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Minimizing aggression during mixing of gestating sows with supplementation of a tryptophan-enriched diet

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HIGHLIGHTS

- Feeding a tryptophan (TRP)-enriched diet increased blood concentration of TRP in gestating sows.
- The TRP-enriched diet reduced sow aggressiveness at mixing.
- The diet increased the sows' activity levels, especially exploratory behaviors.
- The TRP-enriched diet reduced sham-chewing in older sows housed in stall.
- Feeding a TRP-enriched diet to gestating sows may facilitate group formation.

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ABSTRACT

Gestation stalls are criticized for its negative physical and psycho-physiological effects on sow welfare. Group housing benefits sow well-being and when planned properly can minimize aggression during mixing. This study aimed to evaluate the effect of short-term feeding of a TRP-enriched diet at a concentration of 220% the control (CTL) diet, on aggressiveness at mixing of sows at 4 weeks of gestation. Treatment diets were fed for 7 consecutive days; from days 1 to 5 sows were housed in stalls, early in the morning on day 6 sows were grouped by parity and assessed until day 7. Eighteen pens with 4 sows each (n = 72) of similar parity were assigned to CTL and TRP treatments. Sows' behaviors were recorded daily for 12 h, from days 1 to 7. Inactive and active behaviors (alert, walking (pen), rooting, feeding, drinking, eliminating), stereotypic behaviors (bar biting and sham-chewing), and postures (standing, sitting, lying) were assessed by 10-minute scan sampling. Occurrence of agonistic interactions, number of actions such as bites, head knocks and pursuits and their sum per interaction were recorded for each pen using 2-h continuous behavioral observation, at days 6 and 7. Skin lesion scores were assessed from each sow at day 5 and at 48 h post-mixing, using a sow body map subdivided into anterior, central and posterior body regions. A linear mixed model with day as repeated measure, stall or pen as experimental unit, tested the fixed effects of treatment, day, period within day, their interactions, and block by treatment interaction; stall (trt) or pen (trt) as appropriate was used as random effect. Blood concentration of TRP was higher on the mixing day in TRP-fed sows compared to baseline (76%) and CLT-fed sows at mixing (79%; $P < 0.05$), while serotonin concentration did not differ between treatments ($P > 0.05$). The TRP-enriched diet was effective in reducing sham-chewing in stall housed sows of parity 5–9 ($P < 0.05$). In pens, TRP-fed sows spent more time rooting (TRP = 28.0 vs. CTL = 20.7 ± 1.0%; $P < 0.05$) and consequently less time lying down than CTL-fed sows (TRP = 56.1 vs. CTL = 65.1 ± 2.0%; $P < 0.05$). The total number of offensive actions per interaction was greater in the morning than afternoon for both days ($P < 0.05$), but this was less evident in TRP-fed compared to CTL sows mainly on the morning following mixing (3.4 vs. 7.2 ± 1.0, respectively; Trt * period (day) = $P < 0.05$). The average lesion score was lower in the anterior body region of TRP-fed compared to CTL sows (2.1 vs. 2.5 ± 0.2; $P < 0.05$), the most affected area during fights. The TRP-enriched diet reduced sow aggression while increasing behavioral activity, as evidenced by more time rooting and standing while sows had fewer offensive actions per agonistic interaction and lower skin lesion score 48 h post-mixing. A TRP enriched diet provided to gestating sows for a short period prior to social mixing and continued for a short time after is an effective means of reducing aggression and improving the welfare of sows during group formation.

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1. Introduction

Housing gestating sows in stalls, where turning, walking and interacting with other animals are limited [1], is a predominant practice in intensive swine production worldwide. However, transitioning from individual to group housing of sows is a forthcoming trend [2]. This changing process is likely associated with implementation of legislation in the European Union and in some states of the United States [2, 3], as well as a few other countries, where gestation stalls have been banned and sows are mixed in group pens within the first 4 weeks of gestation.

Stalls may allow for better control of sow nutritional condition and pregnancy success, but this housing system impairs sows physically and psychologically [4]. Group housing, on the other hand, has the potential for greater sow productivity and well-being. Pigs naturally engage in aggressive interactions when introduced to unfamiliar conspecifics, to determine their social hierarchy status [5,6] and to gain access to resources such as space and feed [7].

Additional dietary supplementation of tryptophan (TRP), an essential amino acid that animals can only acquire through diet, is a promising tool to reduce aggressiveness during mixing of pigs [8] including sows. Tryptophan is the precursor for synthesis of serotonin (5-HT) both peripherally and in the brain [9] and it can cross the blood–brain-barrier. Thus, ingestion of high amounts of TRP yields increased TRP concentration in the blood, which positively and directly correlates with brain 5-HT availability in pigs [9–12]. The cerebral neurotransmitter 5-HT inhibits aggression [13] and also regulates sleep, appetite, mood, and behavioral activity [14,15].

Poletto et al. [8] reported that feeding TRP at 3 times the requirement for 7 days was effective in increasing blood TRP and 5-HT concentrations and in reducing aggressiveness of replacement growing gilts. Thus, we hypothesized that feeding a TRP-enriched diet for 5 days prior to mixing gestating sows in group pens and continued feeding of the diet for an additional 2 days would reduce sows' behavioral activity and aggression. The objectives of the current study were to determine the effects of short-term feeding of a TRP-enriched diet on blood concentration of TRP and 5-HT, time-budget behavioral activity, and aggressiveness and skin lesion scores following social mixing of multiparous sows at four weeks post-breeding.

