L-Arginine Supplementation during Late Gestation

Subjects: Zoology

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Arginine is one of the functional amino acids that enhances the growth of fetus and placenta development. Since the fetal growth and the nutrient requirement for fetuses are increased hugely during the late gestation period in high-prolific sows, supplementation of L-arginine could have a positive influence on the reproductive performance of sows and piglet uniformity.

Keywords: arginine ; late gestation ; sow ; reproductive performance ; piglet uniformity

1. Introduction

The high prolific sows are developed to improve the number of piglets and sow productivity in the swine industry [1]. However, as they have greater litter size, some problems were reported that the proportion of small piglets at birth, within-litter variation of piglet birth weight, and mortality of suckling piglets were also increased [2][3][4]. These problems are caused by several maternal factors, such as inadequate nutrient intake of late gestation, high number of fetus, insufficient cervical space, or insufficient reproductive tract for fetus development [5][6][7]. Therefore, various studies were conducted to minimize these problems and improve the piglet uniformity of high prolific sows with nutritional strategies including sow body condition, nutrients type or ratio, and functional amino acids [8][9][10].

Fetal growth is rapid during the late gestation period and nutrient requirement for the fetus also increases greatly [8]. The low birth weight of piglets was reported to increase the proportion of stillborn piglets considered to be at a greater risk of mortality and morbidity [9][10]. Since supplying adequate nutrient to sows during the late gestation period is important, an increased feeding method was suggested in order to meet their nutrient requirement. Although increased feeding during late gestation is likely to meet the nutrient requirement of sows and improve piglet birth weight [11][12], it also showed a negative effect on sow body condition and postpartum agalactia [13][14], resulting in poor milk production and lactation feed intake [15][16]. With the effects of arginine, if the nutrient delivery efficiency from the dam to the fetus in late gestation increased by additional arginine supplementation, it could partly be attributed to increase in the birth weight of small fetuses and piglet uniformity at birth.

Most of the previous studies for evaluating the effect of arginine in gestating sows were investigated in the early-gestation period [17][18][19][20] or whole gestation period [21][22][23][24]. Additionally, most previous studies for the effect of arginine supplementation in sows, investigated the effect of 1% arginine supplementation in sow diet. Thus, there is a need to investigate the effects of dietary arginine below 1% of supplementation level keeping in mind the market cost of L-arginine, in order to apply this in the field.

3. Results

The arginine supplementation levels in the late-gestating sows' diet did not affect body weight, backfat thickness, and the lactation feed intake of sows (Table 1).

Table 1. Effects of arginine supplementation levels on body weight and back-fat thickness in late-gestating sows.

	Treatment [1]			SEM [2]	*p*-Value		
	CON	ARG10	ARG15		Diet	Lin.	Quad.
Body Weight, kg							
Day 70	237.1	239.1	238.4	3.58	0.98	0.90	0.85
Day 110	258.2	256.3	252.7	3.33	0.79	0.50	0.99
BW gain (70–110 days)	21.1	17.3	14.3	2.46	0.53	0.27	0.79

	Treatment [1]			SEM [2]	p-Value		
	CON	ARG10	ARG15		Diet	Lin.	Quad.
24 h postpartum	233.7	230.8	227.9	3.73	0.82	0.54	0.92
Day 21 of lactation	229.4	224.9	218.5	3.97	0.53	0.26	0.95
BW loss (0–21 days)	−4.3	−5.9	−9.4	1.67	0.44	0.20	0.96
Backfat Thickness, mm							
Day 70	20.7	21.4	19.1	0.77	0.49	0.35	0.46
Day 110	22.4	22.6	20.7	0.84	0.59	0.37	0.66
BF gain (70–110 days)	2.1	1.3	1.6	0.3	0.51	0.57	0.30
24 h postpartum	21.0	21.1	20.3	0.85	0.91	0.72	0.84
Day 21 of lactation	20.1	19.8	18.6	0.79	0.71	0.43	0.90
BF loss (0–21 days)	−0.9	−1.3	−1.7	0.38	0.69	0.40	0.85
Lactation feed intake, kg/day	4.82	4.95	4.97	0.114	0.85	0.62	0.77

