ChinaRxiv 中X

AI translation · View original & related papers at
chinarxiv.org/items/chinaxiv-201711.01449

Effects of Yucca Extract on Growth Performance, Serum Antioxidant and Immune Indices, Fecal Nitrogen and Phosphorus Excretion, and Microbial Count in Weaned Piglets: Postprint

Authors: He Beibei, Jiang Jianyang, Yu Guanghui, Zhao Weiyong, Sun Pengpeng, Song Chunyang

Date: 2017-10-11T00:00:00+00:00

Abstract

This experiment was conducted to investigate the effects of yucca extract supplementation on growth performance, serum antioxidant and immune indices, nitrogen and phosphorus emissions in feces, and microbial counts in weaned piglets, in order to determine the appropriate supplementation level of yucca extract in piglet diets. A total of 120 healthy Duroc × Landrace × Yorkshire weaned piglets at 28 days of age with a body weight of (8.00±0.46) kg were randomly allocated into 5 groups with 4 replicates per group and 6 piglets per replicate. Group I served as the control group and was fed the basal diet; Groups II–V were supplemented with 90, 120, 150, and 180 mg/kg yucca extract in the basal diet, respectively. The experimental period lasted 28 days. The results showed that: 1) Compared with the control group, Group III exhibited highly significant increases in average daily gain (ADG) and average daily feed intake (ADFI) ($P<0.01$), and a significant decrease in feed to gain ratio (F/G) ($P<0.05$); Groups III, IV, and V showed significant or highly significant reductions in diarrhea rate ($P<0.05$ or $P<0.01$). 2) Compared with the control group, Group III showed significant increases in serum catalase (CAT), superoxide dismutase (SOD) activities, and total antioxidant capacity (T-AOC) ($P<0.05$). No significant differences were observed among groups in serum glutathione peroxidase (GSH-Px) activity and malondialdehyde (MDA) content ($P>0.05$). 3) Compared with the control group, Group III exhibited a significant increase in serum nitric oxide (NO) content ($P<0.05$) and highly significant increases in nitric oxide synthase (NOS) and inducible nitric oxide synthase (iNOS) activities ($P<0.01$); Groups III, IV, and V showed significant increases in serum immunoglobulin G (IgG) content ($P<0.05$). 4) Compared with the control group, Group III showed a significant increase in thymus index

(P<0.05). No significant differences were observed among groups in spleen index (P>0.05). 5) Compared with the control group, Group IV showed a significant reduction in fecal total nitrogen content (P<0.05), and Groups II, III, and IV showed significant reductions in fecal ammonia nitrogen content (P<0.05). No significant differences were observed among groups in fecal total phosphorus content (P>0.05). 6) Compared with the control group, Groups III and IV showed significant reductions in fecal Escherichia coli counts (P<0.05). No significant differences were observed among groups in fecal total aerobic bacteria and Lactobacillus counts (P>0.05). Therefore, under the conditions of this experiment, the recommended appropriate supplementation level of yucca extract in piglet diets is 120 mg/kg.

Full Text

Effects of Yucca schidigera Extract on Growth Performance, Serum Antioxidant and Immune Indexes, Fecal Nitrogen and Phosphorus Emission, and Microbial Counts in Weaner Piglets

HE Beibei[1], JIANG Jianyang[1], YU Guanghui[1], ZHAO Weiyong[2], SUN Pengpeng[1], SONG Chunyang[1]*

(1. College of Animal Science and Technology, Qingdao Agricultural University, Qingdao 266109, China;
2. Animal Husbandry and Veterinary Station of Penglai Nanwang Sub-District, Yantai 265600, China)

Abstract: This experiment was conducted to investigate the effects of dietary Yucca schidigera extract supplementation on growth performance, serum antioxidant and immune parameters, fecal nitrogen and phosphorus excretion, and microbial populations in weaner piglets, and to determine the optimal inclusion level of Yucca schidigera extract in piglet diets. A total of 120 healthy 28-day-old weaner piglets (Duroc × Landrace × Large White) with an initial body weight of (8.00±0.46) kg were randomly allocated to 5 groups with 4 replicates per group and 6 piglets per replicate. Group I served as the control and was fed a basal diet, while groups II through V were fed the basal diet supplemented with 90, 120, 150, and 180 mg/kg Yucca schidigera extract, respectively. The experimental period lasted 28 days. The results showed: 1) Compared with the control group, group III exhibited significantly higher average daily gain (ADG) and average daily feed intake (ADFI) (P<0.01) and significantly lower feed-to-gain ratio (F/G) (P<0.05). The diarrhea rate in groups III, IV, and V was significantly or extremely significantly reduced (P<0.05 or P<0.01). 2) Serum catalase (CAT), superoxide dismutase (SOD) activity, and total antioxidant capacity (T-AOC) in group III were significantly increased compared with the control group (P<0.05). No significant differences were observed among groups in serum glutathione peroxidase (GSH-Px) activity or malondialdehyde

