Original Articles

Effects of Dietary Soybean Hull Supplementation to Fattening Pigs on the Growth Performance and Ammonia Gas Emission from the Excreta

Seizi Sukemori and Shuhei Ikeda
Tokyo University of Agriculture, Department of Agriculture
Funako 1737, Atsugi-shi, Kanagawa Prefecture, 243-0034, Japan

Abstract The present study aimed to evaluate the effects of dietary soybean hull supplementation on the growth performance and ammonia gas emission from excreta of fattening pigs. Six crossbreed (M×Y×B) fattening pigs were assigned to two dietary treatments, as control (no soybean hulls added) and experiment (10% soybean hulls added) groups. There was no significant difference in the results of growth performance and chemical contents of urine and feces. Ammonia gas emission in both groups showed an approximate linear increase and there was no significant difference between two groups. In conclusion, it can be suggested that soybean hulls are a valuable feed source and that they have no negative effect on the growth performance and ammonia gas emission in the 10% dietary supplementation.

Key words: soybean hull, feed source, pig, fattening, ammonia gas emission.
Receipt of Ms.: 14.12.2015. Accepted: 22.12.2015.
Journal of Animal Production Environment Science 15(1):pp38-43. 2016

Introduction

Recently, evaluation of nutritional values of various by-products of less-utilized organic sources in animal production has been required. This is necessary in view of the increasing feed self-sufficiency ratio in Japan and also for the environmental resource cycle. High fiber by-products are poorly digested by mono-gastric animals, therefore information about feeding values of fibrous for pigs is limited. Soybean hull is an inexpensive by-product of soybean oil production and it contains high levels of non-starch polysaccharides (NSP). Usually soybean hull is used for the diet of finishing beef in Japan, however earlier reports (Kornegay [1], Van Oeckel et al., [2]) indicated its feeding value in pig production. The effects of dietary soybean supplementation on the aerial ammonia concentration were observed in some later reports (DeCamp et al., [3], Wang et al., [4]). In these studies in which various mixing ratios of soybean hull were examined, the adequate mixing ratio was not determined. Furthermore, Yamamoto et al. [5,6] proposed the possibility that NSP rich dietary sources such as apple pomace or beet pulp reduced urinary nitrogen excretion through the consumption of extra nitrogen by microbial proliferation in the digestive tract of animals.

Therefore, we hypothesized that a moderate level of soybean hull in the pig diet sustained favorable growth and reduced the

Corresponding author: Seizi Sukemori sukemori@nodai.ac.jp

ammonia gas emission from slurry of pigs fed soybean hull added feed. The present study aimed to evaluate the effects of dietary soybean hull supplementation on the growth performance and ammonia gas emission from slurry of the fattening pigs.

Materials and methods

Animal and experimental plan

A total of 6 crossbreed (Meishan× Yorksher×Barksher) fattening pigs with an average initial body weight of 53.5 ± 2.7 kg were housed in individual metabolic cages. A daily 12h light/dark cycle was maintained under natural ambient temperature. The two dietary treatments were the control (no soybean hulls added) and the experiment (10% soybean hulls added) groups. The reason of 10% soybean hull supplementation was which had no effect on the nutritive value of basal formula feed under the simple mixing of them. Chemical composition of soybean hull is shown in Table 1. The basal feed was a commercial formula feed (Megumi Nikuton 78; Feed-One Holdings, Co. Ltd., Yokohama) and the nutrient composition was also adapted to the requirements for growth stage in the experimental group, in which included soybean hull supplementation. The pigs were assigned to two dietary treatments as control and experiment groups with three pigs each, respectively.

Table 1. Chemical composition (DM%) of soybean hull

CP	13.6
Ether extracts	6.2
Nitrogen free extract	37.3
Crude fiber	37.6
Crude ash	5.3

The appropriate volume of feed was supplied twice a day and drinking water was supplied *ad libitum*. Growth tests were given during periods from 65 kg mean body weight to 110kg mean body weight. Feed intake amount was determined every day and body weight was determined every week. Feces and urine were collected from each pig 1 week prior to the final day and urine volume per day was determined, respectively. They were used for the following experiment and chemical analysis.

