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Effects of saccharin (sweetener) supplementation on growth performance, fecal moisture and litter performance of lactating sows

Xiangxue Liang[1], Sang In Lee[1], Il Seok Lee[2], Jin Ho Cho[3], In Ho Kim[1*]

[1]Department of Animal Resource and Science, Dankook University, Cheonan 31116, Korea
[2]Department of General Education, Dankook University, Cheonan 31116, Korea
[3]Department of Animal Science, Chungbuk National University, Cheongju 28644, Korea

*Corresponding author: inhokim@dankook.ac.kr

Abstract

Feed intake (FI) of sows during lactation is a serious problem because sows require a large amount of energy for high milk production during lactation. Providing a palatable diet is important for lactating sows to cope with the stress of breast-feeding. Palatability can be increased by adding sweeteners to diets. This study was conducted to evaluate the effects of saccharin (sweetener) on growth performance, fecal moisture, and litter performance of lactating sows. Sixteen sows were randomly allotted to one of two dietary treatments in a 27-day trial starting from lactation. The two dietary treatments were supplemented with 0 and 0.2% saccharin (sweetener), respectively. Average daily feed intake (ADFI) was increased ($p < 0.05$) and back fat loss (BFL) was decreased ($p < 0.05$) in sows fed saccharin supplementation diets compared with sows fed control diet during lactation. However, sows' body weight loss, body condition score (BCS), fecal score, and the number of piglet survival were not different ($p > 0.05$) among dietary treatments. The two dietary treatments also had no significantly different effect ($p > 0.05$) on litter weight and average daily gain (ADG) of piglets. Taken together, saccharin has no significant effect on growth performance of piglets but it can increase FI and reduce BFL of lactating sows.

Keywords: fecal score, growth performance, lactating sows, litter performance, saccharin

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Introduction

Taste modifiers are now regularly used in feed to improve palatability. They help ensure that feed is appetizing and that optimum feed intake (FI) is achieved (Clément, 2015; Cho et al., 2016). During the first week post-weaning, piglets have to adjust to receiving dry feed only and this change often leads to diarrhea, reduced FI, and a decrease in weight gain (Munro et al., 2000; Park et al., 2016). It will take long time to reach slaughter weight and farm productivity will be reduced. Thus, researchers have done a lot of research in this area. Artificial sweeteners, routinely included in piglets' diet, were thought to enhance feed palatability (Moran et al., 2010; Kim et al., 2014).

The consumption of sweetened feeds increases intake and reduces stress. The results of the present post-weaning study showed that the addition of high intensity sweeteners to diets for weaning pigs can affect FI characteristics to a limited extent (Sterk et al., 2008). In the 1980s, sweeteners such as saccharin and aspartame started to become popular in food (Clément, 2015). Saccharin is an artificial sweetener, which is about 300 - 400 times as sweet as sucrose or table sugar, but with effectively no food energy. The main advantage of this synthetic sweetener is its favorable price while its disadvantage is the metallic aftertaste, which occurs when high doses are used (Hof, 1999). The pigs generally preferred a diet containing some level of saccharin compared to no saccharin (Aldinger et al., 1959). This study was conducted to evaluate the effects of saccharin on growth performance, fecal moisture and litter performance of lactating sows. Thereby evaluating the effects of saccharin on the productivity of sows.

Materials and Methods

The experimental protocols describing the management and care of animals were reviewed and approved by the Animal Care and Use Committee of Dankook University (DKU-A1989323).

Animals, Housing, and Experimental Design

A total of 16 sows (Landrace × Yorkshire) were used in this experiment. On day 110 of gestation, sows were weighed and moved into the farrowing facility, randomly allotted to one of two dietary treatments, and fed 2.5 kg/day feed to allow for adjustment to the lactation diets before parturition. Experimental treatments contained two levels of saccharin: (i) CON, basal diet; (ii) NS, CON + 0.2% Saccharin. Diets were formulated to meet or exceed the NRC (National Research Council 2012) nutrient requirements for sows (Table 1). Sows were housed in farrowing crates (2.1 m × 0.6 m) which contained an area (2.1 m × 0.6 m) for newborn piglets on each side, and the temperature in the farrowing house was maintained at a minimum of 20℃. Heat lamps were provided for piglets. Piglets were treated according to routine management practices that included teeth clipping, tail docking, ear notching and subcutaneous iron dextran injections (1 mL per pig) within 24 h of birth. On the day of parturition, sows were not offered any feed. On the first day after farrowing, sows were fed with 1.0 kg lactation diet and 2.0 kg on the second day. The daily feed allowance was increased gradually by 1.0 kg per day. One week after farrowing, sows were provided with free access to drinking water throughout the experimental period.