(MDA) content (P>0.05). 3) Serum nitric oxide (NO) content in group III was significantly increased (P<0.05), while nitric oxide synthase (NOS) and inducible nitric oxide synthase (iNOS) activities were extremely significantly increased (P<0.01). Serum immunoglobulin G (IgG) content in groups III, IV, and V was significantly increased (P<0.05). 4) The thymus index in group III was significantly higher than that in the control group (P<0.05), while no significant differences were observed in spleen index among all groups (P>0.05). 5) Fecal total nitrogen content in group IV was significantly reduced compared with the control group (P<0.05), and fecal ammonia nitrogen content in groups II, III, and IV was significantly reduced (P<0.05). No significant differences were observed among groups in fecal total phosphorus content (P>0.05). 6) Fecal Escherichia coli counts in groups III and IV were significantly reduced compared with the control group (P<0.05). No significant differences were observed among groups in total aerobic bacteria or Lactobacillus counts (P>0.05). In conclusion, under the conditions of this experiment, the optimal dietary supplementation level of Yucca schidigera extract for weaner piglets is 120 mg/kg.

Keywords: Yucca schidigera extract; weaner piglets; growth performance; immune index; antioxidant index; nitrogen and phosphorus

---

The production of nursery piglets constitutes a critical component of swine production, with environmental conditions and feed additives being key factors influencing piglet growth performance. Research has shown that ammonia concentrations reaching 100 µg/kg in pig housing can exert extremely significant effects on pig growth and development, creating an urgent need for feed additives that can simultaneously improve growth performance while reducing harmful gas emissions. Yucca schidigera extract, derived from effective components of Yucca plants, serves as a feed additive capable of reducing animal ammonia emissions, regulating intestinal microenvironments, promoting cellular nutrition, and enhancing animal immunity. Cheeke et al. reported that the primary active components of Yucca schidigera extract include saponins, polysaccharides, and yucca phenols. Ding Yongmin et al. demonstrated that saponins in Yucca schidigera extract may function through three primary mechanisms: 1) inhibiting proliferation of harmful bacteria and reducing their populations to maintain a beneficial-to-harmful bacterial ratio; 2) promoting nutrient absorption and improving feed utilization by altering the morphology of digestive tract epithelial cell membranes and reducing membrane surface tension; and 3) possessing immunological properties that enhance animal immune function. Johnston et al., studying various livestock species, found that dietary Yucca schidigera extract supplementation not only reduced concentrations of ammonia and hydrogen sulfide in animal housing but also improved feed utilization and average daily gain. Wang Li et al. observed that Yucca schidigera extract supplementation reduced pig house ammonia concentrations by 33-46%, increased lactating sow feed intake by an average of 0.5 kg/d, and significantly decreased the number of weak piglets. Min et al. found that dietary Yucca schidigera extract im-

proved carcass length, grade, backfat thickness, and loin eye area in pigs. Wang Baoli et al. reported that feeding pigs diets containing Yucca schidigera extract reduced ammonia production from excreta, decreased environmental pollution from swine operations, with an optimal addition level of 90 g/t. Colina et al., investigating dietary modulation to reduce ammonia concentrations in nursery facilities, found that weaner piglets fed diets containing 125 mg/kg Yucca schidigera extract exhibited significantly reduced ammonia concentrations compared with those fed the basal diet. This experiment was designed to investigate the effects of different dietary levels of Yucca schidigera extract on piglet growth performance, serum antioxidant and immune parameters, fecal nitrogen and phosphorus excretion, and microbial populations, thereby providing a scientific basis for determining the optimal supplementation level in piglet diets.

1.1 Experimental Materials

The Yucca schidigera extract used in this experiment was "Furmbao Natural Steroidal Saponin" produced by DPI Distribution & Processing Inc., USA, with active components of 30% total soluble solids, 10.5% saponins, and a B50 value 12 mg. Saponin content: Many functions of Yucca schidigera extract are related to saponins, which should not be less than 10.5%. B50 value: B50 value analysis (nitrophenol method) measures the ammonia-binding capacity of Yucca schidigera extract, representing the weight of extract required to bind 50% of ammonia.

