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Effect of Folic Acid Supplementation on the Serum Antioxidant Profile in Gestating and Lactating Sows

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ABSTRACT: This experiment was conducted to study the effect of dietary folic acid supplementation on antioxidant activity in gestating and lactating 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 (basal diet contained 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. Blood samples were collected from 18 sows (6 sows/treatment) on 0 day and 114th-day post-insemination and 21st day of lactation from cranial vena cava, and serum was harvested as per the standard protocol. Sows antioxidant status was assessed at 0 and 114 days post-insemination and 21st day of lactation. A significant ($P<0.01$) treatment, period and treatment × period interactions were observed in the levels of serum SOD (U/ml), catalase (nmol/min/ml), TAOC (mM/ml) and MDA (µM/ml). The antioxidant enzymes like SOD, catalase and TAOC level were higher in T_1 and T_2 groups, whereas, the serum MDA level was significantly ($P<0.05$) reduced in T_2 group as compared to the control (T_0) group. Based on the above observations in the study it could be concluded that for better production and antioxidant defense gestational supplementation alone was sufficient.

Keywords: Antioxidant, Catalase, Folic acid, Gestating Sow, Malondialdehyde, Lactating Sow, Serum superoxide dismutase, Total antioxidant capacity.

INTRODUCTION

Meeting the nutritional needs of the fast-growing population and providing nutritional security is the biggest challenge for developing countries like India. Currently, the majority of the protein needs of the population are met by the egg and meat from the poultry sector. To meet future demand, piggery is one of the most potent sources for meat production due to its best feed conversion efficiency after broilers (NABARD, 2019). In swine production, litter size at birth and weaning are considered as one of the most important economic variables. Litter size at birth is controlled by ovulation rate, fertilization rate, and losses during gestation (Vangen, 1981; Flint *et al*., 1982). Minimizing these losses and identifying the ways to improve the litter size at birth and weaning is essential to make swine farming more profitable. 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). Elevated HCY induces oxidative stress by forming reactive oxygen species and inhibiting antioxidant activity. To overcome all these negative effects supra-nutritional supplementation of folic acid in the maternal and offspring diet is essential. Thus, the present study aimed to assess the effect of folic acid supplementation on serum antioxidant profile in gestating and lactating sows.

MATERIALS AND METHODS

Folic acid was purchased from MB Vet Chem, Navi Mumbai, Maharastra, India. Eighteen healthy Landlly 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. 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. All the pregnant sows were fed once daily at an allowance of 2.5 kg/day during gestation (0 to 84 days) or 3.0 kg/day (85 to 114 days) along with free access to clean drinking water. After farrowing lactation diet (42 days *i.e.*, till weaning) was

fed to sows to a total of 2.5 kg plus 0.3 kg for every piglet. Blood samples were collected from 18 sows (6 sows/treatment) on 0 day and 114th-day post-insemination and 21st day of lactation from cranial vena cava, and serum was harvested as per the standard protocol. Sows antioxidant status was assessed at 0 and 114 days post-insemination and 21st day of lactation. Serum superoxide dismutase (SOD), catalase (CAT), total antioxidant capacity (TAOC) and, malondialdehyde (MDA) levels were determined by Assay Kits supplied by Cayman Chemical, USA. The data were analyzed statistically using ANOVA procedure of SPSS (version 20.0).

RESULTS AND DISCUSSION

The data pertaining to anti-oxidant enzymes *viz.*, serum superoxide dismutase (SOD), catalase (CAT), total antioxidant capacity (TAOC) and malondialdehyde (MDA) are presented in Table 1 and depicted in Fig. 1-5. A significant (P<0.01) treatment, period and treatment × period interactions were observed (Table 1) in the levels of serum SOD (U/ml), catalase (nmol/min/ml), TAOC (mM/ml) and MDA (µM/ml). Further, within treatment T_1 and T_2 groups showed higher levels of serum SOD, catalase and TAOC as compared to control (T_0) group. Whereas, the MDA level was significantly reduced in the T_2 group as compared to the control (T_0) group, the level of T_1 group was intermediate. Between period, significantly (P<0.01) improved serum SOD and TAOC and significantly (P<0.01) reduced MDA levels were observed on day 114 and day 0 of post-insemination. Further, the serum levels of catalase and MDA were similar on day 114 post-insemination and day 21st of lactation. Whereas, day 0 values were significantly (P<0.01) lower among the periods. However, day 0 values did not differ significantly within the treatments and were comparable among the groups (Table 1).

