The Effect of Spray-dried Porcine Plasma and Tryptophan on Feed Intake and Performance of Weaning Piglets

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ABSTRACT : There were three trials involved in this experiment. All piglets in Trial 1 were randomly distributed into the following 4 treatments. Treatment 1. Corn-soybean diet with 5% SDPP. The tryptophan level was 0.237%. Treatment 2. Corn-soybean diet with 10% meat and bone meal. The tryptophan level was 0.177%. Treatment 3. Treatment 1+0.0662% synthetic tryptophan. The total tryptophan level was 0.303. Treatment 4. Treatment 2+0.0662% synthetic tryptophan. The total tryptophan level was 0.236. Piglets in Trial 2 were distributed randomly into the following 4 treatments. Treatment 1: corn-soybean diet+10% meat and bone meal. The total tryptophan level was 0.176%. Treatment 2: corn-soybean diet+10% meat and bone meal+5% SDPP. The total tryptophan level was 0.180%. Treatment 3: Treatment 1 diet+0.004% synthetic tryptophan. The total tryptophan level was 0.180%. Treatment 4: Treatment 1 diet+0.631% synthetic tryptophan. The total tryptophan level was 0.237%. There were 4 treatments in Trial 3. Treatment 1: corn-soybean diet+10% meat and bone meal. The total tryptophan level was 0.176%. Treatment 2: Treatment 1 diet+0.061% synthetic tryptophan. The total tryptophan level was 0.237%. Treatment 3: Treatment 2 diet+0.061% synthetic tryptophan. The total tryptophan level was 0.298%. Treatment 4: corn-soybean diet+10% meat and bone meal+5% SDPP. The total tryptophan level was 0.180%. The results of Trial 1 showed that the piglets ate significantly more ($p<0.05$) when feed included SDPP in the diet during the first 2 weeks. The feed intake also increased when synthetic tryptophan was added in the 5% meat and bone meal diet; however, the difference did not reach a significant level ($p>0.05$) during the first 2 weeks. Three weeks onwards the feed intake of 5% meat and bone meal treatment was significantly lower ($p<0.05$) than for the other three treatments. The results of Trial 2 showed that the feed intake could be significantly improved only when the total tryptophan level reached 0.237%. Piglets in the 5% SDPP treatment had higher feed intake than piglets in 10% meat and bone meal treatment with 0.180% of tryptophan, but did not reach a significant level ($p<0.05$). Body weight gain also had the same trend as feed intake. The pigs in Treatment 1, the lowest total level of tryptophan treatment (0.176%), had lowest feed intake and weight gain, but the difference did not reach a significant level ($p>0.05$). The pigs in Treatment 1 of Trial 3 had the lowest feed intake and weight gain ($p>0.05$). Treatment 2 (0.237%) had the highest average feed intake from Week 1 to Week 5; the second best result was recorded in Treatment 4. As for the weight gain of the piglets in Treatment 4 (5% SDPP), they had a higher average weight during the first 3 weeks. The feed efficiency was better for Treatment 4 (5% SDPP) during the first 2 weeks. The results of these trials showed that both SDPP and tryptophan had a trend to improve the feed intake and weight gain. ***(Asian-Aust. J. Anim. Sci. 2005. Vol 18, No. 1 : 75-79)***

Key Words : Weaning Piglet, Tryptophan, Feed Intake, Performance

INTRODUCTION

Feed intake is quite low immediately after weaning due to shifting from milk (liquid) to dry feed for piglets (Hsia, 1987a,b). It is also clear that young pigs can grow faster if they eat more after weaning. Young pigs have considerable potential to improve their feed intake. That spray-dried porcine plasma (SDPP) can improve feed intake of weaning piglets has been shown in reports (Gatnau et al., 1993; Hansen et al., 1993; Kates et al., 1994a,b; Coffey and Cromwell, 1995; Owen, et al., 1995; Angulo and Cubilo, 1998; Kim et al., 2000,2001; van Dijk et al., 2004; Lai et al., 2004).

It is not known whether SDPP has some unknown factors, which may be involved in the improvement of feed intake. It suggested that SDPP reduced post-weaning intestinal disease by preventing attachment of pathogens (van Dijk et al., 2001). It is well-known that blood meal has a low relative percentage of isoleucine. However, we also notice that SDPP has a high content of tryptophan. Tryptophan is the precursor of serotonin (Voet and Voet, 1995). That serotonin plays a role in feed intake is also well documented (Henry and Seve, 1993). Henry and Seve (1993) demonstrated that the ratio between tryptophan and large neutral amino acids (LNAA) was one of the important factors in the determination of feed intake. They suggested that tryptophan and LNAA compete for passage through the blood-brain barrier. The purpose of this experiment was to study whether tryptophan could improve feed intake as well as SDPP based on the above theory.

