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Evaluation of Protein Digestibility in Canola Meals between Caecectomised and Intact Adult Cockerels

Ali Nouri Emamzadeh, and Akbar Yaghobfar

***Abstract*—**The experiment was conducted to evaluate digestibility quantities of protein in Canola Meals (CMs) between caecectomised and intact adult Rhode Island Red (RIR) cockerels with using conventional addition method (CAM) for 7 d: a 4-d adaptation and a 3-d experiment period on the basis of a completely randomized design with 4 replicates. Results indicated that caecectomy decreased ($P<0.05$) apparent and true digestibility quantities of protein for CMs, except for CMs 2 and 3. The mean apparent and true digestibility quantities for all CMs in caecectomised (80.5 and 81.4%, respectively) were (3.1 and 3.3%, respectively) less ($P<0.05$) than intact cockerels (83.6 and 84.7%, respectively). Therefore, the caecectomy method increases accuracy of the digestibility measurements of protein for this meal in bioassays based on excreta collection in adult cockerels.

***Keywords*—**Adult cockerels, caecectomy, canola meals, protein digestibility.

I. Introduction

CANOLA meal (CM) is a protein source in the diets of monogastric animals, especially poultry. Its CP content depends on dehulling and oil extraction process, ranging from 32 to 40%, in inverse relation to fiber content. The antinutrients and hull contents are responsible for the relatively limited use of CM in poultry diets [15]. On other hand, the majority of published digestibility quantities of protein for feedstuffs are based on the collection of excreta in intact adult birds [2]. But, the microbial activities of ceca are important problem in the determination of the digestibility of protein. Because, they alter composition and quantity of protein in the excreta [9], [16]. Removal of the ceca significantly decreased protein and amino acid digestibility in some studies [3], [5], whereas small or no significant effects have been found in others [9], [11], [12]. According to Angkanaporn et al. [6], caecectomy has more importance for determining protein and amino acid digestibility of protein sources with poor quality. However, studies about the effect of caecectomy on digestibility of protein for CM are limited [11], [17]. Therefore, the objective of this experiment was to evaluate digestibility quantities of protein in Canola Meals (CMs) between caecectomised and intact adult cockerels.

Ali Nouri Emamzadeh is with the Department of Animal Science, Faculty of Agriculture, Islamic Azad University, Garmsar Branch, Postal Code 3581631167, Garmsar, Iran (corresponding author to provide phone: 00989133127140; e-mail: ali.nouriem@gmail.com).

Akbar Yaghobfar is with the Animal Science Research Institute, P. Box: 31585-1483, Karaj-I.R. Iran. (e-mail: yaghobfar@yahoo.com).

II. Materials and Methods

A. Feedstuffs, Birds, Design and Management

The CMs were obtained from four local oil seed crushing factories. Forty (20 intact and 20 caecectomised as procedure described by Angkanaporn et al. [6]) adult RIR cockerels (average age, 40 weeks; average weight, 2.9 kg) placed in individual metabolic cages 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 a 4-d adaptation period and a 3-d experiment period. In adaptation period, intact and caecectomised cockerels *ad libitum* consumed each of test CMs gradually mixed with a commercial basal diet, then after 24 h starvation, each of the test meals were *ad libitum* fed as single ingredient by those cockerels during 2-d of experimental period, and 24 h starvation in end of experiment period. Also during experiment, a group of eight (four intact and four caecectomised) adult cockerels were given no feed as negative controls to measure of the endogenous nitrogen losses (ENL). Feed intake was recorded and total excreta were collected from each bird during experimental period. The average temperature in the experiment house was 24±2 ^{o}C with a lighting cycle of 16:8 h (light:dark). The experiment and caecectomy procedure were according to the guidelines of Veterinary Faculty, Tehran University for the care and use of animals for scientific purposes.

B. Analytical Methods

The collected excreta were dried, weighed, and ground to pass a 1-mm screen. The samples of the meals and excreta were analyzed for dry matter (DM) and crude fiber (CF) according to Association of Official Analytical Chemists (AOAC) [1]. Crude protein (CP) was determined in the meals according to AOAC [1], but it was determined in the excreta according to precipitable nitrogen method described by Terpstra and Dehart [7].

C. Calculations

Apparent and true digestibility quantities of protein (ADP and TDP) were calculated by using the following formula:

$$\text{ADP } (\%) = [(P_c - P_{Ex})/ P_c] \times 100$$

$$\text{TDP } (\%) = [(P_c - (P_{Ex} + P_E))/ P_c] \times 100$$

P_C (Protein Consumed) = feedstuff intake × feedstuff protein quantity (%)

P_{Ex} (Protein Excreted) = dry excreta weight × excreta protein quantity (%)

P_E (Protein Endogenous) = dry endogenous excreta weight × endogenous excreta protein quantity (%)

D. Statistical Analysis

Statistical analysis of the data for evaluating digestibility quantities of protein in Canola Meals (CMs) between caecectomised and intact adult cockerels was accomplished using the General Linear Model (GLM) procedure of SAS software [13] based on completely randomized design with 4 replications. The Duncan's test was used to elucidate differences between treatments means, with 0.05 level considered as significant.

III. Results

Table I represents chemical compositions of CMs obtained from different factories. Results indicate that the CMs have different quantities of dry matter (DM), crude protein (CP), crude fiber (CF) and nitrogen free extract (NFE).

