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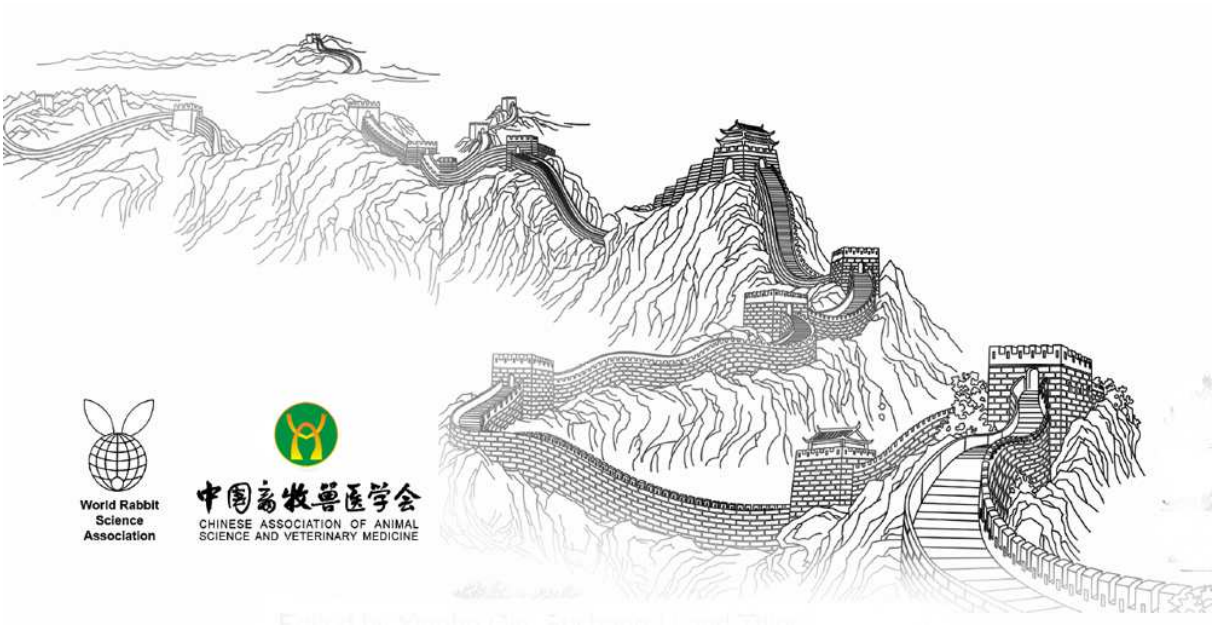

STUDY OF SUITABLE SUPPLEMENTATION OF PANTOTHENIC ACID TO GROWING REX RABBITS

Zhao N., Liu G. Y., Zhu Y.L.., Wu Z.Y., Liu L., Li F. C. *

College of Animal Science and Technology, Shandong Agricultural University, Tai'an 271018, China
*Corresponding author: LI Fuchang, Professor, E-mail: chlf@sdau.edu.cn

ABSTRACT

The experiment was conducted to investigate the effects of dietary pantothenic acid supplemental levels on production performance and antioxidant indices of 3 to 5-month-old Growing Rex Rabbits. Two hundred 3-month Rex rabbits with similar health conditions were randomly assigned to 5 groups with 40 replicates per group and 1 rabbit per replicate. Rabbits in 5 groups were fed with experimental diet with the following pantothenic acid supplemental levels: 0, 10, 20, 40 and 80 mg/kg respectively. The trial lasted for 7 days of adaptation and 53 days for test. The results showed:1) dietary pantothenic acid supplemental levels had extremely significant influence on average daily feed intake ($P<0.01$), had significant influence on feed conversion ratio ($P<0.05$), and the lowest feed/gain was in 40 mg/kg pantothenic acid group, while had no significant influence on average daily gain ($P>0.05$), 2) dietary pantothenic acid supplemental levels had extremely significant influence on fur area, fur height and melatonin concentrations ($P<0.01$), while had no significant influence on fur weight and leather thickness ($P>0.05$), 3) dietary pantothenic acid supplemental levels had extremely significant influence on drip loss ($P<0.01$), had significant influence on meat red value and yellow value ($P<0.05$), while had no significant influence on dressing percentage, pH within 45min, shear stress and meat light value ($P>0.05$).

Key words: pantothenic acid; Rex rabbit; production performance; antioxidant; supplementation.

