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Study on Effect of Chinese Herbal Medicine Additives on Meat, Fur and Hide Quality of Rex Rabbits

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Abstract: The aim of this study was to provide a theoretical basis for population and application of Chinese herbal medicine feed additive in the rex rabbit breeding. About 108 weaned-rex rabbits aged 40 days were divided into 3 groups, each group divided into six repeats. Group A were fed with basal diet; Group B were fed with basal diet and 0.3% level of Chinese herbal medicine feed additives; Group C were fed with basal diet and 0.4% level of Chinese herbal medicine feed additives. After 150 days' breeding, slaughtered them to do sampling for determination. The result showed that: there was significant difference among fur thickness, area of skins, tensile strength and load elongation in each group ($p<0.05$) but no significant difference was found in wool staple length, wool fineness, wool density, hide thickness, shrinkage temperature and pH ($p>0.05$). It was proved that Chinese herbal medicine feed additives could improve fur quality of rex rabbits the best addition of 0.4%.

Key words: Chinese herbal medicine additives, Rex rabbits, fur quality, meat quality

INTRODUCTION

Chinese Herbal medicine feed Additives (CHA) is used widely in swine, poultry, ruminants and aquatic animals but also special economic animals such as deer, rex rabbit, civet cat, etc. in addition to improve their production performance and disease prevention, also health care, quality improvement of livestock products. The broiler diets supplemented with CHA could significantly increase appetite, growth rate and improve feed efficiency, CHA could significantly increase the laying rate of laying hens and feed conversion rate, decreased the mortality rate (Yi, 1994). Compound Chinese herbal medicine could improve the effect of muscle color, help to improve the water holding capacity and taste of muscle (Hu *et al*., 2005; Zhang *et al*., 2002) reported that the addition of natural plant additive for finishing pigs had a significant impact on carcass quality, increased the carcass lean significantly and decreased the rate of carcass fat and backfat thickness. Many studies indicated that adding CHA in the rabbit diets could enhance animal appetite and promote the production performance. Song (2002) to the diet by adding 1% CHA for 60 days fattening rabbits, the results showed that CHA could significantly improve the weight gain and feed conversion rate, decrease the feed/gain and obtain better profits. Wu *et al*. (2006) test results showed that CHA could improve the rate of weight gain of fattening rabbits and feed efficiency, reduce feeding costs. Chen *et al*. (2005) by adding 1% CHA to the basic diet for 60 days fattening rabbits could make daily gain, feed efficiency, the overall economic efficiency increased 17.4, 13.9 and 22.5% than the control group. Xu *et al*. (2004) supplied CHA to 8~12 weeks rabbits diets, the test showed that the CHA on the role of promoting growth and development of young rabbits, the overall weight and individual average weight of the test group increased 5.4 and 0.27 kg, daily gain increased 0.011 kg, weight gain increased 54% compared with the control group, the effect was significant.

Shu found that New Zealand rabbits fed with herbal prescriptions, the mortality decreased significantly, improved feed conversion rate of 24.25%, increased average daily gain of 23.72%. Meng (1994) fed German Angora Angora with herbal, the birth weight could be increased 16% the young rabbits weight gain increased 19% the feed conversion improved 11%. So far, less study has been done on the physical and chemical properties of Rex rabbit's fur (Zilin *et al*., 2007). Therefor, different levels of Chinese herbal medicine additives were added to the feed of Rex rabbit in current study to measure hair length, fineness, density and fur thickness, area,

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extension rate, extension temperature and pH, etc. The purpose of this research is to study the effect of herbal additives on the Rex rabbit fur quality, to provide theoretical foundation and reference of using herbal additives for Rex rabbit feeding industry.

MATERIALS AND METHODS

Animal material: *Oryctolagus cunioculus* also named as Rex rabbit is a typical fur-meat dual purpose rabbit. Their fur has a series of good characters such as short, thick, plain, smooth and beautiful with good appreciation in national and international markets.

Experimental design: One hundred and eight, 40 days age Rex rabbits were randomly divided into 3 groups, 6 replicates in each group with 6 Rex rabbits in each replicate. The 3 groups (A, B, C, Table 1) were provided basal ration without herbal additives, basal ration with 0.3% herbal additives and basal ration with 0.4% herbal additives.

Ration and herbal additives: The experimental ration was granule concentrates which was provided by Gansu Tianbang Ltd. Young rabbit feed was fed for 40~105 days age of Rex rabbit and mature rabbit feed was fed for 106~150 days age of Rex rabbit. The experimental ration and components were shown in Table 2. Herbal additives were composed by eleven kinds of herbs such as *Angelica sinensis*, *Radix astragali*, *Salvia miltiorrhiza*, *Hawthorn*, *Scutellaria baicalensis Georgi*, *Portulaca oleracea* L. and so on. All the herbs were purchased from Lanzhou Medicinal Materials Market and mashed by ultramicro techniques.

