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Article

Effect of Dried Porcine Placenta on Growth Performance in Post-Weaning Pigs

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Abstract

The objective of this research was to investigate the effect of substituting fish meal with dried porcine placenta (DPP) on the growth performance in post-weaning pigs. The experimental animals included 25 males and 25 females. The initial age was approximately 6 wk and the experiment lasted 21 days. Animals fed without DPP acted as the control group, treatment 1 (DPP1), treatment 2 (DPP2), treatment 3 (DPP3) involved substituting fish meal with 40, 60 and 80 % DPP, respectively, while treatment 4 (DPP4) involved entirely substituting fish meal with DPP. Animals in the DPP3 group had the highest final weight and average daily gain (31.15 ± 2.90 kg and 0.69 ± 0.14 kg/head/day). In addition, the feed conversion ratio of the animals in the DPP3 group was the lowest (1.45 ± 0.29). This result indicated that DPP is an effective alternative protein source for swine feed since it significantly improved growth performance. However, substituting fish meal with 100 % DPP would not be a good choice for increased growth performance. In future studies, more research should examine in depth other important traits such as immune traits or growth traits in other periods. Furthermore, processing cost and operating cost of DPP should be considered for sustainable economic efficiency.

Keywords: Dried porcine placenta, growth performance, pigs

Introduction

An important animal feed source for swine is fish meal which is imported using large amounts of income from places such as Peru and Chile [1]. Fish meal is a necessary component of animal feed because it contains a high protein component and essential amino acids. However, because of the high price of fish meal, some producers add other protein sources to reduce the production cost. Therefore, fish meal availability for swine production is crucial to increase the swine population in Thailand.

The placenta is a part of the sow's body which provides nutrition to the fetus and also protects it. Many species of animals such as sheep, goat and cattle eat their own placenta. In fact, the placenta has additional functions such as production of hormones which have a profound influence on the growth and development of the fetus and perhaps even on their metabolism [2]. Togashi *et al*. [3] have studied the nutritional quality of human placental extraction. It is a reservoir of a large number of bioactive molecules such as hormones, proteins, lipids, nucleic acids, glycosaminoglycan, amino acids, vitamins and minerals. It contains many unknown compounds and is believed to have various bioactivities including inhibition or delay of aging, inflammation, sunburn, mutagenicity and oxidation. Moreover, the placenta is known to have no toxic effects.

Swine production in Thailand has developed considerably over the last 10 years. The number of sows in 2010 was approximately 840,000 [4]. If they could produce offspring 2.2 times per year, raw placentas from them may be roughly 2.85 million tons. A large amount of placenta would be expected to be available from commercial swine farms. However, it has not been utilized and has been discarded each year by the producers and farmers. Therefore, if the nutritional properties of porcine placenta can be exploited, it can be a value-added product with economic benefits for industry while reducing environment pollution. One of the problems to be solved before introducing placenta as a feed component is the possibility of pathogenic bacteria contamination. Suitable methods need to be introduced to reduce pathogenic bacteria in order to reduce possible danger in meat production so that the placenta can be exploited as an alternative feed source in swine farms. Moreover, the placenta could substitute synthetic resources in feed because it contains protein and other nutrients [5]. The objective of the study was to investigate the effect of feeding dried porcine placenta (DPP) on the growth performance of pigs.

Materials and methods

Animals and managements

This experiment was conducted at a commercial swine farm in southern Thailand. Animals in this research were crossbreds of 25 % Large white, 25 % Landrace and 50 % Pietrain. In total, 25 female and 25 male animals were used. These experimental animals were weaned at 21 days of age and randomly selected in this research. They had preliminary periods of 5 days with an experimental period of 21 days. They were raised under similar management conditions. Animals were reared indoor in individual pens. Each pen had dimensions of 1.20 × 2.80 m which contained one self-feeder and one nipple water to provide *ad libitum* access to feed and water. Males and females were penned separately. The temperature in the pig's house was maintained at 28 to 32 °C. They were fed 21 % protein concentrate diets, 5 times daily at 07:00 a.m., 10:00 a.m., 13:00 p.m., 15:30 p.m. and 19:00 p.m. Pregnant sows of experimental pigs were vaccinated for Aujeszky's disease, swine fever and atrophic rhinitis/enzootic pneumonia at 4, 3 and 2 wk before farrowing. All experimental pigs were treated against external and internal parasites. They were routinely vaccinated against mycoplasma at 3 wk, 1^{st} and 2^{nd} swine fever at 5 and 8 wk, Aujeszky's disease at 6 wk and 1^{st} and 2^{nd} foot and mouth disease at 7 and 9 wk since the onset to the end of the experiment.

