The Relationship between Excreta Viscosity and TME_n in SBM

Ali Nouri Emamzadeh

***Abstract*—**The experiment was performed to study the relationship between excreta viscosity and Nitrogen-corrected true metabolisable energy quantities of soybean meals using conventional addition method (CAM) in adult cockerels for 7 d: a 3-d pre-experiment and a 4-d experiment period. Results indicated that differences between the excreta viscosity values were (P<0.01) significant for SBMs. The excreta viscosity values were less (P<0.01) for SBMs 6, 2, 8, 1 and 3 than other SBMs. The mean TME_n (kcal/kg) values were significant (P<0.01) between SBMs. The most TME_n values were (P<0.01) for SBMs 6, 2, 8 and 1, also the lowest TME_n values were (P<0.01) for SBMs 3, 7, 4, 9 and 5. There was a reverse linear relationship between the values of excreta viscosity and TME_n in SBMs. In conclusion, there was a reverse linear relationship between the values of excreta viscosity and TME_n in SBMs probably due to their various soluble NSPs.

***Keywords*—**soybean meals (SBMs), Nitrogen-corrected true metabolisable energy (TME_n), viscosity

I. INTRODUCTION

IN most parts of the world, soybean meal (SBM) is the main protein source for commercial animal feeds. In commercial poultry diets, large quantities of SBM are used due to their high protein and favorable amino acid composition. Some authors have attempted to explain the effects of viscosity by implicating physical factors, such as reduced diffusion and inadequate mixing of digesta, as variables hindering the process of digestion [9], [15], and limiting contact of nutrients with the absorptive surface [3]. Water soluble NSP are responsible for the reduction in performance and nutrient digestibility in broiler chicks [1], [18], [26]. It is assumed that an increase in viscosity of the aqueous fractions, as a result of their viscous properties, is the primary mechanism by which these water soluble NSP reduce nutrient digestibility [1], [19]. A second means by which water soluble NSP may reduce performance of chicks has also been discussed, namely that the viscous character of water soluble NSP, and the excessive stimulation of the intestinal microflora is the direct causative agent [10].

The objective of the experiment was to determine the relationship between excreta viscosity and Nitrogen-corrected true metabolisable energy quantities of soybean meals (SBMs) with using conventional adult cockerels.

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II. MATERIALS AND METHODS

The experiment was performed to study the relationship between viscosity and Nitrogen-corrected true metabolisable energy quantities of nine soybean meals (SBMs) with adult Rhode Island Red (RIR) cockerels. Eighty RIR cockerels were placed in individual metabolic cages (0.66 m × 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 8 replicates; with using conventional addition method (CAM) included 3-d adaptation and 4-d experiment period. Eight 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 ^{o}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 ºC overnight. Dried excreta from all birds from each treatment (pooled by replication) were analyzed for viscosity using a Brookfield DVII viscometer as previously described by [21].

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 [2]. Nitrogen correction was carried out using a factor 8.73 kcal per nitrogen retained. Using these values, TMEn was determined using the calculations of Sibbald [12].

Statistical analysis of the data for Soybean Meals (SBMs) in adult cockerels was accomplished using the General Linear Model (GLM) procedure of SAS software [24] based on completely randomized design with 8 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 cchemical composition of soybean meals obtained from different factories. Results indicate that the CMs have different quantities of dry matter (DM), GE (Gross Energy), crude protein (CP), crude fiber (CF) and nitrogen free extract (NFE), Ash and EE (Ether Extract).

