Effects of Porcine Placenta Powder on Reproductive Performance, Serum Immune and Reproductive Hormone Indices, and Milk Composition in Lactating Sows (Postprint)

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Abstract

This experiment aimed to investigate the effects of pig placenta powder on the reproductive performance, serum immune and reproductive hormone indices, and milk composition of lactating sows. Thirty-six multiparous Large White × Landrace sows with similar expected delivery date, body weight, and parity were selected and randomly divided into 4 groups with 9 replicates per group and 1 sow per replicate. The control group was fed a basal diet, while experimental groups I, II, and III were fed the basal diet supplemented with 1%, 3%, and 5% pig placenta powder, respectively. The experiment started on day 104 of gestation and ended on day 21 postpartum. The results showed that: 1) Lactation capacity, individual weaning weight, and litter weaning weight in group III were extremely significantly higher than those in the control group ($P<0.01$), average daily gain of piglets in groups II and III was significantly or extremely significantly higher than that in the control group ($P<0.05$ or $P<0.01$), and sow body weight loss in group III was significantly lower than that in the control group ($P<0.05$). 2) On day 3 postpartum, serum interleukin-6 (IL-6) content in group II was significantly or extremely significantly higher than that in the control group and groups I and III ($P<0.05$ or $P<0.01$), serum immunoglobulin A (IgA) content in groups I, II, and III was significantly higher than that in the control group ($P<0.05$), serum immunoglobulin M (IgM) content in group I was extremely significantly higher than that in the control group and group III ($P<0.01$), and serum prolactin (PRL) content in groups II and III was significantly higher than that in the control group ($P<0.05$). On day 15 postpartum, serum IgA content in groups I and II was significantly or extremely significantly higher than that in the control group and group III ($P<0.05$ or $P<0.01$), serum immunoglobulin G (IgG) content in group II was significantly or extremely significantly higher than that in the control group and group III ($P<0.05$ or

P<0.01); serum IgM content in group I was extremely significantly higher than that in the control group (P<0.01). Serum PRL content in groups I, II, and III was extremely significantly higher than that in the control group (P<0.01). 3) Milk fat percentage in group III was significantly higher than that in the control group and group I (P<0.05), and milk lactose percentage in groups II and III was significantly or extremely significantly higher than that in the control group and group I (P<0.05 or P<0.01). These results indicate that dietary supplementation with pig placenta powder can improve the reproductive performance, serum immune and reproductive hormone indices, and milk quality of lactating sows. Under the conditions of this experiment, the appropriate supplementation level of pig placenta powder was 3%.

Full Text

Effects of Pig Placental Powder on Reproductive Performance, Serum Immune and Reproductive Hormone Indexes, and Milk Composition of Lactating Sows

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Abstract

This experiment was conducted to investigate the effects of dietary pig placental powder on reproductive performance, serum immune and reproductive hormone indexes, and milk composition in lactating sows. Thirty-six multiparous Large White × Landrace sows with similar expected delivery dates, body weights, and parities were randomly allocated into four groups, with nine replicates per group and one sow per replicate. Sows in the control group were fed a basal diet, while those in experimental groups I, II, and III received the basal diet supplemented with 1%, 3%, and 5% pig placental powder, respectively. The trial commenced on day 104 of gestation and concluded on day 21 postpartum. The results showed: 1) Milk yield, individual weaning weight, and litter weaning weight in group III were significantly higher than those in the control group (P<0.01). The average daily gain of piglets in groups II and III was significantly or extremely significantly higher than that in the control group (P<0.05 or P<0.01). Sow body weight loss in group III was significantly lower than that in the control group (P<0.05). 2) On day 3 postpartum, serum interleukin-6 (IL-6) content in group II was significantly or extremely significantly higher than that in the control group and groups I and III (P<0.05 or P<0.01). Serum immunoglobulin A (IgA) content in groups I, II, and III was significantly higher than that in the control group (P<0.05). Serum immunoglobulin M (IgM) content in group I was extremely significantly higher than that in the control group and group III (P<0.01). Serum prolactin (PRL) content in groups II and III was