Chemical analysis and measurements of ammonia gas

Chemical analysis procedures were in accordance to the previous report [7,8]. In a customary method, total nitrogen content in urine was analyzed by the Kjeldahl method and urea was determined with an analysis kit (Funakoshi Chemical, Tokyo) and spectrophotometer UV-1800 (Shimadzu, Kyoto). The pH of each sample centrifuged at 3000 rpm was determined with a pH meter (DKK Toa Co., Tokyo), with the determination of urine pH directly conducted, while for the feces sample it was conducted after the dilution of feces with distilled water in a ratio of 1:4 according to the method by Cahn et al.[9].

In a determination of ammonia gas emission, the procedure was in accordance with the previous reports [7,8] as follows: twenty grams of urine and feces mixture, with a mixing ratio of 1:1 from each pig was placed in a polyethylene sample bag modified with a rubber tube. Three bags were prepared for each determination time, respectively. Each bag was sealed by

vacuum suction and inflated with 6 liters of air. The bag was kept at 30±2℃ for 0,6,12,18, and 24hrs. After treatment, ammonia gas concentration was determined with Kitagawa precision gas detector tubes for ammonia (SD type).

Statistical treatment

Ammonia gas emission from each treated group after the determined period was compared by one-way analysis of variance using Excel statistical software at significant level of $P<0.05$. Chronological variation was treated with the linear regression.

Results

Growth performance

The results of growth test are shown in Table 2. There is no significant difference between the control group and experiment group in the comparisons of body weight gain (kg/d), feed intake (kg/d), feed conversion, and urine volume (kg/d).

Chemical analyses of feces and urine

The results of chemical analyses are shown in Table 3. Although the total nitrogen contents in the experiment group urine two times higher than that of the control group, there is no significant difference.

Ammonia gas emission

The effects of soybean hull supplementation on ammonia gas emission from the mixture of urine and feces are illustrated in Figure 1. Chronological variation in both groups showed approximate linear increase and there was no significant difference between the control and experiment groups at each time of the measurements.

Table 2. Results of growth test

	Control group	Experiment group
Body weight gain (kg/d)	0.80 ± 0.03	0.77 ± 0.02
Feed intake (kg/d)	2.8 ± 0.1	2.8 ± 0.1
Feed conversion (%)	28.1 ± 1.0	27.0 ± 0.6
Urine volume (kg/d)	4.77 ± 0.55	3.56 ± 0.76

Mean±SE, n=3.

Table 3. Results of chemical analyses of feces and urine

	Control group	Experiment group
Feces		
pH	6.87±0.16	6.68±0.32
Nitrogen contents (%)	0.88±0.07	1.09±0.06
Urine		
pH	7.13±0.22	7.21±0.23
Nitrogen contents (%)	0.43±0.16	0.93±0.36
Urea contents (mg/mL)	0.61±0.05	0.74±0.15

Mean±SE, n=3.

Discussion

Underutilized materials should be evaluated as feedstuff from various viewpoints economy, nutritive value, and environment factors. Ani et al. [10] reported that the cost reduction possibility of commercial formula feed of weaner pigs fed soybean hulls was important in animal production. The present study aimed to evaluate the dietary soybean hull supplementation on the growth performance and ammonia gas emission from excreta of finishing pigs.

