

The Effects of *Ligustrum lucidum* Extract on Growth Performance and Meat Quality in Growing-Finishing Pigs

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Abstract: This study was conducted to investigate the effects of dietary supplementation with different levels (0, 0.05, 0.1 and 0.2%) of *Ligustrum lucidum* Extract (LLE) on growth performance and meat quality in pigs. A total of 96 healthy crossbred (Duroc x Landrace x Yorkshire) pigs with an initial body weight of 20 ± 2 kg were randomly assigned to four treatment groups in four replicates of 6 pigs each. The test ended after 7 weeks (101 days), when the average weight of the pigs was 90 ± 2 kg. The results showed that LLE tended to increase the ADG and ADFI and decrease the F/G. The drip loss values in the three treatment groups were reduced by 17.46, 16.51 and 19.38% compared to the control and cooking loss values were reduced by 6.15, 5.01 and 7.16% ($p > 0.05$). The shear force of the 0.2% LLE group was reduced by 15.42% compared with the control group ($p < 0.05$), finishing while those of the 0.1 and 0.05% LLE groups were decreased by 9.16 and 7.77%, respectively ($p > 0.05$). The groups receiving dietary supplementation with LLE exhibited 30.77, 30.77 and 32.39% lower MDA levels ($p < 0.05$) and 4.43, 41.91 and 43.46% higher levels of intramuscular fat. Overall, 0.2% LLE had the most beneficial effects of all doses evaluated.

Key words: *Ligustrum lucidum* extract, pig, growth performance, meat quality, dietary

INTRODUCTION

Since the 1940s, antibiotics have been used as a feed additive for livestock. Although, antibiotics promote animal growth, extensive research has demonstrated several serious problems associated with the use of antibiotics as feed additives such as endogenous animal infections, drug residues, drug resistance and the decline of immune function in livestock and poultry. Therefore, researchers all over the world are working to find alternatives to antibiotics. Among these alternatives, Chinese herbal medicines are particularly attractive due to their natural origins, security, low cost and few side effects.

Many Chinese herbal medicines have been studied as feed additives for many years in China. Dietary supplementation with Chinese herbal compounds significantly increased ADG and ADFI but decreased F/G in weaning piglets (Chen *et al.*, 2008). Yin *et al.* (2007) found that dietary supplementation with 0.2% Chinese herbal compounds relieved weaning stress and significantly increased the ADG but decreased the F/G of weaning piglets. Zhou and Li (2006) found that the addition of honeysuckle, astragalus and other Chinese herbal medicine extracts to growing-finishing pigs' diets reduced the incidence of diarrhea and improved the ADG.

Ligustrum lucidum (*L. lucidum*) also known as Holly son is a traditional drug. In recent years, researchers have studied this herb as a feed additive for livestock. Tian *et al.* (2002) found that the major component of *L. lucidum* is oleanolic acid which is thought to enhance antioxidant activity and immunity. Xu *et al.* (2010) reported that adding LL powder to piglet diets significantly improved growth performance and antioxidant activity.

However, because large quantities of the herb were required, the diets' palatability was reduced. Therefore, researchers isolated an extract of *L. lucidum* using a supercritical CO₂ technique. Hou *et al.* (2011) reported that either *L. lucidum* powder or extract improved piglet growth performance and immune function but the extract group exhibited a stronger effect. On the basis of earlier studies, this experiment investigated the effects of different supercritical CO₂ *L. lucidum* extract levels on the growth performance and meat quality of growing-finishing pigs.

MATERIALS AND METHODS

Animals and experimental procedures: This trial was conducted to study the effects of dietary supplementation with different levels of *L. lucidum* Extract (LLE) on growth

performance and meat quality in pigs. A total of 96 healthy crossbred (Duroc x Landrace x Yorkshire) pigs of both sexes with an initial average weight of 20 ± 2 kg were randomly assigned to four treatment groups with four replicates of 6 pigs each. The trial lasted for 101 days until the BW of the pigs was 90 ± 2 kg.

The control group was fed a basal corn-soybean meal diet and the treatment groups were fed a basal diet supplemented with 0.05% LLE (0.05% LLE group), 0.1% LLE (0.1% LLE group) or 0.2% LLE (0.2% LLE group). During the experiment, pigs were provided feed and water *ad libitum*. All essential nutrients were provided at concentrations slightly exceeding the nutrient requirements recommended by the NRC in 1998 (Table 1).

