



Effects of dietary tryptophan:lysine ratio on the reproductive performance of primiparous and multiparous lactating sows



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ABSTRACT

The objective of this study was to determine the effects of dietary tryptophan (Trp) to lysine (Lys) ratio on the performance of lactating sows. Thirty primiparous and 195 multiparous lactating sows (Landrace × Yorkshire) were allocated on the basis of parity, body weight, and backfat to 5 dietary treatments according to a randomized complete block design with 5 blocks of farrowing date. The 5 experimental diets contained 0.16%, 0.19%, 0.23%, 0.26%, or 0.29% standardized ileal digestible (SID) Trp and SID Lys level was identical (0.87%) for all diets, with the Trp:Lys ratio being 0.18, 0.22, 0.26, 0.30, and 0.33, respectively. Sows received their assigned lactation diets from day 109 of gestation to weaning. Litter size was standardized to 10–12 piglets within 2 days after farrowing. The average lactation length was 19 days and no creep feed was provided. Changes of sow body weight and backfat during lactation, weaning-to-estrus interval, litter size and weight, litter weight gain, preweaning piglet mortality, and performance of subsequent parity (total born alive, stillborns, and mummies) were recorded. A quadratic pattern of body weight loss ($P=0.046$), backfat loss ($P=0.067$), and average daily feed intake ($P=0.096$) with increasing Trp level was observed for the primiparous sows during lactation, and the losses were minimized with the SID Trp:Lys ratio of 0.25 (0.22% SID Trp) and average feed intake was maximized with the SID Trp:Lys ratio of 0.22 (0.19% SID Trp) according to a segmented regression analysis model. Nevertheless, preweaning piglet mortality of the primiparous sows increased linearly and quadratically ($P<0.001$) as Trp level increased. On the contrary, piglet mortality of the multiparous sows decreased linearly ($P=0.031$) with increasing dietary Trp and the mortality was noticeably reduced when the SID Trp:Lys ratio reached 0.26 (0.23% SID Trp). Furthermore, stillborn piglet numbers of multiparous sows in the subsequent parity decreased linearly ($P=0.035$) with increasing level of Trp. Other parameters were not significantly ($P>0.05$) influenced by the dietary treatment. In conclusion, our results indicate that the optimal Trp:Lys ratio for lactating sows is between 0.22 and 0.26.

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1. Introduction

Last few decades sow selection has resulted in high prolificacy and production of lean progeny. Adequate nutrient intake of such sows during lactation is critical and has beneficial effects on sow's subsequent reproductive

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performance including good body condition with a minimum of weight loss and rapid and successful rebreeding (David and Roura, 2009). Deficiencies of amino acid supply including the amount and ratio among amino acids in diets during lactation can lead to significant decreases in longevity and productivity of sows when they are under severe catabolic conditions such as in lactation (Kirchgessner et al., 1992; Kim and Easter, 2003; Roth-Maier et al., 2004). Hence, determination of protein and amino acid requirements of lactating sows is essential to optimize sow reproductive output and longevity (Strathe et al., 2015).

Tryptophan (Trp) is an essential amino acid for monogastric animals because it cannot be synthesized in the body and is a critical nutrient serving as a building block for proteins in pigs (Yao et al., 2011). When corn is used as the main component in pig diets, Trp is generally ranked the third or fourth most-limiting amino acids because of very low concentrations in corn (Paulicks et al., 2006). In contrast to the extensive research on Trp requirement of growing-finishing pigs, there is very limited data on the Trp requirement of sows, especially lactating sows. Lewis and Speer (1974) estimated that 0.12% total Trp was required for optimal lactation performance of lactating sows Libal et al. (1997) observed that increasing dietary Trp levels from 0.12 to 0.17% resulted in higher feed intake and lower weight loss when lactating sows had ad libitum access to diets containing 0.75% lysine. NRC (1998) recommended that the dietary apparent ileal digestible (AID) Trp requirement of lactating sows to be 0.11–0.14%. More recent research indicated that 0.19% AID Trp was required for optimal performance of multiparous lactating sows fed diets containing 0.85% AID lysine (Lys) with the AID Trp: Lys ratio of 0.22 (Paulickset al., 2006; Pampuch et al., 2006). NRC (2012) recommendation for standardized ileal digestible (SID) Trp requirement of lactating sows is in the range of 0.14–0.17% and 0.13–0.16% for primiparous and multiparous sows, respectively.

