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Effects of Dietary Supplementation of Enzymes in Soybean Meal Rich Diet on Performance of Growing-Finishing (20-100 kg) Pigs

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ABSTRACT

The effects of dietary supplementation of NSPase type mixture in growing-finishing pig diets containing high soybean meal was studied by using 180 3-ways crossbred (LW ¥ LR ¥ D) pigs. The animals with 30 kg initial body weight were divided into 3 groups of 60 animals each which was further divided into 4 subgroups of 2 males and 2 females subgroups of 15 animals each. Each group of the animals was randomly fed one of the experimental diets for 105 days. The diets are as follow: for growing period (30-50 kg); Diet 1: A control corn-soybean meal-fish meal diet; Diet 2: corn-soybean meal diet; and Diet 3: Diet 2 but supplemented with NSPase type mixture, and for finishing period (50-100 kg); Diet 1: A control tapioca-soybean meal-fish meal diet; Diet 2: tapioca-soybean meal diet; and Diet 3: Diet 2 but supplemented with NSPase type mixture. There was no significant different in performances of the animals on experimental diets in the growing period. However, during finishing period, pigs on high soybean meal supplemented with NSPase type mixture (Diet 3) had significantly higher final weight ($P<0.05$) and better FCR ($P<0.05$) than those on the same diet but not supplemented with the enzyme (Diet 2). For the combine result of 105 days trial, NSPase type mixture supplementation in high soybean meal diets have demonstrated a positive effect on the improvement of the animals performances although the differences were not statistically significant. However, the enzyme supplementation could significantly improve lean percentage and loin-eye area of the animals ($P<0.05$). The results also demonstrated the economical effects of supplementation of NSPase type mixture in high soybean meal especially tapioca-soybean meal pig diets.

Key words: growing-finishing pig, NSPase, soybean meal rich diet

INTRODUCTION

Soybean meal has become the dominating protein supplement in animal feeding including in pig diets. The concern of *Salmonella spp.* contamination and the high variation of fish meal quality employed by the farmers have promoted more uses of soybean meal in the pig diets in Thailand. However, the cell wall of soybean consists mainly of two interwound NSP ultrastructures, composed of neutral glucan-xylan type primary cell walls and ionic peptic cell wall component (Huisman *et al.*, 2000) which can reduce the uptake of amino acids like lysine and threonine when added to the piglets diet (Zhu, 2001). The entrapment of amino acids by the fiber seem to be

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an important factor in the digestibility of the amino acids (Jondreville *et al.*, 2000). The fiber also has negative influences on the endogenous excretion of amino acids (protein).

The uses of dietary enzymes supplementation to improve the utilization of soybean meal in pig diets have been studied in the recent years (Partridge, 2001). Three types of enzymes which are oligosaccharide degrading enzyme, the protease type enzyme and NSP (non-starch polysaccharide) degrading enzyme mixtures have been used. NSPase type of mixture has been successfully used for the improvement of soybean protein utilization in diet of weaned pig containing high level of soybean meal (Kanto *et al*., 2004). The purpose of the study is to determine the effects of the NSPase type of mixture in corn-soybean meal diet and tapioca-soybean meal diet in growing (30-60 kg) and finishing pigs (60-100 kg), respectively.

MATERIALS AND METHODS

The experiment was conducted at a commercial pig farm in Kampaeng saen district, Nakhon Pathom province. Completely randomized design (CRD) was used. A total of 180 crossbred (LRxLWxD) growing pigs with average initial weight at 30 kg were randomly divided into 3 groups of 60 animals each. Each group of the animal was randomly divided into 4 subgroups of 2 males and 2 female of 15 animals for each subgroups. Animals in each subgroup were kept in a 5 ¥ 6 m solid concrete floor pen where feed and water were provided *ad libitum*. Each group of the animals was randomly fed one of the experimental diets during growing and finishing periods which are Day 1-33 and 34-105 of the trial, respectively, as following.

Growing period:

Diet 1: A control corn-soybean meal-fish meal diet.

Diet 2: A corn-soybean diet.

Diet 3: Diet 2 supplemented with NSPase type mixture.

Finishing period:

Diet 1: A control tapioca-soybean meal-fish meal diet.

