Available online www.jocpr.com

Journal of Chemical and Pharmaceutical Research, 2014, 6(7):1222-1224

Research Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

Effect of dietary fiber on serum biochemical parameters of pregnant sows

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ABSTRACT

To study the effect of dietary fiber on biochemical parameters and reproductive hormones of sows, thirty PIC sows with close parity and breeding time were randomly divided into 5 groups (three duplicates in each group), and those groups were provided respective dietary with 3%, 5%, 7%, 9% or 11% of crude fiber during pregnancy. Concentrations of serum urea nitrogen (SUN), triglyceride (TG), and total cholesterol (TC), and glucose (GLU) on the 28th, 60th, 104th day of pregnant were detected. The results showed that: improved level of crude fiber in the diet decreased the concentrations of SUN, TG, and TC significantly ($P<0.05$), but there was no significant effect on GLU.

Keywords: dietary fiber, pregnant sows, biochemical parameters.

INTRODUCTION

Level of dietary crude fiber added for pregnant sows is a hot issue in swine nutrition researches. It is generally considered that on the basis of guarantee of their nutritional needs, increasing dietary crude fiber level can affect blood biochemical indicators. Yang *et al* (2002) found that with increasing levels of dietary crude fiber in the range of 4% to 12%, level of triglyceride reduce [1]. Johansen *et al* (1994) demonstrated that cellulose lowered the serum glucose [2]. Using the alfalfa meal as a source of crude fiber, this study aims at the impact of dietary crude fiber on the blood biochemical parameters of sows during pregnancy, and providing a theoretical basis for the mechanism of dietary fiber's effects on reproductive performance of sows.

EXPERIMENTAL SECTION

Animals and management

Experiment was carried out in Green Farming Ltd. (Daqing, Heilongjiang). A total of 50 PIC dry sows were confined in crates. According to close mating time, body condition, the litter size in last farrowing, feed intake, and expected parturition day, sows were randomly divided into five groups after mating. In the ends, 30 sows were chosen, and then there were three duplicates in each group and two sows in each replicate.

During pregnancy, diets for each group (Control, C; Treatment I, T1; Treatment II, T2; Treatment III, T3; Treatment IV, T4) contained 3%, 5%, 7%, 9%, or 11% fiber respectively. Sows were fed twice a day, and had free access to drinker. From mating day to 85th day of gestation, the feeding amounts (kg/d) were: 2.00 for C, 2.20 for T1, 2.45 for T2, 2.76 for T3, and 3.16 for T4; form 85th day of gestation to parturition day, there were additional 0.5 kg for each sow.

Experimental diet

The metabolizable energy and other nutritive matter of the diet for control group were up to Feeding Standard of Swine (NY/T65-2004) and basal diet contained 3% crude fiber. The treatment diets were added the alfalfa meal as a source of crude fiber, to make content of crude fiber up to 5%, 7%, 9%, and 11%. The composition and chemical

analysis of each diet was showed in Table 1.

Table 1 The ingredients and chemical composition of each diet

Treatments	C	T1	T2	T3	T4
Ingredients (%)					
Maize	60.25	54.54	48.64	42.83	37.02
Wheat bran	16.90	15.26	13.61	11.97	10.32
Alfalfa powder	0.00	8.80	17.62	26.44	35.26
Soybean meal	13.00	11.81	10.61	9.42	8.22
Fish meal	1.85	1.68	1.51	1.34	1.17
Premix*	4.00	4.00	4.00	4.00	4.00
Total	100.00	100.00	100.00	100.00	100.00
Chemical composition					
Metabolizable energy (MJ/kg)	12.79	11.62	10.44	9.27	8.09
Crude protein (%)	14.96	13.59	12.21	10.84	9.46
Crude fibre (%)	3.00	5.00	7.00	9.00	11.00
Calcium (%)	1.03	1.03	1.03	1.03	1.03
Phosphor (%)	0.71	0.71	0.71	0.71	0.71
Lys. (%)	0.80	0.80	0.80	0.80	0.80
Met. + Cys. (%)	0.55	0.55	0.55	0.55	0.55

