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Effect of Dietary Folic Acid Supplementation on Nutrient Intake and Digestibility in Sows

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ABSTRACT: This study was conducted to know the effect of dietary folic acid supplementation on nutrient intake and digestibility in sows. A total of 18 Landlly crossbred sows (*Landrace* × *Desi*) were randomly distributed into three groups (T_0, T_1 and T_2) of six sows each in a completely randomized design (CRD). The sows in the control (T_0) group were fed with basal diet (folic acid @ 1.3 mg/kg) as per NRC (1998). Whereas, sows in T_1 and T_2 groups were fed the basal diet supplemented with folic acid @ 15 mg/kg throughout gestation and both gestation and lactation, respectively. No significant effect (P>0.05) was observed on body weight (kg) of pregnant sows due to supplementation. The fortnight DMI (g/d) during gestation phase did not differ (P>0.05) among the groups. However, during lactation phase significant increase (P<0.01) was observed in folic acid supplemented groups (T_1 and T_2). No significant supplementation effect was observed on the intake and digestibility of dry matter, organic matter, crude protein, crude fibre, ether extract, nitrogen-free extract, and gross energy during the gestation phase. Based on the observations in this study it could be concluded that supplementation of folic acid @ 1.3 mg and 15 mg/kg diet throughout gestation and lactation period didn't have any effect on nutrient intake and digestibility in gestating and lactating sows.

Keywords: Digestibility, Folic acid, Gestating sow, Lactating sow, Nutrient intake.

INTRODUCTION

Pig farming in India is serving as livelihood, income source and assures food security to pig rearers. In swine production, litter size at birth and weaning are considered as one of the most important economic variables. Folic acid is a water-soluble vitamin that is needed at a higher level for the growth and development of placental structures during gestation (Pond and Houpt 1978). Compared to all other species the HCY (homocysteine) levels are several-fold higher in swine, which indicates the supply of methionine cycle intermediates (methyl donors) may be imbalanced (Cronje, 2008). In swine production, supra-nutritional folic acid supplementation is essential to overcome the higher HCY levels and IUGR. Although pigs cannot synthesize folic acid, bacteria in their lower gut can synthesize and make the faeces as another source of the vitamin (Abad and Gregory 1987). Green leafy plants are a promising and feasible source of folic acid. Change in rearing and waste removal systems have reduced the sow's access to leafy plants and faecal material. These modifications in rearing system led to inaccessibility of two cheaper sources of folic acid for pigs, ushering researchers to reevaluate the management systems to balance folic acid in swine diets.

Supplementation of methionine (0 or 0.2%), folic acid (0, 10 and 25 mg/kg) and vitamin B_{12} (0, 10 and 150 mg/kg) to the growing-finishing pigs did not affect (P>0.13) the total average daily gain (1.05±0.01 kg), average daily feed intake (2.82±0.03 kg) and feed conversion (2.72±0.03) during the eight weeks of experiment (Giguere *et al.*, 2008). Literature pertaining to folic acid supplementation on nutrient utilization and digestibility are very scanty and therefore requires a more detailed study.

MATERIALS AND METHODS

Folic acid was purchased from MB Vet Chem, Navi Mumbai, Maharastra, India. Eighteen healthy Landly crossbred sows (Landrace × Desi) were selected and randomly distributed into three groups (T_0, T_1 and T_2) six sows each in a completely randomized design (CRD) after insemination. All the experimental sows were offered weighed quantity of a mash feed as a single meal once daily (9:30 AM) at an allowance of 2.5 kg/day during gestation (0 to 84 days) and 3.0 kg/day (85 to 114 days) along with free access to clean drinking water. After farrowing lactation diet (up to 42 days *i.e.*, till weaning) was fed to sows to a total of 2.5 kg plus 0.3 kg for every piglet to meet their nutritional requirements (NRC, 1998). The sows in the control (T_0) group were fed with basal diet (folic acid @ 1.3

mg/kg) as per NRC (1998). Whereas, sows in T_1 and T_2 groups were fed the basal diet supplemented with folic acid @ 15 mg/kg throughout the gestation and also during lactation, respectively. Throughout the experimental period the amount of feed offered and leftover feed were weighed daily and sampled twice in a week to assess the average daily dry matter intake (DMI) of sows. A digestion trial was conducted after 60 days of gestation to determine the digestibility of nutrients. To determine the nutrient digestibility, faeces collected throughout the digestion trails collection period were thoroughly mixed and a representative sample was taken for analysis. The samples of feed offered, leftovers and faeces were analyzed for proximate principles as per standard procedures of the Association of Official Analytical Chemists (AOAC, 2000). The data were analyzed statistically using ANOVA procedure of SPSS (version 20.0).

