Effects of Dietary Lysine Supplementation on the Performance of Lactating Sows and Litter Piglets during Different Seasons

C. S. Cheng*, H. T. Yen, J. C. Hsu[1], S. W. Roan[1] and J. F. Wu
Division of Applied Biology, Animal Technology Institute Taiwan, P. O. Box 23, Chunan, 35099, Miaoli, Taiwan, ROC

ABSTRACT : The effect of dietary lysine supplementation on the performance of crossbred lactating sows (n = 49, total 92 litters) and suckling piglets during the warm and cool seasons was studied. Sows were randomly allocated to one of two experimental diets, which were fed throughout a 28-day lactation period. Two diets were formulated based on corn-soybean meal with 6% wheat bran, containing 15% crude protein, and with or without 0.25% lysine-HCl supplementation. No interaction was observed between season and dietary lysine supplementation. Dietary lysine supplementation significantly ($p<0.05$) increased weaning weight (7.11 vs. 6.46 kg) and daily gain (0.20 vs. 0.18 kg) of piglets. During the warm season lactating sows had significantly lower feed intake (3.78 vs. 6.11 kg, $p<0.01$), higher weight loss (19.81 vs. 9.73 kg, $p<0.01$) and backfat loss (0.23 vs. 0.06 cm, $p<0.01$), longer interval from weaning to estrus (9.32 vs. 6.21 days, $p<0.05$), lower litter weight gain (42.13 vs. 52.90 kg, $p<0.01$) and lower daily gain (0.17 vs. 0.21 kg, $p<0.01$) than lactating sows during the cool season. The results indicate that the influences of dietary treatment and season were independent. The 15.0% CP lactation diet with 0.25% lysine-HCl supplementation did not improve the performance of lactating sows and litter piglets, which was impaired by the warm season. ***(Asian-Aust. J. Anim. Sci. 2006. Vol 19, No. 4 : 568-572)***

Key Words : Lactating Sows, Piglet, Performance, Lysine Supplementation, Season

INTRODUCTION

Lysine is considered the first limiting amino acid in typical corn-soybean meal lactation diets. Daily lysine intake is a primary determinant of lactation performance. Johnston et al. (1993) indicated that sows with high potential for milk production consumed approximately 55 g of lysine daily to maximize litter growth rate. Moreover, Yang et al. (2000) reported that litter weight gain responded quadratically to increase in dietary lysine intake from 0.60 to 1.60% during lactation. Furthermore, Han and Lee (2000) reviewed the administration of a diet that exerted a protein sparing effect by supplementation with synthetic amino acids, and the effect of this supplementation on growth performance and reduction of environmental pollutants in swine manure. The supplementation of limited amounts of synthetic amino acids (0.1 to 0.3%) to swine diets could spare 2 to 3 percentage units of dietary protein and substantially reduce nutrient excretion, especially nitrogen. Moreover, lactating sows require a higher daily lysine intake to optimize their nitrogen balance than to maximize lactational performance (King et al., 1993). Feed intake is usually reduced when ambient temperatures exceed the thermoneutral zone (Black et al., 1993). Minimizing excess dietary amino acids may reduce the heat load experienced by sows and thus encourage increased voluntary feed intake during lactation in hot environments. Recent studies have indicated that modern sows require much higher amino acid supplies, mainly because of their increased milk production and larger litters (Johnston et al., 1993; King et al., 1993; NRC, 1998; Easter and Kim, 1998). Insufficient protein or amino acid supplies can decrease milk production (King and Dunkin, 1986; Eastham et al., 1988; King et al., 1993) and affect subsequent reproductive performance (King and Williams, 1984). The primary objective of this experiment was to determine whether the reduction of excess dietary amino acids achieved by similarly crude protein combined with supplementation of synthetic lysine would improve the feed intake and performance of lactating sows during different seasons.

* Corresponding Author: Ching-Shen Cheng. Tel: +886-37-585933, Fax: +886-37-585969, E-mail: cscheng@mail.atit.org.tw
[1] Department of Animal Science, National Chung-Hsing University, 250 Kao-Kung Road, Taichung, 402, Taiwan, ROC.
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MATERIALS AND METHODS

Experimental animals and dietary treatments

Forty-nine crossbred (Landrace×Yorkshire) multiparous sows (total 92 litters) were used in this experiment. During gestation, the sows were fed daily with 2 kg of a diet based on corn-soybean meal-wheat bran containing 13% crude protein (CP), 0.60% lysine, and 3.36 Mcal/kg digestible energy. After farrowing, the sows were randomly and equally allocated to one of two dietary treatments, namely: (1) the control diet containing 15% CP and 0.75% lysine, (2) a diet containing 15% CP and 0.75% lysine supplemented with synthetic lysine to the level of 0.95%. Table 1 lists the composition and chemical analyses of the diets. The two diets had similar digestible energy contents. Moreover, the two diets also had similar vitamin and mineral contents.