Table 1: Experimental design

Groups	Treatments
A	Basal ration
B	Basal ration + 0.3% herbal additives
C	Basal ration + 0.4% herbal additives

Table 2: Formulation for basal ration and the nutrition level of Rex rabbit (dry matter basis)

Ingredients (%)	Ratio (%)	Nutritional level	Values
Corn	65.0	Digestible energy	3188.00
Wheat bran	6.7	(DE, kcal kg^{-1})	
Ferment soybean meal	8.6	Crude Protein (CP, %)	17.82
Soybean meal	13.2	Calcium (Ca, %)	0.87
Import fish meal	2.8	Total Phosphorous (P, %)	0.62
Bean oil	0.3	Salt (%)	0.35
Stone powder	0.9	Lysine (%)*	1.32
$CaHCO_3$	1.0	Methionine+Cystine (%)*	0.81
Salt	0.3		
Choline chloride	0.1		
Flavoring agent	0.1		
Mineral mix	1.0		
Total	100.0		

Components of mineral mix: Manganese 4032.000 mg kg^{-1}, Zinc 5948.00 mg kg^{-1}, Copper 1450.00 mg kg^{-1}, Iodine 35.00 mg kg^{-1}, Selenium 25.00 mg kg^{-1}, Vitamin A 350000.00 IU kg^{-1}, Vitamin D 35000.00 IU kg^{-1}, Vitamin E 4000.00 mg kg^{-1}, Vitamin B2 660.00 mg kg^{-1}; *Means calculated data

Rex rabbit feeding management: All the experimental Rex rabbits were confined in two-line cage with good light and air circulation, three young rabbits per cage and 1 mature rabbit per cage. The young rabbits were fed 3 times day^{-1} in 8:00, 12:30 and 20:00. The mature rabbits were fed two times in 8:00 and 20:00, respectively. Water was available for *ad libitum* by duck-beak model watering trough. The rabbit pen, cage, feed trough and water trough were cleaned and sterilized before experiment.

The rabbit pen was cleaned and sterilized once each day. All the experimental Rex rabbits were expelled parasites and vaccinated with vaccine of rabbit haemorrhagic disease, rabbit pasteurella multocida, *Escherichia coli*. The entire vaccinating program was directed according to the directions of Tianyao Grass Scientific Ltd. Corporation. The Rex rabbits were slaughtered in 150 days age. After maturation of the hide in Lanzhou 3512 Hide Factory, the physical and chemical properties were measured.

Measuring items and methods: Muscle tenderness was measured by shear force of semitendinosus muscle. Acidity (pH) is determined by portable pH meter. Longissimus dorsi muscle (around 2.5 cm) between 4 and 7 lumbar was taken after 2 h of slaughtering, and weighed. The longissimus dorsi muscle was put into the refrigerator at 4°C for 24 h to calculate losing rate. Pressure (35 kg) was applied to measure muscle water losing rate. The entire psoas major muscle without outside membrane and fat was weighed and then the psoas major muscle was boiling cooked for 30 min. After cooling 15 min, it was weighed again to determine cooked muscle rate.

Muscle nutrients measurement: Crude Protein (CP) was measured by Semimicro-Kjeldahl Method. Soxhlet Extractor Method was used to measure Ether Extract (EE). The muscle was dried in oven at 105°C to determine Dry Matter content (DM). Crude ash was obtained by burning muscle at 550°C. GB12398-90 and GB12393-90 were referred to measure calcium and phosphorous content in muscle and the muscle fatty acids profile was determined by referring GB/T 17377-1998.

Amino Acids (AA) measurement: Specimen was pre-treated by Hydrochloric Acid Hydrolyzing Method.

Procedures of pre-treatment is as the following: specimen drying-Soxhlet extracting to solve fat after cooling-drying and mashing-hydrolyzing by adding 6 mol L^{-1} hydrochloric acid-drying by evaporation-constant volume and filtering-analyze by High Performance Liquid Chromatography (HPLC). The physical and chemical properties of Rex rabbit hide and fur such as tensile strength, stretching rate, shrinkage temperature and pH, etc. were determined according to the methods of Hide Physical-Mechanical Properties Measuring Technologies (Wu *et al*., 2006).

Statistical analysis: All the data were analyzed by SPSS11.5 Software by ANOVA analysis. And all means were showed with Standard Deviation (SD).

