EFFECT OF DIETARY STARCH LEVELS ON PERFORMANCE AND DIGESTIBILITY OF GROWING RABBITS

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ABSTRACT

The aim of this study was to evaluate the effects of different levels of starch in diets of growing rabbit on the growth performance and digestibility coefficients. Sixty NZW rabbits were divided randomly into three experimental groups of 20 rabbits each (10 males + 10 females) of 5 weeks of age with an average live body weight of (637.5 ± 6.5 g), were used in this study. Rabbits were equal with respect to body weight and sex. The following 3 diets were obtained: control (17.30% starch and 3.23% EE), High Starch (22.11% starch and 1.37% EE) and Low Starch (12.30% starch and 5.13% EE). All diets were nearly iso-nitrogenous, iso-caloric and contained similar levels of crude fiber and micro elements. Results indicated that rabbits fed diets containing high starch level had significantly highest body weight, while those fed diet with low starch level had the lowest body weight. But no differences were observed with the control diet. Rabbits fed high starch and control diet recorded a higher daily weight gain (28.7 g) than those fed low starch diet (23.8 g/d, $P<0.001$). Rabbits fed high starch diet had the best feed conversion ratio (FCR) (3.37), while the worst FCR was observed with those fed low starch diet (3.63; $P<0.01$). The apparent digestibility of DM, OM, CP and GE significantly increased (about 8% for DM, OM and GE, and 4% CP) with the starch level, whereas digestibility coefficients of EE and NFE significantly decreased (about 10%, $P<0.001$) by increasing the levels of starch in experimental diets. While, no significant differences could be observed in CF digestibility coefficient.

Growth performance and nutrient digestibility coefficients were significantly reduced except digestibility coefficients of EE and NFE in rabbits fed low starch diet, as compared with other starch levels in iso-caloric and iso-fibrous diets .Thus it could be concluded that feeding high starch diet (up to 22.11%) permitted to obtain the best growth performance and digestibility coefficients in growing rabbits.

Key words: Growing rabbits, starch, growth performance, digestibility.

INTRODUCTION

The carbohydrate fraction (starch and fiber) is very important in the young rabbit diets, mainly due to its effects on digestive transit and on substrate available for microbial activity in the hindgut. Both factors affect stability of the microbial ecosystem and gut health Gidenne *et al.* (2005). Starch is the main source of energy in animal nutrition. It is also the primary nutrient in rabbit diets used to promote high level of production. For intensive systems of rabbit production, starch is used in diets to provide the high energy requirement for rabbits. Digestive problems linked to the incomplete development of the enzymatic system in young rabbits and their inabilities to digest completely starch were reported by Gidenne and Fortun-Lamothe (2002) and Debray *et al.* (2003). Since long time, low starch levels are recommended for both weaning and growing rabbits, but the negative role of starch on digestive troubles has been recently put under discussion (Gidenne and Garcia, 2006). Low-digested fibre fractions (ADF = cellulose and lignin) are known to exert a protective role against enteric pathogens by regulating digestive transit and modulating caecal microflora and volatile fatty acid production. On the other hand, increasing inclusion level of dietary fiber decreases both dietary DE content and the overall efficiency for use of DE in the growing rabbits (Ortiz *et al*., 1989 and Garcia *et al*., 1993). Fat

inclusion in fibrous diets could be compensate the negative effect of fiber on energy digestion (Fernandez-Carmona *et al*., 1994).

Therefore, the aim of this study was to evaluate the effects of different levels of starch in iso-caloric and iso-fibrous diets of growing rabbit on the growth performance and digestibility coefficients.

MATERIALS AND METHODS

Animals and experimental design:

The experiments of the present study were carried out at the Rabbitry Farm of Poultry Production Department, Faculty of Agriculture, Kafr El-Sheikh University during the period from January 2007 to May 2007. Sixty NZW rabbits were divided randomly into three experimental groups of 20 rabbits each (10 males + 10 females) of 5 weeks of age with an average live body weight of (637.5 ± 6.5 gm), were used in this study. Rabbits were equal with respect to body weight and sex. Three experimental diets were formulated to cover all essential nutrient requirements for growing rabbits according to De Blas and Mateos (1998). The following 3 diets were obtained: control (17.30% starch and 3.23% EE), high starch diet (HS) (22.11% starch and 1.37% EE) and low starch diet (LS) (12.30% starch and 5.13% EE). All diets were nearly iso-nitrogenous, iso-caloric on the basis of Metabolizable energy and contained similar levels of crude fiber and micro elements. Table 1 shows the ingredient and nutrient composition of these diets. Rabbits were housed in individual galvanized wire flat deck batteries (60 x 50 x 35 cm) with feeder and automatic nipple drinkers. The batteries were arranged in rows in a windowed house naturally ventilated. A cycle of 16 hours of light and 8 hours of dark were used throughout the experiment. All rabbits were kept under the same management conditions. Feed and water were supplied *ad libitum.* Individual body weight and feed intake were taken weekly from 5 weeks until 13 weeks of age. Mortality and the clinical health status of all rabbits were monitored daily.

