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IMPACT OF ASTRAGALUS ROOT RESIDUE ON GROWTH PERFORMANCE, IMMUNITY AND ANTIOXIDANT CAPACITY OF FATTENING PIGS

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ABSTRACT

Astragalus membranaceus is a widely used Chinese medicine. To investigate the effect of Astragalus residue as a feed additive on growth performance, immune performance, and antioxidant capacity of growth finishing pigs, the daily gain, daily feed intake, immune performance, and antioxidant capacity of the experimental group and control group were measured. The results showed that the growth performance, immune performance, and antioxidant capacity of fattening pigs were improved by Astragalus residue, which indicated that Astragalus residue, as a feed additive, was safe and harmless, not only played a pharmacological role but also realized the recycling of resources, which was worthy of further study and popularization.

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INTRODUCTION

Astragalus membranaceus, as a medicinal material with a long history, is a common traditional Chinese medicine. It is a leguminous plant, and its medicinal part is the root , as shown in Figure 1. It has the functions of invigorating qi and raising yang, invigorating qi and consolidating exterior, detoxifying and promoting granulation, promoting diuresis and reducing swelling (Hui and Fengxian, 2013). Morden pharmacological researches indicate that *Astragalus membranaceus* has multiple active ingredients, including astragalus polysaccharides, saponins, flavonoids, various amino acids, and more than 20 elements. Astragalus polysaccharides are commonly used as feed additives in pig production to enhance pig immunity and reduce the occurrence of piglet diarrhea (Hui, 2017; Xuerong et al., 2021; Jinsheng et al., 2022). Traditional Chinese medicine residue is the residue left by pharmaceutical factories after extracting active ingredients, which accounts for about 70% of the total amount of medicinal materials as waste (Li et al. 2022). However, due to technological limitations and the pursuit of single ingredients, the residual active ingredients can still reach a certain proportion and have not been fully utilized. The residue of astragalus root refers to the medicinal waste derived from astragalus root, the amount of *Astragalus membranaceus* in China is huge. *Astragalus membranaceus* residue, as a feed resource, can fully utilize the traditional Chinese medicine components of *Astragalus membranaceus*, and also improve the digestion and absorption of feed to improve its nutritional value.

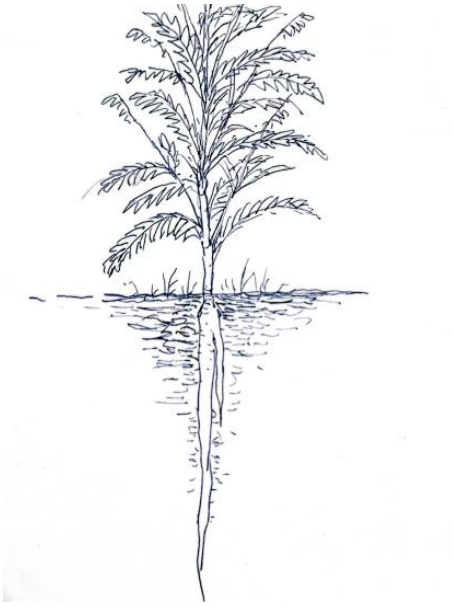

Figure 1. The Astragalus membranaceus

The chemical components of *Astragalus membranaceus* medicinal residue are polysaccharides, flavonoids, saponins, containing crude fiber, crude fat, and various trace elements. The extraction rate of polysaccharides from astragalus root residue is 12.93%, with a purity level of 93.27%, while the content of astragaloside in astragalus medicinal materials is 72.08% (Ran, 2015).These edible nutrients that are beneficial for animal growth and can be used as feed, greatly increasing the palatability and health benefits of animal feed.

Pigs can be divided into piglet stage, shelf pig stage and fattening pig stage according to different physiological and growth stages. The piglet stage is one month, the growth period is 4-5 weeks, and the weight can reach 25-30kg. After 2-3 months, young pigs can be raised in fattening stage. Improper feeding and management of the stage will affect fully grown and ready for slaughter of fattening pigs, and they also face the double challenges of improving disease resistance, anti-stress and improving immune function. It is advisable to have 8-15 pigs in each column in the fattening stage, and 30 kg to 50 kg of adult pigs belong to the fattening stage, and 80-90 kg can be slaughtered. It cannot be ignored in the fattening stage for pigs, which also determines the production efficiency of raising pigs.

Using Astragalus residue as raw material, different feeds are matched according to the characteristics of raw materials and use scenarios, which have specific functions and achieve the effects of enhancing animal production performance, improving immunity, resisting stress and activating enzyme activity. Astragalus residue is a functional feed additive, which contains crude protein and crude fat, which conforms to the global advocacy of energy saving and emission reduction, and realizes the recycling of resources.

The development of natural active substances instead of antibiotics has become a new research hotspot. As a feed additive, Astragalus residue has the characteristics of low cost, obvious effect and easy popularization and application, which ensures the healthy production of animal husbandry. In order to provide scientific basis for rational application of Astragalus residue, the effects of Astragalus residue on growth performance, immune performance and antioxidant capacity of fattening pigs were studied.

