Effects of Combined Application of Different Compound Palatability Enhancers in Creep Feed and Nursery Feed for Piglets (Postprint)

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Abstract

This experiment aimed to investigate the effects of combined application of sweet-fresh compound attractant and sweet compound attractant on growth performance, serum biochemical indices, nutrient apparent digestibility, and fecal microbial count in piglets. Eight litters of 7-day-old Large White piglets were selected and randomly allocated into 2 groups with 4 replicates per group. The two groups received creep feed training using either a basal creep feed (control group) or a test creep feed supplemented with 2 kg/t sweet-fresh compound attractant. At weaning on day 21, piglets were fed a gruel-like diet for 3 days as transition (feed intake not statistically analyzed). Subsequently, 28 piglets with similar body weight and good body condition were selected from each group at 24 days of age, with 4 replicates per group, and continued to receive the corresponding creep feed. On day 37, piglets were switched to nursery diets; the control group continued with the basal nursery diet, while the test group received the basal nursery diet supplemented with 0.8 kg/t sweet compound attractant until the end of the experiment. The experimental period lasted 59 days. The results showed: 1) After the initial creep feed training, compared with the control group, supplementation of sweet-fresh compound attractant in creep feed significantly increased the average daily feed intake of weaned piglets ($P<0.10$) and significantly decreased serum glucagon-like peptide-1 content ($P<0.10$). 2) During the nursery stage, compared with the control group, supplementation of sweet compound attractant in nursery diet significantly increased the average daily feed intake and average daily gain of weaned piglets ($P<0.10$). Comprehensive analysis indicated that combined application of the two compound attractants in creep feed and nursery diet for piglets could improve growth performance, with no effects on fecal microbiota and nutrient apparent digestibility.

Full Text

A Study on the Combined Application Effects of Different Compound Feeding Attractants in Creep and Nursery Feed for Piglets

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Abstract

This study investigated the effects of combined application of an aromatic, sweetener, and flavor enhancer compound feeding attractant (ASF-CFA) with an aromatic and sweetener compound feeding attractant (AS-CFA) on growth performance, serum biochemical indices, nutrient apparent digestibility, and fecal microbial populations in piglets. Eight litters of 7-day-old Large White piglets were randomly divided into two groups with four replicates per group. The control group received a basal creep feed, while the experimental group received creep feed supplemented with 2 kg/t ASF-CFA for creep training. At 21 days of age, all piglets were weaned and fed a porridge-like diet for three days (feed intake not recorded). Subsequently, 28 healthy piglets with similar body weight were selected from each group at 24 days of age and continued on their respective creep feeds with four replicates per group. At 37 days of age, piglets were switched to nursery diets; the control group continued with the basal nursery diet, while the experimental group received nursery diet supplemented with 0.8 kg/t AS-CFA until the end of the trial. The total experimental period was 59 days. The results showed that: (1) After creep training, creep feed supplemented with ASF-CFA significantly increased average daily feed intake (ADFI) of weaned piglets ($P < 0.10$) and significantly reduced serum glucagon-like peptide-1 (GLP-1) content ($P < 0.10$) compared to the control group. (2) During the nursery stage, nursery diet supplemented with AS-CFA significantly increased both ADFI and average daily gain (ADG) of weaned piglets ($P < 0.10$). In conclusion, the combined application of these two compound feeding attractants in creep and nursery feed can improve piglet growth performance without affecting fecal microbial populations or nutrient apparent digestibility.

Keywords: colostrum-flavored aromatic-sweetener-flavor enhancer compound feeding attractant; colostrum-flavored aromatic-sweetener compound feeding attractant; weaned piglets; growth performance; serum biochemical indices

