the SBM and CM based on AME, AMEn, TME and TMEn. The experiment shown that Caecectomy decreased AME, AMEn, TME and TMEn values of SBM approximately 12, 12, 10 and 10%. This decrease for ME values for CM was averagely 5%. There was no significant effect of caecectomy on the ME values in SFM ($p>0.05$), but was intended to decrease ME values for SFM.

Table 3 present the influence of caecectomy bird on Endogenous Energy Loss (EEL) and Endogenous Nitrogen Loss (ENL) in adult cockerels. The caecectomy didn't affected EEL and ENL amounts in adult cockerels ($p>0.05$), But intact cockerels excreted approximately 4% EEL lower and 1.7 % ENL more than the caecectomized cockerels.

Table 1: Chemical composition of soybean, canola and sunflower meals

	Soybean meal	Canola meal	Sunflower meal
DM (%)	93.37	94.34	94.93
GE (Kcal kg^{-1})	4639.00	4647.00	4281.00
CP (%)	44.94	39.58	31.81
CF (%)	7.10	14.70	25.00
NDF (%)	12.60	38.96	47.60
NFE (%)	33.10	29.32	29.55
Ash (%)	6.91	7.20	8.07
EE (%)	1.31	3.53	0.50

Table 2: AME, AMEn, TME, TMEn values (kcal kg^{-1}) of SBM, CM and SFM in intact and caecectomized adult cockerels

Meal	Bird	AME (kcal kg^{-1})	AMEn (kcal kg^{-1})	TME (kcal kg^{-1})	TMEn (kcal kg^{-1})
Soybean	Intact	2573.16 [a]	2573.16 [a]	2763.92 [a]	2764.44 [a]
	Caecectomized	2305.08 [b]	2305.77 [b]	2508.40 [b]	2509.00 [b]
	SEM	19.24	19.23	19.69	19.69
Canola	Intact	2104.95 [a]	2105.45 [a]	2226.33 [a]	2226.61 [a]
	Caecectomized	2011.19 [b]	2011.71 [b]	2129.11 [b]	2129.27 [b]
	SEM	21.6	21.59	21.1	21.1
Sunflower	Intact	1457.37	1457.40	1613.08	1613.19
	Caecectomized	1396.23	1396.33	1561.56	1561.73
	SEM	39.48	39.47	35.48	35.47

[a-b]Means within a column with no common superscript differ significantly ($p<0.001$)

Table 3: Endogenous Energy (EEL) and Nitrogen (ENL) loss in adult intact and cecectomized cockerels

Bird	EEL (cal/72 h)	ENL (g/72 h)
Intact	21.44	1.19
Caecectomized	21.81	1.14
SEM	1.37	0.05

[a-b] Means within a column with no common superscript differ significantly ($p<0.001$)

DISCUSSION

The results of this experiment indicated that removal of the caeca of birds affect on the metabolizable energy contents of SBM and CM. Therefore, result support the findings of those authors (Parsons *et al*., 2000) who reported dry matter digestibility and TMEn content of SBM were lower for caecectomized roosters than intact roosters. They demonstrated that most of the differences in ME between these birds were probably due to digestion of NSP in the caeca of the intact rooster.

Although, caecectomy of cockerels affected metabolizable energy contents of SBM and CM, but didn't affect ME contents of SFM. These problems may be due to amount of insoluble polysaccharide (crude fiber and NDF) contents in SFM, because caused to reduce microbial degradation polysaccharide of SFM in ceca of intact cockerels (Irish and Balnave, 1993; Brillouet *et al*., 1988; Kocher *et al*., 2000). Other researchers demonstrated some reasons such as very low cellulytic activity of cecal microflora or short transit time of digesta in gut of cockerels and, prevention of entering water-insoluble particles to the caeca because of the separation mechanism located cacum-colon region that probably explain the low ability of intact cockerels to digest cell wall (NDF) of SFM (McNab, 1973; Sibbald, 1980; Bjornhag and Sperher, 1977).

However many studdies showed that heat processing for reducing antinutrients likely cause maillard products formation in SBM more than other oil seeds, so that these maillard products decrease digestibility of reducing carbohydrates for gut enzymes, but these carbohydrates could be degradable for caecal microorganisms (Coetzee, 2003; Zuprizal *et al*., 1993; McNab, 1973).

On the other hand, result of this study indicated that Endogenous Energy (EEL) and Nitrogen (ENL) losses weren't differences between intact and caecectomized cockerels. Parsons (1985) reported a higher contribution of microbial protein in excreta of intact roosters compared to cecectomized roosters. Protein synthesis in ceca of conventional chicks was found to be higher than in germ-free chicks (Muramatsu *et al*., 1983). So, these different reports could be contributed to differences in rate of population and activity of caecal bacteria on endogenous excretion in different intact birds.

CONCLUSION

In conclusion, with respect to the caecectomy affected on the metabolizable energy of SBM and CM, except SFM; so these differences are dependent on the compositions and processing conditions of the oil meals in bioassay. Amount of EEL and ENL excretion hadn't differences between caecetomized and intact cockerels.

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