1.2 Experimental Design

A total of 120 healthy 28-day-old weaner piglets (Duroc × Landrace × Large White) with an initial body weight of (8.00±0.46) kg were randomly divided into 5 groups with 4 replicates per group and 6 piglets per replicate (half male and half female). Group I served as the control and was fed a basal diet, while experimental groups (II-V) were fed the basal diet supplemented with 90, 120, 150, and 180 mg/kg Yucca schidigera extract, respectively. The experimental period lasted 28 days.

1.3 Experimental Diets

The experimental diets were formulated according to the feeding standards recommended by NRC (1998). The composition and nutrient levels of the basal diet are presented in Table 1 .

Table 1 Composition and nutrient levels of the basal diet (air-dry basis), %

Items	Content
Ingredients	
Corn	
Soybean meal	

Items	Content
Fish meal	
Whey powder	
Soybean oil	
Yeast	
Premix[1])	
Wheat	
Total	
Nutrient levels[2])	
DE/(MJ/kg)	
Crude protein CP	
Total phosphorus TP	
Available phosphorus AP	
Salt NaCl	
Lysine Lys	

[1]) The premix provided the following per kg of diet: VA 270,000 IU, VC 298 mg, VD 1,700 IU, VE 43.75 mg, VK 3.12 mg, VB 1.87 mg, VB 6.25 mg, VB 12 mg, VB 0.023 mg, nicotinic acid 25 mg, calcium pantothenate 15 mg, folic acid 0.65 mg, biotin 0.4 mg, choline 600 mg, Fe (as ferrous sulfate) 130 mg, Cu (as copper sulfate) 12 mg, Zn (as zinc sulfate) 120 mg, Mn (as manganese sulfate) 50 mg, Ca (as calcium sulfate) 10.35 mg, Se (as sodium selenite) 0.16 mg, Co (as cobalt sulfate) 0.1 mg.
[2]) DE was a calculated value, while others were measured values.

1.4 Animal Management

The experiment was conducted in a fully enclosed pig house with piglets housed in nursery pens with ad libitum access to feed and water. Routine management procedures for immunization and disinfection were followed. The health status of piglets in each pen was observed daily at 08:00, 12:00, 16:00, and 20:00.

1.5 Sample Collection and Processing

Serum: On day 29 of the experiment at 07:00, 6 piglets from each group with body weight close to the group average were selected for blood collection (10 mL via anterior vena cava puncture). Blood samples were centrifuged at 3,000 r/min for 10 minutes to separate serum, which was stored at -20°C until analysis.

Feces: During the final 3 days of the experiment, approximately 40 g of fresh feces were collected each morning from 4 randomly selected healthy piglets in each replicate. Feces were pooled by replicate, sealed in sterile bags, and stored at -20°C.

Tissue samples: On the morning of day 29, 3 piglets from each group with body weight close to the group average were euthanized by intravenous injection

of chlorpromazine hydrochloride (3 mg/kg BW). The abdominal cavity was opened to remove the spleen and thymus, which were weighed after blotting blood and removing fat.

1.6 Measurement Indicators and Methods

1.6.1 Growth Performance All piglets were weighed at 08:00 on day 1 (initial weight) and day 29 (final weight) after overnight fasting to calculate average daily gain. Feed intake was recorded by replicate to calculate average daily feed intake (ADFI) and feed-to-gain ratio (F/G). Diarrhea incidence was observed and recorded throughout the experiment to calculate diarrhea rate.

Diarrhea rate (%) = 100 × (total number of diarrhea incidents) / (number of piglets × experimental days).

1.6.2 Serum Antioxidant Parameters Serum superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GSH-Px) activities, and malondialdehyde (MDA) content were measured using commercial kits purchased from Nanjing Jiancheng Bioengineering Institute according to the manufacturer' s instructions.

1.6.3 Immune Organ Index Immune organ index (g/kg) = immune organ weight / live body weight before slaughter.

1.6.4 Serum Immune Parameters Serum nitric oxide (NO), immunoglobulin G (IgG) content, nitric oxide synthase (NOS), and inducible nitric oxide synthase (iNOS) activities were measured using commercial kits purchased from Nanjing Jiancheng Bioengineering Institute according to the manufacturer' s instructions.

1.6.5 Fecal Nitrogen and Phosphorus Excretion and Microbial Counts Fecal nitrogen and phosphorus excretion and microbial counts were determined using the method described by Tian Lixin. Total nitrogen (TN) content in feces was measured using the Kjeldahl method according to GB/T 6432–1994, and total phosphorus (TP) content was measured according to GB/T 6437.