MATERIALS AND METHODS

Experiment design

The piggery is well illuminated, dry and ventilated, and the manure is cleaned twice a day, once in the morning and evening. The temperature of piggery is 18 -20 ℃, and the feeding density is suitable. In the trial implementation, except for the differences between treatments specified in the trial design, other feeding and management methods were consistent. The test animals are fed by the same breeder. Twenty-four 130-day-old "Durec×Long" fattening pigs in good health were randomly divided into two groups, with 12 fattening pigs in each group. Astragalus residue is provided by Beijing Shengtaier Technology Co., Ltd. The control group was fed with basal diet (Table 1). The experimental group was fed with basal diet supplemented with 10% Astragalus residue. Fattening pigs are free to eat and drink water, and other management is carried out in accordance with the regulations of the test site. The feed intake and diarrhea of pigs in 0-28 days were recorded every day. The trial period was 28 days.

Table 1. Dietary ingredient and nutrient content of the basic diets

Ingredient	Content (%)
Crude protein	≥ 16
Crude ash	≤ 10
crude fibre	≤ 7
moisture	≤ 13
total phosphorus	≥ 0.4
calcium	0.4 ～ 1.3
sodium chloride	0.3 ～ 1.2
lysine	≥ 0.9

Note: Astragalus residues according to the designed ratio before feeding were added into the experimental group diet.

Determination index and method

Changes in body weight of fattening pigs

The fattening pigs were weighed on an empty stomach (by head) on the morning of the 0 th and 28 th days of the experiment. Feed intake of fattening pigs in 0-28 days

Diarrhea rate of fattening pigs

Observe feces every morning and evening, record the number of diarrhea heads in detail and score feces for scoring.

Blood indices

On the 28th day, after fasting weighing, fattening pigs with average body weight were selected from each column. Blood samples were collected from anterior vena cava with vacuum blood collection vessels, left at room temperature for 30 min, then centrifuged at 3500 r/min for 10 min, separated serum and stored at-20 ℃ for biochemical indexes, immunoglobulin, immune factors to be tested. Serum levels of immunoglobulin A (IgA), immunoglobulin G (IgG),

immunoglobulin IgM, interleukin-2 (IL-2) and interleukin-6 (IL-6) were measured by ELISA kit (immunoglobulin quantitative kit). The antioxidant capacity was measured by superoxide dismutase (SOD), glutathione peroxidase (GSH-Px), total antioxidant capacity (T-AOC) and malondialdehyde (MDA).

Determination index and method

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Diarrhea rate of fattening pigs

Observe feces every morning and evening, record the number of diarrhea in detail and feces for scoring.

Table 2. Diarrhea index for score

Score	Index
0	feces strip or granular
1	soft feces, can form
2	feces are thick and shapeless, feces and water are not separated
3	feces are liquid, shapeless, and feces and water are separated

Blood indices

On the 28th day, after fasting weighing, 2 fattening pigs with average body weight were selected from each column. Blood samples were collected from anterior vena cava with vacuum blood collection vessels, left at room temperature for 30 min, then centrifuged at 3500 r/min for 10 min, separated serum and stored at-20 ℃ for biochemical indexes, immune and antioxidant factors to be tested. Serum levels of immunoglobulin A (IgA), immunoglobulin G (IgG), immunoglobulin IgM, interleukin-2 (IL-2) and interleukin-6 (IL-6) were measured by ELISA kit (immunoglobulin quantitative kit). Record the first onset and detect the antibody level of classical swine fever vaccine. The antioxidant capacity was measured by superoxide dismutase (SOD), glutathione peroxidase (GSH-Px), total antioxidant capacity (T-AOC) and malondialdehyde (MDA).

Statistical analyses

Independent sample *t*-test method was analyzed to compare values between the control and treatment groups. The results were shown as mean ± SE. P <0.05 was considered statistical significance.

RESULT

Growth Performance and Diarrhea rate

In Table 3, Compared with control group, pigs supplemented with Astragalus root residue had greater final body weight, ADG, ADGI, G : F and tended to have a lower rate of diarrhea occurrence.

Table 3. Effects of astragalus root residue on growth performance and diarrhea rate in growth finishing pigs

Item	Initial BW	Final BW	ADG	ADFI	F : G	diarrhea rate %
Control	75.20±2.63	85.70±2.36	0.37±0.09	2.48±0.56	5.89±0.89	0.88±0.11
10% astragalus root residue	75.30±1.81	86.88±2.18	0.416±0.10	2.37±0.42	5.69±0.57	0.22±0.05

Note : ^{a,b} Mean values within a row with different superscript letters were significantly different (p<0.05)

Blood biochemical parameters

In Table 4, compared with control group, the pigs supplemented with astragalus root residue decease glucose and triglyceride significantly; the pigs supplemented with astragalus root residue increased cholesterol and triglyceride significantly.