** Premix supplied for 1 kg of complete diet: Cu 18 mg, Fe 135 mg, Mn 20 mg Zn 125 mg, I 0.25 mg, Se 0.3 mg, Vitamin A 11050 IU/kg, Vitamin D3 1450 IU, Vitamin E 56 mg, Menadione 4 mg, Riboflavin 6.5mg, Pantothenic acid 18 mg, Niacin 46 mg, Choline 215 mg, Biotin 0.8mg, Folacin 0.55 mg, Cyanocobalamin 26 μg.*

Biochemical parameters measurement

At the 28th, 60th, and 104th day of gestation (28d, 60d and 104d), 10mL-blood sampling through ear venous was taken before morning feeding. After standing for 30 min at ambient temperature, plasma samples were centrifuged (3000 rpm, 10 min), then separated and stored in the refrigerator at -20°C and -80°C until assay.

The Diacetyl-Oxime Method was used for serum urea nitrogen (SUN) determination, and Colorimetry for triglyceride (TG), Liebermann-Burchard Test for total cholesterol (TC), o-Toluidine Method for glucose (GLU).

Statistical analysis

SAS Version 8 was used to make statistical analysis of experimental data through One-Way ANOVA, and Duncan's multiple-range test was used. All the results of statistical analysis were showed by Mean ± sd.

RESULTS

As shown in Table 2, at the 28th day of gestation, SUN of pregnant sows significantly ($P < 0.01$) decreased with dietary fiber increasing, and SUN in each treatment, except T1, was significantly lower than that in C ($P < 0.01$); at the 60th day of gestation, sows in T3 and T4 had significantly higher SUN than those in C and other treatments ($P < 0.01$); at the 104th day of gestation, SUN of pregnant sows significantly ($P < 0.01$) decreased with dietary fiber increasing, and SUN in each treatment, except T1, was significantly lower than that in C ($P < 0.01$).

Table 2 Effect of dietary fiber on SUN of pregnant sows (mmol/L)

Treatments	C	T1	T2	T3	T4
28d	5.56^{A}±0.03	5.52^{A}±0.10	5.34^{B}±0.03	5.28^{BC}±0.06	5.23^{C}±0.05
60d	7.16^{A}±0.05	7.13^{A}±0.04	7.12^{A}±0.07	6.92^{B}±0. 07	6.89^{B}±0.03
104d	11.19^{A}±0.11	11.16^{A}±0.13	10.84^{B}±0.09	10.35^{C}±0.14	10.30^{C}±0.12

Means with different superscripts are significantly different (capital letters means $p<0.01$, and lowercase letters means $p<0.05$). The same below.

As shown in Table 3, at the 28th day of gestation, sows in T3 and T4 had significantly ($P < 0.01$) higher GLU than those in C and other treatments; at the 60th day of gestation, GLU of pregnant sows significantly ($P < 0.01$) decreased with dietary fiber increasing, but there was no significant difference between T1 and C ($P > 0.05$); at the 104th day of gestation, GLU in T2, T3, or T4 was significantly ($P < 0.05$; $P < 0.01$; $P < 0.01$) lower than that in C.

Table 3 Effect of dietary fiber on GLU of pregnant sows (mmol/L)

Treatments	C	T1	T2	T3	T4
28d	5.09^{A}±0.04	5.06^{A}±0.06	5.11^{A}±0.06	4.90^{B}±0.14	4.79^{B}±0.14
60d	3.68^{Aa}±0.05	3.72^{ABa}±0.03	3.87^{BCb}±0.06	4.23^{Dc}±0.17	3.98^{Cb}±0.14
104d	3.56^{Aa}±0.05	3.48^{Aab}±0.05	3.42^{Ab}±0.11	3.27^{Bc}±0.13	3.16^{Bc}±0.07

As shown in Table 4, at the 28th, 60th, and 104th day of gestation, TC concentration in each treatment was significantly ($p<0.01$) higher than that in C, and TC significantly ($P < 0.01$) decreased with dietary fiber increasing.