Table 1. Composition of diets for lactating sows

Item	Treatments	
	Lysine 0.75%	Lysine 0.95%
Ingredients (%)		
Ground corn	72.80	72.55
Soybean meal	18.64	18.64
Wheat bran	6.0	6.0
Dicalcium phosphate	1.42	1.42
Limestone, pulverized	0.54	0.54
Salt	0.4	0.4
Vitamin premix[a]	0.1	0.1
Mineral premix[b]	0.1	0.1
Lysine-HCl (78% lysine)		0.25
Nutrient composition (Calculated value, %)		
Crude protein	15.00	15.15
Crude fat	3.06	3.06
Crude fiber	3.63	3.63
Calcium	0.80	0.80
Phosphorus	0.65	0.65
Lysine	0.75	0.95
Methionine+cystine	0.54	0.54
Threonine	0.56	0.56
Tryptophan	0.17	0.17
Digestible energy (Mcal/kg)	3.36	3.36
Nutrient content (%) as analyzed		
Crude protein	14.63	14.73
Crude fat	2.79	2.79
Crude fiber	3.26	3.25
Calcium	0.88	0.86
Phosphorus	0.66	0.63
Lysine	0.73	0.94
Gross energy (Mcal/kg)	3.75	3.73

[a] Supplied per kg of diet: vitamin A, 4,000 IU; vitamin D_3, 600 IU; vitamin E, 22 IU; menadione, 2.0 mg; thiamin, 1.0 mg; riboflavin, 4.0 mg; vitamin B_6, 1.0 mg; vitamin B_{12}, 0.02 mg; niacin, 40 mg; pantothenic acid, 12 mg; folic acid, 0.4 mg; biotin, 0.2 mg; choline chloride, 1.0 g.

[b] Supplied per kg of diet: Zn, 80 mg; Cu, 6 mg; Fe, 80 mg; Mn, 10 mg; I, 0.2 mg; Se, 0.1 mg.

Management of sows and piglets

Sows began receiving the experimental diets at farrowing. The sows were fed twice daily and allowed *ad libitum* access to diet and water throughout a 28-day lactation from parturition until weaning. Feed intake was recorded for the entire lactation. The sows were weighed and their backfat depth was measured using an ultrasound device (Scanoprobe 731C, Ithaco Co., USA) within 24 h after farrowing and on weaning. The average backfat thicknesses were measured at approximately 65 mm off the midline over the fourth rib, last rib, and last lumbar vertebrae. Piglets were individually weighed at birth, then weekly during lactation, and finally on weaning. Piglets were treated by routine management practices, including needle tooth clipping, ear notching, and iron injections (200 mg/pig) within 1 d of parturition. After weaning, the sows were moved into gestation stalls and monitored for estrus daily, using a boar, from weaning until estrus was detected. The number of days from weaning to estrus was recorded.

Season separation

The maximum and minimum mean temperatures in the farrowing hours during the experimental period were recorded daily. The maximum mean temperature during the cool season from November to April was 21.58°C, and the minimum mean temperature was 18.80°C (Table 2). Moreover, the maximum mean temperature of the warm season from May to October was 29.16°C, and the minimum mean temperature was 26.36°C (Table 2). The mean humidity value during cool season was 79.33%, and the warm season was 77.5%.

Analytical methods

A sample of lactation diet was collected from each batch at mixing or once monthly. Pooled samples were subjected to analysis for nitrogen, ether extract, crude fiber, calcium, and phosphorus by the methods of the Association of Official Analytical Chemists (1984). Gross energy was determined using an adiabatic oxygen bomb calorimeter (Parr Instrument Co., Moline, Illinois). Lysine was analyzed by ion-exchange chromatography (Biotronik, Amino Acid Analyzer, LC 5001, Wissenschaftliche Gerate Gmbh).