Sampling and Measurements

The body weight (BW) of sows was checked at after farrowing, during weaning and 5 d after weaning. Individual piglet BW was assessed on d 0 (birth weight) and 22 (weaning). The back fat thickness (BFT) of sows was measured 6 cm off the midline at the 10th rib using a real-time ultrasound instrument (Piglot 105, SFK Technology, Herlev, Denmark) after farrowing, weaning, and 5 d after weaning. The number of piglets for every sow was recorded on the farrowing day and the weaning day to evaluate the survival rate of piglets. FI of sows were recorded daily to determine the daily FI during lactation and 5 d after weaning. Fecal score of sows was observed and recorded daily during lactation and 5 days after weaning.

Table 1. Basal diet composition, g/kg (as-fed basis).

Items	Ingredients, %
Corn (USA)	55.89
Wheat hard	3
Distillers dried grains with solubles	7
Soybean ML (EXP)	17.2
Soybean ML (LOC)	5
Rapeseed ML	2
Animal fat	3.75
Tallow	0.5
Molasses	2.5
Lysine-sulfate	0.22
Methionine (99%)	0.04
Limestone	0.45
Dibasic calcium phosphate	1.28
Vitamin premix[y]	0.2
Choline CL (50%)	0.07
Mineral premix[z]	0.1
Salt	0.6
Magnesium oxide	0.2
Analysis level unit	
Dry matter	86.6
Ash	5.2
Crude protein	17.5
Ether extract	6.54
Metabolizable energy (kcal/kg)	3200

[y]Provided per kilogram of diet: all-trans-retinyl acetate, 2.0 mg; cholecalciferol, 0.025 mg; all-rac-α-tocopherol acetate,1.75 mg; menadione (menadione sodium bisulphate), 1.9 mg; riboflavin, 7 mg; thiamine (thiamine mononitrate), 2.1 mg; pyridoxine, 3.2 mg; niacin, 55 mg; capantothenate, 15 mg; cobalamin, 0.04 mg; folic acid, 0.85 mg; D-biotin, 0.1 mg.
[z]Provided per kilogram of complete diet: Fe (as FeSO4·7H2O), 90 mg; Cu (as CuSO4·5H2O), 15 mg; Zn (as ZnSO4), 50 mg; Mn (as MnO2), 54 mg; I (as KI), 0.99 mg; and Se (as Na2SeO3·5H2O), 0.25 mg.

Statistical Analysis

All experimental data were analyzed using the GLM procedure of SAS (2001) as a randomized complete block design (SAS Inst. Inc., Cary, NC, USA) according to their BW. The sow or litter of piglets was used as the experimental unit. The analysis of sow BFT and change during lactation used fat depth at farrowing as covariates. Piglet birth weight was used as covariate for weaning weights during lactation. Lactation length was used as a covariate for piglet survivability, sow and piglet weaning weight, sow FI, and weaning-to-oestrus interval (WOI) and BFT depth change. Variability in the data was expressed as the pooled standard error (SE) and a $p < 0.05$ was considered as significant.

Results

Growth performance of sows

During lactation, average daily feed intake (ADFI) was increased ($p < 0.05$) and BFL was decreased ($p < 0.05$) in sows fed saccharin supplementation diets compared with sows fed CON diet (Table 2). Sow's BW, body weight loss, the number of piglets' survivals and BCS were not different ($p > 0.05$) among dietary treatments (Table 2).

Table 2. Effect of saccharin (sweetener) supplementation on growth performance in lactating sows[r].

Items	CON	Saccharin	SE[s]
Parity	3.9	3.8	0.2
Litter			
Initial	10.7	10.9	0.2
Weaned Piglet	10.3	10.6	0.2
Survival (%)	96.1	97.6	1.2
BW[w] (kg)			
After farrowing	236.8	234.8	5.1
Weaning	218.4	221.1	4.6
5 d after weaning	221.3	223.8	4.5
BW difference 1[t]	18.4	13.6	1.8
BW difference 2	2.8	2.6	0.3
ADFI[x] (kg)			
Lactation	5.7b	6.2a	0.1
After weaning[u]	2.8	2.8	0.1
BFT[y] (mm)			
After farrowing	20.0	20.0	0.3
Weaning	17.0	18.3	0.4
5 d after weaning	17.4	18.5	0.4
BFT difference 1[v]	3.0a	1.8b	0.4
BFT difference 2	0.4	0.3	0.2
BCS[z]			
After farrowing	3.0	3.0	-
Weaning	2.7	2.8	0.1
5 d after weaning	2.8	2.9	0.1

a, b: Means in the same row with different superscripts differ ($p < 0.05$).
[r]Abbreviation: CON, basal diet; NS, CON + 0.2% Saccharin.
[s]SE: Standard error.
[t]BW difference: 1, after farrowing to weaning; 2, weaning to 5 d after weaning.
[u]After weaning: for 5 days from weaning.
[v]BFT difference: 1, after farrowing to weaning; 2, weaning to 5 d after weaning.
[w]BW: body weight.
[x]ADFI: average daily feed intake.
[y]BFT: back fat thickness.
[z]BCS: body condition score.
Each treatment has 8 replications.

