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Effects of supplementing distillers dried grains with solublesin the diet of lactating sows onvariation in the body weight of piglets

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Abstract : Distillers dried grains with solubles (DDGS) is a by-product from processing corn to produce bio-ethanol, and it contains almost three times higher protein, fat, and fiber than corn. Intake of higher amount of nutrients originated from corn in lactating sows may contribute to changes in milk composition and thus alter the growth of suckling piglets. Therefore, the objective of this study was to evaluate effect of supplementingDDGS in the diet of lactating sows on variation in the body weight of piglets. A total of 50 sows with parities of 3 to 5 were usedand allottedinto one of four treatments which included 0 (CON), 10% (DDGS10), 20% (DDGS20), or 30% (DDGS30) DDGS in the diet. Diets were fed to sows during the whole lactation period.Individual body weights of piglets were measured within 24 h after farrowing and at weaning. No significant differences were observed inthe coefficient of variation (CV) for body weight of piglets within a litter after farrowing and at weaning among the treatments ($p>0.05$). There was, however, a tendency of decreases in the CV for body weight of piglets within a litter at weaning compared with that after farrowingin the DDGS10 and DDGS20 treatments. At weaning, the percentage of the number of piglets weighing less than 4.5 kg in DDGS20 (4.86%, 7 out of 144; $p<0.05$) or DDGS30 (5.04%, 6 out of 119; $p=0.059$) was lower than that in CON (12.41%; 17 out of 137) although this pattern was not observed in DDGS10. In conclusion, addition of DDGS in lactating sow diets improved piglet performance by reducing the number piglets weighing less than 4.5 kg.

Key words **:** Body weight, Coefficient of variation, Lactating sow, Piglet

I. Introduction

Recently, biofuel production has markedly increased and contributed to increase in price of corn and pro- duction of corn co-products [e.g.distillers grains with solubles (DDGS)]. This change has led changes in increasing amounts of DDGS in swine diets as a partial replacement of common feed ingredients such as corn and soybean meal (Hoffman and Baker, 2011).

Stein and Shurson (2009) suggested that addition of up to 50% DDGS to gestation dietsand that of up to 30% DDGS to lactation dietshave no negative effects on productive performance of sows based on the previous studies (Wilson et al., 2003; Greiner et al., 2008; Hill et al., 2008;). This guideline is important for swine producers because lots of commercial sow farms commonly use DDGS for gestating and lactating sows since corn price was quite increased. In addition, Generally, DDGS contains almost three times higher protein, fat, and fiber than corn (Stein and Shurson, 2009), which may contribute to change in milk composition directly related to piglet growth.

The objective of this experiment, therefore, was to evaluate the effect of DDGS on variation of piglet body weight of lactating sows.

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II. Materials and Methods

1. Animals, Housing, and Experimental Design

The experimental protocol was reviewed and approved by the Institutional Animal Care and Use Committee at the University of Minnesota. A total of 50 lactating sows (English Belle, GAP genetics, Winnipeg, MB, Canada) with parities of 3 to 5 were used in this experiment. On d 109 of gestation, sows were moved to farrowing stalls equipped with a feeder and waterer in farrowing rooms automatically ventilated and maintained at 20°C. Feed and water were available at all times.Dietary treatments were corn-soybean meal-based diet (CON), CON + 10% DDGS (DDGS10), CON + 20% DDGS (DDGS20), and CON + 30% DDGS (DDGS30). All diets were formulated to meet or exceed National Research Council (1998) estimate of nutrient requirements. The concentrations of crude protein, metabolizable energy, and standardized ileal digestible lysine were similar across 4 diets (Table 1). Sows were fed a common corn-soybean meal-based gestation diet until d 109 of gestation. When sows were moved to farrowing rooms, they wererandomly assigned to dietary treatments and fed 2.5 kg of diets from d 109 of gestation until farrowing. After farrowing, sows were provideddietary treatment-stwice daily as close to *adlibitum* intake until weaning.

2. Measurements and Calculation

Piglets were cross-fostered among sows within each dietary treatment group within 24 h after farrowing to adjust litter size to approximately 10 piglets per

Table 1. Ingredient and nutrient composition of dietary treatments (as-fed basis).