L. lucidum was purchased as privet's dry ripe fruit from the Harbin herbal market, dried at 60°C , ground and strained through a 40 mesh sieve. As described by Lei, LL was extracted by supercritical CO_2 purification. The optimal extraction conditions were: 80% ethanol infiltration for 1 h at a ratio of 1:1 (v/w) followed by extraction for 3 h at a pressure of 18 MPa, temperature of 60°C , 95% ethanol as an entrainer at a ratio of 2:1 (v/w) and CO_2 flow of 4.8 L h^{-1} . Subsequently, the paste extract procedure was performed and the cream production rate was 7%. The composition of the LLE was determined by high performance liquid chromatography and its active ingredient content was 6.87%. CTC was purchased from the Harbin veterinary market.

Sampling: At the beginning and the end of the experiment, pigs were fasted for 12 h and then weighed to obtain Average Daily Gain (ADG), Average Daily Feed

Intake (ADFI) and Feed:Gain (F/G) data. At the end of the experiment, eight pigs per treatment group (2 pigs per replicate) were randomly selected, killed and bled to obtain meat from the longissimus dorsi muscle from the last thoracic vertebrae to the 6th lumbar vertebrae of the left carcass. Pieces ($5 \times 3 \times 2$ cm) were excised from the longissimus dorsi muscle and used to determine water drop loss, cooking loss, shear force, pH and flesh color.

Meat was Weighed (W1), placed in a plastic bag and freely suspended on a steel wire hook at 4°C . Muscle samples were wiped and Weighed (W2) after 24 h to evaluate water drop loss. Cooking loss was determined by calculating the weight loss during cooking. Meat was cooked in a water bath until a temperature of 74°C was achieved and then cooled at room temperature. Force values were determined using a C-LM-type digital muscle-shear apparatus. The pH values at 45 min, 12 and 24 h were recorded with a portable digital instrument. MDA content was determined using a kit from the Jiancheng Biological Engineering Research Institute of Nanking:

$$\text{Intramuscular fat} = \frac{\text{Fat weight}}{\text{Muscle weight}}$$

Statistical analyses: Data were analyzed by one-factorial ANOVA. All statistical analyses were performed in SPSS 17.0. Significant means were subjected to a multiple comparison test (Duncan) at $\alpha = 0.01$ and 0.05 levels (Snedecor and Cochran, 1980). Values were expressed as the means \pm SD. The replicate was considered the experimental unit for performance determination. The numbers (n) used for each statistical calculation were noted in the tables.

RESULTS AND DISCUSSION

Growth performance: As shown in Table 2, there were no significant differences in ADG or F/G between groups ($p > 0.05$) but the ADG values of the three treatment groups were increased by 2.04, 3.40 and 12.07% compared to the control and the F/G values were decreased by 2.17, 0.62 and 11.80%, respectively. The ADFI of the 0.1% LLE group was increased by 3.48% relative to that of the control group ($p > 0.05$) and that of the 0.2% LLE group was increased 4.49%, a significant difference ($p < 0.05$).

Meat quality: As shown in Table 3, the drip loss values in the three treatment groups were reduced by 17.46, 16.51 and 19.38% compared to the control and cooking loss values were reduced by 6.15, 5.01 and 7.16% ($p > 0.05$). The shear force in the 0.2% LLE group was reduced by 15.42% compared to the control group ($p < 0.05$) while those of the 0.1 and 0.05% LLE groups were decreased by 9.16 and 7.77%, respectively ($p > 0.05$).

Table 1: Ingredients and composition of the basal diet

Ingredients (%)	20~60 kg	60~90 kg
Corn	70.00	70.75
Soybean meal	27.00	17.00
Wheat bran	-	10.00
Limestone	0.90	0.90
CaHPO_4	0.90	0.50
Salt	0.30	0.35
Premix	0.50 ¹	0.50 ²
Zeolite	0.40	-
Total	100.00	100.00
Nutrient level (calculated)		
DE (MJ kg^{-1})	14.27	13.89
CP	17.10	14.23
Fat	3.14	3.40
Lys	0.84	0.70
Met	0.28	0.25
Thr	0.53	0.43
Ca	0.63	0.53
P	0.50	0.50
AP	0.28	0.23

The nutrition level was calculated. ¹premix provided per kg diet: VA 15000 IU, VD 3000 mg, VE 40 mg, VK 2 mg, niacin 32 mg, pantothenic acid 16 mg, folic acid 1.6 mg, VB12 0.2 mg, choline chloride 1000 mg; Fe 100 mg, Cu 8 mg, Mn 30 mg, Zn 100 mg, Se 0.3 mg and I 0.5 mg. ²premix provided per kg diet: VA 12000 IU, VD3 1500 mg, VE 40 mg, VK 2 mg, niacin 24 mg, pantothenic acid 12 mg, folic acid 1.2 mg, VB12 0.2 mg, choline chloride 600 mg; Fe 80 mg, Cu 6 mg, Mn 20 mg, Zn 80 mg, Se 0.3 mg and I 0.28 mg