There were three trials involved in this experiment. The first trial was conducted to study whether the feed intake and growth of pigs could be improved by adding tryptophan or SDPP in a diet with either corn soybean or corn soybean and meat and bone meal. The second trial was designed to

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Table 1. Feed formulation and calculated nutrient content of Trial 1

Ingredient/treatment	SDPP	MBM	SDPP+try	MBM+try
	Tryptophan content			
	0.237%	0.177%	0.303%	0.236%
Corn	70.6	71.9	70.53	73.03
Soybean meal	17.4	13.9	17.4	12.7
SDPP	5.0		5.0	
Meat and bone meal		10.0		10.0
Lard	3.0	3.0	3.0	3.0
Salt	0.5	0.5	0.5	0.5
Limestone	1.1		1.1	
Dicalcium phosphate	1.9		1.9	
Mineral premix	0.1	0.1	0.1	0.1
Vitamin premix	0.1	0.1	0.1	0.1
Lysine	0.1	0.3	0.1	0.3
Methionine	0.2	0.2	0.2	0.2
Tryptophan			0.07	0.07
Total	100	100	100	100
Calculated value				
Crude protein	16.8	16.8	16.8	16.593
Calcium	0.980	0.983	0.980	0.980
Phosphorus	0.730	0.740	0.730	0.735
Lysine	1.050	1.100	1.050	1.050
Methionine	0.48	0.48	0.48	0.48
Tryptophan	0.237	0.177	0.303	0.236

Each kg of premix contained Fe, 150 g; Cu, 30 g; Mn, 60 g; Zn 120 g; Co 0.7 g; I, 1.5 g; Se, 0.3 g.

Each kg of premix contained vitamin A, 1,200,000 IU; vitamin D_3, 100,000 IU; vitamin E, 40,000 IU; vitamin K_3, 2 g; vitamin B_1, 3 g; vitamin B_2, 5 g; vitamin B_6, 3 g; vitamin B_{12}, 0.02 g; pantothenic acid, 12 g; niacin, 20 g; folic acid, 1 g; biotin, 0.3 g.

study whether feed intake and performance could reach the same improvement with synthetic tryptophan and/or SDPP at the same level of tryptophan. The last trial was planned to study how much tryptophan should be included in the young pigs' diet.

MATERIALS AND METHODS

Trial 1

There were 48, 28-day weaned piglets, 24 male and 24 female, involved in the trial. The average initial weight was 5.8 kg. All piglets were distributed into the following 4 treatments randomly. Feed formulation is shown in Table 1.

Treatment 1: Corn-soybean diet with 5% SDPP (AP920). The tryptophan level was 0.237% (SDPP).

Treatment 2: Corn-soybean diet with 10% meat and bone meal. The tryptophan level was 0.177% (MBM).

Treatment 3: Treatment 1+0.0662% synthetic tryptophan. The total tryptophan level was 0.303% (SDPP+try).

Treatment 4: Treatment 2+0.0662% synthetic tryptophan. The total tryptophan level was 0.236% (MBM+try).

Piglets were kept in an environmental temperature-controlled chamber. The environmental temperature was set at 29°C during the first week, then decreased 1°C every week until the end of the six-week trial. Each piglet was kept in a pen 0.9 m×2.0 m. Each pen had a feed trough and a water bowl. Feed was provided ad lib and water was supplied all times. The residual feed was cleaned out and weighed at 7:00 am every morning. Fresh and weighed feed was provided immediately after cleaning out the residual feed. Feed was stored in a 15°C cool room. After the initial weighing, the piglets were weighed once per week.

Trial 2

Twenty-four, average weight 5.95 kg weaning female piglets were distributed randomly into the following 4 treatments. Feed formulation is shown in Table 2.

Treatment 1: corn-soybean diet+10% meat and bone meal (MBM). The total tryptophan level was 0.176%.

Treatment 2: corn-soybean diet+10% meat and bone meal +5% SDPP. The total tryptophan level was 0.180%.

Treatment 3: Treatment1 diet+0.004% synthetic tryptophan. The total tryptophan level was 0.180%.

Treatment 4: Treatment 1 diet+0.631% synthetic tryptophan. The total tryptophan level was 0.237%.