significantly higher than that in the control group (P<0.05). On day 15 postpartum, serum IgA content in groups I and II was significantly or extremely significantly higher than that in the control group and group III (P<0.05 or P<0.01). Serum immunoglobulin G (IgG) content in group II was significantly or extremely significantly higher than that in the control group and group III (P<0.05 or P<0.01). Serum IgM content in group I was extremely significantly higher than that in the control group (P<0.01). Serum PRL content in groups I, II, and III was extremely significantly higher than that in the control group (P<0.01). 3) Milk fat percentage in group III was significantly higher than that in the control group and group I (P<0.05). Lactose percentage in groups II and III was significantly or extremely significantly higher than that in the control group and group I (P<0.05 or P<0.01). These results indicate that dietary supplementation with pig placental powder can improve reproductive performance, serum immune and reproductive hormone indexes, and milk quality in lactating sows. Under the conditions of this experiment, the optimal inclusion level of pig placental powder is 3%.

Keywords: pig placental powder; lactating sows; reproductive performance; immune indexes; reproductive hormones; milk quality

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1 Materials and Methods

1.1 Experimental Material

Pig placental powder was prepared from fresh sow placentas collected from the experimental farm, which underwent repeated washing, disinfection, drying, and crushing in the laboratory. The specific processing protocol was as follows: fresh placenta collection → abnormal placenta removal → washing → pulping → drying → crushing → vacuum packaging. The pulped placental fragments were evenly spread on stainless steel drying trays and subjected to two-stage drying using a DZF-6903 vacuum drying oven. Initially, the placental tissue was dried at 65°C and 77.327 kPa for 4 hours. Subsequently, the temperature and vacuum pressure were adjusted to 55°C and 79.993 kPa, respectively, for 20 hours, resulting in a total drying time of 24 hours. The dried placental tissue was then pulverized using a DWF-90 grinder, passed through an 80-mesh sieve, and rapidly vacuum-packaged. The nutritional composition of the pig placental powder, as determined by laboratory analysis, is presented in Table 1 .

1.2 Experimental Design and Diets

Thirty-six multiparous Large White × Landrace sows with similar expected delivery dates, body weights, and parities were randomly divided into four groups, with nine replicates per group and one sow per replicate. The control group was fed a basal diet, while experimental groups I, II, and III received the basal diet supplemented with 1%, 3%, and 5% pig placental powder, respectively. The trial began on day 104 of gestation and ended on day 21 postpartum.

The basal diet for sows was formulated according to the NRC (2012) nutrient requirements for lactating sows. For the experimental diets, protein ingredient levels were adjusted based on the inclusion rate and nutritional composition of pig placental powder to ensure consistent crude protein levels across all groups. The composition and nutrient levels of the experimental diets are shown in Table 2 .

1.3 Feeding Management

Experimental sows were moved to farrowing crates seven days before parturition to acclimate to the environment, and their feed was switched from gestation to lactation diet, marking the start of the formal trial (day 104 of gestation). Sows were limit-fed 1–2 kg/day for three days before farrowing and were not fed on the day of parturition. Feed intake was increased to 2–3 kg/day during the first 2–3 days postpartum, after which sows were allowed ad libitum access to feed. Pigs had free access to water, and pens were kept clean and dry. Piglets were weaned at 28 days of age. Other management practices and immunization procedures followed standard farm protocols.

1.4 Measurement Indicators

1.4.1 Reproductive Performance, Body Condition, and Feed Intake Reproductive performance parameters included recording the number of live piglets per litter on the day of parturition and weighing individual piglets at birth (piglets weighing <0.9 kg were excluded from statistical analysis). Individual piglet weights were measured on days 21 and 28 of lactation (weaning day) to calculate 21-day litter weight, individual weaning weight, litter weaning weight, and average daily gain during lactation. The weaning-to-estrus interval was also recorded.

