Animal Reproduction Science 152 (2015) 55–64

Contents lists available at ScienceDirect

Animal Reproduction Science

journal homepage: www.elsevier.com/locate/anireprosci

Effects of different amounts of konjac flour inclusion in gestation diets on physio-chemical properties of diets, postprandial satiety in pregnant sows, lactation feed intake of sows and piglet performance

H.Q. Sun [a,1], C.Q. Tan [a,1], H.K. Wei [a], Y. Zou [a], G. Long [a], J.T. Ao [a], H.X. Xue [a], S.W. Jiang [b,*], J. Peng [a,*]

[a] *Department of Animal Nutrition and Feed Science, College of Animal Science and Technology, Huazhong Agricultural University, Wuhan 430070, PR China*

[b] *Key Laboratory of Swine Breeding and Genetics of the Agricultural Ministry, College of Animal Science and Technology, Huazhong Agricultural University, Wuhan 430070, PR China*

ARTICLE INFO

Article history:
Received 21 May 2014
Received in revised form 2 November 2014
Accepted 5 November 2014
Available online 14 November 2014

Keywords:
Konjac flour
Lactation feed intake
Piglet performance
Physio-chemical properties
Satiety
Sow

ABSTRACT

This study was conducted to investigate the effects of different amounts of konjac flour (KF) inclusion in the gestation diet on the physio-chemical properties of diets, postprandial satiety in pregnant sows, lactation feed intake of sows and piglet performance during two successive reproductive cycles. Multiparous Landrace sows ($n = 140$) were assigned randomly to one of four experimental diets, and four gestation diets were formulated to contain varying amounts of KF at 0%, 0.6%, 1.2% or 2.2%, respectively. The water binding capacity (WBC) ($P < 0.01$), swelling capacity ($P < 0.01$) of gestation diets, the concentration of total short chain fatty acids ($P < 0.05$) after *in vitro* fermentation of gestation diets increased linearly with increasing inclusion amounts of KF. During the second reproductive cycle, increasing dietary KF linearly increased plasma concentrations of short chain fatty acids (SCFA) 4 h postprandial ($P < 0.05$) and glucagon-like peptide (GLP-1) 2 h postprandial ($P < 0.05$), but decreased the plasma concentration of cortisol (linearly, $P < 0.05$) 1 h postprandial. In addition, there was a linear decrease of the non-feeding oral behavior of gestating sows ($P < 0.01$) when dietary KF increased. There were linear increases in lactation feed intake of sows during entire lactation period ($P < 0.01$) with increasing amounts of KF in the gestation diet. In addition, the number of piglets weaned (linearly, $P < 0.01$; quadratic, $P = 0.01$), average piglet weights and litter weights on day 21 of lactation (linearly, $P < 0.01$) increased with increasing inclusion amounts of KF. In conclusion, inclusion of dietary fiber with great WBC, swelling capacity and fermentation capacity in the gestation diet was beneficial for enhancing postprandial satiety in pregnant sows, increasing lactation feed intake and improved number of piglets weaned per litter through greater pre-weaning survival.

* Corresponding authors at: Department of Animal Nutrition and Feed Science, College of Animal Science and Technology, Huazhong Agricultural University, Wuhan 430070, PR China. Tel.: +86 27 87280122/+86 27 87286912.

E-mail addresses: jiangsiwen@mail.hzau.edu.cn (S.W. Jiang), pengjian@mail.hzau.edu.cn (J. Peng).

[1] Contribute equally to this article.

http://dx.doi.org/10.1016/j.anireprosci.2014.11.003
0378-4320/© 2014 Published by Elsevier B.V.

1. Introduction

It is well known that as the associated body weight gain during gestation increases, feed intake of sows during the subsequent lactation decreases (Weldon et al., 1994; Eissen et al., 2000). Therefore, pregnant sows were recommended to be fed restrictively. Sows are generally restricted fed to amounts of 50% to 60% of their voluntary food intake (Ramonet et al., 1999, 2000) and sows managed under this regimen have greater feeding motivation after feeding (De Leeuw et al., 2008). This resulted in the development of abnormal behavior, which may increase the body injury of sows, and in turn have a negative influence on the reproductive performance of sows (Sekiguchi and Koketsu, 2004).

Inclusion of fiber in gestation diets is a method for reducing abnormal behaviors in sows without providing excess energy. Several studies have shown that dietary fiber inclusion in the gestation diet enhances postprandial satiety and increases lactation feed intake of sows (Meunier-Salaün et al., 2001; Quesnel et al., 2009). Nevertheless, the efficacy by which different types of dietary fiber enhance satiety (Jensen et al., 2012) or increase the lactation feed intake of sows (Veum et al., 2009) varies, possibly because the dietary fiber used in these studies have different physicochemical properties.