RESULTS AND DISCUSSION

The average daily dry matter intake data is presented in Table 1. The results revealed that there was no significant effect (P>0.05) on fortnight DMI (g/d) among the groups during the gestation period (*i.e.*, gestation (0 – 114 days). However, during the lactation period (42 days, till weaning), a significant increase (P<0.01) was observed in fortnight DMI (g/d) following folic acid supplementation. There was no significant effect (P>0.05) on fortnight DMI (g/d) among the groups during the gestation period (*i.e.*, gestation (0 – 114 days). A similar effect was noticed by Mishra *et al.* (2019) who reported that dietary supplementation of betaine (methyl donor) during gestation period did not affect (P>0.05) dry matter intake of sows. Shen-Ping *et al.* (2011) also reported that dietary supplementation of folic acid (0, 12.5, 50 and 100 mg/kg diet) did not affect the average feed intake of lactating sows with uniform litter size. However, in the present study during the lactation period, a significant increase (P<0.01) was observed on fortnight DMI (g/d) following folic acid supplementation coupled with higher feed intake. Hence, the higher fortnightly DMI (g/d) of lactating sows in the T_1 and T_2 groups may be attributed to the higher feed intake, which in turn is due to the higher allowance of feed /piglet to the sows during the lactation period (2.5 kg plus 0.3 kg). Further, the number of piglets per sow was lower in the control (T_0) group when compared to T_1 and T_2 groups.

The data about the daily intake of various nutrients along with their digestibility during the gestation phase are given in Table 2. No significant supplementation effect was observed on the intake and digestibility of dry matter, organic matter, crude protein, crude fibre, ether extract, nitrogen-free extract, and gross energy during the gestation phase. The values were comparable among the groups and were within normal range. Supplementation of folic acid in gestating sows had no effect (P>0.05) on intake and digestibility of dry matter, organic matter, crude protein, crude fibre, ether extract, nitrogen-free extract and gross energy. Literature pertaining to folic acid supplementation on nutrient utilization and digestibility in pigs is scanty to compare the observed findings. However, it corroborates with the findings of Giguere *et al.* (2008) which indicate that supplementation of methionine (0 or 0.2%), folic acid (0, 10 and 25 mg/kg) and vitamin B_{12} (0, 10 and 150 mg/kg) to the growing-finishing pigs did not affect the average daily feed intake (2.82±0.03 kg) during the eight weeks of the experiment. Shen-Ping *et al.* (2011) also reported that dietary supplementation of folic acid (0, 12.5, 50, 100 mg/kg diet) did not affect the feed intake of sows. Chiquette *et al.* (1993) found that supplementation of folic acid to steers at 2 mg/kg body weight had no significant effect on total tract digestibility of nutrients (DM, ADF, NDF and CP). Similarly, Achon *et al.* (1999) observed no effect of dietary folic acid (40 mg/kg diet) supplementation on nitrogen and fat digestibilities in rats. In contrast, Wang *et al.* (2019) reported that supplementation of folic acid (7.2 mg/kg basal diet) increased the ruminal fermentation and nutrient digestibilities in calves. Sahin *et al.* (2003) reported that quails fed with a diet supplemented with vitamin C and folic acid during heat stress showed a significant increase in feed intake. The variability in the results might be due to the differences in the dose, physiological stage and also breed used in different experiments. Therefore, it is very difficult to specify the condition responsible for the positive response of folic acid supplementation.