Growth performance of piglets

The two dietary treatments had no significantly different effect ($p > 0.05$) on the piglets BW (Table 3). Also no difference ($p > 0.05$) was observed in total average daily gain (ADG) of piglets (Table 3).

Table 3. Effect of saccharin (sweetener) supplementation on growth performance in suckling piglets[w].

Items	CON	Saccharin	SE[x]
BW[y] (kg)			
Initial	1.310	1.334	0.032
Weaning	5.702	6.086	0.185
ADG[z] (g)			
Total ADG	200	216	8

[w]Abbreviation: CON, basal diet; NS, CON+ 0.2% Saccharin.
[x]SE: Standard error.
[y]BW: body weight.
[z]ADG: average daily gain.
Each treatment has 8 replications.

Fecal score of sows

The two dietary treatments had no significantly different effect ($p > 0.05$) on fecal scores of sows (Table 4).

Table 4. Effect of saccharin (sweetener) supplementation on fecal score in lactating sows[y].

Items	CON	Saccharin	SE[z]
Fecal Score			
After farrowing	3.1	3.1	0.0
Weaning	3.2	3.2	0.0
5 d after weaning	3.0	3.1	0.0

[y]Abbreviation: CON, basal diet; NS, CON + 0.2% Saccharin.
[z]SE: Standard error.
Each treatment has 8 replications.

Discussion

Taste plays a more important role in livestock animals (such as pigs and calves) than in humans. Hof (1999) reported the possibility of influencing the taste of feed stuffs positively is by the use of sweeteners. There are many references in the literature that sweet tasting components significantly increase FI in animals and this fact is today widely accepted. And many of them focus on using sweeteners in the diet of piglets and weaned pigs, but there are few reports on lactating sows. Frederick and Heugten (2002) reported that some aromatic sweeteners have not had an effect on feed consumption of lactating sows, but the addition of flavor compounds may increase feed consumption and help alleviate lactation demands. Aldinger et al. (1959) showed that there was a significant linear increase of baby pigs in feed consumption with increasing levels of saccharin. And, Monegue (2009) found the same result of weaned pigs. Clément (2015) also reported that the sweetener increases piglets FI and improves the palatability of feeds. Tordoff and Friedman (1989) reported that rats having drunk saccharin significantly increased food intake. These

results were the same as our study in that lactating sows fed saccharin diets have higher ADFI than sows fed the basal diets. The previous study of early weaned pigs by Diaz et al. (1956) reported that both gain and feed efficiency were significantly improved as the level of sugar included in the diet increased from 0 to 15%; however, in our experiment, only FI increased, and sows didn't gain more weight when fed the diets containing 0.2% saccharin compared with those fed the control diet. According to Diaz et al. (1956), a concentration of 5% sucrose was optimal and sucrose tended to increase ADG. The result that lactating sows did not gain weight in our study might have been caused by the different sweetener, lower proportion of saccharin, and different period of pigs. There is still considerable uncertainty as to the effect of saccharin on the growth performance of lactating sows, and further study should be conducted to evaluate this effect.

There is no definitive study on the effect of saccharin on the back fat (BF) of lactating sows. In our study, lactating sows had a lower back fat thickness loss when fed diets contain 0.2% saccharin than fed control diets. Maes et al. (2004) reported that BF measurements constitute a valuable tool to monitor and improve the productivity and efficiency of high-producing herds. Škorjanc et al. (2008) and De et al. (2005) all reported that increasing loss of BFT during lactation was associated with a significant increase in WOI. Čechova et al. (2006) showed that sows with a thicker layer of BF achieve better litter performance and more litters in the course of their lives. According to Houde et al. (2010), fluctuations in BFT during the reproductive cycle should be avoided, as it is associated with declining reproductive performance over subsequent parities. In our study, BFT of lactating sows fed saccharin diet lost less than fed control diet. Thus, lactating sows fed diet containing 0.2% saccharin can shorten the WOI.

Conclusion

In conclusion, 0.2% saccharin supplementation had an obscure effect on the growth performance in lactating sows. However, it can shorten the WOI of lactating sows which is good for productivity and efficiency of high-producing herds.

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