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ON GROWTH PERFORMANCE, BLOOD METABOLITES OF RABBITS.**

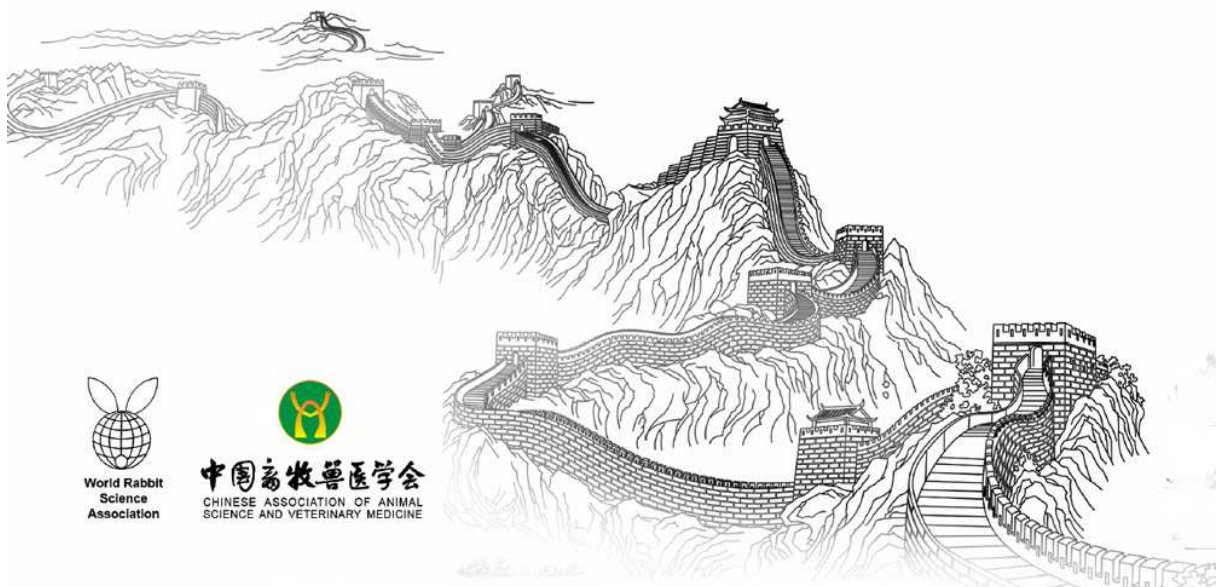
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EFFECT OF DIETARY CITRUS PULP ON GROWTH PERFORMANCE, BLOOD METABOLITES OF RABBITS

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ABSTRACT

A total of 192 post-weaning Hyla rabbits (42 d old) were divided into 4 groups with 0 (control group), 7%, 14% and 21% citrus pulp in the feed, in replacement of corn germ and soya bean meals and corn. The protein and NDF concentrations in control feed were 15.9% and 26.6% respectively. There were no effect of citrus pulp inclusion on growth traits (on average 123 g/d feed intake, 35 g/d weight gain). In the experimental groups, albumin (ALB): globulin (GLO) ratio and calcium (Ca) are all higher than in the control group ($P < 0.05$). In summary, dietary inclusion citrus pulp, up to 21%, did not affect the growth performance, and may improve the immunization and serum Ca level.

Key Words: Citrus pulp, rabbits, growth performance, blood metabolites

INTRODUCTION

Citrus pulp is a by-product of citrus juicing industries, which is a mixture of citrus peel, pulp and seeds. Researches indicate that there is no obvious side effect on the growth performance (Mourao et al., 2008; Yang and Chung, 1985; Nazok et al., 2010). In this experimental study, we tried to find out how the dehydrated citrus pulp (DCP) would influence growth performance, serum biochemical indexes and immunization of rabbits, in order to achieve an optimal feeding strategy.

MATERIAL AND METHODS

Experimental design

A total of 192 post-weaning French Hyla rabbits (42d old, 1.40-1.54 kg in weight) were allotted into 4 groups of 48 animals, and fed either a control feed without DCP or feeds having 7%, 14% and 21% DCP. The feeding experiment lasted 28 days. The experiment was carried out in accordance with the Animal Care and Use Guidelines of College of Animal Science and Technology, Southwest University, Chongqing, China.

Feed and feeding management

Table 1 shows the diet composition and nutrient levels which were determined following rabbit nutrient requirements, as well as considerations of local feed sources in Chongqing. The rabbits were housed in galvanized metal wire cages. Natural lighting and automatic ventilation were used in the rabbit house. The rabbits were fed ad libitum and water was available all time.

Experimental measurements

Growth performance

Rabbits were weighed before fed in the morning at 42 and 70d old. The feed intake was recorded daily to calculate average feed intake, average feed conversion ratio.