TABLE I
CHEMICAL COMPOSITIONS OF THE CANOLA MEALS

Chemical compositions	Canola Meal				
	1	2	3	4	Mean
Dry Matter [a](%)	92.0	93.3	94.2	94.3	93.5 ± 1.08 [b]
Crud Protein (%) [a]	38.2	40.3	41.0	38.7	39.6 ± 1.31
Crud Fiber (%) [a]	13.9	14.8	15.8	14.3	14.7 ± 0.82
NFE [c] (%) [a]	29.1	28.0	26.9	29.7	28.4 ± 1.21

[a] Based on 100 % dry matter
[b] Standard Division
[c] Nitrogen Free Extract

Tables II and III represent influence of caecectomy on apparent and true digestibility quantities of protein for CMs in adult cockerels, respectively. The caecectomy decreased (P<0.05) apparent and true digestibility quantities of protein for CMs, except for CM 2 and 3. The decrements in apparent and true digestibility quantities of protein were (P<0.05) 6.4 and 6.5% respectively for CM 1 and, also 5.0 and 5.2% respectively for CM 4. The mean apparent and true digestibility quantities for all CMs in caecectomised (80.5 and 81.4%, respectively) were (3.1 and 3.3%, respectively) less (P<0.05) than intact cockerels (83.6 and 84.7%, respectively).

TABLE II
INFLUENCE OF CAECECTOMY ON APPARENT DIGESTIBILITY QUANTITIES OF PROTEIN FOR CANOLA MEALS (CMS) IN ADULT COCKERELS (BASED ON 100 % DM)

CMs	Apparent Digestibility		
	Intact	Caecectomised	SEM[1]
1	87.4 [a]	81.0 [b]	0.38
2	83.1	82.3	0.32
3	83.4	83.1	0.26
4	80.4 [a]	75.4 [b]	0.10
Mean[2]	83.6 [a]	80.5 [b]	0.38

[a-b] Means within a row with no common (a, b) superscript differ significantly ($P < 0.05$).
[1] SEM= pooled standard error of mean
[2] Mean of 4 CMs

TABLE III
INFLUENCE OF CAECECTOMY ON TRUE DIGESTIBILITY QUANTITIES OF PROTEIN FOR CANOLA MEALS (CMS) IN ADULT COCKERELS (BASED ON 100 % DM)

CMs	True Digestibility		
	Intact	Caecectomised	SEM[1]
1	88.5 [a]	82.0 [b]	0.36
2	84.2	83.3	0.31
3	84.5	84.0	0.27
4	81.4 [a]	76.2 [b]	0.09
Mean[2]	84.7 [a]	81.4 [b]	0.37

[a-b] Means within a row with no common (a, b) superscript differ significantly ($P < 0.05$).
[1] SEM= pooled standard error of mean
[2] Mean of 4 CMs

Table IV represents influence of caecectomy on quantity of Endogenous nitrogen Loss (ENL) in adult cockerels. The caecectomy did not affected (P>0.05) quantity of ENL in adult cockerels, But caecectomised cockerels excreted 4.2 % ENL less than intact cockerels.

TABLE IV
INFLUENCE OF CAECECTOMY ON ENDOGENOUS NITROGEN LOSS (ENL) IN ADULT COCKERELS

Bird	ENL (g/experimental period)
Intact	1.19
Caecectomised	1.14
SEM[1]	0.05

[a-b] Means within a column with no common superscript differ significantly ($P < 0.05$).
[1] SEM= pooled standard error of mean

IV. Discussion

The Dry matter, crude protein and CF contents of CMs used in this study had approximately differences with those listed by National Research Council [10]. However, compositions especially CP and CF quantities in CM are dependent to variety type and conditions of culture, dehulling and processing of oil seeds.

The results that caecectomy decreased digestibility quantities of protein for CM in adult cockerels indicated microbial metabolism of undigested proteins in the caeca of intact birds, as described in [3], [5]. Han and Parsons [17] indicated that caecal microbes caused protein proteolysis, amino acid deamination and nitrogen production of undigested proteins in hind gut; therefore the removal of the caeca results in increasing excretion of unabsorbed protein and amino acids of dietary and endogenous origin, as reported in [3], [12]. Also, the intensive effect of caecectomy on apparent and true digestibility of some Meals could be related to fewer protein and amino acid digestibility of the protein sources previous to caeca, as discussed by Angkanaporn *et al*. [6], Green *et al*. [12], Han and Parsons [17]. However, factors such as intensive processes during dehulling and antinurient compositions of canola seeds could decrease protein and amino acid digestibility of the CMs before caeca, as described in [8]. Therefore, when excess amounts of protein are left undigested from small gut, it appears to be utilized by the caecal microorganisms. A study [6] indicated that caecal microorganisms have more effect on protein and amino acids digestibility of the meals with less protein quality.

On the other hand, result of this study indicated that nitrogen (ENL) losses were not differences between intact and caecectomised cockerels. Parsons [4] reported a higher contribution of microbial protein in excreta of intact roosters compared to cecectomized roosters. Muramatsu *et al*. [14] indicated that protein synthesis in ceca of conventional chicks was found to be higher than in germ-free chicks. So, these different effects could be contributed to differences in rate of population and activity of caecal bacteria on endogenous excretion in different intact birds.

In conclusion, the caecectomy method increases accuracy of the digestibility measurements of protein for this meal in bioassays based on excreta collection in adult cockerels; Because, the method decreased the microbial activities on nitrogenous substrates of CM in hindgut.

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