TABLE I
CHEMICAL COMPOSITIONS (CC) OF THE SOYBEAN MEALS (SBMS)

CC	SBMs								
	1	2	3	4	5	6	7	8	9
DM(%)	94.3	93.2	91.3	94.1	93.3	93.2	93.0	91.6	94.9
GE (Kcal/Kg)	4692	4723	4702	4532	4494	4725	4644	4700	4545
CP(%)	45.3	46.6	40.9	44.9	45.0	46.6	44.5	43.6	45.9
CF(%)	7.2	6.9	7.3	6.6	8.0	6.8	7.1	6.0	7.2
NFE(%)	33.8	31.3	34.8	34.5	32.2	30.9	33.4	34.1	33.5
Ash(%)	6.3	7.2	6.7	7.1	7.4	6.8	6.6	6.8	7.0
EE(%)	1.7	1.2	1.6	1.0	0.7	2.1	1.4	1.1	1.3

DM: Dry Matter, GE: Gross Energy, CP: Crude Protein, CF : Crude Fiber, NDF: Neutral Detergent Fiber, NFE: Nitrogen Free Extract, EE: Ether Extract. NFE: Nitrogen Free Extract

Table II, presents excreta viscosity values of the SBMs in adult cockerels. Results indicated that differences between the excreta viscosity values were (P<0.01) significant for SBMs. The excreta viscosity values were less (P<0.01) for SBMs 6, 2, 8, 1 and 3 than other SBMs. The lowest and most excreta viscosity values (2.95 and 4.84) were for soybean meals 6 and 5, respectively.

The mean TMEn (kcal/kg) values of SBMs in adult cockerels were presented in Table II. The mean TME_n (kcal/kg) values were significant (P<0.01) between SBMs. The most TME_n values were (P<0.01) for SBMs 6, 2, 8 and 1, also the lowest TME_n values were (P<0.01) for SBMs 3, 7, 4, 9 and 5.

The regression line obtained as a result of plotting the excreta viscosity value against the TME_n values of SBMs are illustrated in Fig. 1. There was a reverse linear relationship between the values of excreta viscosity and TME_n in SBMs. The relationship indicate that an increase in the viscosity decrease TME_n value in SBMs. Comparison of the viscosity and TME_n values confirm this reverse relationship. The SBMs 6, 2, 8 and 1 contained most TME_n values created lowest excreta viscosity values; also the viscosity values were most in SBMs 5, 9, 4 and 7 contained lowest TME_n values.

TABLE II
EXCRETA VISCOSITY AND TMEN[1] VALUES (KCAL/KG) OF SOYBEAN MEALS IN ADULT COCKERELS

Soybean	Viscosity	TME_n
1	3.69 ^{abc}	2809 ^{a}
2	3.19 ^{ab}	2882 ^{a}
3	3.80 ^{abc}	2653 ^{b}
4	4.34 ^{cd}	2634 ^{b}
5	4.84 ^{d}	2540 ^{b}
6	2.95 ^{a}	2948 ^{a}
7	4.18 ^{bcd}	2647 ^{b}
8	3.21 ^{ab}	2833 ^{a}
9	4.20 ^{bcd}	2569 ^{b}
SEM[5]	0.33	45.91

$^{a-b}$ Means within a column with no common (a, b) superscript differ significantly (P < 0.05).
[1] Nitrogen-corrected true metabolisable energy
[5] Standard error of mean

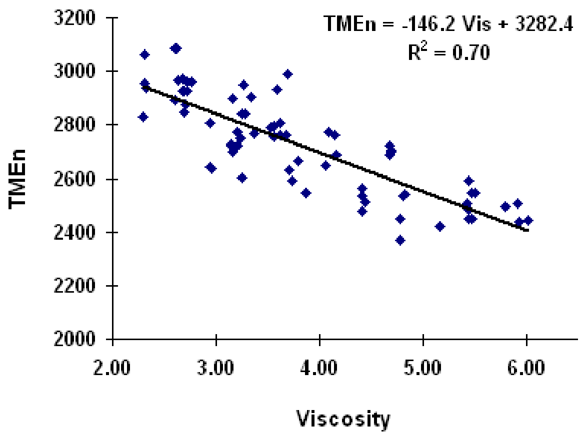

Fig. 1 Regression relationship between the values of excreta viscosity and TMEn in SBMs

IV. Discussion

The results indicated that the TME_n values were (P<0.01) different between SBMs creating various excreta viscosities. Therefore, the reverse linear relationship between the values of excreta viscosity and TMEn in SBMs could support the findings of those authors [1], [19], who an increase in viscosity reduce nutrient digestibility. Moreover, mixing of nutrients with pancreatic enzymes and bile acids and movement of nutrients towards the gastrointestinal wall are reduced by an increase in digesta viscosity, which consequently limits digestion and absorption [4], [25].