There is some evidence that the effect of dietary fiber on body metabolism in mice, rats or human is dependent on the hydration properties and fermentation capacity of the fiber that is fed. The physicochemical properties of dietary fiber may affect postprandial satiety in animals by altering the digestive physiology (Benelam, 2009). Konjac flour (KF) is derived from the tuber of Amorphophallus konjac C. Koch (Chua et al., 2010), and has been consumed as rubbery jelly, noodles and other food products by humans in Asia for centuries. Konjac flour has great viscosity and swelling capacity (McCarty, 2002), and is highly fermented by gut microbiota which produce short-chain fatty acids (Chen et al., 2005, 2006). Therefore, it was hypothesized in the present research that inclusion of KF in the gestation diet may be beneficial for enhancing postprandial satiety in pregnant sows and increasing lactation feed intake of sows because of the unique physicochemical properties of KF.

2. Materials and methods

The study was conducted in accordance with Huazhong Agriculture University Animal Care and Use Committee guidelines.

2.1. Animals, diets and housing

A total of 140 Landrace sows with an average parity of 3.97 ± 1.74 were used in this trial. After breeding, sows were separated into three groups (48, 48, 44 sows, respectively) to start the experiment and each group of sows were randomly allotted to one of four dietary treatment groups based on parity and BW. All sows were maintained on the same dietary treatments in reproductive cycle 1 and 2. Four isoenergetic and isonitrogenous gestation diets were formulated (Table 1): a control diet based on corn and soybean meal (control diet); the second diet included 0.6% konjac flour (0.6% KF diet); the third diet included 1.2% konjac flour (1.2% KF diet); the fourth diet included 2.2% konjac flour (2.2% KF diet). All diets had the same amounts of insoluble fiber (ISF) and NDF, the amounts of soluble fiber increased with the increasing inclusion amounts of KF. The diets were supplied twice a day (0700 and 1430 h) as restricted-fed from mating until the day of farrowing. Daily allowances during gestation are presented in Table 2. In contrast, all sows were fed *ad libitum* the same lactation diets (Table 1), which were supplied three times a day (0700, 1100 and 1730 h). Sows and piglets had free access to drinking water, and piglets were not provided with supplemental ("creep") feed during lactation. Pregnant sows were housed individually in gestation stalls (2.2 m × 0.7 m × 1.1 m). Sows were moved from the gestation stalls to the farrowing rooms on days 106 ± 2 of gestation and then kept in individual farrowing crates with stalls (2.2 × 0.7 m) in pens that provided space on both sides of the stall (2.2 × 0.5 m) for the pigs after birth. During the experimental period, data from sows with illness, serious lameness, death and reproductive failure were not included as part of the analyses.

2.2. Performance measurement

Sows were weighed individually on days 0 and 106 of gestation, within 24 h after farrowing and at weaning using scales with an accuracy of ±0.1 kg. Backfat thickness at 65 mm on each side of the dorsal midline at the last rib (P_2) was measured by ultrasonography (PIGLOG105, SFAK-Technology) on the same days. After farrowing, numbers of total piglets born and piglets born alive were recorded. Cross-fostering was kept within diet treatments to adjust litter size to about 10 ± 0.8 piglets per sow within 48 h after parturition. Piglets were weaned at an average age of 22 ± 1 d. At weaning, number of weaned piglets was recorded. Piglets were weighed within 24 h of birth (day 0), on days 7, 14, 21 of lactation and at weaning. The daily feed intake of sows during lactation was measured each morning by weighing daily feed refusals. After weaning, weaning-to-estrus intervals of sows were recorded.

2.3. Behavior determinations

On days 70, 71 and 72 of gestation during second reproductive cycle, 20 healthy sows (5 parity 3 sows per dietary treatment) were observed for 2 h in each of 2 daily observation periods beginning after the morning and afternoon feedings; observations were repeated on 3 successive days. At the beginning of each time, the four investigators entered the animal room and each observer stationed themselves in front of the five selected sows in the respective treatment. A video-camera was used for the recordings. Each sow was observed for a total of 18 min (4.5 min × 4 sessions) within each observation period, the final ethogram is provided in Table 3. A total of 108 min (18 min/each period × 2 times × 3 days) of video was recorded and analyzed per sow.