Table 4. The effect astragalus root residue on of blood biochemical parameters

Item	Control	10% Astragalus root residue
Glucose (mg/dl)	90.4±1.90[a]	84.96±1.80[b]
Globulin(g/dl)	2.60±0.22 [b]	2.89±0.11 [a]
Cholesterol(g/dl)	121.7±6.45 [a]	112.8±4.93 [b]
triglyceride(g/dl)	43.2±2.74 [a]	36.4±2.8 [b]
Total protein(g/dl)	6.5±0.19 [a]	6.8±0.21 [b]

Note: [a,b] Mean values within a row with different superscript letters were significantly different (p<0.05)

Immunity

In Table 5, compared with the control, 10% astragalus root residue increased the IgA、IgG、IgM content, and reduced (P < 0.05) IL-2 and IL-6 concentrations, (P < 0.05).

Table 5. Effects of astragalus root residue on Immunity in growth finishing pigs

Item	Control	10% Astragalus root residue
IgA	15.44±1.12 [b]	20.77±0.25 [a]
IgG	9.44±0.47 [b]	16.15±0.98 [a]
IgM	7.25±0.37[b]	16.25±0.98 [a]
IL-2	35.67±3.54[b]	23.77±1.01[a]
IL-6	112.43±4.19[b]	97.51±4.32[a]

Note: [a,b] Mean values within a row with different superscript letters were significantly different (p<0.05)

Antioxidant capacity

In Table 6, the SOD, GSH-Px and TOA activities of 10% astragalus root residue group were increased (P < 0.05) and the MDA content decreased (P < 0.05) compared with control group.

Table 6. Effects of astragalus root residue on Immunity in growth finishing pigs

Item	Control	10% Astragalus root residue
GSH-pX	128.71±1.23[b]	150.24±3.43[a]
SOD	44.87±2.68 [b]	58.37±0.78[a]
T-AOC	12.75±0.93 [b]	16.55±0.32 [a]
MDA	1.56±0.79 [b]	1.22±0.21 [a]

Note: [a,b] Mean values within a row with different superscript letters were significantly different (p<0.05)

DISCUSSION

The development of Astragalus residue as feed additive is a research hotspot in recent years, which can improve the utilization rate of Astragalus-traditional Chinese medicine and reduce waste pollution. Astragalus residue can improve disease resistance, immunity and reduce mortality (Ying et al. 2023). It is found that adding 15%-30% Astragalus residue to the diet of infants and adults can increase the content of amino acids and α-linolenic acid in muscle and reduce the water loss in muscle (Ran, 2025). The results of this study showed that Astragalus residue can improve the performance of fattening pigs. This S.L. reported that Astragalus powder additive has the same mechanism of promoting animal growth (Yuan et al., 2006). After extraction, there are still some Astragalus polysaccharide residues. Hydrolysis of cellulose and hemicellulose in Astragalus residue can also get polysaccharide. It may be that Astragalus contains a wide range of nutrients, except main polysaccharides, saponins and flavonoids; there are amino acids, vitamins, trace elements, etc., so it has nutritional effects on animal body. Li et al. (2004) showed that the content of MDA in serum decreased significantly when rats were given *Rhodiola astragalus* mixture in hypoxia model (Li et al., 2004). Studies have shown that *Astragalus membranaceus* and its effective components saponins and polysaccharides can significantly improve the enzyme activity of the body and have the effect of antioxidant damage. Lei et al., (2016) found that each component of polysaccharide AX-I in *Astragalus membranaceus* residue has scavenging effect on superoxide anion (Shunhan et al., 2009; Lei et al., 2005), and the effect of *Astragalus membranaceus* residue on improving antioxidant capacity of fattening pigs in this study may be consistent with it. Xiao Xiao and others injected Astragalus polysaccharide injection into dogs intramuscularly, and found that Astragalus polysaccharide injection improved the content of immunoglobulin in dogs. Shunhan et al. (2009) reported that Astragalus polysaccharide can improve the level of cytokines in mouse serum; high concentration of Astragalus extract can inhibit the induction of cytokine IL-2. In this study, Astragalus residue reduced the content of IL-2 and IL-6, which may be due to the bidirectional effect of Astragalus on immune regulation. Tian et al. (2019) believes that *Astragalus membranaceus* residue can improve the immunity of pigs, improve their disease resistance, increase the daily gain of fattening pigs, and improve the meat quality. Although different adding methods, it has same effects on the production performance of fattening pigs (Tian et al. 2019). Preliminary progress has been made in the research of Astragalus residue, among which many studies are about the content of known effective components, and its pharmacological and biological activities have also been explored. It is worth considering how to make efficient use of Astragalus residue.

CONCLUSION

The results showed that adding 10% Astragalus residues to the feed of fattening pigs could improve the immunity and antioxidant capacity of fattening pigs, and had the potential to improve the growth performance of fattening pigs. Astragalus residue, as a green feed and health feed, broadens the research ideas in the field of feed.

COMPETING INTEREST

The authors declare that they have no competing interests.

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