1.7 Data Processing and Statistical Analysis

Data were analyzed using one-way ANOVA with SPSS 17.0 statistical software. Duncan' s multiple comparison test was used for post-hoc analysis. Differences were considered significant at $P<0.05$ and extremely significant at $P<0.01$. Results are expressed as "mean ± standard deviation."

2.1 Effects of Yucca schidigera Extract on Growth Performance of Piglets

As shown in Table 2 , the ADG and ADFI of groups II, III, IV, and V were higher than those of group I. For ADG, group III showed a 19.43% increase compared with group I (P<0.01), while groups II, IV, and V showed increases of 6.61%, 8.81%, and 6.88%, respectively (P>0.05). Group III was significantly higher than groups II and V (P<0.05) but not significantly different from group IV (P>0.05). For ADFI, group III showed a 14.24% increase compared with group I (P<0.01), and group IV showed an 11.37% increase (P<0.05), with no significant differences between group III and groups II, IV, or V (P>0.05). The F/G ratio was lowest in group III, which was significantly lower than all other groups (P<0.05), while no significant differences were observed between groups II, IV, V and group I (P>0.05). Diarrhea rate in groups IV and V was reduced by 57.32% and 53.48% compared with group I (P<0.01), while group III showed a 42.85% reduction (P<0.05) and group II showed a 28.59% reduction (P>0.05).

Table 2 Effects of Yucca schidigera extract on growth performance of piglets

Items	Group I	Group II	Group III	Group IV	Group V
Initial weight/kg	8.06±0.37	7.95±0.43	8.03±0.36	8.02±0.31	7.97±0.47
ADG/g	384.14±40.88^Aab	410.54±41^ABab	458.78±19.69^Bc	417.98±27.25^ABbc	410.58±32.14^ABb
ADFI/g	610.23±6.38^Aa	632.16±9.19^ABab	697.18±15.24^Bb	679.61±11.24^ABb	653.22±13.43^ABab
F/G	1.58±0.05^a	1.55±0.11^a	1.52±0.13^b	1.62±0.32^a	1.61±0.24^a
Diarrhea rate/%	29.17±0.21^Aa	20.83±0.34^ABa	16.67±0.45^ABb	12.45±0.91^Bb	13.57±0.63^Bb

In the same row, values with different small letter superscripts indicate significant difference (P<0.05), different capital letter superscripts indicate extremely significant difference (P<0.01), and same or no superscripts indicate no significant difference (P>0.05). The same applies below.

2.2 Effects of Yucca schidigera Extract on Serum Antioxidant Parameters of Piglets

As shown in Table 3 , serum CAT activity in groups II, III, IV, and V increased by 4.96%, 8.06%, 6.13%, and 4.72%, respectively, compared with group I (P<0.05). Serum SOD activity in group III increased by 6.89% compared with group I (P<0.05). No significant differences were observed among groups in serum MDA content or GSH-Px activity (P>0.05). Serum T-AOC in groups II, III, IV, and V increased by 6.17%, 9.52%, 6.85%, and 5.41%, respectively, compared with group I (P<0.05).

Table 3 Effects of Yucca schidigera extract on serum antioxidant indexes of piglets

Items	Group I	Group II	Group III	Group IV	Group V
CAT/(U/mL)	46.16±0.95^a	48.45±0.43^b	49.88±0.20^c	48.99±0.25^b	48.34±0.33^b
SOD/(U/mL)	121.66±1.93^a	123.48±1.13^a	130.16±0.92^b	122.05±0.12^a	124.66±0.74^a
MDA/(nmol/mL)	3.52±0.15	3.41±0.02	3.40±0.08	3.39±0.23	3.42±0.11
GSH-Px/(U/L)	127.51±2.36	133.58±2.63	132.49±2.04	135.18±3.42	130.24±2.25
T-AOC/(U/mL)	13.13±0.13^a	13.94±0.08^b	14.38±0.25^c	14.03±0.11^b	13.84±0.07^b

2.3 Effects of Yucca schidigera Extract on Serum Immune Parameters of Piglets

As shown in Table 4 , serum IgG content in groups III, IV, and V increased by 6.80%, 7.77%, and 5.83%, respectively, compared with group I (P<0.05). Serum NO content in groups II, III, IV, and V increased by 3.03%, 17.91%, 4.34%, and 8.66%, respectively, compared with group I, with only group III showing a significant difference (P<0.05). Serum NOS activity in group III increased by 26.42% compared with group I (P<0.01), while group IV showed a 13.40% increase (P<0.05). Serum iNOS activity in group III increased by 17.43% compared with group I (P<0.01), while group IV showed a 10.22% increase (P<0.05).