In reproductive performance, dietary arginine levels during late gestation had no influence on the number of piglets for total born, stillborn, mummy, and born alive (Table 2). However, piglet birth weight showed a quadratic response ($p < 0.03$) such that the piglet birth weight was decreased by the arginine levels from 0.72% to 1.0%, whereas it was increased by the arginine level from 1.0% to 1.5%. Additionally, increasing the inclusion level of dietary arginine tended to increase ($p < 0.10$) the alive litter weight linearly. Increasing the dietary arginine levels in late gestation did not affect the farrowing time, helping frequency, and placenta weight.

Table 2. Effects of arginine supplementation levels on reproductive performance in late-gestating sows.

	Treatment [1]			SEM [2]	p-Value		
	CON	ARG10	ARG15		Diet	Lin.	Quad.
No. of Pigs							
Total born	13.7	15.0	14.8	0.50	0.53	0.46	0.41
Stillborn	0.7	0.7	0.8	0.12	0.93	0.73	0.89
Mummy	0.2	0.3	0.1	0.08	0.49	0.31	0.53
Born alive	12.8	14.0	13.9	0.45	0.35	0.31	0.31
Total litter weight, kg	19.61	19.91	21.49	0.521	0.30	0.13	0.73
Alive litter weight, kg	18.47	19.01	20.69	0.506	0.19	0.07	0.81
Piglet birth weight, kg	1.57 [A]	1.38 [B]	1.52 [A]	0.036	0.08	0.85	0.03
Farrowing time, min	182.4	186.2	205.7	9.33	0.58	0.31	0.82
Helping frequency	0.80	0.81	1.00	0.141	0.82	0.55	0.85
Placenta weight, kg	3.74	3.74	3.90	0.224	0.95	0.76	0.90
Placenta efficiency	5.80	5.89	6.02	0.246	0.94	0.73	0.98

Increasing dietary arginine levels in late gestation linearly increased ($p < 0.05$) the litter weight at day 21, and the litter weight gain, such that litter weight and litter weight gain for ARG15 tended to be greater than those for CON (Table 3). The piglet weight at day 21 of lactation was linearly increased ($p < 0.05$) as the dietary arginine level increased in late gestation. Additionally, increasing the dietary arginine level in late gestation linearly increased ($p < 0.05$) piglet weight gain, such that the piglet weight gain for ARG15 tended to be greater than that for CON.

Table 3. Effects of arginine supplementation levels on litter performance in late-gestating sows.

	Treatment [1]			SEM [2]	p-Value		
	CON	ARG10	ARG15		Diet	Lin.	Quad.
No. of Piglets							
After-fostering	11.5	11.6	11.6	0.10	0.90	0.77	0.72
Day 21 of lactation	10.7	10.4	10.9	0.16	0.52	0.49	0.36
Litter Weight, kg							
After-fostering	17.67 [a]	16.01 [b]	17.73 [a]	0.326	0.04	0.63	0.01
Day 21 of lactation	53.74 [B]	53.31 [B]	60.27 [A]	1.332	0.05	0.02	0.32
Weight gain (0–21 days)	36.06 [B]	37.17 [AB]	42.58 [A]	1.262	0.07	0.02	0.64
Piglet Weight, kg							
After-fostering	1.55 [a]	1.38 [b]	1.53 [a]	0.031	0.04	0.82	0.01
Day 21 of lactation	5.03	5.14	5.51	0.103	0.13	0.04	0.78
Weight gain (0–21 days)	3.48 [B]	3.74 [AB]	3.98 [A]	0.093	0.08	0.03	0.66

The effect of dietary arginine levels in late gestation on the piglet uniformity is presented in Table 4. The SD for piglet birth weight was linearly increased ($p < 0.05$), and the CV for piglet birth weight had a tendency of linear increase ($p < 0.10$) as the dietary arginine level increased in late gestation. The piglet BW distribution at birth showed a significant difference ($p < 0.01$) among dietary treatment (Figure 1). However, dietary arginine levels in late gestation did not affect the piglet uniformity and BW distribution at day 21 of lactation.