In agreement with the results, higher TAOC and lower MDA levels were observed in type 2 diabetes patients supplemented with folic acid (5 mg/d) as compared to the placebo group (Aghamohammadi *et al.*, 2011). Liu *et al.* (2012) reported that dietary folic acid supplementation decreased the protein carbonyls and MDA concentration in the liver of IUGR piglets. Similarly, reduced serum and tissue MDA, homocysteine and ACTH concentrations (Sahin *et al.*, 2003b) were found in the heat-stressed quails supplemented with vitamin C (250 mg/kg of diet) and folic acid (1 mg/kg of diet). Likewise, Sahin *et al.* (2003a) reported that the malondialdehyde (MDA) level decreased following folic acid supplementation under cold stress in broiler Japanese quails. It has been reported that the antioxidant function of folate might be due to reduced level of homocysteine (pro-oxidant) and free radicals (Racek *et al.*, 2005) and enhanced antioxidant enzymatic activity pathways instead of mitochondrial respiratory functions (Huang *et al.*, 2001; Handy *et al.*, 2005).

Table 1: Effect of dietary folic acid supplementation on serum antioxidant profile (Mean *± SE) in gestating and lactating sows.

Treatment†	Days post-insemination		Lactation	Treatment mean	P value		
	0 day	114 day	21st day		T	P	T*P
SOD (U/ml)							
T_0	63.49^{cd}±3.81	64.95^{bcd}±0.63	64.82^{bcd}±0.61	64.42^{B}±1.23	0.007	<0.001	0.027
T_1	62.46^{d}±1.14	75.74^{a}±1.94	66.23^{bcd}±1.14	68.14^{A}±1.57			
T_2	63.70^{cd}±3.09	73.78^{ab}±1.85	71.87^{abc}±1.47	69.78^{A}±1.61			
Period mean	63.21^{Y}±1.58	71.49^{X}±1.43	67.64^{XY}±0.96				
Catalase (nmol/min/ml)							
T_0	5.44^{c}±0.73	7.23^{abc}±0.41	6.64^{bc}±0.67	6.44^{B}±0.38	0.030	<0.001	0.086
T_1	5.21^{c}±0.77	9.53^{a}±0.56	8.75^{ab}±0.55	7.83^{A}±0.57			
T_2	5.35^{c}±0.32	9.25^{ab}±0.36	9.54^{a}±0.76	8.04^{A}±0.54			
Period mean	5.33^{Y}±0.35	8.67^{X}±0.35	8.31^{X}±0.47				
TAOC (mM/ml)							
T_0	0.17^{b}±0.01	0.19^{b}±0.01	0.18^{b}±0.01	0.18^{B}±0.00	<0.001	<0.001	<0.001
T_1	0.17^{b}±0.01	0.29^{a}±0.01	0.19^{b}±0.01	0.22^{A}±0.01			
T_2	0.16^{b}±0.01	0.29^{a}±0.01	0.25^{a}±0.02	0.23^{A}±0.02			
Period mean	0.17^{Z}±0.01	0.25^{X}±0.01	0.21^{Y}±0.01				
MDA (nmol/ml)							
T_0	18.01±3.18	33.58±1.95	34.32±2.43	28.64^{A}±2.30	0.011	0.001	0.222
T_1	19.75±3.87	24.18±3.66	27.65±2.80	23.86^{AB}±2.04			
T_2	17.54±4.24	23.27±2.52	21.27±2.48	20.69^{B}±1.82			
Period mean	18.43^{Y}±2.07	27.01^{X}±1.89	27.75^{X}±1.90				

