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Effects of diet additive supplements on the performance and cost of grower-finisher production: A case study in Nakhon Sawan Province, Thailand

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Abstract The results showed that 0.5% phytase enzyme supplementation did not affect the production performance significantly (P>0.05) resulted to the lowest cholesterol, triglyceride, Economic Loss Index values and the best Product Index value. For experiment 2, the effect of the level of probiotic supplementation with *Bacillus* sp. on the performance and cost of small and medium-sized grower-finisher pigs were used 3 small crossbred breeds of pigs with 36 fattening periods. The different pigs as in the first experiment revealed their initial average weight was 58 kilograms. The results showed that 1.0% supplementation with probiotics did not significantly affect the production performance (P>0.05) to produce pork with the greatest tenderness and juiciness, product index, economic loss index, and saleable head return. In addition, the return of investment was significantly better for the 1% supplementation group than both in the control group and the 0.5% supplementation group (P <0.05).

Keywords: Diet Additive, Grower-finisher, Nakhon Sawan Province, Performance and cost

Introduction

Pig farming is currently being developed in a more commercial way to allow swine to grow faster with higher productivity and a lower cost. Modern technology can result in higher production volumes, but the pigs tend to experience increased stress, resulting in subsequent pig loss (Department of Livestock, 2017) because these young pigs are usually weak and can develop complications easily. We focused on pigs raised by small farmers in the Nakhon Sawan province of Thailand (Figures 1 and 2). Most farmers tend to use various antibiotics that are added to the pig feed to stimulate growth, reduce stress and prevent disease. These antibiotics have disadvantaged because they are substances produced by microbes that have the potential to destroy other microbes. While they can be helpful and

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harmful, if used for a long time, they will cause the microbes to become resistant and they also often have residual effects on the animals, which will affect consumption. In addition, in the production of animal feed, many problems have been found in single-stomach animal production. The residue of phosphorus in the faeces can lead to environmental problems. In addition, it was found that the causes of stress were unclear and that the gastrointestinal tract of the pigs during early growth periods were not fully developed, causing poor digestion and absorption of nutrients. The pigs faced diarrhea, weak health, decreased immunity and slowed growth (Kitja *et al.*, 1994; Uthai, 1994).