Diet 2: A tapioca-soybean meal diet.

Diet 3: Diet 2 supplemented with NSPase type mixture.

NSPase type mixture used in the study was AVEzyme, manufactured by AVEVE, B.V., Belgium and the inclusion rate is 500 g/ton feed. All experimental diets were formulated according to nutritional specification adopted by the farm and were fed to the animals in mashed form. Feed ingredients and chemical composition of the experimental diets in the growing and finishing periods were shown in Table 1 and 2, respectively.

Initial weight and final weight of the animals for each period were recorded. Feed intake was weekly determined and the health status as well as the uses of medication was recorded throughout the study. At the end of the study, 2 animals from each subgroup (replication) were randomly slaughtered and subjected to carcass study.

The experimental data were subjected to analysis of variance and the difference among means were determined by the method of Duncan's New Multiple Range Test (SAS, 1989).

RESULT AND DISCUSSION

The effects of NSPase type mixture supplementation in corn-soybean meal diet in growing pigs (30-60 kg) and in tapioca-soybean meal diet in finishing pigs (60-100 kg) were shown in Table 3 and 4, respectively. The overall effects of NSPase type mixture supplementation in growing-finishing pigs (30-100 kg) and the effects of dietary NSPase type mixture supplementation on carcass characteristics of marketing pigs were

Table 1 Feed ingredients and chemical composition of the experimental diets for growing pig period (30 - 60 kg).

	Diet 1	Diet 2	Diet 3
Corn	61.60	59.22	59.22
Soybean meal (44%)	28.60	34.25	34.26
Fish meal (58%)	4.00	-	-
Rice bran oil	2.00	2.00	2.00
Dicalcium phosphate	3.00	3.70	3.70
Salt	0.35	0.35	0.35
L - Lysine. HCI	0.15	0.16	0.16
DL-Methionine	0.05	0.07	0.07
AVEzyme (g/ton)	-	-	500
Vitamins-Minerals premixs	0.25	0.25	0.25
Total	100	100	100
Chemical composition by calculation			
Crude protein (%)	20.00	20.00	20.00
ME (kcal/kg)	3230	3233	3233
Fat (%)	4.91	4.54	4.54
Crude fiber (%)	3.58	3.88	3.88
Calcium (%)	1.07	1.01	1.01
Avail. phosphorus (%)	0.76	0.79	0.79
Lysine	1.21	1.21	1.21
Met + cys	0.72	0.72	0.72
Tryptophan	0.24	0.26	0.26
Threonine	0.77	0.78	0.78
Cost (Baht/kg)	7.52	7.30	7.39

Prices of July 2002.

shown in Table 5 and 6, respectively.

For growing period (30-60 kg) (Table 3), no significant difference in final weight, average weight gained, average feed intake, average daily gained and feed conversion ratio (FCR) among the animals on the experimental diets was observed. Withdrawal of fish meal from the diet (Diet 2) have caused slightly poorer weight gained and average daily gained than those on the Diet 1 but the difference was not significant. The enzyme supplementation of high soybean meal diet (Diet 3) provided no improvement of the animal performance and the different was not statistically significant. There is probably due to that the level of soybean meal in corn-soybean diet (Diet 2) and corn-soybean diet supplemented with NSPase type mixture (Diet 3) were not high enough for the beneficial effects of NSPase to clearly demonstrated. For finishing period (60-100 kg) (Table 4), there were significantly different in final weight and average weight gained of the animals on the experimental diets ($P<0.05$). Withdrawal of fish meal from the control diet (Diet 2) caused a significantly lower final weight of the animals ($P<0.05$). The supplementation of NSPase type mixture in high soybean meal diet

Table 2 Feed ingredients and chemical composition of the experimental diets in finishing pig period (50 - 100 kg).