Table 2: Effects of LLE supplementation on growth performance in growing-finishing pigs (Means±SEM)

Items ¹	Control	0.05% LLE	0.1% LLE	0.2% LLE
ADG (g day ⁻¹)	656.53±39.5	669.91±41.25	678.88±13.68	735.76±38.22
ADFI (g day ⁻¹)	2097.36±5.83 ^{ab}	2095.21±20.73 ^{ab}	2170.35±34.34 ^a	2077.09±34.85 ^b
F/G	3.22±0.20	3.15±0.220	3.20±0.030	2.84±0.190

¹ADG = Average Daily Gain, ADFI = Average Daily Feed Intake, F/G = Feed: Gain; ^{a,b}Means in the same row with different superscripts differ (p<0.05)

Table 3: Effects of LLE supplementation on meat quality in growing-finishing pigs (Means±SEM)

Items	Control	0.05% LLE	0.1% LLE	0.2% LLE
Drip loss (%)	4.18±0.3500	3.450±0.400	3.490±0.490	3.370±0.620
Cooking loss (%)	37.55±0.6600	35.240±1.560	35.670±2.250	34.860±0.550
Tenderness (N)	31.00±2.1400 ^b	28.160±0.930 ^{ab}	28.590±1.540 ^{ab}	26.220±1.080 ^a
Intramuscular fat (%)	4.51±0.9500	4.710±0.570	6.400±1.160	6.470±1.180
MDA (nmol mg ⁻¹ prot)	0.247±0.016 ^a	0.171±0.039 ^b	0.171±0.019 ^b	0.167±0.005 ^b

^{a,b}Means in the same row with different superscripts differ (p<0.05)

Table 4: Effects of LLE supplementation on pH value in meat from growing-finishing pigs (Means±SEM)

Items	Control	0.05% LLE	0.1% LLE	0.2% LLE
pH 45 min	6.35±0.11	6.38±0.09	6.40±0.14	6.38±0.14
24 h	5.67±0.05	5.70±0.09	5.69±0.03	5.71±0.12
48 h	5.68±0.06	5.63±0.01	5.66±0.04	5.76±0.08

^{a,b}Means in the same row with different superscripts differ (p<0.05)

The data in Table 3 shows that the groups supplemented with LLE had 30.77, 30.77 and 32.39% lower MDA levels than the control group (p<0.05) and 4.43, 41.91 and 43.46% higher levels of intramuscular fat.

No significant differences in the pH values at 45 min, 24 or 48 h were found but the changes in pH over time were lower in magnitude in the 0.2% LLE group (Table 4).

The data gathered in this study show that adding the Chinese herbal medicine *L. lucidum* to the diets of animals has several positive effects. Earlier studies showed that supplementation with *L. lucidum* promoted the growth of layer chickens (Shi *et al.*, 2009), enhanced the disease resistance of newborn piglets and improved the production performance of piglets (Cao *et al.*, 2008; Xu *et al.*, 2010) consistent with the results. Furthermore, adding 1% *L. lucidum* to a chick diet promoted animal growth but had no significant differences from the antibiotics group (Ma *et al.*, 2004). All of the above findings support the results of the study. *L. lucidum* extract improved the growth performance of growing-finishing pigs and 0.2% extract was the most effective dose.

Meat quality is influenced by many factors such as animal variety, nutrition, management before slaughter and slaughtering techniques. The literature indicates that lipid oxidation is the most important cause of poor meat quality. Lipid oxidation produces aldehydes and alcohols that produce odors in meat. Lipid oxidation begins in the phospholipids of cell membranes when cell membrane integrity is damaged; this not only generates a peculiar smell such as WOF but also leads to more drip loss and cooking loss (Wallace *et al.*, 1982, Schaefer *et al.*, 1995). In turn, drip loss and cooking loss affect the flesh color,

tenderness and other culinary parameters. The pH value reflects meat hydrolysis (Swatland, 1992). Bejerholm and Barton (1986) found that increased pork fat content is associated with improved tenderness. This study represents an objective evaluation of meat quality traits including tenderness, drip loss and cooking loss, pH, MDA and intramuscular fat.

Table 3 shows that there were significant differences in MDA content and tenderness but not in intramuscular fat, drip loss and cooking loss, between groups. LLE supplementation increased the intramuscular fat and improved the pork water-holding capacity. These findings are consistent with the results of LL supplementation in broilers (Wang, 2007).

CONCLUSION

In this study, LLE as a feed additive has several advantages and it plays an active role in improving the growth performance and meat quality of growing-finishing pigs. Furthermore, 0.2% LLE had the most beneficial effects of the doses tested.

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