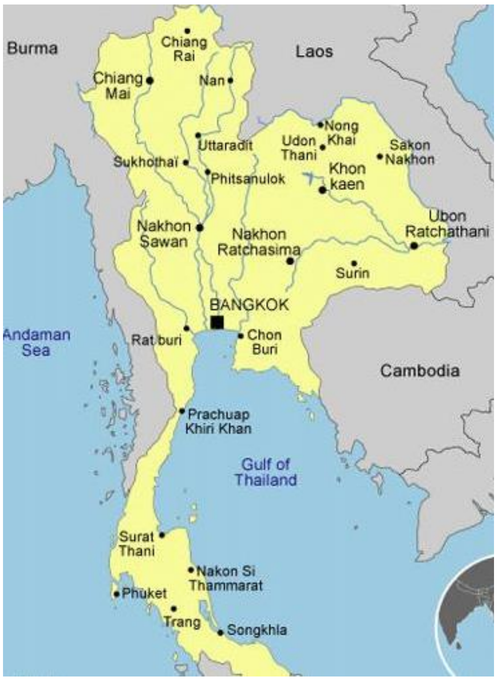

Figure 1. Shows the location of Thailand

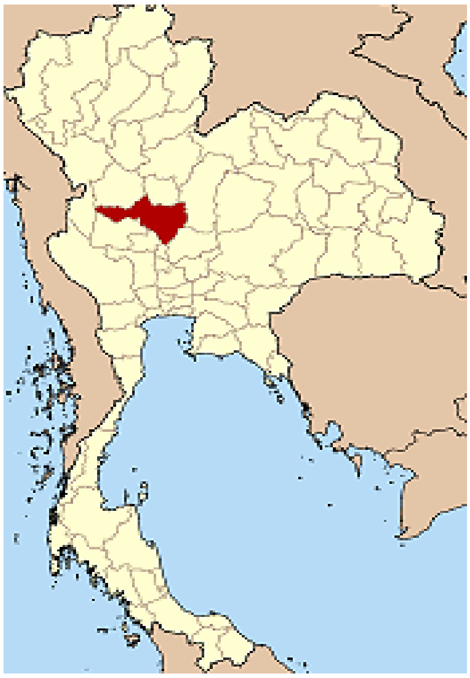

Figure 2. Shows the location of Nakhon Sawan province of Thailand

Currently, various types of enzymes have been introduced, and probiotics are frequently being added to pig feed in order to improve the animals' health. Phytase enzymes are often added to pig feed at all ages. Because single-stomach animals produce reduced phytase enzymes, pigs can utilize less of the phosphorus in their pig feed. Commercial supplementation with phytases in pig feed helps to increase the utilization of phosphorus, reduces the excretion of phosphorus in the faeces and the growth efficiency of pigs (Parichat, 2014). Enzymes have the property of phytase digestion that can be used in the animal feed industry need to function well in a condition that has a high acidity or in conditions similar to the environment in the animal stomach. Probiotics are a group of living microbes commonly used as a supplement in pigs. These microbes help the intestines to function and develop. In addition, the swine farming industry in Thailand is continuously developing in regard to feeding, breeding, management, and disease prevention (Kitja *et al*., 1994). To increase production efficiency, the probiotic bacteria *Bacillu*s sp. can help the pigs remain healthy and have better growth. Once the pigs have eaten the probiotics, the probiotics will grow in their intestinal tracts and create a balanced state of intestinal microflora, which often loses its balance under stress conditions. It is important to use an amount that is not harmful to the pigs. In addition, probiotics can help to improve feed utilization efficiency and leave no residual effects in the pigs (Balasingham *et al*., 2017; Thepsapsorn and Woranuch, 2012). Therefore, this research scope aimed to study the effects of different levels of phytase and probiotic supplementation in feed on the performance and cost of grower-finisher pigs suitable for raising by smallholders in the Nakhon Sawan province of Thailand**.**

Materials and methods

The study was divided into 2 experiments and conducted the experiments in open greenhouses.

Experiment 1: It was studied on the effects of dietary supplementation with phytase enzymes on the performance and cost of production of grower pigs. The initial weight of the pigs was 30 kilograms, and they were raised on small and medium-sized farms. The experimental animals were 3 small crossbred breeds of pigs (Large White, Landrace, and Dur Rock), and a total of 36 pigs were used over the 48 days of the experiment. The complete randomized design (CRD) was divided into 3 groups (each group had 4 replications per group; 3 pigs) and can be classified as follows: Treatment 1, the control group; treatment 2, 0.5% phytase supplementation group (25,000 units of PTU/kg); and Treatment 3: 1.0% phytase supplementation group (50,000 units PTU/kg). The feed contained 18% protein for pigs (NRC, 1998) which determined according to the Pearson Square method. The main raw materials were 12% fermented yeast protein and 20% ready-made pig feed head protein. As of 2018, the price of yeast fermenters was 4 baht per kilogram, and the price of pig feed head protein was 11.50 baht per kilogram. The blood was sampled from the animals from the anterior vena cava for haematology analysis and measurement of AST, triglyceride and cholesterol. The feed cost, feed cost per gain, product index, and economic loss index were calculated. We recorded the amount of feed eaten every week and weighed the pigs weekly to calculate the feed intake, weight gain, feed conversion ratio, average daily gain, and calculated cost. The means were compared among groups with Duncan's new multiple range test by using the Statistical Analysis System (SAS, 1985).

Experiment 2: The effects of supplementation of the feed with different levels of the probiotic *Bacillus* sp. on the performance and cost of finishing pig production were investigated. The finisher pigs on the farms of small farmer were 3 types of hybrids (Large White, Landrace, and Dur Rock) with 36 fattening periods. Their initial weight was 58 kilograms. The experimental period was 48 days. Using different pigs as in the first experiment and the pigs were adjusted for 14 days prior to collecting experimental data. The CRD trial was divided into 3 groups (each group had 4 replications per group; 3 pigs) and can be categorized to the following treatments, treatment 1 was the control group without probiotic supplementation treatments; treatment 2 was probiotics supplement group with 0.5% *Bacillus* sp. treatment in the diet; treatment 3 was group with 1.0% *Bacillus* sp. probiotic supplement in mixed animal feed as the needs of the finisher pigs with 16% protein (NRC, 1998) according to the Pearson Square method. The main raw material was 12% yeast fermented protein and 20% complete pig feed heads. The price of yeast used for raising animals at the end of year 2018 which fermented potatoes that was 4 baht / kilogram, and the price of feed heads was 11.50 baht / kilograms with full feed and water. The cost of the components is given above. After the experiment, the pigs' carcasses were analysed for meat moisture content, protein and fat (AOAC, 1995). The sensory evaluation of all treatments was conducted by cutting the pork meat crosswise until the meat fibres were around 2 mm thick, and then it was cooked in water at 80 ℃ for 10 minutes without any additives. Then, 50 evaluators were tasted the meat and scored it from 1–5 for its softness, flavour, juiciness, and satisfaction (Sanchai, 2010). As described above, the feed intake, weight gain, feed conversion ratio, average daily gain, the cost and economic returns of probiotic supplementation of pig feed were calculated. Treatment means were compared using Duncan's new multiple range test by statistical analysis system program (SAS, 1985).