Irish and Balnave [8], reported that low average metabolisable energy value of soybean meal (SBM) is caused by the carbohydrate fraction, which consists mainly of non starch polysaccharides (NSP) in the range from 160 to 220 g & kg dry matter. The level of NSP in soybean meals may vary considerably depending on variety [17]. Digestibility of NSP is especially low in poultry [11], [16]. The presence of soluble NSP, viscous compounds, in feedstuffs is associated with decreased use of nutrients, increased digesta viscosity, and enlargement of the intestines [7], [5], [14]. Lavinia et al [23], showed that there is correlation between the protein source/ level and the NSP value of the diet with a direct effect on intestinal parameters and digestibility.

Some papers [15], [17], [23], showed that heat processing for reducing antinutrients may cause maillard products formation in SBM, so that these maillard products decrease digestibility of reducing carbohydrates for gut enzymes.

In poultry, gastrointestinal microorganisms have a highly significant impact on the uptake and utilization of energy and other nutrients and on the response of poultry to anti-nutritional factors (such as nonstarch polysaccharides (NSP) and excreta viscosity [13], [16], [20].

In conclusion, there was a reverse linear relationship between the values of excreta viscosity and TME_n in SBMs probably due to their various soluble NSPs; but, other factors such as difference in other chemical composition, antinutritional factors or heat process extent of SBMs may be affected their metabolisable energy values.

REFERENCES

[1] A. I. Fengler, and R. R. Marquardt. "Water-Soluble Pentosans from Rye.1. Isolation, Partial-Purification, and Characterization." *Cereal Chemist.* 1988, vol 65(4), pp 291–297.

[2] *Association of Official Analytical Chemists, Official Methods of Analysis*, 15th ed. Arlington, VA**,** AOAC. 1990.

[3] C. A. Edwards, and R. J. Barneveld. "Lupines for livestock and fish. Pages 385–410 in Lupine as Crop Plants." *Biology, Production and Utilization.* (Gladstones, J.S., Atkins, C., Hamblin, J., ed.). CAB Int., Oxon, UK. 1998.

[4] C. A. Edwards, I.I. Johnson, and N.W. Read. "Do viscous polysaccharides slow absorption by inhibiting diffusion or convection?" *Euro. J. . Clinical. Nutr.* 1988, vol **42**, pp. 307–312.

[5] C. H. M. Smits, A. Veldman, M. W. A. Verstegen, and A. C. Beynen. "Dietary carboxymethylcellulose with high instead of low viscosity reduces macronutrient digestion in broiler chickens." *J. Nutr.* 1997, vol 127, pp. 483–487.

[6] C. M. Parsons, Y. Zhang, and M. Araba. "Nutritional evaluation of soybean meals varying in oligosaccharide content." *Poult. Sci.* 2000, vol 79, pp. 1127–1131.

[7] G. Annison, and M. Choct. "The anti-nutritive activities of cereal non-starch polysaccharides in broiler diets and strategies minimising their effects." *World's Poult. Sci. J.* 1991, vol. 47, pp. 232– 242.

[8] G. G. Irish, and D. Balnave. "Nonstarch Polysaccharides and Broiler Performance on Diets Containing Soybean-Meal as the Sole Protein-Concentrate." *Austra. J. Agri. Res.* 1993, vol 44(7), pp. 1483–1499.

[9] G. Isaksson, I. Lundquist, and I. Ihse. "Effect of dietary fiber on pancreatic enzyme activity in vitro: the importance of viscosity, pH, ionic strength, adsorption, and time of incubation." *Gastroenterology*. 1982, vol 82, pp. 918–924.