Digestibility trial:

A digestibility trial was performed on twenty four male NZW rabbits, at least three months old and similar in body weights, to determine the apparent nutrient digestibility of the three experimental diets (8 males for each treatment). Animals were housed in metabolism cages that allowed separation of faeces and urine. Faeces produced daily were collected in polyethylene bags and stored at - 20ºC Perez *et al.* (1995) for five consecutive days according to the European reference method for rabbit digestibility trials.

Chemical analyses:

At first, hard faeces was dried at 60ºC for 48 hr. to determine DM, while DM of diets were performed using an air oven at 135ºC for 2 hr. Chemical analysis were carried out for diets and hard faeces, according to methods of AOAC (1995) for ash, CP, CF and EE. Gross energy was determined in an adiabatic bomb calorimeter in Animal and Poultry Nutrition and Production Department, National Research Center, Dokki, Cairo, Egypt. Nutrient digestibility coefficients were calculated as described by Perez *et al.* (1995).

Statistical analysis:

Data were subjected to analysis of variance, using the general linear GLM procedure (SAS, 1998). The application of the least significant ranges among the different treatment means was done according to Duncan (1955).

Table 1: Ingredient and chemical composition of experimental diets.

Ingredient	Dietary starch level		
	LS	Control	HS
Berseem hay	24.50	29.00	32.70
Barley	4.60	23.90	41.90
Soybean meal (44%)	12.80	15.70	18.20
Wheat bran	52.40	26.90	3.90
Soybean oil	3.00	1.50	-
Limestone	1.80	1.15	0.60
Dicalcium phosphate	-	0.95	1.80
Salt	0.20	0.20	0.20
Premix(1)	0.30	0.30	0.30
DL-Methionine	0.20	0.20	0.20
Anti-fungi(2)	0.10	0.10	0.10
Anti-oxidant(3)	0.10	0.10	0.10
Total	100.0	100.0	100.0
Chemical Analysis (% as DM):			
Dry matter (DM)	86.90	86.61	86.29
Ash	5.80	5.55	5.30
Crude protein (CP)	17.07	17.05	17.00
Crude fiber (CF)	13.45	13.48	13.41
Metabolizable energy (ME) (kcal/kg)(4)	2351	2353	2351
Ether extract (EE)	5.13	3.23	1.37
N-Free extract (NFE)	42.72	46.73	49.67
Starch(5)	12.30	17.30	22.11
Calcium (5)	1.15	1.15	1.15
Phosphorus(5)	0.73	0.72	0.72
Methionine(5)	0.46	0.45	0.45
Lysine(5)	0.81	0.84	0.86

(1) PESTMIX produced by Pestar Company, China. Each 3 Kg vitamin and mineral mixture contain: Vitamin A 12000000 IU, Vit.D3 2200000 IU, Vit. E 10000 mg, Vit.K,2000 mg, Vit.$B_1$1000mg, Vit.$B_2$4000mg, Vit.$B_6$1500mg, Vit.B_{12}10mg, Pantothenic Acid 10000mg, Niacin 20000mg, Biotin 50 mg, Folic acid 1000mg, Choline chloride 500gm, Selenium 100mg, Manganese 55000mg, Zinc 50000mg, Iodine 1000 mg and carrier CaCO3, to 3000 g.
(2) Mycostat, Agil, England.
(3) FEEDOX®dry, IMP EXTRACO (Belgium).
(4) Calculated according to Maertens *et al.* (2002)
(5) Calculated according to Villamide *et al.* (1998)

RESULTS AND DISCUSSION

Results concerning the effect of dietary starch levels on performance and digestibility of growing rabbits are presented in (Table 2).Final body weight of rabbits fed low starch diet decreased ($P < 0.001$) by 11.68 than those fed control diet. However, no significant differences between the high starch diet and the control diet could be observed. Rabbits fed diet containing 22.11% starch recorded the highest value of daily weight gain, followed by rabbits received control diet, with insignificant differences between them. While, the lower value was observed for rabbits fed diet containing 12.30% starch as compared with the control diet (23.8 *vs.* 28.4 g, $P<0.001$). These results are in agreement with those obtained by Xiccato *et al.* (2002) who reported that high starch diet increased ($P<0.05$) weight gain and Tazzoli *et al.* (2009) who observed that final live weight and daily growth tended to decrease ($P < 0.05$) with decreasing the level of starch from 19.6 to 11.5 % in the rabbit diets.