The data were analyzed by ANOVA as an incompletely randomized block design. The independent variables in the statistical model were the main effects of the lactation dietary treatment and season. Individual sows and litter measurements were considered as the experimental units. All data showing any effect of diet and season on litter growth rate or sow performance between the lactation

Table 2. The maximum and minimum mean temperature in farrowing houses during experimental period

Month	The mean temperature of cool season (°C)		Month	The mean temperature of warm season (°C)	
	Max. T.	Min. T.		Max. T.	Min. T.
November	25.15	22.15	May	27.21	24.21
December	23.40	20.52	June	30.45	27.28
January	19.31	15.82	July	31.18	29.39
February	16.98	15.02	August	30.24	27.74
March	19.68	16.75	September	29.50	26.87
April	24.97	22.52	October	26.40	23.66
Average	21.58	18.80	Average	29.16	26.36

Max. T. = Maximum temperature. Min. T. = Minimum temperature.

Table 3. The effect of dietary lysine supplementation on performance of lactating sows during warm and cool seasons

Season (S)	Cool season		Warm season		Significance		
Lysine (L, %)	0.75	0.95	0.75	0.95	S	L	S×L
No. of sows	18	25	23	26			
Parity of sow	3.78	3.52	3.50	3.88	NS	NS	NS
Daily feed intake (kg)	5.95 [a]	6.23 [a]	3.76 [b]	3.79 [b]	**	NS	NS
Sow body weight (kg)							
Farrowed	205.61	206.78	206.20	203.05	NS	NS	NS
Weaned	193.77[a]	198.57 [a]	184.43 [b]	184.98 [b]	*	NS	NS
Loss	-11.84[ab]	-8.21[a]	-21.77[c]	-18.07[bc]	**	NS	NS
Sow backfat thickness (cm)							
Farrowed	2.08	1.87	2.00	1.97	NS	NS	NS
Weaned	2.01[a]	1.82[ab]	1.79[ab]	1.72[b]	+	NS	NS
Loss	-0.08[a]	-0.05[a]	-0.21[b]	-0.26[b]	**	NS	NS
Interval between weaning and estrus (days)	5.69[a]	6.59[ab]	8.60[ab]	10.00[b]	*	NS	NS

[a, b, c] Means of the same row without the same superscripts are significantly different.
NS: No significance; +: p<0.10, * p<0.05, ** p<0.01.

dietary treatment and season were evaluated. Moreover, all statistical analyses were computed using the GLM procedure of SAS (1988). Differences between treatment means were tested with LSMEANS Statement.

RESULTS AND DISCUSSION

Sow performance

Table 3 lists the effects of seasons and lysine levels on the lactating multiparous sows. No interactions were observed between seasons and dietary lysine supplementation. Moreover, no significant influence was found on sow feed intake, changes in body weight or backfat thickness, or interval between weaning and estrus among dietary lysine supplementation in the similar seasons. Neither seasons nor lysine levels influenced sow body weight or backfat thickness during farrowing. The average daily feed intake of sows for the cool season was 5.95 and 6.23 kg, while for the warm season it was 3.76 and 3.79 kg, respectively, for the two lysine level treatments during the 28-day lactation period. The results of feed intake of sows in the similar season differed little between the dietary treatments. This finding is similar to that of Ji and Kim, (2004). Split by season, the average daily feed intake of sows was 6.11 and 3.78 kg, respectively, for the cool and warm seasons. During the warm season lactating sows had significantly (p<0.01) lower feed intake than during the cool season. Seasons thus significantly influenced the feed intake of lactating sows. One of the most obvious consequences of elevated under controlled environment (ambient) temperature is a marked decrease in the voluntary feed intake as already observed (Schoenherr et al., 1989; Black et al., 1993; Prunier et al., 1994, 1997; Quiniou and Noblet, 1999; Johnston et al., 1999; Renaudeau et al., 2001). Body weights or backfat losses of sows from farrowing to weaning were significantly affected (p<0.01) by the different seasons. Split by season, sow body weight losses were 9.73 and 19.81 kg (p<0.01), and backfat losses were 0.06 and 0.23 cm (p<0.01), respectively, during the lactation period among the cool and warm seasons. Lactating sows fed during the warm season had significantly higher lactation weight loss and backfat loss (p<0.01) than those fed during the cool season. Similarly, Johnston et al. (1999) reported that sows exposed to hot environments increased loss of body weight compared with sows exposed to warm environments. Temperature significantly influenced the body weight losses of lactating sows (Quiniou and Noblet, 1999; Renaudeau et al., 2001). Cheng and Yen (1994) reported that lactation loss of sow liveweight and backfat was significantly higher, which was connected with a higher level of feed intake in the cool season than in warm season given similar diet. Brand et al. (2000) reported that body weight loss from lactation was higher in sows fed a low feeding level than in those fed a high feeding level. Hence the greater lactation weight and backfat loss of sows in a warm vs. cool season corresponds with the decreased feed intake of sows in the warm season. Seasonal differences significantly affected (p<0.05) the interval between weaning and estrus of sows. Split by season, the interval between weaning and estrus of sow was 6.21 and 9.32 days, respectively, in the cool and warm seasons. During the warm season lactating sows had significantly longer interval from weaning to estrus (p<0.01) than they did during the cool season. The hot environment reduced the percentage of sows displaying estrus by d 15 postweaning compared with the warm environment (Johnston et al., 1999). This study obtained a similar result.