Raw porcine placenta collection and dry

Raw porcine placentas were collected 2 - 5 h after farrowing. Corrected porcine placentas were pooled for preparation in the next process. The placentas were washed with distilled water to remove dust and blood. The raw porcine placentas were cooked in boiled water until done. They were dried at room temperature and then completely dried in a hot air oven (100 °C) for 8 h and crushed with a blender for homogenization. DPP could be kept dry at room temperature. The DPP samples were mixed and made homogenous in proportions described in the experimental design.

Experimental design

The experiment was designed as a randomized complete block design (RCBD or RBD). Sex was blocked in this experiment in order to reduce residual error from variation in gender's growth performance. In addition, this effect was significantly different for initial weight from preliminary research. Fish meal was substituted with DPP creating 4 experimental diets with 40, 60, 80 and 100 % of DPP in fish meal. Within each treatment, pigs were randomly selected for the following diets: 1) control (without porcine placenta) 2) to 5) 40, 60, 80 and 100 % DPP substituted for fish meal in a controlled diet. The components for each dietary feed are presented in **Table 1**. Feed ingredients in all diets were analogous except for the fish meal and DPP components. For all diets nutritional values were estimated and adjusted such that the nutrients were the same as that in the control feed (**Table 2**). The experimental diets were consumed in their entirety on most days because the amount of feed offered was adjusted daily to minimize refusals.

Table 1 Feed formula for post-weaning pigs in the experiment (g).

	Control	DPP1	DPP2	DPP3	DPP4
DPP	0.00	10.00	15.00	20.00	25.00
Broken rice	490.00	490.00	490.00	490.00	490.00
Soybean oil	43.00	43.00	43.00	43.00	43.00
Soybean meal	135.00	135.00	135.00	135.00	135.00
Full-fat soybean	235.00	235.00	235.00	235.00	235.00
Fish meal	25.00	15.00	10.00	5.00	0.00
L-Lysine	2.80	2.80	2.80	2.80	2.80
DL-Methionine	2.20	2.20	2.20	2.20	2.20
L-Threonine	1.20	1.20	1.20	1.20	1.20
Monodicalcium Phosphate	25.40	25.40	25.40	25.40	25.40
Calcium carbonate	12.00	12.00	12.00	12.00	12.00
Salt	2.40	2.40	2.40	2.40	2.40
Premix*	5.00	5.00	5.00	5.00	5.00
Milk replacer	25.00	25.00	25.00	25.00	25.00
Total	1004.00	1004.00	1004.00	1004.00	1004.00

DPP1 refers to substituting fish meal with 40 % dried porcine placenta, DPP2 refers to substituting fish meal with 60 % dried porcine placenta, DPP3 refers to substituting fish meal with 80 % dried porcine placenta and DPP4 refers to substituting fish meal with 100 % dried porcine placenta.
*Vitamins and trace minerals

Table 2 The estimated nutritional values of the control and treatment diets.

	Control	*DPP1	DPP2	DPP3	DPP4
Metabolizable Energy (kcal/kg)	3,503.17	3,464.64	3,445.38	3,426.12	3,406.86
Crude protein (%)	21.12	21.34	21.46	21.57	21.68
Fat (%)	9.77	9.74	9.73	9.72	9.70
Fiber (%)	2.69	2.67	2.65	2.64	2.62
Calcium (%)	1.00	1.00	1.00	0.99	0.99
Phosphorus (%)	0.88	0.87	0.87	0.86	0.86
Lysine (%)	1.35	1.41	1.43	1.46	1.49
Methionine+Cysteine (%)	0.84	0.84	0.84	0.83	0.83
Threonine (%)	0.90	0.91	0.91	0.91	0.91
Tryptophan (%)	0.28	0.27	0.26	0.26	0.25

*See footnotes in **Table 1**

Measurements and sample collection

Quantities of feed offered and refused were recorded daily for each animal. Samples of DPP, fish meal and soybean meal were randomly collected for determination of dry matter (DM) content, moisture, crude protein, fat and ash. They were taken for chemical composition analysis and amino acids components of DPP were analyzed by AOAC [6]. The feed intake (FI) was calculated daily for each animal as the DM offered minus the DM refused. Animals were weighed at the start and the end of the experiment (21 days). The average daily gain (ADG) was determined for the experimental period by subtracting initial body weight (BW) at the end of the period or experiment and dividing by the number of days. Furthermore, feed conversion ratio (FCR) was taken into account in the total FI per weight gain.

