

DOSE-DEPENDENT EFFECT OF CELLULASE SUPPLEMENTATION ON PERFORMANCE OF EARLY-WEANED RABBIT

EIBEN Cs.¹, MÉZES M.², SZIJÁRTÓ N.³, KUSTOS K.², GÓDOR-SURMANN K.¹, ERDÉLYI M.²

¹Department of Rabbit Breeding and Genetics, Institute for Small Animal Research, H-2101 Gödöllő, P.O. Box 417, Hungary.

²Department of Nutrition, Szent István University, H-2103 Gödöllő, Páter K. u. 1., Hungary.

³Department of Agricultural Chemical Technology, Budapest University of Technology and Economics, H-1521 Budapest, P.O. Box 91, Hungary.

eiben@katki.hu

ABSTRACT

One hundred and twenty NZW rabbits were weaned and distributed into four groups with respect to litter size and body weight at 23 days of age. Rabbits received *ad libitum* unmedicated commercial diets supplemented with high (H = 52.80 FPU/kg), moderate (M = 35.20 FPU/kg) or low (L = 11.99 FPU/kg) levels of a cellulase complex which enzyme activities correspond to 75%, 50% and 17% of our earlier applied dose of 70.40 FPU/kg feed. The control group (C) was fed *ad libitum* the same diet but without enzyme addition. Between 63 and 77 days of age, all groups received the C diet. The rabbits were kept individually in wire mesh fattening cages (30x61x28 cm) under controlled indoor conditions (15-20°C, 16:8 L:D lighting regimen). It was concluded that supplementation of diet for early-weaned rabbits with a cellulase complex reaching 35.20 and 52.80 FPU/kg enzyme activity affects positively the production, namely, the feed conversion between 23 and 77 days of age was better (2.97, 2.91, 3.04 and 3.03 in the H, M, L and C groups, respectively; P=0.039). Both daily weight gain from day 23 to 77 (43.9, 43.5, 42.6 and 43.1 g, resp.; P=0.634) and the body weight at 77 days (2964, 2944, 2905 and 2932 g, resp.; P=0.822) was similar for all the groups. Considering also animal sanitary state, another benefit was the lower (P=0.046) mortality caused by enteritis (3%, 13%, 13% and 20%, respectively) during the fattening period.

Key words: rabbit, nutrition, cellulase enzyme, growth.

INTRODUCTION

Forthcoming prohibition of antibiotic growth promoters in the European Union stimulates research for their alternatives. As part of these efforts studying the effects of exogenous enzymes is one of the most promising solution.

Fiber is the most crucial constituent of rabbit feeds. The bulk provided by the high fiber content in the diet, though poorly digestible, helps preventing enteritis. On the other hand, exogenous fibrolytic enzymes can promote caecal fermentation and modify volatile fatty acid concentrations, affecting the colonisation of useful bacteria in the caecum and so can contribute to maintain the good health status of the animal. Non-starch-polysaccharide (NSP) enzymes and cellulase might be the most promising ones for improving sanitary state and consequently performance of rabbits.

Microbial activity is modified by age: pectinase, xylanase and cellulase activity of bacteria increased by 80% between 25 and 34 days of age in rabbits (GIDENNE *et al.*, 2002). In our previous study (EIBEN *et al.*, 2002) the effect of a dietary cellulase-hemicellulase complex (endoglucanases, cellobiohydrolases, β -glucosidases) supplementation on the performance of 23-day-old early-weaned rabbits was studied. In agreement with SZIJÁRTÓ *et al.* (2004), addition of these exogenous enzymes resulted in better performance, especially during the first two weeks after weaning. Namely, feed to gain ratio has been improved, whereas weight gain was not affected, accompanied by a reduced feed intake. However, optimum level of dietary cellulase inclusion has not been revealed, yet.

Based on our previously used dose (100% = 70.40 FPU/kg diet), this work studied the effects of dietary cellulase supplementation with high (75%), medium (50%) or low (17%) levels on growth traits and mortality in early-weaned rabbits.

MATERIAL AND METHODS

New Zealand white rabbits (n=120) born in one reproduction cycle and weaned at 23 days of age were divided into four groups considering body weight at weaning (510 to 516 g). One group was used as reference, fed the unmedicated commercial fattening diet (C). Nutrient content of the diets was determined according to the Hungarian National standard (crude protein 18.0%, crude fat 4.45%, crude fiber 14.4%, digestible energy 10.3 MJ/kg). The experimental groups were fed the same C diet but supplemented with high (H), medium (M) and low (L) doses of cellulase. Based on our earlier study, where 70.40 FPU cellulase activity was added to 1 kg diet (EIBEN *et al.*, 2002), we supplied 75 (52.80 FPU/kg), 50 (35.20 FPU/kg) and 17 (11.99 FPU/kg) per cent of that amount in the diet of H, M and L groups, respectively (Table 1). A liquid cellulase-hemicellulase enzyme complex, produced by controlled fermentation process of *Trichoderma reesei* Rut C-30 fungi strain on used corrugated cardboard as cellulose substrate (SZIJÁRTÓ *et al.*, 2004) was sprayed homogeneously on the surface of the pelleted reference feed. Diet and water was provided *ad libitum* during the whole experimental period. After 63 days of age, when the endogenous enzymatic capability is more sufficient, all groups were fed the C diet until the end of fattening, at 77 days of age.