Body condition changes were assessed by measuring sow body weight and backfat thickness (at 6.5 cm from the dorsal midline at the level of the last rib) on the day of parturition and day 28 postpartum (weaning day) to calculate body weight loss and backfat change during lactation. Daily feed intake was accurately recorded for each sow to calculate average daily feed intake (ADFI) for each group.

1.4.2 Serum Immune and Reproductive Hormone Indexes On days 3 and 15 postpartum, 10 mL of blood was collected from the anterior vena cava of three randomly selected sows per group (12 sows total) before morning feeding. After standing at room temperature for 15 minutes, blood samples were centrifuged at 3,000 r/min for 15 minutes. Serum was harvested, aliquoted into 1.5 mL centrifuge tubes, and stored at -20°C for subsequent analysis.

Enzyme-linked immunosorbent assay (ELISA) kits were used to determine the concentrations of interleukin-6 (IL-6), tumor necrosis factor- (TNF-),

interferon- (IFN-), immunoglobulin A (IgA), immunoglobulin M (IgM), immunoglobulin G (IgG), luteinizing hormone (LH), and prolactin (PRL).

1.4.3 Milk Composition On day 14 of lactation, milk samples (20 mL per sow) were collected from the anterior, middle, and posterior teats of each sow and pooled. Samples were stored at -20°C until analysis. Milk composition, including fat percentage, protein percentage, lactose percentage, and non-fat solids content, was analyzed using a MILK YWAY-CP2 automatic milk composition analyzer.

1.5 Data Processing

Experimental data were initially processed using Excel 2012 software. Statistical analysis was performed using SPSS 19.0 software for one-way ANOVA, followed by LSD multiple comparison tests. Differences were considered significant at $P<0.05$ and extremely significant at $P<0.01$. Results are expressed as "mean ± standard deviation."

2 Results

2.1 Effects of Pig Placental Powder on Reproductive Performance and Body Condition of Lactating Sows

As shown in Table 3 , milk yield, individual weaning weight, and litter weaning weight in group III were extremely significantly higher than those in the control group ($P<0.01$), with no significant differences between groups II and III ($P>0.05$). Milk yield in group III was significantly higher than that in group I ($P<0.05$), and individual weaning weight was extremely significantly higher than that in group I ($P<0.01$). The average daily gain of piglets in the control group was significantly lower than that in group II ($P<0.05$) and extremely significantly lower than that in group III ($P<0.01$), while no significant difference was observed between groups II and III ($P>0.05$). Average daily feed intake in groups II and III was significantly higher than that in the control group and group I ($P<0.05$), with the highest value observed in group III. Sow body weight loss in group III was significantly lower than that in the control group and group I ($P<0.05$), with no significant difference between groups II and III ($P>0.05$). No significant differences were detected among groups in birth weight, sow backfat change, or weaning-to-estrus interval ($P>0.05$).

2.2 Effects of Pig Placental Powder on Serum Immune Indexes of Lactating Sows on Day 3 Postpartum

As presented in Table 4 , on day 3 postpartum, serum IL-6 content in group II was extremely significantly higher than that in group I ($P<0.01$) and significantly higher than that in the control group and group III ($P<0.05$). Compared with group III, serum TNF- and IgG contents in group I were significantly increased ($P<0.05$), and serum IgM content was extremely significantly increased

(P<0.01). No significant differences in serum TNF- content were observed among the other groups (P>0.05). Serum IgM content in group I was extremely significantly higher than that in the control group (P<0.01), with no significant difference between groups I and II (P>0.05). Serum IgG content in group II was significantly higher than that in group III (P<0.05), while no significant differences were found among group I, group II, and the control group (P>0.05). Serum IFN- and IgA contents in group I were significantly higher than those in the control group (P<0.05), with no significant differences among groups I, II, and III (P>0.05).