RESULTS AND DISCUSSION

The effect of adding different levels of CHA on physical and chemical properties of Rex rabbit meat: The physical and chemical properties of Rex rabbit's muscle were shown in Table 3. There were no significant differences of tenderness, cooked muscle rate, water content and EE among the three groups ($p>0.05$). Compared with Group A, tenderness and EE in Group B and C showed an increasing trend. But no statistical difference was found ($p>0.05$). The pH increased 4.53 and 6.16% in Group B and C compared with Group A and the pH of C group was significantly higher than Group A and B ($p<0.05$).

There was no significant difference of pH between Group A and B. The storage losing rate was increased 10.15 and 28.68% in Group B and C based on Group A and Group C was significantly higher than Group A and B ($p<0.05$). No significant difference was found between Group A and B ($p>0.05$). Compared with Group A, the CP in Group B and C increased 3.86 and 5.96%, respectively. The CP in Group B was significantly higher than in Group A ($p<0.05$) and extremely significant difference was found between Group C and A ($p<0.01$). There was no significant difference between Group B and C ($p>0.05$).

The effect of adding different levels of CHA on AA content of Rex rabbit meat: Eighteen AA were measured in present trial (Table 4). The highest total AA in longissimus dorsi muscle was found in Group C, 23.84 g/100 g and the lowest was in Group A, 19.06 g/100 g. It was 20.94 g/100 g in Group B. The results also showed that the highest amount of major tasty AA was in Group C, 8.32 g/100 g which was 34.90% of total AA, the lowest in Group A, 6.46 g/100 g, 33.89% of total AA. There was the highest essential AA in Group C, 11.47 g/100 g and then in Group B, 10.64 g/100 g. The lowest in Group A, 9.61 g/100 g.

Table 3: The effect of CHA on the psychical properties of Rex rabbit's muscle

Groups	A	B	C
pH	5.52±0.13^{a}	5.77±0.14^{a}	5.86±0.19^{b}
Tenderness(N cm^{-2})	3.35±0.08	3.83±0.39	3.46±0.23
Water losing rate (%)	1.87±0.10^{a}	1.61±0.14^{a}	1.44±0.09^{b}
Storage losing rate (%)	3.94±0.15^{A}	4.34±0.09^{b}	5.07±0.25^{aB}
Cooled muscle rate (%)	0.64±0.11	0.65±0.09	0.66±0.12
Water content (%)	0.64±0.08	0.63±0.13	0.60±0.09
EE (%)	1.28±0.11	1.35±0.21	1.92±0.41
CP (%)	19.95±0.25^{aA}	20.72±0.20^{b}	21.14±0.20^{bB}

The same line with different lower case means significant difference ($p<0.05$). The same line with different capital letters means extremely significant difference ($p<0.01$)

Table 4: The effect of CHA on Rex rabbit content of muscular free amino acids (g/100g)

	Group		
AA	A	B	C
Threonine[1]	1.01	1.08	1.30
Valine[1]	1.18	1.26	0.63
Methionine[1]	0.17	0.27	0.23
Isoleucine[1]	1.02	1.17	1.34
Leucine[1]	1.81	1.97	2.30
Phenylalanine[1]	0.76	0.99	1.16
Lysine[1]	1.96	2.12	2.25
Histidine[1]	0.33	0.29	0.44
Tryptophan[1]	0.19	0.25	0.28
Arginine[1,2]	1.18	1.24	1.54
Aspatic acid	2.00	2.13	2.59
Glycine[2]	0.99	1.00	1.29
Glutamic acid[2]	2.99	3.25	3.85
Alanine[2]	1.30	1.32	1.64
Proline	0.63	0.83	0.86
Cysteine	0.21	0.18	0.24
Serine	0.88	0.88	1.09
Tyrosine	0.45	0.71	0.81
Total AA	19.06	20.94	23.84
Total essential AA	9.61	10.64	11.47
Essential AA/Total AA (%)	50.42	50.81	48.11
Major tasty AA	6.46	6.81	8.32
Major tasty AA/Total AA (%)	33.89	32.52	34.90

[1]Means people essential AA; [2]Means major tasty AA

The effect of adding different levels of CHA on fatty acids concentration of Rex rabbit meat: The SFA in Rex rabbit muscle were 31.8, 33.3 and 31.8% in Group A-C (Table 5). The UFA were higher in Group B (54.8%) and C (55.5%) than in Group A (53.3%) and it was also higher for essential fatty acids in Group B (28.6%) and C (29.6%) than in Group A (27.5%), 4.00 and 8.00% increase in Group B and C compared with Group A. There were still some ingredients that were undetected, 14.9, 11.9 and 12.7% in Group A-C. At all, C18:1 and C16:0 showed the

highest amount among the total AA. The concentration of C18:2 and C18:3 in Group B and C with CHA was higher than in Group A without CHA.