2. Materials and methods

2.1. Animals and housing

All procedures were performed with the approval of the Federal University of Santa Catarina's Animal Care and Use Committee, protocol number PP00690. Multiparous (2 to 9 parities) sows ($n = 71$; Large White × Landrace) at four weeks post-breeding were used in this study. One sow, assigned to the control treatment, died of digestive problems on the second day after mixing and was excluded from all the study's analyses (originally $n = 72$).

The experiment was carried out on a commercial farm of 260 sows in Arvoredo, Santa Catarina, Brazil (latitude 27° 04′28″S), between the months of August and November 2011. Sows were bred on average 28 days after farrowing and were housed in individual stalls of 1.10 m^2 (0.60 m wide × 1.83 m deep), with 2/3 solid concrete flooring and 1/3 plastic grid in the back. All sows were allocated to the same room, and water was provided ad libitum in a trough located at the front of the stalls, which was emptied and used as a feeder at meal times.

Experimental sows, which had already been on treatment, were pregnancy checked at four weeks post-breeding. Sows were assigned to groups of four based on similar parity and body size and moved to pens (n = 18) located in the same room as the stalls. Each pen provided an area of 3.5 m^2 per sow (4.0 m wide × 3.5 m long), had fully solid concrete flooring and solid walls. Water in each pen was also provided ad libitum by a nipple drinker and feed was delivered on the floor in the front area of the pen in a straight line of 1.5 m long to minimize competition. The room was naturally illuminated and ventilated.

2.2. Experimental design and diets

The experiment was organized in five time blocks spaced by a mean interval of 30 days. Two diet treatments were tested: a standard control gestation diet (CTL diet) and a standard gestation diet enriched with 220% concentration of the tryptophan found in the control diet (TRP-enriched diet). A total of 3 kg of concentrate was fed to each sow daily, split into two meals fed at 0730 and 1630. The standard diet was composed of corn, soybean meal, wheat bran and a vitamin/mineral mix (242 Gestation Supermix, Vitamix Animal Nutrition, New Itaberaba, SC) and followed nutritional requirements adopted by the Brazilian swine industry for gestation [16]. Powdered L-tryptophan was added at the expense of starch (5 kg/t), keeping the concentration of all other large essential amino acids (LNAA) constant in both diets, thus only increasing the TRP:LNAA ratio in the TRP-enriched diet. Samples from both diets were collected and crude protein and amino acid content were determined with mass spectrophotometry by M. Cassab Laboratory (São Paulo, SP), a laboratory licensed by the Brazilian Ministry of Agriculture. Details on diet composition and the analyzed diet compositions fed to the experimental sows are presented in Table 1.

For the diet trial, sows respectively assigned to treatments were initially fed the CTL and TRP-enriched diets during 5 consecutive days while housed in the gestation stalls, i.e. days 1–5. In the morning of day 6, approximately 1 h after feeding, sows were mixed in the group pens and continued to be fed the same diets until the afternoon meal of day 7 (48 h after social mixing). From the morning of day 8 until the afternoon of day 10 – the final three days of the trial – all sows received the standard CTL diet.

2.3. Blood collection and HPLC assay

Blood samples were collected from all sows ($n = 71$) on the day prior to starting the feeding trial (baseline, d 0) while they were housed in the stalls, 2 h after mixing sows in the group pens (1000 on day 6) and on the morning of day 8 (at 1000). Samples were collected into 10 mL ethylenediaminetetraacetic acid-coated (K_3EDTA) tubes from jugular

Table 1
Composition of the control and high-tryptophan (TRP) diets provided to gestating sows during a 7 day feeding trial.

	Control diet	High-TRP diet
Ingredient, %		
Ground corn	63.00	62.50
Soybean meal, 48% CP	18.00	18.00
Wheat bran	16.00	16.00
Vitamin/mineral supermix[a]	3.00	3.00
L-Tryptophan[b]	–	0.50
Analyzed composition		
Crude protein, (%)	15.62	15.13
Lysine, (%)	0.84	0.91
Tryptophan[c], (μg/100 g)	398.50	876.00

[a] Provided per kg of gestation diet: folic acid, 25 mg; nicotinic acid, 450 mg; pantothenic acid, 375 mg; antioxidant; 2500 mg; biotin, 25 mg; calcium, maximum 206 g; choline chloride, 9000 mg; cobalt, 18 mg; copper, 3125 mg; iron, 2000 mg; fluoride, maximum 604.8 mg; phosphorus, 79.06 g; iodine, 30 mg; manganese, 1250 mg; selenium, 8 mg; sodium, 43.23 g; vitamin A, 200,000 IU; vitamin B1, 30 mg; vitamin B12, 500 μg; vitamin B2, 50 mg; vitamin B6, 25 mg; vitamin D3, 40,000 IU; vitamin E, 400 mg; vitamin K, 50 mg; zinc, 2500 mg (242 Gestation Supermix, Vitamix Animal Nutrition, Nova Itaberaba, SC, Brazil).

[b] L-Tryptophan (Evonik Industries, São Paulo, SP, Brazil) was added at the expense of starch to create the high-tryptophan (high-TRP) diet.

[c] The analyzed TRP concentration in the gestating sow diet composition corresponds to 220% of the TRP in the control diet.