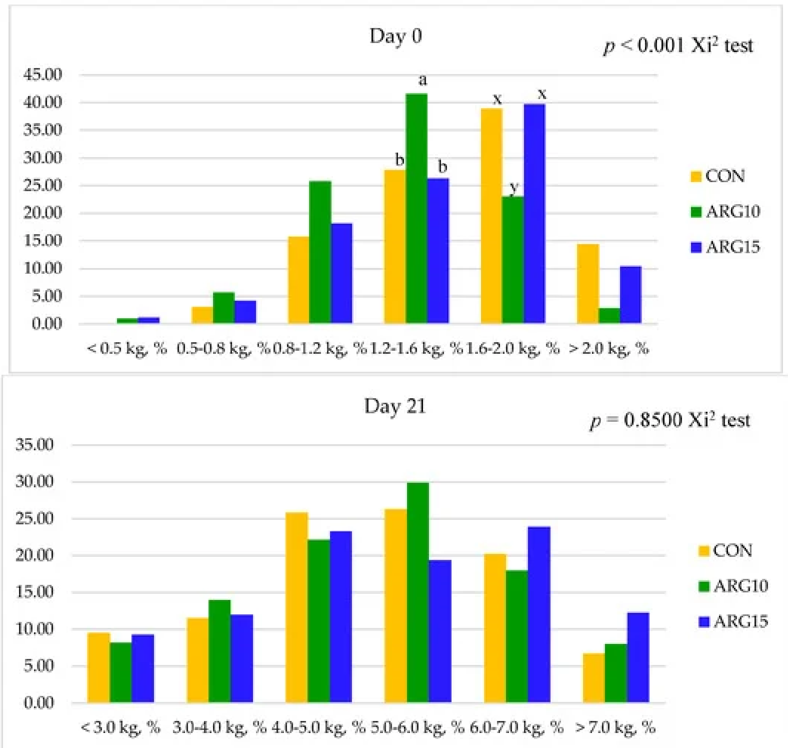

Figure 1. Effect of arginine supplementation level in late gestating sows on piglet distribution into body weight classes on day 0 and day 21 of lactation by the FREQ procedure, with Chi-square test. CON: corn-SBM-based diet with Arg 0.72%, Arg10: corn-SBM-based diet with Arg 1.0%, Arg15: corn-SBM-based diet with Arg1.5%.

Table 4. Effects of arginine supplementation levels on piglet uniformity in late-gestating sows.

	Treatment [1]			SEM [2]	p-Value		
	CON	ARG10	ARG15		Diet	Lin.	Quad.
Piglet Uniformity at Birth							

	Treatment [1]			SEM [2]	p-Value		
	CON	ARG10	ARG15		Diet	Lin.	Quad.
Avg. BW, kg	1.57	1.38	1.52	-	-	-	-
SD	274.0	293.5	334.3	12.72	0.13	0.04	0.94
CV	18.4	21.8	22.9	1.01	0.15	0.07	0.41
Piglet Distribution into Birth Weight Classes							
<0.5 kg, %	0	1.0	1.2	0.30	0.24	0.15	0.38
0.5–0.8 kg, %	3.1	5.6	4.2	0.79	0.44	0.59	0.25
0.8–1.2 kg, %	15.8	25.8	18.2	2.36	0.21	0.87	0.07
1.2–1.6 kg, %	27.9 [b]	41.5 [a]	26.3 [b]	4.39	0.03	0.49	0.01
1.6–2.0 kg, %	39.0 [ab]	23.0 [b]	39.7 [a]	5.55	0.08	0.64	0.03
>2.0 kg, %	14.5	2.9	10.4	5.67	0.15	0.70	0.06
Piglet Uniformity at day 21							
Avg. BW, kg	5.03	5.14	5.51	-	-	-	-
SD	1186.8	1198.1	1277.4	47.64	0.69	0.41	0.84
CV	24.6	24.4	25.1	1.17	0.97	0.85	0.89
Piglet Distribution into BW Classes at day 21							
<3 kg, %	9.5	8.1	9.3	1.41	0.91	0.99	0.67
3–4 kg, %	11.5	14.0	11.9	1.46	0.77	0.99	0.48
4–5 kg, %	25.8	22.1	23.3	2.39	0.83	0.72	0.62
5–6 kg, %	26.3	29.9	19.4	2.17	0.14	0.12	0.19
6–7 kg, %	20.2	17.9	23.9	2.01	0.48	0.36	0.42
>7 kg, %	6.7	8.0	12.2	1.80	0.41	0.19	0.86