The specific objectives were to study the effects of different levels of phytase supplementation in feed on the performance and cost of advanced grower pigs raised by small scale farmers in the Nakhon Sawan province, Thailand. Moreover, the effects of different levels of *Bacillus* sp. probiotic supplementation in feed on the performance, and cost of finishing pig production by smallholders in the Nakhon Sawan province of Thailand were investigated.

Results

Experiment 1 showed the effect of enzyme supplementation in feed on production performance and production return according to pig age examined the amount of feed consumed, weight gain, meat exchange rates, growth rates, haematology values, feed costs and production costs. The experimental results are shown in Table 1.

Table 1. shows the effects of dietary enzyme supplementation on production performance and hematology values of advanced pigs throughout the experiment

Item		Phytase Enzyme (%)		P-value
	Control	0.5	1.0	
Initial Weight (kg/h)	30.85	30.08	30.60	-
Final Weight (kg/h)	58.49	57.58	58.49	-
Weight Gain (kg/h)	26.66	27.50	27.89	ns
Feed Intake (kg/h)	1.62	1.67	1.69	ns
Feed Conversion Ratio	2.49	2.41	6.60	ns
Average Daily Gain (kg/h)	0.65	0.67	0.66	ns
AST (U/L)	86	47	37	-
Triglyceride (mg/dl)	54	28	60	-
Cholesterol (mg/dl)	108	84	110	-

Note: ^{ns} the letter that shows the not difference significantly (P>0.05)

The effect of dietary supplementation of phytase on the performance and haematology values in grower pigs, weight gain amount according to feed eaten, growth rate, the meat exchange rate of the control group, and phytase supplementation in groups with 0.5 and 1.0% feed intake were determined (Table 1). There were no statistically significant differences (P> 0.05) for the haematology analysis. The AST (U/L) of the 1.0% phytase supplementation group tended to be lower than the 0.5% phytase supplementation and control groups. For the triglyceride and cholesterol values, the values for the 0.5% supplementation group tended to be lower than the control group and the 1.0% supplementation group. Phytase supplementation of diets of advanced grower pig diets for the cost of feed and pig production during the experiment showed that the feed cost and feed cost per gain in the control group were decreased in the phytase supplementation group at the level of 0.5% in feed and 1.0% phytase supplementation group. The product Index found that supplementing with phytase enzyme at 1.0%in the diet tended to decrease phytase supplementation at the level of 0.5% compared to the control group. The economic index was lower in 0.5% supplementation group than the 1.0% supplementation and control groups, as shown in Table 2.

Experiment 2showed the effects of different levels of probiotic supplementation on production performance and production returns in finishing pigs. There were no significant differences among the groups over the experimental period of 6 weeks in terms of weight gain, amount of feed consumed, meat exchange rate, growth rate or the chemical composition of the pork (moisture, protein, and fat) (P> 0.05), as summarized in Table 3. For consumer acceptance, it was found that supplementing *Bacillus* sp. with probiotics 0.5 percent in the diet resulted in the highest produced pork with the best flavour and satisfaction, while the 1.0% supplementation group had the softest and juiciest meat, as shown in Table 4.

Table 2. The effects of dietary phytase supplementation on feed cost and grower pigs production

Items		**Phytase Enzyme** (%)		**P-value**
	Control	**0.5**	**1.0**	
Feed Cost (bath/kg)	6.85	7.85	8.85	ns
Feed Cost per Gain (bath/kg)	12.15	14.85	16.45	ns
Product Index (%)	44	45	30	ns
Economic Loss Index (%)	79	68	70	ns

Note: [ns] the letter that shows the not difference significantly (P>0.05)

Table 3. The supplementation of probiotic *Bacillus* sp. in feed on finishing pig production performance and chemical composition of pork

Items		**Probiotics percentage** (%)		**P-value**
	control	**0.5**	**1.0**	
Initial Weight (kg/h)	60.20	60.08	60.60	-
Final Weight (kg/h)	95.49	95.58	95.69	-
Weight Gain (kg/h)	33.54	33.61	33.93	ns
Feed Intake (kg/h)	105.55	105.00	105.50	ns
Feed Conversion Ratio	3.15	3.18	3.10	ns
Average Daily Gain (kg/h)	0.65	0.67	0.66	ns
Moisture (%)	75.74	74.99	75.93	ns
Protein (%)	16.00	16.75	16.56	ns
Fat (%)	6.68	6.93	6.70	ns

Note: [ns] the letter that shows the not difference significantly (P>0.05)

Table 4. The supplementing *Bacillus* sp. probiotics with feed on pork quality scores and consumer acceptance

Items (score)	**Control**	**Probiotics Percentage** (%)		**P-value**
		0.5	**1.0**	
Softness of the meat	3.00	3.16	3.20	ns
Toughness of meat	3.14	3.08	3.02	ns
Juiciness of the meat	2.98	3.09	3.12	ns
The taste	3.19	3.25	3.20	ns
Overall satisfaction	3.20	3.30	3.28	ns