Table 4 Effects of Yucca schidigera extract on serum immune indexes of piglets

Items	Group I	Group II	Group III	Group IV	Group V
IgG/(g/L)	1.03±0.02^a	1.05±0.04^a	1.10±0.03^b	1.11±0.09^b	1.09±0.03^b
NO/(μmol/L)	52.75±9.23^a	54.35±8.81^ab	62.20±4.33^b	55.04±3.86^ab	57.32±5.04^ab
NOS/(U/mL)	30.81±2.64^Aa	31.55±2.67^Aa	38.95±2.59^Bb	34.94±2.83^ABb	33.13±3.39^ABa
iNOS/(U/mL)	7.63±0.64^Aa	7.98±0.36^Aa	8.96±0.11^Bb	8.41±0.31^ABb	7.99±0.17^Aa

2.4 Effects of Yucca schidigera Extract on Immune Organ Index of Piglets

As shown in Table 5 , group III significantly increased the thymus index compared with group I (P<0.05), while groups II, IV, and V also increased the thymus index but without significant differences (P>0.05). Groups II, III, IV, and V all increased the spleen index compared with group I, but no significant differences were observed (P>0.05).

Table 5 Effects of Yucca schidigera extract on immune organ index of piglets (g/kg)

Items	Group I	Group II	Group III	Group IV	Group V
Thymus index	1.45±0.17^a	1.47±0.13^a	2.03±0.23^b	1.71±0.34^a	1.55±0.38^a
Spleen index	1.51±0.20	1.59±0.19	1.67±0.29	1.71±0.38	1.61±0.14

2.5 Effects of Yucca schidigera Extract on Fecal Nitrogen and Phosphorus Emission of Piglets

As shown in Table 6 , group IV had the lowest fecal total nitrogen content, which was 4.73% lower than that of group I (P<0.05). Groups II, III, and V also had lower values than group I, but without significant differences (P>0.05). Fecal ammonia nitrogen content in groups II, III, and IV was significantly lower than that in group I (P<0.05), with reductions of 14.71%, 17.65%, and 13.24%, respectively. Group V also had lower values than group I, but without significant difference (P>0.05). Fecal total phosphorus content in groups II, III, IV, and V was reduced compared with group I, but no significant differences were observed (P>0.05).

Table 6 Effects of Yucca schidigera extract on fecal nitrogen and phosphorus emission of piglets

Items	Group I	Group II	Group III	Group IV	Group V
Total nitrogen%	3.38±0.10^a	3.35±0.07^a	3.32±0.06^a	3.22±0.04^b	3.29±0.11^a
Total phosphorus%	4.94±0.13	4.82±0.10	4.83±0.05	4.77±0.06	4.87±0.09
Ammonia nitrogen/(mg/g)	0.68±0.04^a	0.58±0.04^b	0.56±0.05^b	0.59±0.04^b	0.61±0.05^ab

2.6 Effects of Yucca schidigera Extract on Fecal Microbial Counts of Piglets

As shown in Table 7 , total aerobic bacterial counts in groups II, III, IV, and V were lower than that in group I, but without significant differences (P>0.05). Fecal Escherichia coli counts in groups III and IV were significantly lower than that in group I (P<0.05), with reductions of 4.26% and 4.81%, respectively. Groups II and V also had lower values than group I, but without significant differences (P>0.05). Lactobacillus counts in groups II, III, IV, and V were higher than that in group I, but no significant differences were observed (P>0.05).

Table 7 Effects of Yucca schidigera extract on fecal microorganism number of piglets (lg(CFU/g))

Items	Group I	Group II	Group III	Group IV	Group V
Total aerobic bacteria	9.10±0.04	8.98±0.05	8.96±0.08	8.72±0.23	8.99±0.16
Escherichia coli	7.28±0.10^a	7.13±0.05^a	6.97±0.07^b	6.93±0.12^b	7.04±0.08^ab
Lactobacillus	7.44±0.07	7.59±0.31	7.62±0.14	7.58±0.25	7.61±0.16