The blood concentration of AAs in the gestating sows is presented in Table 5. Increasing arginine supplementation to late-gestating sows linearly increased ($p < 0.05$) the blood concentrations of arginine and ornithine at day 90 and day 110 of gestation, respectively. On the other hand, the blood concentrations of alanine at day 110 of gestation for sows fed a diet with higher dietary arginine were linearly decreased ($p < 0.03$) compared to those for sows fed the isonitrogenous control diet. Additionally, glutamine concentration for sows at day 110 of gestation was quadratically increased ($p < 0.05$), as the dietary arginine level increased. There were no significant differences in blood concentrations of other AA, among dietary treatments. The plasma concentrations of arginine, lysine, and methionine for day 90 of gestation were greater ($p < 0.05$) than those for day 70 of gestation. The plasma concentrations of alanine and glutamine for day 110 of gestation were greater ($p < 0.05$) than those for day 70 of gestation, whereas the plasma concentrations of citrulline, glycine, leucine, ornithine, taurine, and valine for day 110 of gestation were less ($p < 0.05$) than those for day 70 of gestation. There were interactions ($p < 0.05$) between arginine and the date effect in the plasma concentration for ornithine such that there was no significant difference in the plasma ornithine concentration for day 70 of gestation, whereas plasma ornithine concentrations at day 90 of gestation for ARG10 and ARG15 treatments were greater ($p < 0.05$) than that for CON treatment, and plasma ornithine concentration at day 110 of gestation for ARG15 treatment was greater ($p < 0.05$) than those for CON and ARG10 treatments.

Table 5. Effects of arginine supplementation levels on plasma amino acid profile in late-gestating sows.