2.3 Effects of Pig Placental Powder on Serum Immune Indexes of Lactating Sows on Day 15 Postpartum

As shown in Table 5 , on day 15 postpartum, serum IL-6 content in group III was significantly lower than that in the control group and group II (P<0.05), with no significant differences between groups I and III or between the control group and group II (P>0.05). Serum IFN- content in groups II and III was significantly lower than that in the control group (P<0.05), while no significant difference was observed between the control group and group I (P>0.05) or between groups II and III (P>0.05). Serum IgA content in group II was extremely significantly higher than that in the control group (P<0.01), with no significant difference between group III and the control group (P>0.05) or between groups I and II (P>0.05). Serum IgM content in group I was extremely significantly higher than that in the control group (P<0.01), while no significant differences were detected among the control group, group II, and group III (P>0.05). Serum IgG content in group II was extremely significantly higher than that in group III (P<0.01) and significantly higher than that in the control group (P<0.05), with no significant differences among the control group, group I, and group III (P>0.05). No significant differences in serum TNF- content were observed among any groups (P>0.05).

2.4 Effects of Pig Placental Powder on Serum Reproductive Hormone Indexes of Lactating Sows

As indicated in Table 6 , on day 3 postpartum, serum PRL content in groups II and III was significantly higher than that in the control group (P<0.05), with no significant difference between groups II and III (P>0.05) or between group I and the control group (P>0.05). On day 15 postpartum, serum PRL content in groups I, II, and III was extremely significantly higher than that in the control group (P<0.01), with the highest value observed in group II, which was significantly higher than that in group I (P>0.05). No significant difference was detected between groups I and III (P>0.05). Serum PRL content on day 15 postpartum decreased compared with day 3 postpartum across all groups, while no significant differences in serum LH content were observed among groups at either time point (P>0.05).

2.5 Effects of Pig Placental Powder on Milk Composition of Lactating Sows

As demonstrated in Table 7 , milk fat percentage in group III was significantly higher than that in the control group and group I ($P<0.05$), with no significant difference between groups II and III ($P>0.05$). Lactose percentage in group III was extremely significantly higher than that in the control group and group I ($P<0.01$), while group II also showed significantly higher lactose percentage compared with the control group and group I ($P<0.05$). No significant differences were observed among groups in milk protein percentage or non-fat solids content ($P>0.05$).

3 Discussion

3.1 Effects of Pig Placental Powder on Reproductive Performance and Body Condition of Lactating Sows

In recent years, advances in intensive farming technology and breeding have substantially improved sow reproductive performance. The growth performance of suckling piglets serves as a crucial indicator of sow reproductive capacity. During lactation, piglets primarily obtain nutrients from sow milk, and their healthy growth largely depends on the sow' s health status and milk quality. High-quality milk in sufficient quantities promotes rapid growth, strong immunity, and greater weaning weight in piglets, which significantly benefits subsequent fattening performance.

Reports on the effects of animal placental preparations on livestock reproductive performance and growth promotion are relatively limited compared with studies on their bioactive substances. Research has shown that animal placentas contain various immunomodulatory substances that promote lymphocyte proliferation and differentiation, enhance immunity, stimulate bone marrow hematopoietic function, and exert hematopoietic effects. Lu et al. reported that animal placentas contain 14 trace elements and 16 amino acids, including seven essential amino acids and eight trace elements. Huang found that supplementing lactating sow diets with certain amino acids effectively increased milk fat percentage, protein percentage, total solids, and non-fat solids content, while improving litter weaning weight and daily gain. The present results demonstrate that dietary supplementation with 1%, 3%, and 5% pig placental powder increased sow milk yield, individual weaning weight, and average daily gain of piglets during lactation compared with the control group. Pig placental powder not only enhanced sow immunity but also effectively supplemented trace elements and regulated amino acid levels, thereby improving lactation capacity and milk quality. These findings align with previous studies, suggesting that the immunomodulatory substances in pig placental powder safeguarded sow health. Additionally, trace elements from the placental powder absorbed into the sow' s bloodstream may have participated in milk synthesis to improve milk quality or crossed the blood-milk barrier to be ingested by piglets, thus promoting their

healthy growth.