INTRODUCTION

Pantothenic acid (PA) is a component of coenzyme A (CoA), acyl CoA and acyl carrier protein, and the coenzyme form of PA is involved in acyl group transfer reactions, tricarboxylic acid cycle and acetylation of choline (Lin et al., 2012). Consequently, this vitamin plays an important role in the synthesis as wel1 as the degradation of fatty acids. However, few reports at present have addressed the effects of PA on the growing Rex rabbits, the most of reports were connected with fisheries and poultry.

MATERIALS AND METHODS

Animals and experimental design

Two hundred 3-month Rex rabbits with similar health conditions were randomly assigned to 5 groups with 40 replicates per group and 1 rabbit per replicate. The experiment lasted for 60 days, which included a 7-day adaptation period and a 53-day experimental period. Feeds were provided ad libitum and the feeder was refilled at 07:00 and 18:00 daily. The residual feed in the raising cages was collected daily. Individual weight was measured at the beginning and at the end of the trial and the average daily gain (ADG) was calculated. The average daily feed intake (ADFI) was calculated according to total of food intake divided by total experimental days, and feed to gain conversion ratio (F/G) was calculated. The ADG, ADFI and F/G calculation did not include the 7-day adjustment period. Measurement of rabbit meat quality were as following: the pH value was determined from each rabbit in 45 min post mortem with a pH meter equipped with a pH probe, The flesh color was measured by a CR-10-type colorimeter by the production of Konica Minolta, including L-value, a-value and b-value. Fur weight was measured with an electronic scale including head and limbs. Multiply length by width to get fur area: the length was measured from neck to tail root, while width was measured at the narrowest waist with a tape. Two times leather thickness was measured with a

vernier caliper after fur fold up. Fur height was measured from the root to the tip with a straightedge. The assay procedure follows the basic principle of competitive Melatonin ELISA Kit (GenWay Biotech Inc.) whereby there is competition between a biotinylated and a non-biotinylated antigen for a fixed number of antibody binding sites. Optical density (O.D.) was measured with a microplate spectrophotometer (Biotek ELx808) at 405 nm within 10 min after pipetting of the stop solution. Plasma melatonin content is then determined by comparing the O.D. of the sample to the standard cure.

Chemical Analyses of experimental diets

The diets were formulated according to the requirement of growing rabbit recommended by NRC (1977) and De Blas and Mateos (1998) and were pelleted (Table1).

Five different pantothenic acid supplemental levels were prepared: 0 (control), 10, 20, 40, and 80 mg/kg. The measured levels of pantothenic acidin the diets were 6.68, 15.16, 27.32, 48.80 and 88.65 mg/kg, respectively.

Table 1: Composition (%) and nutrient levels (%) of the experimental diet (air-dry basis).

Ingredients	Percentage	Nutrient levels [2)]	Content
Corn	15.00	Digestible energy (MJ/kg)	10.28
Soybean meal	10.00	Crude protein	16.20
Wheat bran	12.00	Crude fiber	17.47
Big wheat (skin)	10.00	Crude ash	11.75
Peanut vine	30.00	Ether extract	2.79
Sunflower meal	8.00	Lysine(Lys)	0.60
Rice bran	10.00	Methionine (Met)	0.27
Premix [1)]	5.00	Calcium	0.97
Total	100.00	Phosphorus	0.43

[1]Premix provided per kg diet: Vit A 10 000 IU, Vit D_3 2 000 IU, Vit E 50 mg, Vit K_3 2.5 mg, Vit B_1 5 mg, Vit B_2 10 mg, Vit B_3 50 mg, Vit B_6 10 mg, Vit B_{11} 2.5 mg, Vit B_{12} 1 mg, choline chloride 400 mg, Fe (as ferrous sulfate) 100 mg, Zn (as zinc sulfate) 50 mg, Cu (as copper sulfate) 40 mg, Mn (as manganese sulfate) 30 mg, I (as potassium iodide) 0.5 mg, Se (as sodium selenite) 0.05 mg, $CaHPO_4$ 15 000 mg, NaCl 5 000 mg, Lys 1 500 mg, Met 1 500 mg, 10% bacitracin zinc 300 mg, complemental mixed meal.

[2]DE was a calculated value, while the other nutrient levels were measured values.

Statistical Analysis

Statistical analysis of the data was performed by ANOVA using the SAS 9.2 generalized linear model, with each animal considered as an experimental unit. Data are expressed as mean and SEM. $P < 0.05$ and $P < 0.01$ were considered to be significant and extremely significant, respectively.