Item	Treatments[1)]			
	CON	DDGS10	DDGS20	DDGS30
Ingredient (g/kg)				
Corn	662.0	622.9	587.8	549.5
Soybean meal, 47.5%	274.0	218.0	159.0	103.0
Distillers dried grains with solubles	0.0	100.0	200.0	300.0
Choice white grease	25.0	19.2	12.5	6.2
Dicalcium phosphate	23.8	21.4	18.7	15.9
Limestone	4.7	6.5	8.3	10.1
Salt	3.5	3.5	3.5	3.5
Sow Vit-Min premix[2)]	5.0	5.0	5.0	5.0
Biotin premix[3)]	2.0	2.0	2.0	2.0
L-Lysine HCl	0.0	1.5	3.2	4.8
Analyzed energy and nutrients				
Gross energy (MJ/kg)	16.5	16.8	17.1	17.5
Metabolizable energy (MJ/kg)[4)]	14.2	14.2	14.2	14.2
Crude protein (g/kg)	180.4	182.6	177.0	175.7
Acid detergent fiber (g/kg)	87.6	107.6	117.9	145.6
Neutral detergent fiber (g/kg)	50.2	62.2	70.2	81.7
Calcium (g/kg)	9.2	9.8	9.7	9.3
Phosphours (g/kg)	8.0	8.1	7.7	7.2
Total lysine (g/kg)	10.4	10.6	10.7	10.9

[1)]CON = control diet; DDGS10 = CON + 10% DDGS; DDGS20 = CON + 20% DDGS; DDGS30 = CON + 30% DDGS.
[2)]Premix supplied the following per kg of diet: Zn, 90.31 mg; Mn, 18.01 mg; Fe, 53.96 mg; Cu, 5.40 mg; Se, 0.30 mg; I, 2.20 mg; niacin, 55.07 mg; pantothenic acid, 33.04 mg; vitamin A, 11,013 IU; vitamin D, 2,753 IU; vitamin E, 55 IU; riboflavin, 9.9 mg; vitamin K, 4.41 mg; vitamin B12, 0.06 mg; choline, 495 mg; pyridoxine, 1.65 mg; folic acid, 1.65 mg; thiamine, 1.01 mg.
[3)]The premix supplied 0.51 mg of biotin per kg of diet.
[4)]Calculated values.

sow. Individual body weights of piglets were measured within 24 h after farrowing and at weaning to calculate coefficient of variation of body weight of individual piglet within a litter.

$$\text{Coefficient of variation (\%)} = \frac{\text{Standard deviation}}{\text{Mean}} \times 100$$

Based on the data for the individual body weight of piglet at weaning, the number of piglets less and greater than body weight 4.5 kg were counted and recorded within each dietary treatment. Diet samples were collected from each batch of manufactured feed and analyzed for gross energy that was measured by bomb calorimetry (Parr 1281 bomb calorimeter, Parr instrument Co., Moline, IL), crude protein (method 934.13; AOAC 2006), acid detergent fiber (method 973.18; AOAC 2006), neutral detergent fiber (Holst, 1973), calcium and phosphorus (method 958.01; AOAC 2006), and total lysine (method 982.30 E; AOAC 2006).

3. Statistical Analysis

Data were analyzed using the ProcGLM procedure (SAS Inst. Inc, Cary, NC) in a completely randomized design. The experimental unit was the litter or piglet. The statistical model for coefficient of variation of body weight of individual piglet within a litter after farrowing and at weaningincluded effect of dietary treatmentas a fixed effect. Pair-wise comparisons were also performed when the effect of parityshowed significance or tendency. The Chi-square test was used for the number of piglets (%) less and greater than body weight 4.5 kg. Statistical significance and tendency were considered at $p<0.05$ and $0.05\leq p<0.10$, respectively.

III. Results and Discussion

In short, Song et al. (2010) reported dietary effects of DDGS on performance and milk composition of lactating sows. This study indicated that addition up to 30% DDGS in lactating sow diets had no negative effect on sow and litter performance, energy and N digestibility, and milk composition. Based on the materials and methods as well as data from Song et al. (2010), the present study evaluated effect of DDGS on variation ofpiglet body weight of lactating sows.