	Treatment [1]			SEM [2]	p-Value					
	CON	ARG10	ARG15		Diet	Lin.	Quad.	Group	Date	Group × Date
Alanine, μmol/L										
Day 70	609.5	487.0	454.0	46.75	0.49	0.27	0.56	0.09	<0.01	0.51
Day 90	709.1	710.5	652.0	37.24	0.79	0.53	0.79			
Day 110	878.4 [A]	916.3 [A]	628.7 [B]	53.05	0.06	0.03	0.26			
Arginine, μmol/L										
Day 70	154.5	255.0	195.8	23.65	0.31	0.66	0.14	<0.01	<0.01	0.27
Day 90	262.9 [b]	349.1 [b]	482.7 [a]	29.44	<0.01	<0.01	0.88			
Day 110	196.4 [b]	301.2 [a]	366.9 [a]	24.34	<0.01	<0.01	0.34			
Aspartic Acid, μmol/L										
Day 70	14.0	14.3	13.5	1.33	0.97	0.88	0.89	0.69	0.15	0.74
Day 90	18.8	31.4	18.3	4.79	0.46	0.82	0.23			
Day 110	14.4	14.0	14.4	0.87	0.98	0.96	0.85			
Citrulline, μmol/L										
Day 70	128.0	109.3	114.5	5.64	0.54	0.48	0.34	0.96	<0.01	0.58
Day 90	114.8	133.8	127.3	6.99	0.54	0.58	0.35			
Day 110	97.8	89.7	98.9	4.19	0.68	0.80	0.40			
Cystine, μmol/L										
Day 70	2.00	0.33	1.00	0.408	0.38	0.47	0.20	0.70	0.50	0.75
Day 90	0.88	1.50	1.29	0.308	0.71	0.68	0.49			
Day 110	3.40	2.33	1.00	0.928	0.57	0.31	0.93			
Glutamic Acid, μmol/L										
Day 70	240.5	260.3	198.0	30.72	0.72	0.58	0.66	0.60	0.07	0.81
Day 90	173.3	211.6	189.3	16.13	0.63	0.81	0.36			
Day 110	170.6	153.8	152.6	13.82	0.84	0.64	0.76			
Glutamine, μmol/L										
Day 70	260.5	220.7	249.5	23.86	0.84	0.95	0.58	0.27	0.01	0.48
Day 90	343.8	328.9	289.4	14.64	0.32	0.14	0.88			
Day 110	299.8 [a]	330.8 [a]	259.9 [b]	10.39	0.03	0.04	0.04			
Glycine, μmol/L										
Day 70	1224.5	1186.7	1073.5	38.59	0.27	0.13	0.85	0.58	0.03	0.76
Day 90	1206.0	1291.5	1204.9	30.62	0.43	0.83	0.20			
Day 110	1070.9	1105.3	1117.9	39.67	0.88	0.66	0.85			
Histidine, μmol/L										
Day 70	93.0	103.3	93.0	5.31	0.72	0.90	0.46	0.36	0.21	0.98
Day 90	103.9	116.5	96.6	6.80	0.51	0.56	0.31			
Day 110	90.8	97.0	88.7	3.60	0.69	0.71	0.42			
Isoleucine, μmol/L										
Day 70	107.0	121.3	104.0	6.11	0.51	0.72	0.32	0.65	0.81	0.92

	Treatment [1]			SEM [2]	p-Value					
	CON	ARG10	ARG15		Diet	Lin.	Quad.	Group	Date	Group × Date
Day 90	120.4	125.8	115.7	3.46	0.52	0.50	0.35			
Day 110	134.2	119.5	109.4	11.82	0.69	0.42	0.84			
Leucine, μmol/L										
Day 70	210.5	220.3	202.8	10.62	0.82	0.74	0.66	0.66	0.02	0.84
Day 90	217.6	228.4	205.7	6.21	0.36	0.35	0.26			
Day 110	194.8	165.5	168.0	13.38	0.61	0.48	0.54			
Lysine, μmol/L										
Day 70	281.5	321.0	239.5	18.85	0.17	0.24	0.19	0.44	<0.01	0.71
Day 90	409.4	423.6	438.9	18.45	0.83	0.55	0.93			
Day 110	282.4	326.5	296.3	14.23	0.48	0.85	0.25			
Methionine, μmol/L										
Day 70	48.5	57.7	50.8	2.80	0.47	0.92	0.24	0.48	<0.01	0.92
Day 90	73.0	72.4	68.6	2.48	0.76	0.47	0.86			
Day 110	58.6	62.3	59.0	2.20	0.79	0.96	0.50			
Ornithine, μmol/L										
Day 70	208.0	163.3	146.0	17.04	0.43	0.22	0.58	0.12	<0.01	<0.01
Day 90	149.6 [b]	194.1 [a]	228.1 [a]	9.85	<0.01	<0.01	0.32			
Day 110	114.4 [b]	143.8 [b]	184.6 [a]	9.38	<0.01	<0.01	0.80			
Phenylalanine, μmol/L										
Day 70	93.0	98.0	84.5	13.60	0.53	0.42	0.52	0.24	0.07	0.77
Day 90	85.5	104.8	85.6	4.51	0.13	0.75	0.05			
Day 110	79.3	81.7	76.4	3.83	0.89	0.72	0.71			
Proline, μmol/L										
Day 70	408.0	422.0	379.5	21.51	0.73	0.59	0.67	0.75	0.21	0.75
Day 90	389.5	400.6	434.3	13.71	0.42	0.19	0.87			
Day 110	349.8	386.5	377.7	15.44	0.60	0.55	0.47			
Serine, μmol/L										
Day 70	186.5	179.7	153.8	7.66	0.17	0.09	0.75	0.26	0.08	0.83
Day 90	167.6	215.6	158.0	16.59	0.33	0.64	0.16			
Day 110	139.5	153.3	134.6	7.01	0.61	0.65	0.35			
Taurine, μmol/L										
Day 70	141.5	119.0	83.0	13.35	0.22	0.10	0.96	0.13	<0.01	0.14
Day 90	83.0	92.9	88.4	4.40	0.67	0.72	0.42			
Day 110	67.8	66.2	72.9	2.96	0.68	0.44	0.62			
Threonine, μmol/L										
Day 70	177.0	191.7	161.3	13.47	0.68	0.61	0.56	0.05	0.05	0.82
Day 90	138.1	149.1	126.0	6.86	0.42	0.39	0.31			
Day 110	133.2	167.2	105.6	11.06	0.11	0.16	0.08			