[10] G. L. Campbell, and H. L. Classen. "Improvement of the nutritive value of rye for broiler chickens by gamma irradiation-induced viscosity reduction." *Br. Poult. Sci.* 1983, vol 24(2), pp. 205–12.

[11] H. Jorgensen, Zhao, H. Q., Bach Knudsen, K. E., and Eggum. B. "The influence of dietary fibre source and level in the development of the gastrointestinal tract, digestibility and energy metabolism in broiler chickens." *Br. J. Nutr.* 1996, vol 73, pp. 379–395.

[12] I. R. Sibbald. "A bioassay for true metabolizable energy in feedstuffs." *Poult. Sci.* , 1976, vol 28, pp. 487–493.

[13] J. M. McNab. "The avian caeca: A review." *World's Poult. Sci. J.* 1973, vol 29, pp. 251–263.

[14] J. S. Philip, H. J. Gilbert, and R. R. Smithard. "Growth, viscosity and beta-glucanase activity of intestinal fluid in broiler chickens fed on barley-based diets with or without exogenous beta-glucanase." *Br. Poult. Sci.* 1995, vol 36, pp. 599–603.

[15] K. Ebihara, and Schneeman, B. O. "Interaction of bile acids, phospholipids, cholesterol and triglyceride with dietary fibers in the small intestine of rats." *J. Nutr.* 1989, vol 119, pp. 1100–1106.

[16] K. L. Leske, and C. N. Coon. "Nutrient content and protein and energy digestibilities of ethanol-extracted, low alpha-galactoside soybean meal as compared to intact soybean meal." *Poult. Sci.* 1999, vol 78(8), pp. 1177–83.

[17] L. K. Karr-Lilienthal, C.T. Kadzere, C.M. Grieshop, G.C. and J. Fahey. "Chemical and nutritional properties of soybean carbohydrates as related to non ruminants: A review." *Livest. Product. Sci.* 2005, vol, 97, pp. 1–12.

[18] M. Choct, and G. Annison. "Anti-nutritive activity of wheat pentosans in broiler diets." *Br. Poult. Sci*. 1990, vol 31(4), pp. 811–21.

[19] M. Choct, and G. Annison. "The inhibition of nutrient digestion by wheat pentosans." *Br. J. Nutr.* 1992, vol 67(1), pp. 123–32.

[20] M. Choct, and M. Sinlae. "Effects of xylanase supplementation on between-bird variation in energy metabolism and the number of Clostridium perfringens in broilers fed a wheat-based diet." *Austr. J. Agri. Res.* 2006, vol 57(9), pp. 1017–1021.

[21] M. R. Bedford, and H. L. Classen. "An in vitro assay for prediction of broiler intestinal viscosity and growth when fed rye-based diets in the presence of exogenus enzymes." *Poult. Sci.* 1993, vol 72, pp. 137–143.

[22] M. Zuprizal, A. M. Larbier, and P. A. Geraert. "Influence of ambient temperature on true digestibility of protein and amino Acids of rapeseed and soybean meals in broilers." *Poult. Sci.* 1993, vol 72, pp. 289–295.

[23] S. Lavinia, D. Drinceanu1, N. Corcionivoschi, C. Julean, D. Stef, D. Mot, E. Simiz. "The effect of dietary non-starch polysaccharides on the intestinal viscosity and on the cecal microflora of broiler fed with various protein sources." *Arch. Zootech.* 2009, vol 12 (3), pp. 22–29.

[24] *SAS® User's Guide: Statistics.* Version 6, 4th ed. SAS Institute Inc., Cary. NC, 1990.

[25] T. Antoniou, R. R. Marquardt, and P.S. Cansfield. "Isolation, partial characterization and antinutritional activity of a factor (pentosans) in rye grain." *J. Agri. Food. Chemist.* 1981, vol. **28**, pp. 1240–1247.

[26] W. B. White, and H. R. Bird. "The Viscosity Interaction of Barley Beta-Glucan with Trichoderma-Viride Cellulase in the Chick Intestine." Poult. Sci. 1981, vol 60(5), pp. 1043–1048.