No differences were observed on coefficient of variation of body weight of individual piglet within a litter after farrowing and at weaning between lactating sows fed DDGS treatments and those fed CON (Table 2). The coefficient of variation of body weight of individual piglet within a litter at weaning was numerically decreased by feeding DDGS10 or DDGS20 to lactating sows compared with that after farrowing, not in CON or DDGS30 (Table 2). At weaning, the number of piglets (%) less than body weight 4.5 kg in DDGS20 (4.86%, 7 out of 144; $p<0.05$) or DDGS30 (5.04%, 6 out of 119; $p=0.059$) was lower than that in CON (12.41%; 17 out of 137), but this pattern was not shown in DDGS10 (Figure 1).

Lactating sows fed DDGS may be expected to have poor performance compared with lactating sows fed CONbecause high fiber contents in DDGS may contribute to reduction of energy and nutrient utilization in feeds (Renteria-Flores et al., 2008; Stein and Shurson, 2009). Therefore, it was expected that addition of DDGS in diets may decrease productive performance of lactating sows. However, Song et al. (2010) showedno adverse effects on productive performances of lactating sows- because it may be related to high fat contents in DDGS (Stein and Shurson, 2009). The fat in DDGS provideshighly-efficient energyand may also contribute to increased nutrient digestibility of other dietary components by increased retention time of feeds in the intestine (Cervantes-Pahm and Stein, 2008). This potential effect of fat in DDGS may compensatethe negative energy and nutrients utilizationby the fiber contents in DDGS. In addition, this potential effect may affect milk pro-duction which is directly related to litter performance. The presentstudy showed that coefficient of variation

Table 2. Effects of supplementing distillers dried grain with solubles (DDGS) in the diet of lactating sows on the coefficient of variation for body weights of suckling piglets within a litter.

Item		Dietary treatment[1)]				SEM	P-value
		CON	DDGS10	DDGS20	DDGS30		
Number of sows		14	9	15	12		
Number of piglets		137	86	144	119		
CV[2)], %	Farrowing	15.90	16.70	17.28	14.29	1.61	0.853
	Weaning	16.90	15.28	16.62	14.91	1.85	0.531

[1)]CON = control diet; DDGS10 = CON + 10% DDGS; DDGS20 = CON + 20% DDGS; DDGS30 = CON + 30% DDGS.

[2)]CV =coefficient of variation of body weight of individual piglet within a litter, CV (%) = $\frac{\text{Standard deviation}}{\text{Mean}}$ x 100.

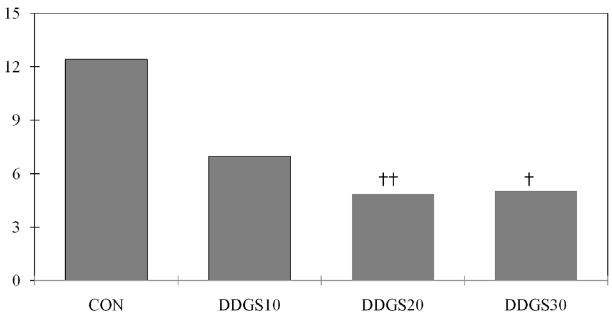

Fig. 1. Percentages of the number of piglets weighing less than 4.5 kg at weaning in each treatment. CON = control diet; DDGS10 = CON + 10% DDGS; DDGS20 = CON + 20% DDGS; DDGS30 = CON + 30% DDGS. †Tend to p<0.10 or ††significantly (p<0.05) differ from the control group.

of body weight of individual piglet within a litter at weaning was numerically decreased by feeding DDGS10 or DDGS20 to lactating sows compared with that after farrowing and that the number of piglets (%) less than body weight 4.5 kg in DDGS20 or DDGS30 was lower at weaning than that in CON. The reason for this observation may be greater fat contents in milk from lactating sows fed DDGS, as Song et al. (2010) showed fat contents in milk from sows fed DDGS treatments were numerically higher than those from sows fed CON. Pettigrew (1981) and Lauridsen and Danielsen (2004) also reported that increasing concentrations of fat in diets increased milk fat content, which can contribute to improvement of piglet performance.

IV. Conclusion

DDGS contains almost three times higher protein, fat, and fiber than corn, which may contribute to change in milk composition directly related to piglet growth. Therefore, the present study evaluated the effect of DDGS on variation ofpiglet body weight of lactating sows and indicated DDGS improved piglet performance by reduced number of piglets (%) less than body weight 4.5 kg.

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