The management was the same as for Trial 1 except the pigs were raised in the pen until 8 weeks after weaning. The environmental temperature was set at 29°C during the first week, then decreased 1°C every week until 6 weeks, then kept constant to the end of eight weeks.

Trial 3

There were 24, 28-day weaning female piglets, average weight 5.89 kg used in the present trial, distributed into the following 4 treatments. Feed formulation is shown in Table 3.

Treatment 1: corn-soybean diet+10% meat and bone meal. The total tryptophan level was 0.176%.

Treatment 2: Treatment 1 diet+0.061% synthetic tryptophan. The total tryptophan level was 0.237%.

Treatment 3: Treatment 2 diet+0.061% synthetic tryptophan. The total tryptophan level was 0.298%.

Treatment 4: corn-soybean diet+10% meat and bone meal+5% SDPP. The total tryptophan level was 0.180%. The management was the same as for Trial 1.

Data were analyzed by least squares analysis of variance

Table 2. Feed formulation and calculated nutrient content of Trial 2

Ingredient/treatment	MBM	MBM+SDPP	MBM+try	MBM+try
	Tryptophan content			
	0.176%	0.180%	0.180%	0.237%
Corn	72.1	77.67	72.1066	72.22
Soy meal	13.69	3.08	13.6630	13.47
Lard	3.0	3.0	3.0	3.0
Meat and bone meal 50% CP	10.0	10.0	10.0	10.0
Limestone	0.05	0.11	0.05	0.05
Salt	0.3	0.3	0.3	0.3
Mineral premix	0.1	0.1	0.1	0.1
Vitamin premix	0.1	0.1	0.1	0.1
Lysine	0.38	0.33	0.38	0.4
Methionine	0.21	0.31	0.22	0.22
Threonine	0.07	-	0.08	0.08
Tryptophan	-	-	0.0004	0.06
SDPP	-	5.0	-	-
Total	100	100	100	100
Calculated value				
Crude protein	16.8	16.8	16.8	16.8
Lysine	1.1	1.1	1.1	1.1
Methionine	0.48	0.48	0.48	0.48
Threonine	0.576	0.576	0.576	0.576
Tryptophan	0.176	0.180	0.180	0.237

Each kg of premix contained Fe, 150 g; Cu, 30 g; Mn, 60 g; Zn 120 g; Co 0.7 g; I, 1.5 g; Se, 0.3 g.
Each kg of premix contained vitamin A, 1,200,000 IU; vitamin D_3, 100,000 IU; vitamin E, 40,000 IU; vitamin K_3, 2 g; vitamin B_1, 3 g; vitamin B_2, 5 g; vitamin B_6, 3 g; vitamin B_{12}, 0.02 g; pantothenic acid, 12 g; niacin, 20 g; folic acid, 1 g; biotin, 0.3 g.

Table 3. Feed formulation and calculated nutrient content of Trial 3

Ingredient/treatment	MBM	MBM +try	MBM +try	MBM +SDPP
	Tryptophan content			
	0.176%	0.237%	0.298%	0.180%
Corn	72.1	72.22	73.49	77.67
Soybean meal	13.69	13.47	12.06	3.08
Lard	3.0	3.0	3.0	3.0
Meat and bone meal	10.0	10.0	10.0	10.0
Limestone	0.05	0.05	0.05	0.11
Salt	0.3	0.3	0.3	0.3
Mineral premix	0.1	0.1	0.1	0.1
Vitamin premix	0.1	0.1	0.1	0.1
Lysine	0.38	0.4	0.40	0.33
Methionine	0.21	0.22	0.22	0.31
Threonine	0.07	0.08	0.13	-
Tryptophan	-	0.06	0.15	-
AP920	-	-	-	5.0
Total	100	100	100	100
Calculated value				
Crude protein	16.8	16.8	16.8	16.8
Lysine	1.1	1.1	1.1	1.1
Methionine	0.48	0.48	0.48	0.48
Threonine	0.576	0.576	0.58	0.576
Tryptophan	0.176	0.237	0.298	0.180

Each kg of premix contained Fe, 150 g; Cu, 30 g; Mn, 60 g; Zn 120 g; Co 0.7 g; I, 1.5 g; Se, 0.3 g.
Each kg of premix contained vitamin A, 1,200,000 IU; vitamin D_3, 100,000 IU; vitamin E, 40,000 IU; vitamin K_3, 2 g; vitamin B_1, 3 g; vitamin B_2, 5 g; vitamin B_6, 3 g; vitamin B_{12}, 0.02 g; pantothenic acid, 12 g; niacin, 20 g; folic acid, 1 g; biotin, 0.3 g.

using the GLM procedure of SAS 8.0 (2000). The model included main effects of treatment. The test of significance was by Duncan's multiple range test.