Statistical analysis

Data were analyzed using the model: $y_{ijk} = \mu + A_i + S_j + \beta (x_{ij} - \overline{x}) + e_{ijk}$ where y_{ijk}; observation for each animal, receiving a type of diet i, of sex j and covariate of initial weight ($\beta (x_{ij} - \overline{x})$); μ= the overall mean and e_{ijk}= the residual effect. The average initial weight of the animal allotted the control diet tended to be heavier at the start of the feeding trial than the other groups ($P < 0.05$). Because of this, data were statistically analyzed using initial weight as a covariate variable. One-way ANOVA was carried out to compare growth performance using the general linear model of R statistical program version 2.11.1 [7]. The results are presented as least square mean values and standard error. Differences between treatment means were determined by the Duncan's New Multiple Range Test. Differences among means with $P < 0.05$ were accepted as representing statistically significant differences.

Results and discussion

Average weight and diameter of raw placenta per piglet for individuals that could be measured were found to be 127.89 ± 9.48 g with a length of 11.00 ± 1.45 cm. If there were approximately 12 piglets/litter, raw placentas weighed approximately 1.80 kg/sow including the fetus and wall of uterus placentas. The raw placenta weight of multiparous sows was observed to be higher than primiparous sows. Porcine placentas from all sows were corrected for oven-drying at 100 °C. The study from [8] demonstrated that freeze drying porcine placenta for 20 h was superior to oven drying for processing that was a good biomaterial with high nutritional quality. However, freeze drying is very expensive for the producers and the period of drying in this process is higher than that needed for the oven-dried process. Also, DPP from the freeze drying process would probably be difficult to use in the feed substitution process. In this study, a ton of raw placentas yielded approximately 130.50 kg of DPP. Therefore, the weight of DPP was roughly 10 times lower than raw porcine placenta. DPP was used for post weaning pigs in this study since the requirement for crude protein from birth to the weaning period was higher than at other periods [9]. Utilization of DPP had some limitations as the source of porcine placentas from commercial farms and the amount of DPP product required would not be adequate for the growing to finishing period. The physical properties of porcine placenta were shown to be undesirable as raw porcine placenta has a disgusting odor and a higher stench than DPP. Color of raw porcine placentas is dark red before oven-drying while DPP became dark brown afterwards. Although the texture of raw porcine placentas was soft, smooth and slime, DPP was finely powdered.

Samples of DPP, fish meal and soybean meal were taken for chemical composition analysis by AOAC with results presented in **Table 3**. High protein of soybean meal was extracted by the solvation mechanism. Proximate analysis of DPP indicated its potential as a good protein source. The analyzed crude protein of DPP (84.50 %) was higher than fish meal (71.02 %) and soybean meal (48.93 %). It was shown that fish meal contained a very high percentage of crude protein. This may be due to the high quality of fish or contamination by other sources of protein such as urea, chicken feathers, etc. Ash of DPP and soybean meal were roughly 4 times lower than fish meal since it may contain high concentrations of minerals including calcium, phosphorus, iron, magnesium, sodium and zinc, along with trace amounts of many other substances. The same results were obtained by [8]. In depth study, the amino acid profile of DPP was analyzed and is shown in **Table 4**. Cystine and tryptophane were close to zero from this analysis. Glutamic acid, glutamine, aspartic acid, lysine and glycine were the most abundant amino acids in DPP. This same result was obtained by [8]. However, the quantity of amino acids in DPP for this study was dissimilar to that found in [8] because the method for porcine placental extraction was different. Not only essential amino acids but also non-essential amino acids were lower than 60 % quality fish meal crude protein as described by the Department of livestock development in Thailand [10]. In the present study, essential amino acids were expected to be sufficient for post-weaning pig requirements but some essential amino acids such as lysine, methionine and threonine were added in a type of synthetic amino acids consisting of all formulated diets being at or above the pigs' nutrient requirement for this feeding period.

Table 3 Chemical composition analysis of dried porcine placenta (DPP), fish meal and soybean meal.