	Diet 1	Diet 2	Diet 3
Tapioca	51.80	49.83	49.83
Soybean meal (44%)	34.85	40.22	40.22
Fish meal (58%)	4.00	-	-
Molasses	4.00	4.00	4.00
Rice bran oil	2.00	2.00	2.00
Dicalcium phosphate	2.60	3.20	3.20
Salt	0.35	0.35	0.35
L – Lysine.HCl	-	0.03	0.03
DL - Methionine	0.15	0.15	0.15
AVEzyme (g/ton)	-	-	500
Vitamins-Minerals Premixs	0.25	0.25	0.25
Total	100	100	100
Chemical composition by calculation			
Crude protein (%)	19.00	19.00	19.00
ME (kcal/kg)	3182	3189	3189
Fat (%)	2.86	2.57	2.57
Crude fiber (%)	4.43	4.69	4.69
Calcium (%)	1.04	0.93	0.93
Avail. phosphorus (%)	0.70	0.70	0.70
Lysine (%)	1.16	1.16	1.16
Met + cys (%)	0.69	0.69	0.69
Tryptophan (%)	0.23	0.25	0.25
Threonine (%)	0.72	0.73	0.73
Cost (Bath/kg)	6.75	6.51	6.60

Prices of July 2002.

(Diet 3) improved average total weight gained, average feed intake and average daily gain of the animals although the difference were not significant. However, the enzyme supplementation significantly improved the final weight and feed conversion ratio of the animals ($P<0.05$). The withdrawal of fish meal in tapioca based finisher pigs diet (Diet 2) forced a high use of soybean meal (40.22%) which have caused high level of NSP in the diet and impaired the digestibility of amino acids (Jondreville *et al*., 2000). The high NSP content in Diet 2 might be responsible for the lower performances of the finishing pigs on the diet when compared to the control (Diet 1). Supplementation of NSPase type mixture in the high soybean meal diet (Diet 3) clearly demonstrated the improvement of average weight gained, average feed intake and average daily gain of the animals on the diet although the different were not statistically significant. But the enzyme supplementation resulted in the significant improvement of average final weight and feed conversion ratio ($P<0.05$). The supplementation of the NSPase may cause the improvement of

Table 3 Effects of AVEzyme supplementation in growing (30-60 kg) pig diets on performance of the animals.

	Diet 1	Diet 2	Diet 3
Growing period			
Initial No. of animals	60	60	60
Final No. of animals	59	60	59
Initial weight (kg)	34.07	33.73	33.93
Final weight (kg)	60.25	59.35	59.44
No. of days on test	33	33	33
Average weight gained (kg)	26.18	25.62	25.51
Average feed intake (kg)	27.90	54.03	56.12
Average daily gained (kg)	0.793	0.776	0.773
Feed conversion ratio	2.21	2.11	2.20

Table 4 Effects of AVEzyme supplementation in finishing (60 - 100 kg) pig diets on performance of the animals.

	Diet 1	Diet 2	Diet 3
Initial No. of animals	59	60	59
Final No. of animals	59	58	58
Initial weight (kg)	60.25	59.35	59.44
Final weight (kg)	102.23 b	99.96 a	104.75 b
No.of days on test	72	72	72
Average weight gained (kg)	41.98	40.61	45.31
Average feed intake (kg)	155.20	151.70	159.49
Average daily gained (kg)	0.583	0.564	0.629
Feed conversion ratio	3.70b	3.74b	3.52a

[a,b] Mean in the same line with different superscripts are significantly different ($P<0.05$).

amino acids digestion and absorption of the diet. The NSPase type mixture, which contains mainly glucanase, xylanase and pectinase will attack the NSP in soybean meal which is neutral glucan-xylan and ionized peptic cell wall and resulted in more digestion of the fiber and less entrapment of the amino acids in the diet. More amino acids availability is responsible for the improvement of animal performances on the Diet 3. It is very interesting to note that the improvement of amino acids availability by the NSPase supplementation has produced greater effects than the use of fish meal in the diet as indicated by the superior performances of the animals on Diet 3 to those on the Diet 1 ($P<0.05$).

For growing-finishing period (30-100 kg) (Table 5), the overall results clearly showed the beneficial effects of the NSPase type mixture supplementation in growing-finishing pig diets. Withdrawal of fish meal in the diet (Diet 2) caused

Table 5 Effects of AVEzyme supplementation in growing-finishing (30 - 100 kg) pig diets on performance of the animals.