RESULTS

Trial 1

The results (Table 4) show that the piglets ate more significantly ($p<0.05$) when feed included SDPP in the diet during the first 2 weeks. The feed intake also increased when synthetic tryptophan was added in the 5% meat and bone meal diet; however, the difference did not reach a significant level ($p>0.05$) during the first 2 weeks. Three weeks onwards the feed intake of the 5% meat and bone meal treatment was significantly lower ($p<0.05$) than those of the other three treatments.

The average feed intake was lower but did not reach a significant level for the piglets in Treatment 4 when compared with the two SDPP treatments. It is also interesting to note that the two SDPP treatments were significantly better than for the pigs in both the meat and bone meal and meat and bone meal supplement with tryptophan treatments. The piglets in the meat and bone meal treatment during the final 4 weeks had lower weight gain than did the piglets in the other three treatments. The average weight gain of piglets in both SDPP treatments was better than for piglets in the MBM+tryptophan treatment. The feed efficiency also showed the same trend as the trend in weight gain.

Table 4. Effect of SDPP and tryptophan on the performance of weaning piglets (Trial 1)

Week /treatment	SDPP	MBM	SDPP+try	MBM+try	SE
	Tryptophan content				
	0.237%	0.176%	0.303%	0.237%	
	Feed intake (g)				
1-2	290[a]	199[b]	268[ab]	212[b]	87.09
3-4	590[a]	380[b]	577[a]	501[a]	127.85
5-6	1,093[a]	797[c]	1,096[a]	948[b]	164.42
1-6	480[a]	344[b]	485[a]	415[ab]	101.11
	Weight gain (g)				
1-2	204[a]	86[b]	195[a]	118[b]	82.98
3-4	346[a]	220[b]	348[a]	311[a]	104.87
5-6	637[ab]	433[c]	670[a]	532[bc]	127.60
1-6	375[ab]	246[c]	404[a]	320[b]	83.18
	Feed efficiency (g/g)				
1-2	1.48[ab]	2.40[a]	0.59[b]	1.28[ab]	1.82
3-4	1.83	1.97	1.65	1.71	0.40
5-6	1.74	2.08	1.63	1.80	0.51
1-6	1.31[ab]	1.41[a]	1.19[b]	1.31[ab]	0.14

Different letters in the same row show significant difference ($p<0.05$).

Table 5. Effect of SDPP and tryptophan on the performance of weaning piglets (Trial 2)

Week /treatment	MBM	MBM +SDPP	MBM +try	MBM +try	SE
	Tryptophan content				
	0.176%	0.180%	0.180%	0.237%	
	Feed intake (g)				
1-2	215[b]	238[b]	231[b]	310[a]	49.42
3-4	505[b]	649[ab]	583[ab]	726[a]	118.80
5-6	794[b]	944[ab]	901[ab]	981[a]	126.42
7-8	1,180	1,283	1,234	1,197	124.18
1-4	360[b]	444[ab]	407[ab]	518[a]	90.17
5-8	987	1,113	1,067	1,089	144.86
1-8	673	778	737	804	130.49
	Weight gain (g)				
1-2	175[b]	180[b]	176[b]	253[a]	49.71
3-4	290[b]	431[a]	369[ab]	435[a]	86.92
5-6	466	536	500	564	108.17
7-8	635	672	611	589	67.65
1-4	232[b]	306[ab]	273[ab]	344[a]	62.81
5-8	550	604	555	577	94.06
1-8	391	455	414	460	78.50
	Feed efficiency (g/g)				
1-2	1.26	1.37	1.32	1.23	0.16
3-4	1.76[a]	1.51[c]	1.59[bc]	1.68[ab]	0.13
5-6	1.72	1.75	1.93	1.77	0.27
7-8	1.86[b]	1.90[b]	2.01[a]	2.03[a]	0.09
1-4	1.56[a]	1.45[b]	1.50[a]	1.51[a]	0.09
5-8	1.80	1.83	1.96	1.90	0.13
1-8	1.73	1.71	1.79	1.75	0.09

Different letters in the same row show significant difference ($p<0.05$).

Trial 2

The results (Table 5) show that the feed intake could be significantly improved only when the total tryptophan level reached 0.237%. Piglets in 5% SDPP treatment had a higher feed intake than piglets in 10% meat and bone meal treatment with 0.180% of tryptophan, but did not reach a significant level ($p<0.05$). Body weight gain also had the same trend as feed intake. As for feed efficiency, the difference was not so consistent.