In the current study, soybean hulls did not affect growth performance. This result was consistent with the results of Wang et al. [4] and Quadros et al. [11], who found no effect on pig performance when 0 to 15 % or 0 to 16 % soybean hulls were added to finishing pig feed. Kornegay [1] and Stewart et al. [12] also reported that 30 % soybean hull supplementation in finishing pig feed reduces average daily gain and suggested that 15 % soybean hull level could

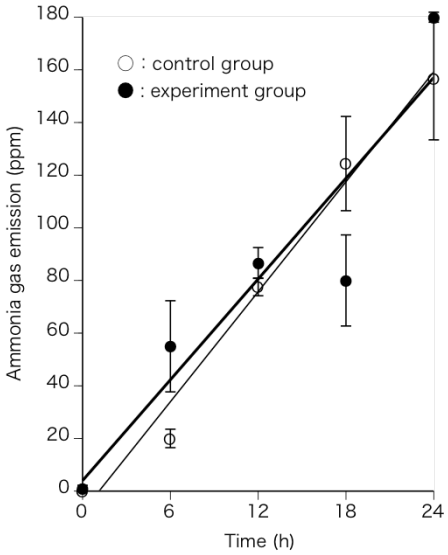

Figure 1 Chronological variation of ammonia gas emission
Regression equation and coefficient are as follows:
f(x)=4.178x - 4.962, r=0.9824 in the control group.
f(x)=3.828x - 3.428, r=0.8674 in the experiment group.

be used in swine feed without adverse effects. By contrast, DeCamp et al. [3] suggested that 10% soybean hulls added in finishing pig feed can improve average daily gain in accordance with the increasing fat level derived from soybean hulls, i.e. soybean hulls have no effect on the growth performance in themselves. In this study, soybean hulls were supplemented to the 10 % level, which had no effect on the nutritive value of basal formula feed under the simple mixing of them. In conclusion, 10 % supplementation of soybean hulls has adverse effect on the finishing pig performance and it is possible to use in swine feed source.

Yamamoto et al. [5,6] reported that the addition of NSP rich dietary source to reduced CP, amino acid supplemented feed reduced urinary nitrogen excretion and increased fecal nitrogen excretion. They explained this mechanism as follows: NSP enhances the microbial proliferation and extra nitrogen was positively used for the microbial protein synthesis in digestive tract of animals. In the chemical analyses, nitrogen content of the experiment group is higher than that in the control group. This result was consistent with the roles of NSP. Although the urine was individually collected with no contamination of feces, urine volume in the experiment group was less than that in the control group, therefore the content may be increased or something else may be mixed in the urine. Wang et al. [4] observed the effects of dietary soybean hull level on ammonia gas emission from slurry after 5 day fermentation. In their results, ammonia gas was linearly and significantly increased with increased soybean hull level. DeCamp et al. [3] also reported that the change in ammonium N with the soybean hull fed pigs was an 8 % increase. The present results showed no influence on the ammonia gas emission from excreta, i.e., they were not consistent with the above-mentioned results. In the used level of soybean hull supplement, there is no difference between the studies of present and DeCamp et al. [3], therefore it is difficult to conceive a reason for this.

The effect of dietary soybean hull supplementation on the meat quality, which is examined in some studies, remains to be clarified in the future study.

In conclusion, 10% dietary supplementation of soybean hull is no negative effect on the growth performance and ammonia gas emission and can be a valuable feed source.

Acknowledgement

Authors sincerely thank Ms.

M.Isoguchi, Ms. M.Naganuma, and Mr. Y.Seino for valuable help in conducting this study.

References

[1] Kornegay, E.T., 1981. Soybean hull digestibility by sows and feeding value for growing-finishing swine. J.Anim.Sci., 53, 138-145.

[2] Van Oeckel, M.J., Warnants, N., De Paepe, M., Casteels, M., Boucque, C.V., 1998. Effect of fibre-rich diets on the backfat skatole content of entire male pigs. Livest.Prod.Sci., 56, 173-180.

[3] DeCamp, S.A., Hill, B., Hankins, S.L., Herr, C.T., Richert, B.T., Sutton, A.L., Kelly, D.T., Cobb, M.L., Bundy, D.W., and Powers, W.J., 2001. Effects of soybean hulls on pig performance, manure composition, and air quality. Purde Univ. 2001 Swine Res.Rep., 84- 89.