RESULTS AND DISCUSSION

Effects of dietary pantothenic acid on growth performance

Dietary pantothenic acid supplemental levels had extremely significant influence on average daily feed intake ($P<0.01$), had significant influence on feed/gain ($P<0.05$), and the lowest feed/gain was in 40 mg/kg pantothenic acid group, while had no significant influence on average daily gain ($P>0.05$). This research shows that when supplemental level is 40 mg/kg, F/G ratio was minimum. The reason might be that the appropriate pantothenic acid level reduces the stress of the gut and peroxidation damage, promotes intestinal health, diarrhea in practical breeding process relatively less in the other groups.

Table 2: Effects of dietary pantothenic acid supplemental levels on growth performance of 3 to 5-month-old Rex Rabbits (n=40 per group).

Items	Dietary Pantothenic Acid supplemental levels (mg/kg)					R-MSE	*P*-value
	0	10	20	40	80		
Initial Body Weight (g)	1 790.00	1 823.63	1 818.33	1 808.13	1 843.75	166.37	0.69
Average Daily Gain (g/d)	17.36	17.36	18.24	18.22	17.15	2.40	0.14
Average Daily Feed Intake (g/d)	149.58^{A}	144.30^{B}	147.55^{C}	144.44^{B}	146.08^{BC}	3.79	<0.0001
F/G ratio	8.76^{a}	8.69^{a}	8.52^{ab}	8.05^{b}	8.22^{ab}	1.19	0.045

In the same row, values with different small letter superscripts mean significant difference ($P<0.05$), and with different capital letter superscripts mean significant difference ($P<0.01$), while with the same or no letter superscripts mean no significant difference ($P>0.05$).

Effects of dietary pantothenic acid on fur quality and plasma melatonin (MT) content

Dietary pantothenic acid supplemental levels had extremely significant influence on fur area and wool length (P<0.01), while had no significant influence on fur weight and fur thickness (P>0.05). Dietary pantothenic acid supplemental levels had extremely significant influence on plasma MT content (P<0.01). Pantothenic acid plays an important role in synthesis and excretion of melatonin. Welch (1990) implanted ten feral female goats with melatonin (1.86 mg/kg body weight) and observed that melatonin can increase cashmere length of mid-side staples 65% higher in two years. Gu Zilin *et al.* (2007) implanted melatonin in the 45-50 day rabbits and found it could enhance the growth speed of immature rabbit after weaning, accelerate the differentiation of hair follicles and increase the density of coat, promote growth, thickening and mature skin. So pantothenic acid may be promoted pineal gland to synthetize and secrete melatonin, and then promoted the growth and development of fur. Lanszki (2010) also proved melatonin implantation can improve Angora rabbit hair production and weight gain, but be found the rabbit hair fiber length also increased.

Table 3: Effects of dietary pantothenic acid supplemental levels on fur quality and plasma melatonin (MT) content of 3 to 5-month-old Rex Rabbits (n=8 per group).

Items	Dietary pantothenic acid supplemental levels (mg/kg)					R-MSE	*P*-value
	0	10	20	40	80		
Fur area ($cm^{2)}$	$1\,028.60^{A}$	$1\,043.96^{A}$	$1\,120.75^{B}$	$1\,171.39^{B}$	$1\,155.95^{B}$	62.49	<0.0001
Fur weight (g)	347.50	348.75	362.50	383.75	377.50	32.30	0.11
Leather thickness (mm)	2.65	2.76	2.95	2.93	2.71	0.24	0.05
Fur height (cm)	1.94^{A}	2.21^{BC}	2.28^{B}	2.23^{BC}	2.10^{C}	0.12	<0.0001
Plasma MT content (pg/ml)	249.53^{A}	281.73^{AB}	363.40^{BC}	409.90^{C}	399.65^{C}	1.83	0.001

In the same row, values with different small letter superscripts mean significant difference (*P*<0.05), and with different capital letter superscripts mean significant difference (*P*<0.01), while with the same or no letter superscripts mean no significant difference (*P*>0.05).

Effects of dietary pantothenic acid on meat quality

Dietary pantothenic acid supplemental levels had extremely significant influence on drip loss (P<0.01), had significant influence on meat red value and yellow value (P<0.05), while had no significant influence on dressing percentage, pH within 45 min, shear stress and meat light value (P>0.05). Strydom (2008) research shows that in addition to meat safety factor, other properties such as color, meat flavor and flavor and tenderness are very important reasons when determining meat nutrition value and quality indicators.