Chemical composition (%)	DPP	Fish meal	Soybean meal
Dry matter	91.45	90.90	87.60
Moisture	8.59	8.20	10.57
Crude protein	84.50	71.02	48.93
Fat	0.25	0.17	1.21
Ash	5.44	19.39	5.42

Table 4 Amino acid composition analysis of dried porcine placenta (DPP).

Amino acid profiles	Unit: mg/100g of DPP
Histidine	19.31
Isoleucine	62.71
Leucine	32.53
Lysine	86.42
Methionine	11.51
Phenylalanine	19.85
Threonine	24.78
Tryptophane	0.00
Tyrosine	5.35
Valine	46.05
Alanine	70.44
Arginine	43.63
Aspartic acid	146.10
Asparagine	11.37
Cysteine	74.09
Cystine	0.00
Glutamic acid	209.50
Glutamine	104.69
Glycine	80.97
Hydroxyproline	33.93
Proline	22.84
Serine	42.75

The effect of DPP substitution on growth performance in post-weaning pigs is represented in **Table 5**. The initial weight in this study for the 2 sexes was significantly different. The same result was in agreement with those obtained by [11,12]. The average initial weights of males and females were found to be 17.75 ± 1.11 and 16.50 ± 1.23 kg. This effect was blocked in the experimental design. The difference in final weight of animal between DPP substitution and control diets was roughly 2.03 kg. Estimated lysine percentage as an essential amino acid for the 4 formulated DPP diets was similar to the control diets but ADG and FCR in the control group were not enhanced. Nevertheless, the consumption of feed with DPP present was significantly higher than in the control group. This result indicated that palatability based on odor and taste between the control and DPP substituted diets was similar.

Table 5 Least square means and standard errors of growth performance of pigs in each treatment.

	Control	***DPP1**	**DPP2**	**DPP3**	**DPP4**
Number of animals (heads)	10	10	10	10	10
Feeding period (days)	21	21	21	21	21
Initial body weight (kg)	17.80 ± 1.05	17.10 ± 0.93	16.80 ± 1.23	16.60 ± 1.22	16.15 ± 1.15
Final weight (kg)	26.80 ± 0.63^{a}	27.50 ± 1.13^{a}	29.20 ± 1.51^{b}	31.15 ± 2.90^{c}	27.50 ± 0.78^{a}
Average daily gain (kg/head/day)	0.42 ± 0.05^{a}	$0.49 \pm 0.07^{a,b}$	0.59 ± 0.10^{c}	0.69 ± 0.14^{d}	$0.54 \pm 0.06^{b,c}$
Feed Intake (kg/day)	0.97 ± 0.03^{a}	0.94 ± 0.02^{b}	$0.99 \pm 0.03^{a,c}$	$1.01 \pm 0.01^{c,d}$	1.02 ± 0.03^{d}
Feed conversion ratio	2.26 ± 0.26^{a}	1.89 ± 0.25^{b}	1.67 ± 0.30^{c}	1.45 ± 0.29^{d}	1.89 ± 0.27^{b}

*See footnotes in **Table 1**
$^{a, b, c}$ and ^{d} Different superscripts in the same row differ significantly (P < 0.05)

The feeding trial comparing among control, 40, 60, 80 and 100 % DPP substitution on pigs revealed that the 80 % DDP substitution group had a significantly higher ADG (0.69 kg/head/day) than other groups because of a higher FI (1.01 kg/day). These results reveal that pig fed with DPP3 had significantly lower (P < 0.05) FCR (1.45 ± 0.29) when compared with other treatments. In the present study, it was revealed that DPP especially DPP3 in which fish meal was substituted with 80 % DPP improved the growth in post-weaning pigs. These results are in agreement with [13] who reported that total daily gain for piglets was significantly improved by milk composition of their sows affected by placenta feeding.