The effect of adding different levels of CHA on the fur of Rex rabbit: The fur density was shown in Table 6. An increasing trends of fur density and length were found from Group A-C but no statistical difference ($p>0.05$) which indicated that CHA had the function to improve fur density. According to the standard length of Rex rabbit fur, 1.6-2.3 cm, the fur length of Rex rabbit in present 3 groups was in the scope of standard. The fur length in buttock was higher than in back and it was the shortest in shoulder. No statistical significant difference was found among the three parts ($p>0.05$). Although, there was no significant difference, CHA showed a positive effect on the fur quality with increasing the tenderness.

The effect of adding different levels of CHA on the hide quality of Rex rabbit: There was no significant difference of hide thickness among the 3 groups ($p>0.05$). The fur and hide thickness was significantly higher in CHA Group (B, C) than in A group ($p<0.05$) with an increase of 19.7 and 18.2% compared with Group A. But there was no significant difference between Group B and C ($p>0.05$). The hide area was largest in Group C and lowest in Group A (1114.52 cm^2 vs. 978.65 cm^3). Compared with Group A, there was an significant increase of 10.7 and 13.9% in Group B and C ($p<0.05$). There was no significant difference between Group B and C ($p>0.05$). The results indicated that CHA could significantly increase Rex rabbit hide area (Table 7).

The effect of adding different levels of CHA on the physical and chemical properties of Rex rabbit fur: The measured tensile strength, stretching rate, shrinkage temperature and pH in present study were all within the National Industrial Standard (Table 8). The tensile strength in CHA Group (B, C) was significantly higher than in A group with an increase of 26.7 and 60.0% ($p<0.05$). And there was no significant difference between Group B and C ($p>0.05$).

A significant increase of 14.5% and 6.9% in Group B and C was found compared with Group A ($p<0.05$). The pH was decreased 2.92 and 2.65% when adding CHA in Group B and C than in Group A with no statistical significant difference ($p>0.05$). According to the non-significant difference of pH before and after fur solving ($p>0.05$), the main acids are non-organic acids. And the highest amount of non-organic acids was in Group C and the lowest in Group A. there was no significant difference of shrinkage temperature among the three groups ($p>0.05$). The highest shrinkage temperature was in Group C with 0.4% CHA.

Above all, CHA had a positive function to improve the physical and chemical properties of Rex rabbit fur and hide. In present study, 0.4% addition of CHA showed the best effects.

The effect of CHA on the meat quality of Rex rabbit: Adding CHA increased tenderness and fat content of Rex Rabbit compared with control. The 0.3 and 0.4% CHA supplementation increased muscle pH 4.5 and 6.2%, storage losing rate 10.15 and 28.68%, muscle CP 3.86 and 5.96%. There is the positive relationship between pH and water holding capacity, muscle tenderness. pH is not only the direct appearance of acidity of muscle but also has an important effect on meat quality which is a key index for meat quality detection. pH has a direct influence on muscle tenderness, drip loss, meat color and so on (Fletcher, 1995)

The content of main tasty AA in longissimus dorsi muscle has a high influence on muscle tasty such as glutamic acid, arginine, alanine, glycine and so on. The Rex rabbit muscle with 0.4% CHA showed a good

Table 5: The effect of CHA on Rex rabbit muscular fatty acids composition (%)

	Groups		
Items	A	B	C
C14:0	1.20	2.00	1.60
C16:0	22.20	23.70	21.90
C16:1	2.60	4.20	3.60
C18:0	8.40	7.60	8.30
C18:1	21.00	20.60	20.60
C18:2*	16.70	19.30	19.00
C18:3*	1.00	1.50	1.30
C20:1	0.20	0.20	0.20
C20:4*	9.80	7.80	9.30
C22:6 (DHA)	2.00	1.20	1.50
Saturated Fatty Acids (SFA)	31.80	33.30	31.80
Unsaturated Fatty Acids (UFA)	53.30	54.80	55.50
Total fatty acids	100.00	100.00	100.00
UFA/SFA	167.61	164.56	174.53
Essential fatty acids	27.50	28.60	29.60