Introduction

In animal husbandry, improving feed palatability typically increases feed costs. Therefore, enhancing palatability while reducing feed costs has become essential for improving farming profitability. Animals instinctively select feed based on palatability [1]. Feeding attractants stimulate olfactory and gustatory organs through "aroma" and "taste," triggering a series of commands from the brain center that induce increased appetite in piglets [2]. Moreover, attractants such as flavor enhancers and aromatic agents can encourage suckling piglets to explore feed in creep feeders, promoting earlier feed intake and adaptation to changes in nutrient sources and forms [3], thereby alleviating weaning syndrome symptoms such as reduced feed intake, slow growth, and diarrhea [4]. During the later nursery period, piglets' gastrointestinal tracts are basically mature and feeding habits become relatively stable, diminishing the role of flavor enhancers. Therefore, adding only aromatic-sweetener compound attractants can reduce feed costs. Previous studies have shown that adding aromatic agents, sweeteners, and flavor enhancers to piglet diets can improve growth performance [5-7]. While the application of these individual attractants is well-established, most research has focused on single use of aromatic agents or sweeteners, or only aromatic-sweetener compound attractants. Reports on the combined use of different compound attractants in creep and nursery feeds are limited. Therefore, this study aimed to investigate the effects of combined application of a colostrum-flavored aromatic-sweetener-flavor enhancer compound feeding attractant (ASF-CFA) and a colostrum-flavored aromatic-sweetener compound feeding attractant (AS-CFA) on piglet growth performance, serum biochemical indices, dietary nutrient apparent digestibility, and fecal microbial flora, providing scientific basis for their combined application in creep and nursery feeds.

1.1 Experimental Materials

Both the aromatic-sweetener-flavor enhancer compound feeding attractant (product code 78457) and the aromatic-sweetener compound feeding attractant (product code 78245) were provided by Lucta (Guangzhou) Flavors Co., Ltd. Both products featured a colostrum flavor profile with 20% sweetness intensity. The umami taste was provided by amino acids, amino acid salts, nucleotides, plant extracts, and yeast hydrolysates.

1.2 Experimental Design and Diet Formulation

The experiment employed a completely randomized block design. Eight litters of 7-day-old Large White piglets were randomly divided into two groups with four replicates per group. The control group received basal creep feed, while the experimental group received creep feed supplemented with 2 kg/t ASF-CFA for creep training. At 21 days of age, piglets were weaned and fed a porridge-like diet for three days (feed intake not statistically recorded). Subsequently, 28 healthy piglets with similar body weight and good condition were selected from each group at 24 days of age, with four replicates per group, and continued

on their respective creep feeds. At 37 days of age, piglets were transitioned to nursery diets; the control group continued with basal nursery diet, while the experimental group received nursery diet supplemented with 0.8 kg/t AS-CFA until the end of the trial. The total experimental period was 59 days, with daily feed intake recorded for each replicate. The composition and nutrient levels of the basal creep feed are shown in Table 1 , and those of the basal nursery feed are shown in Table 2 .

1.3 Feeding Management

The trial was conducted from June 24 to August 18, 2015, at Liaoning Aidemeng Swine Breeding Co., Ltd. The pig house temperature was maintained at (26 ± 3)°C. All experimental piglets were housed in the same building and managed according to conventional procedures and normal immunization programs. Throughout the trial, piglets had ad libitum access to feed and water.

1.4 Measurements

1.4.1 Growth Performance Piglets were weighed at 7, 21, 24, 37, and 65 days of age to calculate average daily feed intake (ADFI), average daily gain (ADG), and feed-to-gain ratio (F/G). Fecal consistency was observed daily each morning to assess diarrhea and record observations. Feces were scored on a four-level scale: normal (0), soft (1), viscous (2), and watery (3), with diarrhea index calculated accordingly. Diarrhea rate (%) = (number of diarrheal piglets × days) / (total number of piglets × trial days) × 100. Diarrhea index = total diarrhea scores / number of piglets.

1.4.2 Serum Biochemical Indices At the end of the trial, four piglets were randomly selected from each replicate and 10 mL of blood was collected from the anterior vena cava after overnight fasting. Serum was obtained by centrifugation at 3,000 rpm for 15 minutes after allowing blood to clot for 15 minutes, and stored at -20°C until analysis. Serum growth hormone (GH), leptin (Lep), and cholecystokinin (CCK) concentrations were determined by radioimmunoassay using kits purchased from Tianjin Jiuding Medical Bioengineering Co., Ltd., Beijing Huabulite Biotechnology Research Institute, and Shanghai Second Military Medical University Neurobiology Department, respectively, and measured using an Sn-69513 immunocounter according to manufacturer instructions. Serum glucagon-like peptide-1 (GLP-1) and ghrelin concentrations were determined by enzyme-linked immunosorbent assay using kits purchased from Nanjing Baisenjia Biotechnology Co., Ltd., and measured using a Multiskan MK3 microplate reader according to manufacturer instructions.