3.2 Effects of Pig Placental Powder on Serum Immune and Reproductive Hormone Indexes of Lactating Sows

Lamm reported that IgA, IgG, and IgM are major components of humoral immunity that defend against pathogen invasion. IgA primarily participates in mucosal immunity by forming immune complexes in mucosal tissues to resist damage from foreign pathogens. IgM is the predominant antibody produced during the early stage of primary humoral immune responses and exhibits strong anti-infective properties. IgG, accounting for approximately 75% of total immunoglobulins, directly reflects the level of systemic immunity. IFN- and IL-6 are also important immunoregulatory cytokines. While direct studies on placental preparations affecting immune substances in animals are scarce, numerous reports exist on placental factors influencing immune organs. Cui et al. found that placental powder significantly increased spleen and thymus weights and splenic lymphocyte transformation rates in mice. Fang et al. demonstrated that sheep placental factors significantly enhanced the ability of splenic B lymphocytes to produce antibodies and markedly increased IgG levels in mouse blood compared with low-dose groups. The current results showed that serum IgA, IgG, and IgM contents in all experimental groups were higher than those in the control group on both days 3 and 15 postpartum, with serum IL-6 content being highest in the 3% supplementation group and serum IFN- content highest in the 1% group. These findings are consistent with previous reports, indicating that pig placental powder positively affects the immunity of lactating sows. Furthermore, placentas contain PRL, which promotes milk secretion and improves milk quality. The results revealed that serum PRL content in all experimental groups exceeded that of the control group, with higher levels observed in the 3% and 5% groups. Although serum PRL content decreased on day 15 postpartum compared with day 3 across all groups, experimental groups maintained higher levels than the control group, demonstrating that pig placental powder significantly promotes lactation capacity in sows, which corroborates previous research findings.

3.3 Effects of Pig Placental Powder on Milk Composition of Lactating Sows

The present results indicated that lactose and milk fat percentages in all experimental groups were higher than those in the control group, with the most pronounced effects observed in the 3% and 5% groups. However, no significant differences were detected in milk protein percentage or non-fat solids content among groups. Lactose, milk fat, and protein are primary nutritional components of milk and crucial indicators of milk quality, directly influencing the growth and development of suckling piglets. Lactose and protein primarily provide energy for piglets, while milk fat is mainly utilized for fat deposition in newborn piglets. Multiple factors affect milk composition, including trace

element and amino acid intake in lactating sows and hormonal levels. Placentas are rich in various bioactive substances, trace elements, amino acids, and reproductive hormones. Previous studies reported that placentas contain not only reproductive hormones such as PRL but also 14 trace elements and 16 amino acids, including multiple essential trace elements and amino acids. The increased lactose and milk fat percentages observed in the experimental groups may be attributed to the combined effects of various trace elements, amino acids, and PRL provided by pig placental powder. Ben-Jonathan et al. found that PRL promotes the synthesis of lactose and milk fat in mammary glands while increasing milk protein production. Chen et al. reported that PRL enhances the secretory capacity of casein and lactose in bovine mammary epithelial cells, elevating lactose and milk fat content in milk. The serum reproductive hormone results from this study clearly demonstrated that serum PRL content in all experimental groups was significantly higher than that in the control group, further supporting the inference that increased lactose and milk fat content is closely related to PRL or other reproductive hormones present in pig placental powder. The underlying mechanisms warrant further investigation.

4 Conclusion

1. Dietary supplementation with pig placental powder improved reproductive performance, serum immune and reproductive hormone indexes, and milk composition in lactating sows. The most notable improvements were observed in milk yield, individual weaning weight, and average daily gain of piglets for reproductive performance; in serum IgA, IgG, IgM, IL-6, and IFN- contents for immune indexes; in serum PRL content for reproductive hormone indexes; and in lactose and milk fat percentages for milk composition.

2. Based on the comprehensive results of this study, a 3% inclusion level of pig placental powder is recommended for optimal improvement in reproductive performance, serum immune and reproductive hormone indexes, and milk quality in lactating sows.

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