Note: [ns] the letter that shows the not difference significantly (P>0.05)**,** Scored it from 1-5 for its (1 = not good, 2 = fair, 3 = moderate, 4 = good, 5 = very good)

The results of the study of production costs and the economic returns of probiotics supplementation in finishing pig diets were used by small-scale farmers in Nakhon Sawan province of Thailand that found to be no statistically significant differences among the groups in terms of feed cost, feed cost per gain, survival rate, net profits per head or net profits per kg (P>0.05). The 1.0% supplementation group, it was found that the product index, economic loss index, saleable head return and return on investment were significantly better than the values of 0.5% supplementation and control groups (P <0.05) as shown in Table 5.

Table 5. The production costs and economic rewards of probiotic supplementation in feed finishing pig

Items	**Control**	**Probiotics Percentage (%)**		**P-value**
		0.5	**1.0**	
Feed Cost (bath/kg)	7.75	8.29	8.83	ns
Feed Cost per Gain (bath/kg)	11.50	12.03	12.43	ns
Survival Rate (%)	100	100	100	ns
Product Index (%)	20.95 [b]	21.39 [b]	25.10 [a]	*
Economic Loss Index (%)	79.05 [b]	78.61 [b]	55.90 [a]	*
Salable Head Return (bath/head)	4,188 [b]	4,132 [b]	4,284 [a]	*
Return of Investment (%)	55 [b]	54 [b]	60 [a]	*
Net Profits per Head (bath)	3,212	3,088	3,152	ns
Net Profits per Kg (bath)	38.34	37.36	36.96	ns

Note: [a, b, *] the letters that showed the difference significantly (P <0.05), [ns] the letters that showed not difference significantly (P>0.05), the price of yeast fermented total feed head 20 CP%, the price was 7.75 baht / kg, probiotics price was 360 baht / kg. in the year of 2019 at Nakhon Sawan province, Thailand.

Discussion

The effect of the level of phytase supplementation in feed on the performance and cost of grower pig feed for small scale farmers in the 0-6week model; the weight gain, amount of feed eaten, meat exchange rate and the rate of growth of the control group and 0.5 and 1.0% phytase supplementation groups showed no statistically significant differences (P> 0.05). In addition, Cromwell (1995) reported that the average daily growth rate in the experimental group that received *B. Subtilis* PDS-9 was equivalent to that in the experimental group that received dietary supplements. As also reported by Defa *et al*. (1999); Somkid and Arunee

(2013) experiment with supplemental phytase levels at 250 units / kg for 3-6 weeks resulted in increased growth per person per day, and the meat exchange rate of controlled farming and phytase enzyme supplementation at 10g and 20g ranged from 0-1, 1-2, 2-3, 3-4, 4-5, and 5-6. The Uthai (1994) and Yi *et al*. (1996) it was found that supplementation of phytase enzymes at levels of 500 and 1000 units PTU / kg resulted in better diet conversion rates than those in the control group. In terms of the amount of feed consumed per week, it was found that controlled farming with supplementation with 1.0g and 20g phytase resulted in ranges of 0-1, 1-2, 2-3, 3-4, 4-5, and 5-6. During rearing periods 0-3, 3-6, 0-6, there were no differences, and Somkid and Arunee (2013); Cromwell (1995) found that all pig feed formulas resulted in statistical differences in production performance and the growth rate based on the amount of feed consumed, and the final weights were better than those in the control group.

The second experiment which examined the effect of the level of *Bacillus* sp. probiotic supplementation in feed on the performance and cost of finishing pig production of small farmers found that *Bacillus* sp. probiotic supplementation in the diet throughout the experiment affected weight gain, the amount of feed eaten, the meat exchange rate, and the growth rate. There was no statistically significant difference ($P>0.05$) as also reported by Gaggia *et al.* (2010); Dowarah *et al.* (2017) the use of 0.05, 0.1 and 0.2% probiotics in diets increased the growth rate of pigs, and feeding efficiency improved. Hou *et al*. (2015); Balasingham *et al.* (2017) found that supplementation with probiotics at 0.5 and 1.0 / kg resulted in the increased effectiveness of feed use compared to that in the control group. The pigs fed all the formulas showed statistical differences in production performance. In addition, the group receiving probiotics showed an increased growth rate, amount of feed eaten and final weight compared to the control group, and Wandee *et al*. (2011); Hou *et al*. (2015); Suekrit (2018) reported that supplementation with probiotics in pigs produced increased growth per day, feed conversion rates and final weights compared to those in pigs without probiotic supplementation, but this has an increased effect on feed costs than that in other groups; in addition, the cost of feed per weight gain of the group receiving probiotic supplements produced from *B. subtilis* PDS2-9 was comparable to that of other groups.

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