The plane of nutrition of gestating sows is presented in Table 3. Gestating sows' average body weight (kg) and metabolic body weight during digestion trial were comparable (P>0.05) among the groups. No significant difference (P>0.05) was observed on DMI, CPI, DCPI and TDNI (g/day). Whereas, DMI, CPI, and TDNI (g/kg $W^{0.75}$) were significantly higher (P<0.01) and DCPI (P<0.05) was also higher in control (T_0) group and the T_1 and T_2 groups were similar and comparable. The energy kinetic values g/day and g/kg $W^{0.75}$ were not different (P>0.05) among the groups. Comparative plane of nutrition with NRC (1998) feeding standard showed higher CP and DE intake by the gestating sows (Table 4). Gestating sow's average bodyweight and metabolic bodyweight during digestion trial were comparable (P>0.05) among the groups. No significant difference (P>0.05) was observed on DMI, CPI, DCPI and TDNI (g/day). Whereas, DMI, CPI and TDNI on g/kg $W^{0.75}$ were significantly higher (P<0.01), also a significant increase in DCPI (P<0.05) was noticed in control (T_0) as compared to T_1 and T_2 groups. This could be due to the numerically lower metabolic body weight of control (T_0) group animals compared to T_1 and T_2 groups. The energy kinetic values g/day and g/kg $W^{0.75}$ were not different (P>0.05) among the groups. However, as compared to NRC (1998) feeding standards, the animals in the present study consumed about 22% more CP. The estimated daily CP intake, DE intake and feed intake (DM kg per day) recommended by NRC (1998) for gestating sows weighing around 170 kg with a gestation weight gain of 40 kg was 233.12 g, 6405 kcal and 1.88 kg respectively. As compared to NRC (1998) feeding standards, the animals in the present study consumed about 22% more CP (286.50 g). This difference in CP intake of the experimental animals might be due to higher average feed intake by the experimental sows (≈2.25 kg/day) in comparison to the NRC (1998) standards. In a study conducted by Matte *et al.* (1992) to evaluate the folic acid requirement of gestating and lactating sows, the gestating sows were fed 2.5 kg feed as on as fed basis which is equivalent to a dry matter supply of 2.25 kg per day. The study conducted by Matte *et al.* (1992) was concentrated on the effect of folic acid on the litter size and performance of piglets and not on the plane of nutrition. However, the present study refers to the study by Matte *et al.* (1992) in order to justify the higher DMI (≈2.25 kg/day) as against the recommendations of NRC (1998).

Table 1: Effect of dietary folic acid supplementation on fortnight DMI (g/day) of sows.

Fortnight	Treatment†			SEM	P value
	T_0	T_1	T_2		
Gestation period					
1	2259.56	2260.61	2262.71	0.69	0.163
2	2243.38	2243.76	2246.38	3.53	0.934
3	2237.68	2237.91	2237.89	0.74	0.991
4	2242.59	2247.30	2248.30	1.90	0.435
5	2225.08	2227.85	2226.65	1.39	0.725
6	2451.96	2442.28	2446.12	32.31	0.993
7	2655.70	2653.84	2656.17	1.19	0.706
Lactation period					
1	2926.91	3492.07	3437.02	210.91	0.494
2	4096.06^c	5051.11^a	4990.06^b	68.80	<0.001
3	3949.45^c	4971.52^a	4835.88^b	70.92	<0.001

^{abc} Means bearing different superscripts in a row differs significantly (P≤0.05) and (P≤0.01)
T_0, basal diet; T_1 and T_2, basal diet supplemented with FA @ 15mg/kg feed throughout the gestation and also during lactation period, respectively

Table 2: Effect of dietary folic acid (FA) supplementation on intake and digestibility of nutrients in gestating sows.

Parameter	Dietary treatments			SEM	P value
	T_0	T_1	T_2		
Average BW (kg)	185.2±9.37	191±10.75	189.5±8.13	5.17	0.904
Dry matter					
Intake (g/day)	2248.9±5.79	2247.3±6.71	2248.6±5.99	3.23	0.982
Digestibility (%)	85.8±1.04	85.5±0.89	85.9±0.83	0.49	0.945
Organic matter					
Intake (g/day)	2144.3±5.52	2142.8±6.4	2144±5.71	3.08	0.982
Digestibility (%)	87.2±1.06	86.9±0.87	87.3±0.82	0.48	0.938
Crude protein					
Intake (g/day)	286.4±0.74	286.2±0.85	286.4±0.76	0.41	0.982
Digestibility (%)	79.9±0.63	80.1±0.74	80.2±0.68	0.36	0.944
Crude fibre					
Intake (g/day)	86.2±0.22	86.1±0.26	86.2±0.23	0.12	0.982
Digestibility (%)	57.3±0.41	57.0±0.41	56.7±0.55	0.25	0.713
Ether extract					
Intake (g/day)	67.9±0.17	67.8±0.20	67.9±0.18	0.10	0.982
Digestibility (%)	63.8±2.14	63.6±2.37	64.4±2.48	1.22	0.968
Nitrogen free extract					
Intake (g/day)	1703.8±4.39	1702.5±5.08	1703.5±4.54	2.45	0.982
Digestibility (%)	90.8±1.44	90.4±1.03	91.0±1.03	0.62	0.945
Gross energy					
Intake (g/day)	7944.1±23.34	7938.4±26.55	7942.9±24.03	12.91	0.986
Digestibility (%)	82.7±0.41	82.4±0.51	82.9±0.62	0.28	0.839