* Mean of six samples

^{abcd} Means bearing different superscripts differs significantly (P≤0.05) and (P≤0.01)

$^{AB/XY}$ Means bearing different superscripts within a column (AB) or row (XY) differ significantly

†Sows in control group (T_0) fed basal diet, whereas, sows in groups T_1 and T_2 were fed basal diet supplemented with folic acid @ 15mg/kg feed throughout the gestation and also during lactation period, respectively

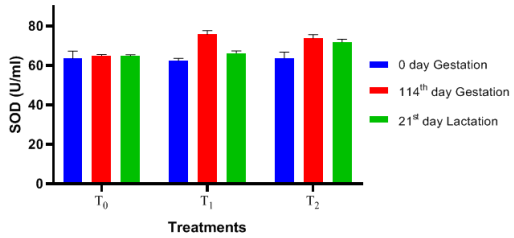

Fig. 1. Effect of dietary folic acid supplementation on SOD (U/ml) level in gestating and lactating sows.

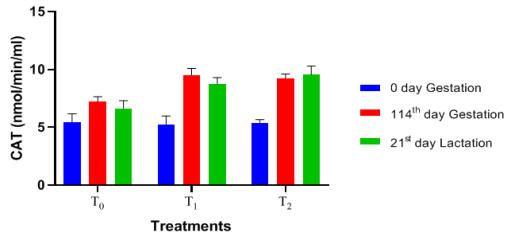

Fig. 2. Effect of dietary folic acid supplementation on CAT (nmol/min/ml) level in gestating and lactating sows.

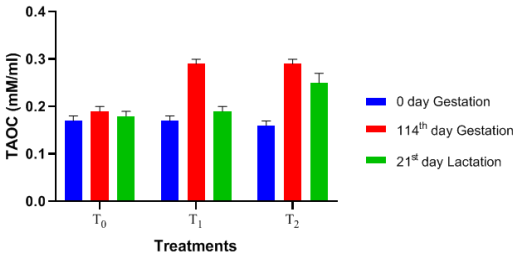

Fig. 3. Effect of dietary folic acid supplementation on TAOC (mM/ml) level in gestating and lactating sows.

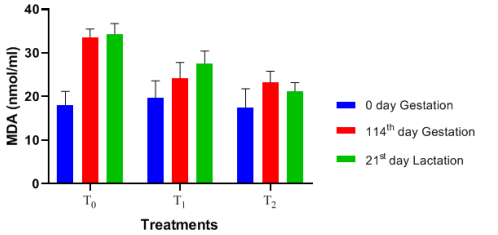

Fig. 4. Effect of dietary folic acid supplementation on MDA (nmol/ml) level in gestating and lactating sows.

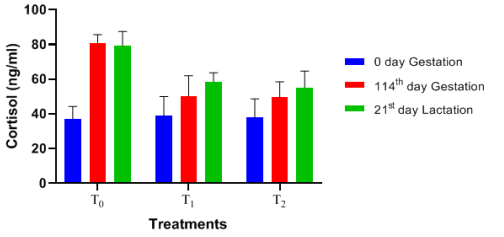

Fig. 5. Effect of dietary folic acid supplementation on Cortisol (ng/ml) level in gestating and lactating sows.

CONCLUSIONS

The results of the present study indicate that supplementation of folic acid (@ 15 mg/kg feed) throughout gestation and lactation showed a similar kind of response. However, lactational folic acid supplementation significantly reduced the MDA levels. The serum antioxidant enzyme levels of supplemented groups were comparable and did not differ significantly. Based on the above observations it could be concluded that for better production and antioxidant defense gestational supplementation of folic acid (15 mg/kg) was sufficient.

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