[4] Wang, Y., Chen, Y.J., Cho, J.H., Yoo, J.S., Huang, Y., Kim, H.J., Shin, S.O., Zhou, T.X., and Kim, I.H., 2009. Effect of soybean hull supplementation to finishing pigs on the emission of noxious gases from slurry. Anim.Sci.J., 80, 316-321.

[5] Yamamoto, A., Aoki, Y., Itoh, M., Ishikawa, Y., Yamauchi, Y., Yamada, M., and Furuya, S. 2002. Effect of dietary addition of dried apple pomace on the nitrogen excretion in urine and feces of growing pigs. Jpn.J.Swine Sci., 39, 8-13.

[6] Yamamoto, A., Itoh, M., Furukawa,C., Nagamine, T., Kameoka, T., and Furuya, S., 2003. Reduction of urinary nitrogen excretion and ammonia emission from slurry by feeding a lowering protein diet supplemented with beet pulp in the growing pigs. Jpn.J.Swine Sci., 40, 135-140.

[7] Mino,M., Ikeda, S., and Sukemori, S., 2014. Effect of green tea catechin supplementation in diets for pigs on ammonia emissions from urine and feces mixture. Anim.Prod.Environ.Soc. Jpn., 13, 28-35.

[8] Sukemori,S., Shiota,Y., Ohta,Y., and Ikeda, S., 2015. Ammonia gas emissions from the feces and urine mixtures excreted by fattening pigs fed silage of sweet potato stalks and rice bran. Anim.Prod.Environ. Soc.Jpn., 14, 40-46.

[9] Cahn, T.T., Verstegen, M.W.A., Aarnink, A.J.A., and Schrama, J.W. 1997. Influence of dietary factors on nitrogen partitioning and compositions of urine and faeces of fattening pigs. J.Anim.Sci., 31, 700-706.

[10] Ani, A.O., Ezemagu, I.E., and Ugwuowo, L.C., 2013. Growth performance of weaner pigs fed soybean hull based diets. J.Anim.Feed Res., 3, 137-142.

[11] Quadros, A.R.B., Moreira, I., Furlan, A.C., Ribeiro, C.R., Perdigao, L., and Kutshenko, M., 2008. Different inclusion levels of soybean hull on isoenergetic growing-finishing pig diets. Ciencia Rural, 38, 463-469.

[12] Stewart, L.L., Kil, D.Y., Ji, F., Hinson, R.B., Beaulieu, A.D., Allee, G.L., Patience, J.F., Pettigrew, J.E., and Stein, H.H. 2013. Effects of dietary soybean hulls and wheat middlings on body composition, nutrient and energy retention, and the net energy of diets and ingredients fed to growing and finishing pigs. J.Anim.Sci., 91, 2756-2765.

Soybean hull is adequate for swine feed

原　著

肥育豚に大豆皮を給与することが肥育成績とふん尿からのアンモニアガス揮散に及ぼす影響

祐森誠司、池田周平
東京農業大学農学部
243-0034　神奈川県厚木市船子 1737

本試験は、肥育豚に大豆皮を給与することが肥育成績とそれを摂取した肥育豚が排泄するふん尿から揮散するアンモニア濃度に及ぼす影響の検討を目的とした。交雑種（M×Y×B）6 頭を大豆皮を含まない対照区と 10%の大豆皮を含む試験区に配分した。肥育試験の結果、大豆皮の給与による差は認められず、排せつ物中の窒素化合物などの含量にも統計的な有意差は認められなかった。また、糞尿混合物からのアンモニア揮散量は時間経過に伴い直線的に増加し，両区に差は認められなかった。これらより、大豆皮はその給与による悪影響は認められず、有益な飼料資源であり、養豚飼料としては 10%程度配合する事が可能と推察された。

キーワード：　大豆皮、飼料資源、豚、肥育、アンモニアガス揮散.

連絡担当者：　祐森誠司　 sukemori@nodai.ac.jp