Table 4: Effects of dietary pantothenic acid supplemental levels on meat quality of 3 to 5-month-old Rex Rabbits (n=8 per group).

Items	Dietary pantothenic acid supplemental levels (mg/kg)					R-MSE	*P*-value
	0	10	20	40	80		
Dressing percentage（%）	55.62	52.51	51.52	50.89	53.03	6.99	0.70
pH value	6.61	6.71	6.72	6.70	6.58	0.12	0.10
Drip loss (%)	10.80^{AC}	13.97^{B}	10.08^{BC}	9.41^{B}	12.95^{A}	0.03	0.004
Shear force (kg.f)	3.05	3.04	2.98	2.83	2.88	0.25	0.32
L	35.81	37.95	34.78	36.56	37.88	3.82	0.41
a*	35.01^{ab}	34.43^{a}	37.40^{abc}	38.96^{bc}	40.54^{c}	4.09	0.03
b*	-5.04^{a}	-6.06^{abc}	-6.56^{bc}	-7.35^{c}	-5.64^{ab}	1.32	0.02

In the same row, values with different small letter superscripts mean significant difference (*P*<0.05), and with different capital letter superscripts mean significant difference (*P*<0.01), while with the same or no letter superscripts mean no significant difference (*P*>0.05).

CONCLUSIONS

Considering all indexes of this experiment, the appropriate dietary pantothenic acid supplemental levels are 20 ~ 40 mg/kg for 3 to 5-month-old Rex Rabbits (dietary pantothenic acid measured content are 27.32~48.80 mg/kg).

ACKNOWLEDGEMENTS

We would like to thank our anonymous reviewers and our colleagues from the Animal Nutrition Laboratory for their valuable critiques and suggestions. We acknowledge support from the earmarked fund for Modern Agro-industry Technology Research System (CARS-44-B-1) and the Special Fund for Agroscientific Research in the Public Interest (2000903006).

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Study of Suitable Supplementation of Pantothenic Acid to Growing Rex Rabbits

N. Zhao, G. Y. Liu, Y. L. Zhu, Z. Y. Wu, L. Liu, F. C. Li*

College of Animal Science and Technology, Shandong Agricultural University, Tai'an 271018, China

***Corresponding author: LI Fuchang, Professor, E-mail: chlf@sdau.edu.cn**

RABBIT NUTRITION AND METABOLISM LAB

The message

The study of Rex Rabbit nutritional requirement is a little poor in China, especially on vitamin nutrition.Our lab knowned as rabbit nutrition and metabolism lab had accomplished the study of CP, EE,standard amino acid and vitamin, meanwhile this experiment to investigate the pantothenic acid supplementation of the Rex Rabbits is a complementary and perfect on the Rex Rabbit nutritional requirement.

Introduction

The experiment was conducted to investigate the effects of dietary pantothenic acid supplemental levels on production performance and antioxidant indices of 3 to 5-month-old Growing Rex Rabbits. Two hundred 3-month Rex rabbits with similar health conditions were randomly assigned to 5 groups with 40 replicates per group and 1 rabbit per replicate. Rabbits in 5 groups were fed with experimental diet with the following pantothenic acid supplemental levels: 0, 10, 20, 40 and 80 mg/kg respectively. The trial lasted for 7 days of adaptation and 53 days for test.

Fig 1. Molecular structure of pantothenic acid

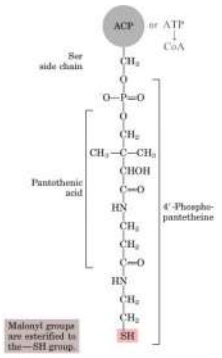

Fig 2. Molecular structure of ACP and CoA

Method

1.Feeding experiment

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

Ingredients	Percentage	Nutrient levels [2]	Content
Corn	15.00	Digestible energy (MJ/kg)	10.28
Soybean meal	10.00	Crude protein	16.20
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Sunflower meal	8.00	Lysine(Lys)	0.60
Rice bran	10.00	Methionine (Met)	0.27
Premix [1]	5.00	Calcium	0.97
Total	100.00	Phosphorus	0.43

Two hundred 3-month Rex rabbits were randomly assigned to 5 groups with 40 replicates per group and 1 rabbit per replicate. The experiment lasted for 60 days, which included a 7-day adaptation period and a 53-day experimental period.Feeds were provided ad libitum and the feeder was refilled at 07:00 and 18:00 daily.