The highest value of relative growth rate was found for rabbits fed diet containing high starch level (22.11%),while the lowest value for those fed diet containing 12.30% starch (111.5% *vs.*102.1%; P<0.001). These results are in agreement with the findings of Belenguer *et al.* (2000) who found that inclusion of high levels of starch in growing rabbit diets promoted the highest growth rate. Rabbits fed diet with 22.11% starch recorded the best of performance index value , while the worst value was found in those fed diet containing 12.30% starch (68.9 *vs.* 55.2% ; P<0.001). The depression in performance index may be due to decrease in final body weight. Feed intake was decreased (P<0.01) by10.87% with rabbits fed LS diet as compared with those fed control diet. While no significant differences could be observed between rabbits fed HS and control diets. This is in accordance with

Table 2: Effect of experimental diets on growth performance of growing NZW rabbits from 5 to 13 weeks of age.

Parameters	Dietary starch level			SEM	Sig.
	LS	Control	HS		
No. of Animals	20	19	18	-	-
Initial body weight (g)	635.5	638.8	638.3	6.53	NS
Final body weight (g)	1968.3^{b}	2228.5^{a}	2261.3^{a}	37.50	***
Daily weight gain (g)	23.8^{b}	28.4^{a}	29.0^{a}	0.610	***
Feed intake (g/d)	86.1^{b}	96.6^{a}	96.5^{a}	2.313	**
Feed conversion ratio	3.63^{a}	3.42^{b}	3.37^{b}	0.085	**
Relative growth rate (1)	102.1^{b}	110.8^{a}	111.5^{a}	1.165	***
Performance index (%) (2)	55.2^{b}	65.8^{a}	68.9^{a}	2.056	***
Digestibility Coefficients (%):					
Dry matter (DM)	64.7^{b}	66.0^{b}	69.5^{a}	0.48	***
Organic matter (OM)	64.4^{b}	66.4^{ab}	70.6^{a}	0.41	*
Crude protein (CP)	74.9^{c}	76.1^{b}	77.9^{a}	0.30	***
Crude fiber (CF)	23.5	23.8	24.2	0.47	NS
Ether extract (EE)	84.7^{a}	80.8^{b}	75.4^{c}	0.60	***
Nitrogen free extract (NFE)	76.7^{a}	73.6^{b}	69.2^{c}	0.64	***
Gross energy (GE)	62.4^{c}	64.9^{b}	67.5^{a}	0.46	***

HS = High Starch, LS = Low Starch, SEM = Standard error of means, Sig= significance
*: Significant at 5% level of probability; **: Significant at 1% level of probability;
***: Significant at 0.1% level of probability; NS: Non-significant.
$^{a, b, c}$ Means in the same row the different superscripts are significantly different (P<0.05).
(1) Relative growth rate = [(Final body weight- Initial weight) / (Final body weight+ Initial weight)/2] x100
(2) Performance index = (Final live body weight (kg)/ Feed conversion ratio) x100, according to North (1981)

data observed by Xiccato *et al.* (2008) who found that feed intake significantly increased by 5.65% with increasing the level of starch from 9.6 to 18.9% in the rabbit diets. Moreover, Tazzoli, *et al.* (2009) reported decreased feed intake as the levels of starch decreased in the diets.

Rabbits fed HS diet had the best feed conversion ratio (FCR) (3.37), while the worst FCR was observed with those fed LS diet (3.63; P<0.01). Results reported here agree with those reported by Amber (2007) and Xiccato *et al.* (2008) who found that FCR was significantly improved as the level of starch increased in the diets. On the contrary, Tazzoli *et al.* (2009) observed that Conversion index tended to improve (2.72 to 2.68; L<0.01) with decreasing the levels of starch from 19.6 to 11.5 % in rabbit's diets, when they used diets different in energy content.

Crude protein apparent digestibility of rabbit fed HS diet was higher (P <0.001) by 2.37%, while rabbits fed LS diet was lower (P <0.001) by 1.58% than those fed control diet. The apparent digestibility of DM, OM and GE were significantly increased, but digestibility coefficients of EE and NFE were significantly decreased (P<0.001) by increasing the levels of starch in experimental diets. While, no significant differences could be observed in CF digestibility coefficient. The decrease in EE digestibility is mainly due to decrease the level of EE in experimental diets, as a result of starch level

increased. The same result was observed by Bhatt and Swain (2003) who observed significant (P<0.05) improvement for digestibility of CP and EE with fat supplementation (2, 4, 6 and 8%). On the contrary, Tazzoli *et al.* (2009) found that digestibility of DM, GE and NDF were increased (P<0.05) by 4.48, 5.6 and 48.75%, respectively, as the starch level decreased from 19.6 to 11.5% in rabbit diets.

CONCLUSIONS

Growth performance and nutrient digestibility coefficients were significantly reduced except digestibility coefficients of EE and NFE in rabbits fed low starch diet, as compared with other starch levels in iso-caloric and iso-fibrous diets .Thus it could be concluded that feeding high starch diet (up to 22.11%) permitted to obtain the best growth performance and digestibility coefficients in growing rabbits.

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