	Diet 1	Diet 2	Diet 3
Initial No. of animals	60	60	60
Final No. of animals	59	58	58
Initial weight (kg)	34.07	33.73	33.93
Final weight (kg)	102.23	99.96	104.75
No. of days on test	105	105	105
Average weight gained (kg)	68.16	66.23	70.82
Average feed intake (kg)	213.10	205.73	215.61
Average daily gained (kg)	0.649	0.631	0.674
Feed conversion ratio	3.13	3.11	3.04

the reduction of the animals performances although the difference was not statistically significant. NSPase type mixture supplementation in high soybean meal diet (Diet 3) could improve performances of the animals although the differences were not statistically significant. Although the effects of NSPase type mixture was very prominent in the finishing period, the effects of the enzyme was low during the growing period and caused non-significant effects in the overall growing-finishing period. However, the results demonstrated the clear beneficial trend of the NSPase type mixture supplementation in growing-finishing pig diet.

Carcass study of animals have indicated that NSPase type mixture supplementation significantly increased lean percentage and loin-eye area of the animals ($P<0.05$) (Table 6). Pigs on high soybean meal diet supplemented with NSPase type mixture (Diet 3) averaged 2.83 % (47.38 % vs 44.55 %) and 5.06 % (47.38 % vs 42.32 %) higher lean percentage than those on the high soybean meal diet without the enzyme supplementation (Diet 2) and those on the control diet with fish meal (Diet 1), respectively. The pigs on high soybean meal diet supplemented with NSPase type mixture (Diet 3) also averaged 8.41 cm^2 (63.55 cm^2 vs 55.14 cm^2) and 14.86 cm^2 (63.55 cm^2 vs 48.69 cm^2) larger in loin-eye area than those on the high soybean diet without NSPase supplementation (Diet 2) and the control diet with fish meal (Diet 1), respectively. The dietary supplementation of

Table 6 Effects of AVEzyme supplementation in growing-finishing pig (30-100 kg) diets on carcass characteristics of the animals.

	Diet 1	Diet 2	Diet 3
Body weight at slaughtered (kg)	117	118	117
Carcass percentage	77.77	79.93	79.42
Lean percentage	42.32a	44.55a	47.38b
Loin-eye area (cm2)	48.69a	55.14a	63.55b
Back-fat thickness (inch)	1.12	1.06	1.15

[a,b] Means in the same line with different superscripts are significantly different ($P<0.05$)

NSPase type mixture supplementation would increase the digestion of NSP in the soybean meal, which resulted in more amino acids digestibility and availability of the soybean to the animals. Pigs on Diet 3 would have more protein and amino acids available for lean deposition than those on the Diet 1 and Diet 2, and therefore obtained the highest lean percentage and loin-eye area. The poorer growth of animals on Diet 2 may be responsible for the higher lean percentage and loin-eye area than those on the control diet (Diet 1), although the different was not significant.

The results of the study clearly showed the economic potential of NSPase type mixture supplementation in high soybean meal especially in tapioca-soybean meal growing-finishing pig diets. Supplementation of the NSPase type mixture in the diet (Diet 3) not only improved average daily gain and feed conversion ratio of the animals by 6.8 % (0.674 kg vs 0.631 kg) and 2.3 % (3.04 vs 3.11), respectively but also improved lean content and loin-eye area in animal carcass by 6.35 % (47.38 % vs 44.55 %) and 15.25 % (63.55 cm2 vs 55.14 cm2), respectively when compared to those on the high soybean meal diet without the enzyme supplementation (Diet 2). It is therefore, economical to use NSPase in high soybean meal growing-finishing pig diets.

CONCLUSION

The NSPase type mixture employed in the study has demonstrated beneficial effects on the improvement of finishing pig performances on high soybean meal (tapioca-soybean meal) diet ($P<0.05$) and the improvement of carcass characteristics ($P<0.05$) of growing-finishing pigs on corn-soybean meal diet during the growing period (20-50 kg) and on the tapioca-soybean meal diet during finishing period (50-100 kg). Effects of NSPase type mixture supplementation in corn-soybean meal diet was unclear probably due to the low content of soybean meal in the diet and confirmation of the result need to be done. Economical effects of NSPase supplementation in growing-finishing pig diets containing corn-soybean meal and tapioca-soybean meal in growing and finishing periods, respectively has demonstrated.

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