3.1 Effects of Yucca schidigera Extract on Growth Performance of Piglets

Average daily gain, average daily feed intake, and feed-to-gain ratio are three primary indicators for evaluating piglet growth performance. The current experimental data demonstrate that dietary Yucca schidigera extract supplementation can increase ADG and ADFI while reducing F/G ratio in weaner piglets. Zheng Guangyao reported that Yucca schidigera extract not only improved piglet growth performance but also significantly reduced odor concentrations in pig farms. Luo Xianglin et al., using replacement gilts as experimental subjects, found that supplementation with 40 mg/kg Yucca schidigera extract increased ADG by 6.2% and reduced F/G ratio by 3.6% compared with the control group, while effectively reducing the incidence of conjunctivitis in breeding pigs. These findings are consistent with the results of the present study. Gao Jianzhong et al. reported that piglets typically develop diarrhea 3-4 days post-weaning, with diarrhea incidence peaking at approximately 32.4% around one week post-weaning before gradually declining after two weeks. The current experimental results align with this pattern, with diarrhea rates peaking during days 4-7 and stabilizing after day 12, and all experimental groups showing lower diarrhea rates than the control group.

3.2 Effects of Yucca schidigera Extract on Serum Antioxidant Parameters of Piglets

Serum GSH-Px, SOD, and CAT activities, MDA content, and T-AOC are important indicators reflecting the antioxidant capacity of the organism. Liu Ruxiang and Fan Shijun et al. demonstrated that serum MDA content reflects the degree of lipid peroxidation in the body and can indirectly indicate the extent of cellular damage, with higher MDA content indicating greater cellular damage and lower MDA content indicating less damage. T-AOC serves as a comprehensive indicator for measuring the overall antioxidant capacity of the organism. Wan Shanxia et al. reported that GSH-Px exists in four different types, with serum GSH-Px being the most commonly used. Xu Xianxiang et al. indicated that saponins in Yucca schidigera extract possess antioxidant properties. Li Guang et

al. reported that saponins have immunomodulatory effects. The current experimental results show that dietary Yucca schidigera extract supplementation can increase serum T-AOC and CAT, SOD, and GSH-Px activities while reducing serum MDA content in weaner piglets, suggesting that Yucca schidigera extract can enhance serum antioxidant capacity under the experimental conditions.

3.3 Effects of Yucca schidigera Extract on Serum Immune Parameters of Piglets

IgG possesses antimicrobial and antiviral immunological activities. Guo Junqing reported that serum IgG content is positively correlated with humoral immune function. Liu Liru et al. indicated that IgG is the primary antibody against infection and can activate complement through the classical pathway, mediating antibody-dependent cellular cytotoxicity (ADCC) and opsonization against cellular antigens. In this experiment, serum IgG content in all treatment groups was higher than that in the control group, possibly because active components in Yucca schidigera extract stimulated plasma cells in the spleen and lymph nodes to produce more IgG for immune response. NO is a crucial physiological signaling molecule at both intracellular and intercellular levels, playing important roles in immune, neural, and circulatory systems. The mechanism by which polysaccharides promote NO synthesis may involve activation of lymphocytes, promotion of iNOS gene expression, and increased iNOS synthesis, thereby enhancing NO synthesis and secretion. In this study, serum NO content and NOS and iNOS activities in treatment groups were higher than those in the control group, consistent with the findings of Xiao Huali et al. and Wang Jianwen et al. This may be because components in Yucca schidigera extract can stimulate lymphocytes, promote iNOS expression, increase serum NOS activity, elevate serum NO content, and thereby enhance animal immune capacity.

3.4 Effects of Yucca schidigera Extract on Immune Organ Index of Piglets

The thymus is the central organ of cellular immunity in piglets and represents a primary immune organ, while the spleen is a peripheral immune organ and a secondary lymphoid organ. The spleen contains approximately 40% T cells and 60% B cells and plays an important role in humoral immunity. Rivas et al. suggested that immune organ index directly reflects the strength of animal immune function. In this experiment, the thymus index in all treatment groups was higher than that in the control group, with group III showing the best effect. The spleen index in all treatment groups was also higher than that in the control group, indicating that Yucca schidigera extract can promote the growth of thymus and spleen in piglets, thereby enhancing their immune capacity.

3.5 Effects of Yucca schidigera Extract on Fecal Nitrogen and Phosphorus Emission of Piglets

Chen Huajie added different levels of Yucca schidigera extract to chicken excreta to compare their effects on ammonia nitrogen content, finding that all levels significantly reduced ammonia nitrogen content in chicken excreta, with 0.024 g/L showing the best effect. These results are similar to the current study, where all treatment groups reduced fecal ammonia nitrogen content in piglets, and groups II, III, and IV achieved significant reductions. This may be because active components in Yucca schidigera extract can slow the rate of urea decomposition to ammonia, functioning similarly to urease inhibitors. Under the experimental conditions, all treatment groups reduced fecal total nitrogen and total phosphorus content, indicating that Yucca schidigera extract can improve nitrogen and phosphorus utilization in piglets, resulting in lower fecal nitrogen and phosphorus excretion compared with the control group.