*Means essential fatty acids for people

Table 6: The effect of CHA on Rex rabbit fur

		Fur length (mm)			Fur fineness (μm)		
Groups	Fur density (No./cm^2)	Shoulder	Back	Buttock	Shoulder	Back	Buttock
A	14547±1375	16.63±1.07	16.75±1.35	17.83±1.06	17.56±0.44	17.02±0.75	17.10±1.13
B	14630±2362	18.62±1.82	20.40±2.02	20.82±3.08	18.59±2.23	18.95±2.04	18.24±1.51
C	15464±2535	18.64±1.03	18.95±1.73	19.86±2.04	18.07±2.21	18.74±2.19	18.73±1.75

Table 7: The effect of CHA on Rex Rabbit quality of hides

Groups	Hide thickness (mm)	Fur and hide thickness (mm)	Hide area (cm^2)
A	0.69±0.08	1.32±0.02^{ab}	978.65±23.35^{ab}
B	0.74±0.16	1.58±0.24^{a}	1083.42±30.43^{a}
C	0.69±0.03	1.56±0.10^{b}	1114.52±55.43^{b}

Table 8: The effect of CHA on Rex Rabbit fur of physical and chemical properties

				pH		
Groups	Tensile strength ($N\ mm^{-2}$)	Stretching rate (%)	Shrinkage temperature (°C)	Specimen	After solving	Difference
A	7.50±1.50^{ab}	65.50±5.50^{ab}	81.00±3.00	3.77±0.15	4.55±0.23	0.78±0.04
B	9.50±0.50^{a}	75.00±2.00^{a}	78.50±1.50	3.66±0.19	4.53±0.19	0.87±0.08
C	12.00±3.00^{b}	70.00±9.00^{b}	83.50±2.50	3.67±0.13	4.56±0.35	0.89±0.07
National standard	≥7	≥20	≥70	3.5~6.5		

composition of AA, especially in major tasty AA and essential AA. Fatty acid is another important meat quality index. The concentration of fatty acids, especially the content of intramuscular fatty acids is very important for high meat quality. The essential fatty acids in CHA group were higher than control. If there are too many saturated fatty acids in animal products, it is easy to incur endarterium atherosclerotic plaque and form atherosclerosis. Unsaturated fatty acids can maintain the fluid of cell membrane and keep normal physiological function. The Group C with 0.4% CHA supplementation has the highest UFA/SFA. Compared with Group A and B, the UFA/SFA in Group C increased 4.13 and 6.06% and the UFA, essential fatty acids in Group C were also higher than Group A and B.

The effect of CHA on the quality of Rex rabbit fur and hide: The factors that affect Rex rabbit fur and hide quality are density, fineness and so on. The higher density means the better quality. The fur density and tidiness showed an increasing trend with CHA supplementation but not statistical difference ($p>0.05$). The thickness of fur and hide with 0.4 and 0.3% CHA increased 19.7 and 18.2% compared with control ($p<0.05$). The hide area has an important effect on using value. According to the purchasing standard of National Animal Products Imports and Exports Corporation, the Rex rabbit area should be larger than 1111 cm^2. The Rex rabbit hide area with 0.3 and 0.4% CHA increased 10.7 and 13.9% than control ($p<0.05$). The indirect reason of increasing hide area with adding CHA was the increase of bodyweight by CHA supplementation, which was the same with the results from Jian-Hua (2004) and Shi-Cheng (2002).

The effect of CHA on physical and chemical properties of Rex rabbit fur and hide: The prominent merit of Rex rabbit fur and hide is soft and tight with high strength. The extension rate is an important index to determine the using duration of hide. The extension rate is affected by fibre amount, thickness, strength and fibre knitting mode. The extension rates in present study were 12.00 N mm^{-2} with 0.4% CHA, 9.50 N mm^{-2} with 0.3% CHA and 7.50 N mm^{-2} without CHA ($p<0.05$). It indicated that CHA could increase the Rex rabbit hide extension rate. After applying high strength, two circumstances will appear-flexible transfiguration and permanent transfiguration. Regardless the intensity of strength, flexible transfiguration and permanent transfiguration will act simultaneously. The extension rate is important for light hide to affect the wearing comfortableness. The group with 0.4 and 0.3% CHA in present study increased extension rate 14.5 and 6.9% than control ($p<0.05$).

Normally, there will be some amounts of acids in hide which influence the finished leather quality. If the pH is <3.5, it means the acids are too high in the hide and the hide can not be stored for a long time (Wu *et al*., 2006). The present study showed no significant difference of pH with CHA addition which indicated CHA had little effects on pH of Rex rabbit hide.

CONCLUSION

This study shows that the supplementation of CHA can improve Rex rabbit meat quality and fur (hide) quality. The adding CHA is a good management practice to improve Rex rabbit value and 0.4% addition of CHA showed good effect in present study.

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