Growth of animals which received DPP4 was not the best performance. Although pigs fed with DPP4 had high FI, they had low feed efficiency. It could be concluded that the DPP4 had low digestibility and consequently they had low ADG (0.54 ± 0.06 kg/head/day). Hence, substituting fish meal entirely with DPP does not improve growth performance and could be unnecessary for application in field work. In addition, some essential amino acid profiles between DPP and fish meal have dissimilar concentrations and not only essential amino acid but also non-essential amino acid compositions were possibly unbalanced. Substituting fish meal with DPP should consider the quantity of essential amino acids and minerals in DPP. It is known that fish meal contains an unidentified growth factor. Also, animals fed completely with DPP probably lack this factor that is present in fish meal. Consequently, growth performance of DPP4 did not give the highest growth traits. The partial substitution of DPP or substituting fish meal with 80 % DPP is an option to improve growth traits of pigs when compared between total substitution and without substitution of fish meal with DPP in this research. The content of protein, glucose and minerals in the milk composition of sows was changed by feeding them placenta [11-12,14]. It has an influence on plasma biochemical composition in sows and immunoglobulin G in piglets absorbed from maternal colostrums for passive immune protection until its own immune system develops. Therefore, this study confirms that animals could utilize DPP without any toxicity or subclinical symptoms. Also, the producers and farmers could partially substitute fish meal with DPP in free choice feeding.

Conclusions

In conclusion, substitution of fish meal with DPP and feeding to post-weaning pigs influenced their growth performance in this study. Although the other specialty protein sources can be fed individually in a complete diet, combining them may provide complementary benefits. This study showed that feeding alternative sources such as dried porcine placenta either alone or in combination with fish meal can improve growth performance compared with pigs fed diets with only fish meal. This study found that including 80 % of DPP and 20 % of fish meal gave the highest ADG and the best FCR. Hence, swine producers and farmers may use porcine placenta waste from sow farrowing as swine feed when other protein sources are not available. Nevertheless, there are considerable differences between protein sources in their ability to supply amino acids in a sufficient quantity to meet the requirement of the pigs. Therefore, more precise dietary formulation may be achieved if the availability of the amino acids in a feedstuff was taken into account.

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References

[1] Food and Agriculture Organization of the United Nations (FAO). Fish stat Plus-Total Production Dataset. FAO Fishery Department. 2009.

[2] RV Anthony, SL Pratt, R Liang and MD Holland. Placenta fetal hormonal interactions: impact on fetal growth. *J. Anim. Sci*. 1995; **73,** 1861-71.

[3] S Togashi, N Takahashi, M Iwama, S Watanabe, K Tamagawa and T Fukui. Antioxidative collagen-derived peptides in human-placenta extraction. *J. Nutr. Sci. Vitaminol*. 2002; **48**, 36-9.

[4] The Swine Raisers Association of Thailand. Statistical information of sow and finishing pigs. Available at: http://thaiahpa.com/images/Feed6.pdf, accessed July 2011.

[5] E Alsat, J Guibourdenche, A Couturier and D Evian-Brion. Physiological role of human placenta growth hormone. *Mol. Cell. Endocrinol.* 1998; **140**, 121-7.

[6] AOAC. *AOAC*, *Official Methods of Analysis*, Association of Analytical Chemists, Washington DC. 2005.

[7] R program. R program version 2.11.1. Institute for Statistics and Mathematics, GNU General Public License. 2010.

[8] A Jang, C Jo, IJ Kim and M Lee. Nutritional quality of dried pig placenta. *J. Food Sci. and Tech*. 2007; **12**, 89-94.

[9] ET Kornegay, AJ Lewis, JE Pettigrew, NC Steele and PA Thacker. *Proteins and Amino Acids. In*: GL Cromwell, DH Baker and RC Ewan ET (eds.). Nutrient Requirements of Swine. 10th revised ed. Nation Academy Press 2101, Washington DC, 1998, p. 16-30.

[10] Department of livestock development, Available at: http://www.dld.go.th/inform/kfish.html, accessed June 2011.

[11] M Ellis, AJ Webb, PJ Avery and I Brown. The influence of terminal sire genotype, sex, slaughter weight, feeding regime and slaughter-house on growth performance and carcass and meat quality in pigs and on the organoleptic properties of fresh pork. *Anim. Sci*. 1996; **62**, 521-30.

[12] Y Hyun and M Ellis. Effect of group size and feeder type on growth performance and feeding patterns in growing pigs. *J. Anim. Sci.* 2001; **79**, 803-10.

[13] RD Song, GM Li, SD Lee, N Hasegawa, YM Song, YH Kim, HJ Jung and JC Park. Effect of placenta feeding to sows on plasma biochemical composition and growth of their piglets. *Anim. Sci. J.* 2008; **79**, 248-54.

[14] SD Lee, T Sonoda, N Hasagawa, R Fukunaga, H Harada, YM Song and R Hidaka. Variations of blood corpuscle, IgG of plasma and milk in placenta-fed sows. *Anim. Sci. J.* 2006; **77**, 510-7.