Given the dramatic improvement of sow reproductive performance over recent decades and associated increases of milk output, growth of piglets and longevity and the additional functions of Trp in regulating many important physiological activities in animals, it is necessary to determine the Trp requirements of contemporary sows. The objective of this study was to investigate the effects of different ratios of Trp to Lys achieved by supplementation of graded levels of Trp to a conventional lactation diet on reproductive performance of primiparous and multiparous lactating sows.

2. Materials and methods

2.1. Experimental design and animal management

This experiment was conducted at the Southern Research and Outreach Center, University of Minnesota, Waseca, Minnesota, USA. The experiment was reviewed and approved by the Institutional Animal Care and Use Committee of the University of Minnesota.

Concentrations of amino acids and crude protein in corn, soybean meal, and distiller's dried grains with solubles

(DDGS) used in this study were analyzed before diet formulation. Standardized ileal digestibilities of amino acids in these ingredients were based on NRC (2012) and those of synthetic amino acids were assumed to be 100%. Five lactation diets (SID Trp:Lys ratio: 0.18, 0.22, 0.26, 0.30, or 0.33) were formulated by supplementation of synthetic tryptophan in a basal lactation diet containing 0.87% standardized ileal digestible (SID) lysine (Table 1). Thus SID tryptophan level in the experimental diets was 0.16%, 0.19%, 0.23%, 0.26%, or 0.29%. All other nutrients met or exceeded NRC (2012) recommendations. A randomized complete block design was utilized in this study with farrowing date as the block. More specifically, 5 batches of lactation trial were conducted from January to March in the year 2015 with about 45 lactating sows per batch. Thirty primiparous and 195 multiparous lactating sows (Topigs 20; Landrace × Large White) were allocated to 1 of the 5 aforementioned treatments on the basis of body weight, backfat, parity, and farrowing date.

The sows were housed individually in gestation stalls, bred by artificial insemination using Duroc semen (Compart's Elite Genes, Nicollet, MN USA) and fed once a day from breeding to day 35 of pregnancy. The pregnant sows were moved to large group pens equipped with electronic sow feeders from day 36–108 of pregnancy. On day 109 of gestation all the sows were housed individually in farrowing crates, with fully slatted floors equipped with a feeder and one nipple drinker, and received their assigned experimental lactation diets. Rooms were ventilated mechanically and the farrowing room temperature was maintained at approximately 18–20 °C. A heat lamp and mat were provided for newborn piglets in each crate during the first week in the lactation period. Litter size was standardized to 10–12 piglets within 2 days after farrowing and the average lactation length was 19 days.

One corn-soybean meal-DDGS based common diet [15.26% crude protein, 14.02 MJ metabolizable energy/kg, SID lysine 0.57%, SID tryptophan 0.12%] was fed to sows from breeding to day 108 of gestation. The sows were given 1.8, 2.0, 2.3, and 2.5 kg/day during the pregnancy period of day 1–55, 56–83, 84–97, 97-farrowing, respectively, and thin sows were provided an extra amount of feed (0.45 kg/day). On the day of farrowing, sows did not receive any feed and the amount of feed was increased by about 1.1 kg per day for the first 5 days post farrowing, followed by ad libitum feeding. Lactating sows were fed twice a day at 7:30 am and 3:00 pm and had free access to water from nipple drinkers.

2.2. Measurements and analyses

The sows were weighed and backfat depth was measured at the P2 position on day 109 of pregnancy and days 1 and 18 of lactation after the morning feeding. The feed intake of sows was measured daily. The piglets were weighed on day 1 and at weaning. No creep feed was provided. Numbers and weight of dead piglets during the whole lactation period were recorded for calculation of pre-weaning mortality and litter weight gain. The weaning-to-estrus interval was recorded. After weaning, all sows were fed the common gestation diet and managed

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