	Treatment [1]			SEM [2]	p-Value					
	CON	ARG10	ARG15		Diet	Lin.	Quad.	Group	Date	Group × Date
Tryptophan, μmol/L										
Day 70	61.0	76.0	62.5	4.37	0.36	0.92	0.19	0.10	0.40	0.85
Day 90	62.8	67.1	64.1	2.35	0.75	0.91	0.46			
Day 110	54.6	66.5	60.0	3.00	0.29	0.62	0.15			
Tyrosine, μmol/L										
Day 70	98.0	104.7	91.5	7.10	0.77	0.69	0.63	0.17	0.23	0.96
Day 90	98.1	120.9	97.7	6.37	0.24	0.77	0.10			
Day 110	87.1	101.3	89.7	4.03	0.36	0.99	0.16			
Valine, μmol/L										
Day 70	306.5	330.3	284.0	15.04	0.46	0.48	0.39	0.25	0.01	0.93
Day 90	276.9 [AB]	293.6 [A]	253.4 [B]	7.49	0.09	0.12	0.10			
Day 110	252.0	230.3	202.7	19.14	0.57	0.31	0.93			

The dietary arginine levels for the late-gestating sows had no significant influence on the blood concentrations of BUN, creatinine, total protein, and urea for sows in the late gestation period (Table 6). The blood concentrations of BUN, creatinine, and urea for day 110 of gestation were greater ($p < 0.05$) than those for day 70 of gestation. There were no interactions between arginine and the date effect in the blood concentrations for BUN, creatinine, total protein, and urea. Increasing the dietary arginine levels for sows during late gestation did not affect the milk composition of colostrum and milk (day 21 of lactation) in lactating sows (Table 7).

Table 6. Effects of arginine supplementation levels on blood profiles in late-gestating sows.

	Treatment [1]			SEM [2]	p-Value					
	CON	ARG10	ARG15		Diet	Lin.	Quad.	Group	Date	Group × Date
Blood urea nitrogen, mg/dL										
Day 70	12.5	11.7	11.9	0.45	0.85	0.72	0.63	0.99	0.01	0.93
Day 90	11.3	12.0	12.5	0.57	0.69	0.41	0.83			
Day 110	14.3	14.5	14.1	0.57	0.56	0.84	0.83			
Creatinine, mg/dL										
Day 70	1.76	1.74	1.95	0.091	0.59	0.41	0.70	0.48	<0.01	0.89
Day 90	2.23	2.43	2.39	0.104	0.74	0.63	0.55			
Day 110	2.97	2.90	3.18	0.097	0.48	0.32	0.50			
Total protein, g/dL										
Day 70	6.85	6.67	7.15	0.256	0.76	0.63	0.67	0.95	0.98	0.65
Day 90	6.86	7.23	6.71	0.170	0.47	0.60	0.27			
Day 110	6.93	6.73	7.00	0.175	0.82	0.80	0.57			
Urea, mg/dL										
Day 70	26.8	25.0	25.5	0.97	0.85	0.73	0.62	0.99	0.01	0.93
Day 90	24.1	25.6	26.7	1.22	0.69	0.42	0.83			
Day 110	30.6	31.1	30.1	1.22	0.96	0.84	0.83			

Table 7. Effects of arginine supplementation levels during late gestation on milk composition in lactating sows.