Table 1. Diets composition and nutrient levels

Ingredients	Control	7% DCP	14% DCP	21% DCP
Soybean meal	5.50	6.00	7.67	9.10
corn	26.52	25.00	23.00	17.10
Wheat bran	5.20	7.00	9.00	8.50
Alfalfa meal	44.95	44.71	43.40	41.70
Corn germ meal	15.20	8.00	1.00	0.00
Dried citrus pulp	0.00	7.00	14.00	21.00
Dicalcium phosphate	1.00	0.60	0.20	0.80
salt	0.50	0.50	0.50	0.50
Premix †	1.00	1.00	1.00	1.00
Lys	0.01	0.04	0.04	0.06
Met	0.11	0.15	0.19	0.24
Total	100.00	100.00	100.00	100.00
Calculated nutrient level, %				
DE (MJ/KG)	10.83	10.83	10.89	10.91
Crude Protein (%)	15.8	15.2	15.1	15.1
Crude Fibre (%)	13.6	13.9	13.9	14.0
Calcium (%)	0.95	1.00	1.08	1.30
Phosphorus (%)	0.51	0.52	0.53	0.70
Lys (%)	0.71	0.70	0.71	0.70
Ether Extract (%)	3.9	3.3	3.6	3.3
Met (%)	0.50	0.51	0.52	0.51
NDF (%)	26.6	26.5	25.6	26.2
ADF (%)	15.7	16.4	16.7	17.3
starch	22.5	20.1	18.5	14.2

† Provided per kilogram of diet: 10000 IU of vitamin A; 1000 IU of vitamin D3; 30 mg of Vitamin E; 1 mg of vitamin K3; 1 mg of vitamin B1; 3.5 mg of Vitamin B2 ; 5mg of Cu; 30mg of Fe; 1mg of I; 0.08 mg of Se; 30 mg of Zn; 15 mg of Mn.

Serum biochemical indexes

At the end of the experiment, 12 rabbits (70d old, 2.30-2.60 kg LW) in each group were chosen, and then 10ml blood was taken by cardiac puncture from each rabbit. Auto-biochemical analyzer was used to analyze the concentration of alanine transaminase (ALT), alkaline phosphatase (AKP), Albumin (ALB), Globulin (GLO), Calcium (Ca), by using commercial kits, according to the manufacturer instructions (Nanjing Jiancheng Bioengineering Institute, Nanjing, China).

Statistical analysis

The experimental data was pre-processed with Excel before analyzing variance with SPSS 18.0. Multiple comparisons were made by using Duncan's multiple range test.

RESULTS AND DISCUSSION

Growth performance

The dietary inclusion of dehydrated citrus pulp had no significant impact on the feed intake or on the growth of the different groups (table 2). This was consistent with the previous observations by Santos et al., (2014), Nazok et al. (2010) or Mourao et al. (2008). No toxic symptoms or pathological changes were found in the rabbits fed with citrus pulp (Tokarnia et al., 2001).

Table 2. Effect of dietary inclusion of dried citrus pulp on rabbits' performance

	Control	7% DCP*	14% DCP	21% DCP	SEM#	P value
Initial body weight (g/rabbit)	1482	1453	1460	1500	30	0.68
Weight at the end (g/rabbit)	2415	2382	2446	2538	42	0.098
Feed intake (g/d/rabbit)	123	118	121	131	4.29	0.193
Body weight gain (g/d/rabbit)	33	33	35	37	1.96	0.513
Feed-to-gain ratio	3.68	3.57	3.45	3.59	0.18	0.852

* 7% DCP, 14% DCP, 21% DCP group had 7%, 14% and 21% citrus pulps in the feed respectively. #SEM, Standard error of the means.

Serum biochemical indices

The results in Table 3 show that ALT levels in the blood serum were similar among the 4 groups. The experimental groups all displayed higher ALB, ALB:GLO ratio ($P<0.05$), Ca ($P<0.05$) levels than the control group.

Table 3. Effect of dietary inclusion of citrus pulp on rabbit blood biochemical indices

	Control	7% DCP*	14% DCP	21% DCP	SEM#	P value‡
ALT u/L	51.75 ^b	49.75 ^b	39.13 ^a	50.13 ^b	3	0.19
AKP u/L	126 ^a	174 ^b	126 ^a	143 ^a	9	0.01
ALB g/L	16.9 ^a	19.6 ^c	18.3 ^b	18.5 ^b	0.33	<0.001
ALB:GLO ratio	0.504 ^a	0.584 ^b	0.568 ^b	0.563 ^b	0.015	0.004
Ca mmol/L	2.96 ^a	3.13 ^b	3.11 ^b	3.18 ^b	0.04	0.006

* 7% DCP, 14% DCP, 21% DCP group had 7%, 14% and 21% citrus pulps in the feed respectively. #SEM, Standard error of the means. ‡ Means within a row with a letter in common differ ($P<0.05$). ALT-alanine transaminase, AKP- alkaline phosphatase, ALB-Albumin g/L, GLO-Globulin, Ca-calcium.

AKP is an hydrolase and it helps to improve the immunization of an organism (Ming et al., 2012). In this study, the albumin:globulin ratio levels in the DCP groups were higher than in control group, which suggests a good global health status of the rabbits. The dietary inclusion of DCP slightly increased the serum Ca concentration ($P<0.05$), probably because DCP is a good source of calcium (Nazok et al., 2010).

CONCLUSION

Inclusion of dehydrated citrus pulp in substitution of corn and soya bean in the diet of the growing rabbit did not modify growth performances, but seems a good sources of calcium.

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2. MATERIAL AND METHODS

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3. RESULTS



Table 1. Effect of dietary inclusion of dried citrus pulp on performance and serum biochemical of rabbits

	Control	7% DCP*	14% DCP	21% DCP	SEM#	P value
Initial body weight (g/rabbit)	1482	1453	1460	1500	30	0.68
Weight at the end (g/rabbit)	2415	2382	2446	2538	42	0.098
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