Control group (T_0), basal diet: T_1 and T_2 basal diet supplemented with FA @ 15mg/kg feed throughout the gestation and also during lactation period, respectively

Table 3: Effect of dietary folic acid supplementation on nutritive value and the plane of nutrition in gestating sows.

Parameter	Dietary treatments			SEM	P value
	T_0	T_1	T_2		
Bodyweight					
Kg	185.2±9.37	191.0±10.75	189.5±8.13	5.17	0.904
g/kg $W^{0.75}$	50.1±1.89	51.3±2.15	51.0±1.65	1.04	0.905
DMI					
g/d	2249.0±5.8	2247.4±6.73	2248.6±6	3.24	0.982
g/kg $W^{0.75}$	44.8^a±0.12	43.8^b±0.14	44.0^b±0.12	0.15	0.001
CPI					
g/d	286.5±0.72	286.3±0.84	286.4±0.75	0.40	0.982
g/kg $W^{0.75}$	5.7^a±0.00	5.6^b±0.03	5.6^b±0.00	0.02	<0.001
DCPI					
g/d	228.8±0.59	229.2±0.68	229.6±0.61	0.35	0.628
g/kg $W^{0.75}$	4.55^a±0.03	4.45^b±0.03	4.50^{ab}±0.00	0.02	0.044
TDNI					
g/d	2229.1±5.74	2227.5±6.65	2228.8±5.93	3.20	0.982
g/kg $W^{0.75}$	44.4^a±0.12	43.4^b±0.14	43.6^b±0.12	0.15	0.001
Energy kinetics (kcal/d)					
GE intake	7944.1±23.34	7938.4±26.55	7942.9±24.03	12.91	0.986
FE outgo	1370.9±36.47	1394.1±44.81	1361.0±53.23	24.05	0.871
DE intake	6573.2±13.96	6544.3±20.67	6581.9±31.39	13.02	0.512
ME intake	6310.3±13.40	6282.6±19.84	6318.6±30.14	12.50	0.512
Nutritive value (per 100g DM)					
DCP	10.4±0.09	10.4±0.11	10.4±0.08	0.05	0.841
TDN	86.4±1.03	86.1±0.84	86.5±0.80	0.47	0.943

[ab]Means bearing different superscripts in a row differs significantly ($P \leq 0.05$) and ($P \leq 0.01$)
T_0, fed basal diet; T_1 and T_2, basal diet supplemented with FA @ 15mg/kg feed throughout the gestation and also during lactation period, respectively

Table 4: Comparative plane of nutrition with NRC (1998) feeding standard during gestation phase.

Parameters	Dietary treatments		
	T_0	T_1	T_2
Crude Protein (CP)			
Requirement (g/d)	233.12	233.12	233.12
Intake (g/d)	286.5	286.3	286.4
Deviation (%)	+22.90	+22.81	+22.86
Digestible energy (DE)			
Requirement (kcal/d)	6405	6405	6405
Intake (kcal/d)	6573.2	6544.3	6581.9
Deviation (%)	+2.56	+2.13	+2.69

T_0, basal diet; T_1 and T_2, basal diet supplemented with FA @ 15mg/kg feed throughout the gestation and also during lactation period, respectively

CONCLUSIONS

Gestating sows' average body weight (kg) and metabolic bodyweight during digestion trial were comparable among the groups. No significant change was observed in the intake and digestibility of DM, OM, CP, CF, EE, NFE and GE during the gestation phase due to supplementation. Hence, based on the observations in this study it could be concluded that supplementation of folic acid @ 1.3 mg and 15 mg/kg diet throughout gestation and lactation period didn't have any effect on nutrient intake and digestibility in gestating and lactating sows.

FUTURE SCOPE

Folic acid and cyanocobalamin combination can be tried.

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Conflict of Interest. None.

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