1.4.3 Fecal Microbial Counts On the day before trial conclusion, five piglets with good growth and similar condition were selected from each replicate. Fecal samples (~50 g per piglet) were collected between 06:00 and 08:00, packaged in sterile self-sealing bags, and stored at -20°C for enumeration of

Escherichia coli, *Lactobacillus*, and *Bifidobacterium* using the plate spreading method. All culture media were purchased from Qingdao Hi-tech Industrial Park Hope Bio-Technology Co., Ltd. Results were expressed as log colony-forming units per gram of feces [log(CFU/g)].

1.4.4 Nutrient Apparent Digestibility Acid-insoluble ash (AIA) was used as an internal marker to determine nutrient apparent digestibility. Four piglets with good growth and similar condition were selected from each group. Fecal samples were collected daily from 07:00 to 09:00 for three days before trial conclusion. Two 200 g samples were collected from each piglet, mixed with 20 mL of 10% tartaric acid solution to prevent ammonia volatilization, and stored frozen individually. Samples were transported to the laboratory under sealed low-temperature conditions, then dried at 65°C. Crude protein (CP), ether extract (EE), calcium (Ca), phosphorus (P), and crude ash contents in feed and feces were determined using the internal marker method according to *Feed Analysis and Feed Quality Detection Technology* [8].

1.5 Data Processing and Analysis

All data were analyzed using SPSS 22.0 software for one-way ANOVA. Results are expressed as "mean ± standard deviation." Significance was set at $P < 0.10$, with $P > 0.10$ considered not significant.

2.1 Effects of ASF-CFA Supplementation in Creep Feed During Pre-Weaning Training on Suckling Piglet Growth Performance

As shown in Table 3 , ASF-CFA supplementation in creep feed during the training period had no significant effects on average daily feed intake, average daily gain, or feed-to-gain ratio of suckling piglets ($P > 0.10$).

2.2 Effects of ASF-CFA Supplementation in Creep Feed on Weaned Piglets

2.2.1 Growth Performance As shown in Table 4 , ASF-CFA supplementation in creep feed significantly increased average daily feed intake of weaned piglets by 8.8% ($P < 0.10$) compared to the control group, but had no significant effects on average daily gain, feed-to-gain ratio, diarrhea rate, or diarrhea index ($P > 0.10$).

2.2.2 Serum Biochemical Indices As shown in Table 5 , ASF-CFA supplementation in creep feed significantly reduced serum GLP-1 concentration by 9.7% ($P < 0.10$) compared to the control group, but had no significant effects on other serum biochemical indices ($P > 0.10$).

2.2.3 Fecal Microbial Populations As shown in Table 6 , ASF-CFA supplementation in creep feed had no significant effects on fecal microbial populations

of weaned piglets ($P > 0.10$).

2.2.4 Nutrient Apparent Digestibility As shown in Table 7 , ASF-CFA supplementation in creep feed had no significant effects on nutrient apparent digestibility of weaned piglets ($P > 0.10$).

2.3 Effects of AS-CFA Supplementation in Nursery Feed on Weaned Piglets

2.3.1 Growth Performance As shown in Table 8 , AS-CFA supplementation in nursery feed significantly increased both average daily feed intake and average daily gain of weaned piglets by 6.0% and 9.0%, respectively ($P < 0.10$), but had no significant effect on feed-to-gain ratio ($P > 0.10$).

2.3.2 Fecal Microbial Populations As shown in Table 9 , AS-CFA supplementation in nursery feed had no significant effects on fecal microbial populations of weaned piglets ($P > 0.10$).

2.3.3 Nutrient Apparent Digestibility As shown in Table 10 , AS-CFA supplementation in nursery feed had no significant effects on nutrient apparent digestibility of weaned piglets ($P > 0.10$).

2.4 Effects of Combined Application of Two Compound Attractants on Piglet Growth Performance Throughout the Trial

As shown in Table 11 , over the entire trial period, combined application of the two compound attractants significantly increased both average daily feed intake and average daily gain of piglets by 4.7% and 9.5%, respectively ($P < 0.10$), but had no significant effect on feed-to-gain ratio ($P > 0.10$).