Piglet performance

Table 4 lists the effects of dietary lysine supplementation on performance of suckling piglets during

Table 4. The effects of dietary lysine supplementation on performance of suckling piglets during warm and cool seasons

Season (S)	Cool season		Warm season		Significance		
Lysine (L, %)	0.75	0.95	0.75	0.95	S	L	S×L
Litter size							
Initial	9.83	9.28	9.52	9.42	NS	NS	NS
Weanling	9.33	8.88	8.78	8.81	NS	NS	NS
Survival (%)	95.34	95.91	92.91	93.25	NS	NS	NS
Piglet weight (kg)							
Initial	1.42	1.57	1.47	1.48	NS	NS	NS
Weanling	6.81[b]	7.85[a]	6.18[b]	6.41[b]	**	*	NS
Daily gain	0.19[b]	0.22[a]	0.17[c]	0.18[bc]	**	*	NS
Litter weight gain	50.60[a]	54.56[a]	40.79[b]	43.32[b]	**	NS	NS

[a, b, c] Means of the same row without the same superscripts are significantly different.
NS: No significance, * p<0.05, ** p<0.01.

warm and cool seasons. No interactions between seasons and dietary lysine supplementation were observed. There were no significant influence on litter size, piglet survival, initial piglet weight, or litter weight gain among dietary lysine supplementation in the similar seasons. Neither season nor lysine level affected litter size, piglet survival, and initial piglet weight. Similarly, Knabe et al. (1996), Stahly et al. (1990), Johnston et al. (1993), Monegue et al. (1993), Weeden et al. (1994), Richert et al. (1997), Touchette et al. (1998), and Cheng et al. (1999; 2001) all reported that the level of dietary lysine did not affect litter size at weaning. The average weight of weaning piglets for the two lysine level treatments during the cool season was 6.81 and 7.85 kg, while during the warm season it was 6.18 and 6.41 kg, respectively. The daily gain of piglets for the cool season for the two lysine level treatments was 0.19 and 0.22 kg, while for the warm season was 0.17 and 0.18 kg, respectively. Increasing dietary lysine level from 0.75 to 0.95% produced significantly (p<0.05) higher weaning weight and daily gain of piglets in the cool season, but was not associated with any significant differences in dietary lysine supplementation during the warm season. In the present study, sows fed the 0.75, or the 0.95% lysine diet consumed an average of 45 and 59 g per day of lysine, respectively, during the cool season. The response of piglet weights to increasing lysine intake from 45 to 59 g per day is consistent with other reports. Maximal response in pig weaning weights, or litter weaning weights, occurred at 47 g lysine per day (Stahly et al., 1990; sows consuming 20 to 47 g per day), 55 g per day (Johnston et al., 1993; sows consuming 36 to 57 g per day), 55 g per day (Monegue et al., 1993; sows consuming 35 to 55 g per day), and 57 g per day (Richert et al., 1997; sows consuming 36 to 57 g per day). This study obtained similar results if daily lysine intake was increased from 45 to 59 g. Split by season, the average weight of weaning piglets was 7.41 and 6.30 kg in the cool and warm seasons, respectively. The daily gain of piglets was 0.21 and 0.17 kg during the cool and warm seasons, respectively. The litter weight gain was 52.90 and 42.13 kg in the cool and warm seasons, respectively. During the warm season lactating sows had significantly (p<0.01) lower piglet weaning weight, daily gain, and litter weight gain than during the cool season. Similar decreases have been observed for sows at high ambient temperatures (Schoenherr et al., 1989; Black et al., 1993; Prunier et al., 1997; Johnston et al., 1999; Quiniou and Noblet, 1999). This investigation obtained a similar result.

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