3.6 Effects of Yucca schidigera Extract on Fecal Microbial Counts of Piglets

The piglet digestive tract contains large populations of beneficial microorganisms that play important roles in nutrient absorption, with Lactobacillus and Escherichia coli considered primary indicators of intestinal health. Murali et al. and Castillo et al. demonstrated that the ratio of Lactobacillus to E. coli in the animal digestive tract and intestine serves as an indicator of intestinal microbial balance, with the relative abundance reflecting intestinal health status. When Lactobacillus populations exceed E. coli populations, they can inhibit intestinal pathogens and benefit animal growth, whereas higher E. coli populations can promote growth of harmful microorganisms and negatively affect animal growth. Under the conditions of this experiment, dietary Yucca schidigera extract supplementation reduced total aerobic bacteria and E. coli counts while increasing Lactobacillus counts in feces, reflecting changes in intestinal microbial populations and improving the balance by increasing beneficial Lactobacillus and reducing harmful E. coli.

Conclusion

Based on the comprehensive results of this experiment, dietary supplementation with Yucca schidigera extract can improve growth performance, serum antioxidant and immune parameters, reduce nitrogen and phosphorus excretion, and improve intestinal microbial balance in weaner piglets. Under the experimental conditions, the optimal dietary supplementation level of Yucca schidigera extract for piglets is 120 mg/kg.

References

[1] Wang Zhe. Feeding and health management of piglets[J]. China Animal Health, 2016(2): 14–15.

[2] Bai Zhaopeng, Zhu Haisheng, Gao Yunfeng. Research progress on ammonia reduction measures in livestock housing[J]. Feed Review, 2011(9): 38-40.
[3] Cui Yuhua. Hazards of ammonia in pig houses and control measures[J]. Modern Animal Husbandry Science and Technology, 2017(2): 39.
[4] Cui Xiumei, Yang Zaibin, Yang Weiren, et al. Application of Yucca schidigera extract in livestock production[J]. Feed Wide Angle, 2011(5): 43-.
[5] CHEEKE P R. Actual and potential applications of Yucca schidigera and Quillaja saponaria saponins in human and animal nutrition[M]//OLESZEK W, MARSTON A. Saponins in Food, Feedstuffs and Medicinal Plants. Netherlands: Springer, 2000.
[6] Ding Yongmin. Study on the effects of Yucca schidigera extract on broiler performance, blood biochemical parameters and nutrient utilization[D]. Master' s Thesis. Tai' an: Shandong Agricultural University, 2010.
[7] JOHNSTON N L, QUARLES C L, FAGERBERG D J, et al. Evaluation of yucca saponin on broiler performance and ammonia suppression[J]. Poultry Science, 1981, 60(10): 2289-2292.
[8] Wang Li, Zhang Hongxing, Zhu Heyan. Effect of probiotics and Yucca schidigera extract on reducing harmful gas concentrations in pig houses[J]. Feed Industry, 2007, 28(23): 29-31.
[9] MIN T S, KIM J D, HYUN Y, et al. Effects of environmentally friendly agents on growth performance, nutrient digestibility, nutrient excretion and carcass characteristics in growing-finishing pigs[J]. Asian-Australasian Journal of Animal Sciences, 2001, 14(4): 540-547.
[10] Wang Baoli, Fan Xinpeng, Lu Li, et al. Experiment on reducing ammonia concentration in pig houses using Yucca plant extract[J]. Livestock and Poultry Industry, 2010(9): 52-55.
[11] COLINA J J, LEWIS A J, MILLER P S, et al. Dietary manipulation to reduce aerial ammonia concentrations in nursery pig facilities[J]. Animal Science, 2001, 79(12): 3096-3103.
[12] Tian Lixin. Effects of Yucca schidigera extract on milk performance, immune function and ammonia emission in dairy cows[D]. Master' s Thesis. Hohhot: Inner Mongolia Agricultural University, 2014.
[13] Zheng Guangyao. Effects of Yucca schidigera extract on environmental pollution and pig growth performance in pig farms[J]. Forest Products Chemical Industry Communications, 2000, 34(2): 26-28.
[14] Luo Xianglin, Xie Pixiong, Wan Xiqing. Effects of Yucca extract on growth performance of replacement gilts and ammonia concentration in pig houses[J]. Swine Production, 2004, 22(3): 40-41.
[15] Gao Jianzhong, Huang Kehe. Research progress on animal selenium proteins[J]. Animal Husbandry and Veterinary Medicine, 2004, 36(7): 39-42.
[16] SZCZUBIAL M, KANKOFER M, WAWRON W. The dynamics of changes in erythrocyte glutathione peroxidase activity and serum selenium content during the periparturient period in sows[J]. Polish Journal of Veterinary Sciences, 2004, 7(1): 21-26.
[17] Liu Ruxiang, Hou Minghai, Li Yanqin, et al. Effects of different vitamin A levels on blood antioxidant indexes in Holstein breeding bulls[J]. Southwest