2.5 Economic Benefits of Dietary Supplementation with Two Compound Attractants

As shown in Tables 12 and 13 , the net profit per piglet supplemented with 2 kg/t ASF-CFA was 8.74 yuan higher than the control group, with a return on investment of 1:8.23. The net profit per piglet supplemented with 0.8 kg/t AS-CFA was 10.20 yuan higher than the control group, with a return on investment of 1:9.81. The overall return on investment for the entire period was 1:9.01.

3.1 Effects of ASF-CFA Supplementation in Creep Feed During Training on Piglets

During the pre-weaning period, feed intake level has minimal impact on suckling piglet growth rate because piglets primarily rely on sow milk rather than creep feed [9]. The purpose of creep feed supplementation is twofold: to train piglets

to recognize feed and prepare them for dietary transition after weaning, and to prevent nutritional deficiency due to gradually decreasing milk supply [10].

After creep training, ASF-CFA supplementation in post-weaning creep feed significantly increased feed intake and reduced serum GLP-1 concentration. This occurred because the aromatic profile of ASF-CFA resembles sow milk, reducing novelty and exploration time while shortening the recovery period for feed intake during weaning stress. Additionally, the sweetener and flavor enhancer components improved diet palatability, maintaining higher feed intake throughout the period. The reduction in serum GLP-1 decreased satiety signals, thereby increasing feed intake [11]. These findings align with Liu et al. [5], who reported increased feed intake after adding aromatic and sweetener agents to piglet diets.

Although ASF-CFA significantly increased average daily feed intake, it did not significantly affect average daily gain. This may be attributed to the three-day post-weaning period when piglets were fed porridge-like diets similar to milk, allowing gastrointestinal adaptation to carbohydrates and plant proteins. When solid creep feed was introduced, feed intake increased, but the piglets' digestive capacity at this physiological stage was limited, preventing complete absorption of the additional nutrients. Consequently, only a portion was manifested as increased daily gain, resulting in no significant effects on average daily gain or feed-to-gain ratio.

3.2 Effects of AS-CFA Supplementation in Nursery Feed on Piglets

During the nursery stage, piglets' gastrointestinal tracts are basically mature, reducing the need for flavor enhancers and allowing cost reduction through AS-CFA supplementation. Post-weaning AS-CFA supplementation (with the same aromatic profile as ASF-CFA but without flavor enhancers) significantly increased both average daily feed intake and average daily gain. Feng et al. [12] demonstrated that milk-flavored attractants increased feed intake by 5.4% under normal conditions and 9-12% under stress conditions. Yao et al. [13] showed that feeding attractants substantially increased average daily feed intake and gain in weaned piglets. Zhang et al. [14] reported that aromatic agents increased feed intake, daily gain, feed utilization by 11.6%, and economic benefits by 30.7%. Our results are consistent with these findings.

Flavor enhancers do not affect other taste sensations but enhance flavor characteristics and improve palatability [15]. Therefore, although the compound lacked flavor enhancers, the aromatic and sweetener components continued to exert feeding attraction and palatability improvement [16-17]. As the digestive system developed, piglets could more fully digest and absorb dietary nutrients, storing them as fat and muscle. Consequently, AS-CFA supplementation significantly improved both average daily feed intake and gain.

3.3 Effects of Combined Application of Two Compound Attractants Throughout the Trial

Combined application of both attractants significantly increased average daily feed intake and gain throughout the entire trial period, demonstrating that their combined use in creep and nursery feeds can improve piglet growth performance while reducing production costs through stage-specific application.

The lack of effect on fecal microbial populations may be because piglets had already passed the weaning stress period and adapted to nursery diets, with intestinal physiology largely normalized, preventing full expression of the attractants' potential to promote gastrointestinal development and microbial balance. Nutrient digestibility depends on feed ingredient composition, processing technology, and animal condition. Our relatively low digestibility values compared with Chen et al. [18] and Zhu et al. [19] may be related to pig breed and attractant type.

Conclusion

Combined application of aromatic-sweetener-flavor enhancer compound feeding attractant and aromatic-sweetener compound feeding attractant in creep and nursery feeds can improve piglet growth performance without affecting intestinal microbial populations or nutrient apparent digestibility.

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Note: Figure translations are in progress. See original paper for figures.