Table 6. Effect of SDPP and tryptophan on the performance of weaning piglets (Trial 3)

Week/ treatment	MBM	MBM +try	MBM +try	MBM +SDPP	SE
	Tryptophan content				
	0.176%	0.237%	0.298%	0.180%	
	Feed intake (g)				
1-2	222	329	302	312	82.64
3-4	503[b]	780[a]	664[ab]	737[a]	158.15
5-6	930[b]	1,163[a]	1,137[a]	1,159[a]	123.64
7-8	1,167[b]	1,366[a]	1,422[a]	1,465[a]	119.45
1-4	362[b]	554[a]	483[ab]	524[a]	125.75
5-8	1,049[b]	1,264[a]	1,279[a]	1,312[a]	121.46
1-8	706	909	881	918	174.72
	Weight gain (g)				
1-2	158[b]	251[ab]	216[ab]	305[a]	78.37
3-4	333[b]	476[a]	419[ab]	453[ab]	99.91
5-6	540[b]	673[a]	691[a]	676[a]	79.54
7-8	543[b]	671[a]	749[a]	716[a]	102.00
1-4	246[b]	363[a]	318[ab]	379[a]	88.95
5-8	541[b]	672[a]	720[a]	696[a]	76.08
1-8	394[b]	518[a]	519[a]	538[a]	97.57
	Feed efficiency (g/g)				
1-2	1.48[a]	1.33[a]	1.41[a]	1.03[b]	0.19
3-4	1.53	1.63	1.60	1.63	0.19
5-6	1.72	1.73	1.65	1.71	0.12
7-8	2.19	2.05	1.90	2.11	0.37
1-4	1.51	1.53	1.53	1.38	0.17
5-8	1.93	1.89	1.78	1.90	0.18
1-8	1.80	1.76	1.70	1.71	0.15

Different letters in the same row show significant difference ($p<0.05$).

Trial 3

The pigs in Treatment 1, the lowest total level of tryptophan treatment (0.176%), had the lowest feed intake and weight gain, but the difference did not reach a significant level ($p>0.05$). However, Treatment 2 (0.237%) had the highest average feed intake from Week 1 to Week 5; the second best result was recorded in Treatment 4. As for the weight gain of the piglets in Treatment 4 (5% SDPP), they had a higher average weight during the first 3 weeks. Especially the second week posted significantly higher weight gain than did the other treatments. The feed efficiency was better for Treatment 4 (5% SDPP) during the first 2 weeks. The other periods seemed to have no consistent results (Table 6).

DISCUSSION

The above 3 trials pointed out that both tryptophan and SDPP could improve feed intake of pigs. However, Trial 3

also showed that feed intake of pigs can be improved when the total level of tryptophan is increased from 0.177% to 0.237% in a diet in which 10% meat and bone meal is included. If we look at average feed intake, the pigs ate more when 5% SDPP (0.237% try) was included in the corn soybean diet, compared to the diet which also had 0.237% tryptophan but whose basal diet was corn soybean+10% meat and bone meal. The result may be due to two possibilities; firstly, the low ratio between tryptophan and LNAA, and secondly, the tryptophan availability may be low in meat and bone meal. There was a trend that feed intake increased when the tryptophan level in the diet increased from 0.180% to 0.237% in Trial 2. In Trial 3 an attempt was made to find out whether feed intake could be improved when tryptophan was further increased from 0.237% to 0.298%, but the results showed that the feed intake did not respond to this increase. SDPP causing an increase in feed intake in pigs has been reported. SDPP did not contain a high percentage of vitamin and/or minerals when compared with soybean meal or other common feed ingredients. However, SDPP had both a high percentage of tryptophan and a higher ratio between tryptophan and LNAA. Henry and Seve (1993) suggested that tryptophan competed with LNAA to pass into the brain. The higher the ratio between tryptophan and LNAA, the higher the chance is of tryptophan passing into the brain. Although pigs in SDPP treatment had significantly higher weight gain than tryptophan treatment during the first 2 weeks, the difference was getting less and less whether this was due to insufficient of isoleucine of blood products which caused lower growing performance.

This experiment suggests that synthetic tryptophan could replace part of SDPP to improve feed intake in pigs. There was no need to provide the total level of tryptophan higher than 0.237% in diet. It is important to note the availability of tryptophan in diets and the ratio between tryptophan and LNAA in diets.

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