China Journal of Agricultural Sciences, 2008, 21(3): 798-801.
[18] Fan Shijun, Han Youwen, Li Defa, et al. Effects of high temperature stress and superoxide treatment on MDA content and GSH-Px activity in chick liver[J]. China Feed, 2001(10): 11-13.
[19] Zhu Hongjuan. Effects of different selenium sources and levels on growth performance and blood antioxidant indexes in broilers[D]. Master' s Thesis. Changsha: Hunan Agricultural University, 2006.
[20] Wan Shanxia, Hua Jing, Zhang Shuping. Effects of bovine colostrum on serum antioxidant enzyme activities and MDA levels in piglets[J]. Journal of Beijing Agricultural College, 2008, 23(4): 5-6, 40.
[21] Xu Xianxiang, Xia Lunzhu, Gao Jiarong. Research progress on antioxidant effects of saponins from traditional Chinese medicine[J]. Chinese Journal of Traditional Chinese Medicine Science and Technology, 2004, 11(2): 126-128.
[22] Li Guang, Li Haobo, Liu Lu, et al. Research progress on physiological activities and application of saponins[J]. Animal and Veterinary Sciences, 2003, 19(6): 3-6.
[23] Xie Hongbing. Effects of compound Chinese herbal immune enhancer on immune function of weaner piglets[D]. Master' s Thesis. Fuzhou: Fujian Agriculture and Forestry University, 2004.
[24] Guo Junqing. Study on effects of leucine and calcium -hydroxy- -methylbutyrate on immune function and production performance of cashmere goats[D]. Master' s Thesis. Hohhot: Inner Mongolia Agricultural University, 2009.
[25] Liu Liru, Hua Jing, Wang Xiaoxia, et al. Effects of antimicrobial peptides on blood immune parameters and intestinal microflora in broiler roosters[J]. Chinese Journal of Animal Nutrition, 2012, 20(9): 1812-1818.
[26] Chen Hongliang. Study on preparation of plant polysaccharides and their effects on immune function in broilers[D]. PhD Thesis. Beijing: Chinese Academy of Agricultural Sciences, 2002.
[27] Xiao Huali, Hou Yongqing, Ding Binying, et al. Effects of compound immune enhancer on growth performance, plasma biochemistry and immune parameters in weaner piglets[J]. Feed Industry, 2008, 29(20): 6-8.
[28] Wang Jianwen, Mou Qiyun. Immune enhancement effects and veterinary clinical application of some Chinese herbal compounds[J]. Chinese Journal of Traditional Veterinary Medicine, 1990(4): 36-38.
[29] Guo Yuming. Animal Immunonutrition[M]. Beijing: Science Press, 2011: 6-30.
[30] RIVAS A L, FABRICANT J. Indication of immunodepression in chickens infected with various strains of Marek' s disease virus[J]. Avian Diseases, 1988, 32(1): 1-8.
[31] Chen Huajie. Effects of extracts from Lauraceae, Allium and Yucca on ammonia volatilization in broiler excreta and their mechanisms[D]. Master' s Thesis. Hangzhou: Zhejiang University, 2006.
[32] CASTILLO M C, MARTÍN-ORÚE S M, MANZANILLA E G, et al. Quantification of total bacteria, Enterobacteria and Lactobacilli populations in pig digesta by real-time PCR[J]. Veterinary Microbiology, 2006, 114(1/2): 165-

170.
[33] MURALIDHARA K S, SHEGGEBY G G, ELLIKER P R, et al. Effect of feeding Lactobacilli on the coliform and Lactobacillus flora of intestinal tissue and feces from piglets[J]. Journal of Food Protection, 1977, 40(5): 288-295.
[34] CASTILLO M, MARTÍN-ORIÚE S M, ANGUITA M, et al. Adaptation of gut microbiota to physical structure of different types of dietary fibre[J]. Livestock Science, 2007, 109(1/2/3): 149-152.

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

Source: ChinaXiv —Machine translation. Verify with original.