2.Measurement

The residual feed in the raising cages was collected daily. Individual weight was measured at the beginning and at the end of the trial and the average daily gain (ADG) was calculated. The average daily feed intake (ADFI) was calculated according to total of food intake divided by total experimental days, and feed to gain conversion ratio (F/G) was calculated.

Measurement of rabbit meat quality were as following: the pH value was determined from each rabbit in 45 min post mortem with a pH meter equipped with a pH probe, The flesh color was measured by a CR-10-type colorimeter by the production of Konica Minolta, including L-value, a-value and b-value.

Fur weight was measured with an electronic scale including head and limbs. Multiply length by width to get fur area: the length was measured from neck to tail root, while width was measured at the narrowest waist with a tape. Two times leather thickness was measured with a vernier caliper after fur fold up. Fur height was measured from the root to the tip with a straightedge.

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RESULTS

1.Effects of dietary pantothenic acid supplemental levels on growth performance of 3 to 5-month-old Rex Rabbits (n=40 per group).

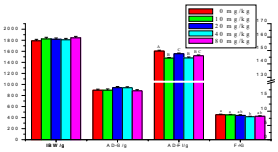

Fig 3. Effects of dietary pantothenic acid supplemental levels on growth performance of 3 to 5-month-old Rex Rabbits

Note:In the same row, values with different small letter superscripts mean significant difference (P<0.05), and with different capital letter superscripts mean significant difference (P<0.01), while with the same or no letter superscripts mean no significant difference (P>0.05).

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2.Effects of dietary pantothenic acid supplemental levels on fur quality (n=40 per group).

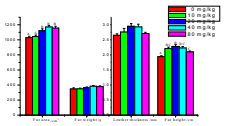

Fig 4. Effects of dietary pantothenic acid supplemental levels on fur quality

Dietary pantothenic acid supplemental levels had extremely significant influence on fur area and wool length (P<0.01), while had no significant influence on fur weight and fur thickness (P>0.05). Dietary pantothenic acid supplemental levels had extremely significant influence on plasma MT content (P<0.01). Pantothenic acid plays an important role in synthesis and excretion of melatonin. Welch (1990) implanted ten feral female goats with melatonin (1.86 mg/kg body weight) and observed that melatonin can increase cashmere length of mid-side staples 65% higher in two years. Gu Zilin et al. (2007) implanted melatonin in the 45-50 day rabbits and found it could enhance the growth speed of immature rabbit after weaning, accelerate the differentiation of hair follicles and increase the density of coat, promote growth, thickening and mature skin. So pantothenic acid may be promoted pineal gland to synthetize and secrete melatonin, and then promoted the growth and development of fur. Lanszki (2010) also proved melatonin implantation can improve Angora rabbit hair production and weight gain, but be found the rabbit hair fiber length also increased.

3.Effects of dietary pantothenic acid on meat quality (n=40 per group).

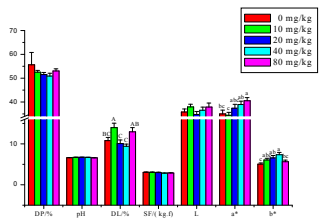

Fig 5. Effects of dietary pantothenic acid on meat quality

Dietary pantothenic acid supplemental levels had extremely significant influence on drip loss (P<0.01), had significant influence on meat red value and yellow value (P<0.05), while had no significant influence on dressing percentage, pH within 45 min, shear stress and meat light value (P>0.05). Strydom (2008) research shows that in addition to meat safety factor, other properties such as color, meat flavor and flavor and tenderness are very important reasons when determining meat nutrition value and quality indicators.

CONCLUSIONS

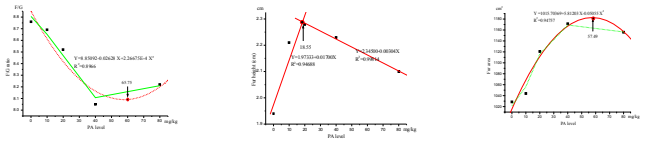

Fig 6, 7, 8Quadratic regression polynomial analysis between F/G ratio , Fur height, fur area (cm)and dietary PA levels; Fig 9-2 Double linear regression analysis between fur height and dietary PA levels

Considering all indexes of this experiment, the appropriate dietary pantothenic acid supplemental levels are 20 ~ 40 mg/kg for 3 to 5-month-old Rex Rabbits (dietary pantothenic acid measured content are 27.32~48.80 mg/kg)