	Treatment [1]			SEM [2]	p-Value		
	CON	ARG10	ARG15		Diet	Lin.	Quad.
Casein, %							
Colostrum	6.57	6.08	5.62	0.571	0.81	0.52	0.91
Milk (21 days)	4.05	4.32	4.09	0.119	0.63	0.98	0.34
Fat, %							
Colostrum	6.68	5.43	6.91	0.485	0.43	0.69	0.23
Milk (21 days)	4.04	6.82	6.32	0.368	0.13	0.23	0.10
Protein, %							
Colostrum	8.28	7.91	7.29	0.804	0.89	0.63	0.99
Milk (21 days)	4.72	4.77	4.61	0.115	0.86	0.68	0.72
Lactose, %							
Colostrum	4.72	4.35	4.31	0.187	0.65	0.44	0.60
Milk (21 days)	5.77	6.26	5.91	0.134	0.32	0.86	0.14
Total Solid, %							
Colostrum	21.9	20.1	20.9	0.76	0.67	0.67	0.43
Milk (21 days)	16.9	19.2	18.1	0.54	0.23	0.49	0.12
Solid not Fat, %							
Colostrum	13.3	12.7	11.9	0.68	0.74	0.44	0.93
Milk (21 days)	10.7	11.0	10.6	0.17	0.64	0.66	0.41

4. Discussion

Supplementing sow diet with L-arginine during the late gestation did not influence the gain of BW and BF in sows for the late gestation period and loss of BW and BF in sows for the lactation period. This was in agreement with the result of Quesnel et al. [25], who reported that dietary supplementation with 25.5 g/day L-arginine from day 77 to farrowing did not affect the BW after farrowing and BF before farrowing of sows. Additionally, Bass et al. [26] reported that dietary supplementation with 1% L-arginine for gestating sows from day 93 to day 110 had no influence on BW loss, following farrowing or during lactation. However, they observed that improved late gestation BW gain of sows fed a diet with 1% L-arginine was revealed in parity 0 and parity 1, whereas, there was no difference in late gestation BW gain compared to the control animals and 1% L-arginine-supplemented sows in parity 2+, implying that supplementation with 1% L-arginine partially met the arginine requirement in gilts or sows with parity 1 sows, not in sows with parity 2+. The difference between the current study and that of Bass et al. [26] with regard to the effect of dietary arginine in late gestation on the changes of BW or BF for sows could have been due to the difference in the parities of sows in the treatment group. Additionally, the lack of difference in the changes of BW and BF for sows during the whole experiment period could partly have been due to the same nitrogen content of diets among the dietary treatments, with the addition of L-Alanine as the isonitrogenous control.

Dietary effects of L-arginine was reported such that supplementation of L-arginine was found to increase nitric oxide, enhancing the delivery of essential nutrients from maternal to fetal blood [27][28][29], and increasing the polyamines necessary for embryogenesis and placental growth [30][31][32]. Since the nitric oxide and polyamines are important for angiogenesis and embryogenesis, arginine enhanced the growth of fetus and placenta development [32][33]. The litter size, including the number of total born or born alive was not affected by the dietary arginine effect in the present study, which was in agreement with the results from the studies of Quesnel et al. [25] and Nantapaitoon et al. [34], who reported that 1% L-arginine supplementation for late-gestating sows had no influence on the number of piglets at birth. However, previous studies reported that arginine supplementation enhanced conceptus survival or sow litter size in the period of early-gestation [19][35], or whole gestation [21][22][24]. The number of developing embryos is decided in early gestation, because most of the embryonic losses occurred during early gestation [36], and the dead embryos were not reabsorbed by the uterus after day 40 of gestation [37]. Thus, the differences among studies with regard to the effects of dietary arginine on the litter size of sows could have been due to differences in the supplemented period for the diet with L-arginine.

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