Table 4 Effect of dietary fiber on TC of pregnant sows (mmol/L)

Treatments	C	T1	T2	T3	T4
28d	45.78^{Aa}±0.63	41.28^{Bb}±0.34	40.13^{Bc}±0.33	39.15^{BCd}±0.37	36.78^{Cd}±0.23
60d	86.20^{A}±0.78	81.07^{B}±0.82	73.04^{C}±1.47	60.99^{D}±1.60	56.19^{E}±1.10
104d	197.91^{A}±0.81	186.73^{B}±0.78	172.02^{C}±0.96	152.30^{D}±3.93	143.02^{E}±6.98

As shown in Table 5, at the 28th day of gestation, there was no significant difference for TG between each treatment and C (P> 0.05); at the 60th day of gestation, sows in T3 and T4 had significantly higher TG than those in C and other treatments (P <0.01); at the 104th day of gestation, TG concentration in each treatment was significantly (p<0.01) higher than that in C, and TG significantly (P <0.01) decreased with dietary fiber increasing.

Table 5 Effect of dietary fiber on TG of pregnant sows (mmol/L)

Treatments	C	T1	T2	T3	T4
28d	64.14±0.96	64.07±0.54	63.81±0.29	63.70±0.28	63.69±0.29
60d	54.72^{A}±0.26	54.53^{A}±0.28	54.42^{A}±0.18	53.60^{B}±0.26	53.56^{B}±0.35
104d	46.10^{A}±0.21	45.57^{B}±0.26	44.81^{C}±0.17	42.73^{D}±0.37	41.42^{E}±0.33

DISCUSSION

SUN is an accurate indicator of animal's protein metabolism and amino acid balance of dietary. As nitrogenous substances increased in the diet, metabolism of amino acids being stronger, or tissue damaged, concentration of SUN increased [3]. WANG *et al*. (2008) reported that adding pectin in sow's diet increased total nitrogen and microbial nitrogen excretion in fecal, decreased urinary nitrogen excretion, reduced ammonia concentration in fecal, and SUN [4]. This study showed that increasing dietary fiber significantly (P < 0.05) decreased SUN on early, middle and late gestation, especially for T3 and T4, which is consistent with previous studies.

Johansen *et al.* (1994) demonstrated that cellulose could lower blood GLU level [2]; Liu *et al.* (2007) studied the effects of dietary fiber on goose, and found that high-fiber diets can significantly decrease GLU [5]; Zhou (2006) found that there was no significant difference in GLU between goose with different dietary fiber level (4%, 8%, and 12%) [6]. In present study, higher dietary fiber level had no effect on GLU in the early and middle pregnancy, and in late pregnancy GLU decreased with the increase of the amount of crude fiber, which as opposed to previous studies. This might be attributed to the sow's physiological characteristics and different crude fiber source.

Anderson (1990) observed that higher dietary crude fiber can significantly reduce TC in blood [7]. The metabolic process of crude fiber can reduce TC and LDL-cholesterol, regulate appetite, and enhance balance of sodium and fluid [3, 4]. Gao *et al.* (2003) found that with increasing dietary crude fiber (in the range of 4% to 12%), TC, TG and LDL-cholesterol reduced, and HDL-cholesterol increased [8]. The results of present study supported previous studies.

In conclusion, improved level of crude fiber in the diet could decrease the concentrations of SUN, TG, and TC, then affect the metabolism of pregnant sows.

Acknowledgments
This study was supported by General Bureau of Land Reclamation of Heilongjiang Province (No. 200335) and Department of Education of Heilongjiang Province (No. 2041160002).

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