As pre-weaning litter size can influence the individual milk intake and later on feed consumption (SCAPINELLO *et al.*, 1999), special attention was given to homogeneity at grouping. Therefore, four rabbits of average weight were selected from medium-sized

litters (5-9) and were proportionately distributed into the four groups. Weanlings were housed individually in wire-net fattening cages (30x61x28cm) under controlled environmental conditions (15-20 C°, 16:8 L:D photoperiod). Three-three cages of animals per treatment were followed by three control ones repeatedly in a row of cages. Live weight and feed intake of rabbits were measured at 23, 35, 49, 63 and 77 days of age. Date and cause of mortality were recorded. Weight gain and feed conversion ratio were calculated from the data.

The effects of the treatment (four levels) were statistically evaluated by one factor analysis of variance and by Chi² probe with using the Statgraphics 6.0 software (1992).

RESULTS AND DISCUSSION

Medium (50%) and high (75%) level of cellulase addition tended (P=0.822) to increase the body weight at 77 days of age by 0.4 to 1 per cent compared to the C group (2944 and 2964 g vs 2932 g, Table 1). This is consistent with our previous result (EIBEN *et al.*, 2002) where the rabbits fed a diet with 70.40 FPU/kg cellulase supplementation reached a 3 per cent relatively larger (P=0.239) 77d body weight (2778 g) as compared to the control animals (2692 g).

On the two weeks subsequent to weaning, feed conversion ratio (FCR) was 4 per cent better for M and H, than in the C group, however, it no longer differed significantly in contrast to our earlier data with higher level (70.40 FPU/kg diet) of cellulase inclusion (1.90 vs 2.51 in the treated and in the control groups, P=0.001).

Between 35 and 49 days of age, rabbits in H group tended to gain better (P=0.067), and showed 9 per cent more efficient (P=0.021) feed utilization than C group. Moreover, FCR improved even in the M and L groups. Between 49 and 63 days of age, rabbits in M group had the best (P=0.036) FCR among the groups.

After 63 days of age, when C diet was provided to all groups, a relatively higher (P>0.05) feed intake and more favorable FCR were found in M and H groups resulting in a tendency of improved gain compared to the L and C groups. This tendency is partly in line with our earlier finding, where returning to the control feed in group with higher dose of cellulase (70.40 FPU/kg) the feed consumption increased (196 vs 133 g/day), whereas the FCR impaired (3.26 vs 2.59) but after all, the weight gain improved (44.1 vs 37.9 g/day) in comparison with the control group in this period (EIBEN *et al.*, 2002).

Concerning the whole fattening period from 23 to 77 days of age, the advantageous effect of cellulase supplementation appeared, but it was less pronounced than in our previous trial (EIBEN *et al.*, 2002) with higher dose, when a 4 per cent increase in weight gain was recorded (41.2 vs 39.6 g). Namely, rabbits in H group tended to increase DWG only 1.9 per cent (43.9 g/day), while those in M group 0.9 per cent (43.5 g/day) when compared with rabbits in C group (43.1 g/day). Beside equal feed intake, the feed utilization was more efficient (P=0.039) in M and H (2.91-2.97 g/g) groups, than in the

other two groups (3.03-3.04 g/g). This agrees with the finding of GIPPERT and CSÍKVÁRY (1988), who reported a beneficial effect of cellulase supplementation on FCR.

The cellulase supplementation decreased significantly (P=0.046) the mortality rate by 7 to 17 per cent caused by enteritis during the fattening period (Table 1).

Table 1 Effect of dietary cellulase supplementation on performance traits and mortality in early-weaned rabbits

rabbits (n)	Dose of cellulase supplementation				P level
	High: 75% (52.80 FPU/kg)	Medium: 50% (35.20 FPU/kg)	Low: 17% (11.99 FPU/kg)	Control: 0% (0 FPU/kg)	
	30	30	30	30	
age in days	Body weight, g				
23	512±8	510±8	513±8	516±8	0.969
35	1075±21	1077±21	1070±21	1087±21	0.951
49	1792±31	1730±32	1759±33	1753±33	0.581
63	2326±36	2300±38	2301±38	2318±40	0.952
77	2964±44	2944±45	2905±45	2932±46	0.822
	Daily weight gain, g/day				
23-35	40.2±1.3	40.4±1.3	39.6±1.3	40.9±1.3	0.907
35-49	50.7 ^a ±1.3	46.6 ^b ±1.3	47.9 ^{ab} ±1.3	46.5 ^b ±1.3	0.067
49-63	38.1±1.2	40.6±1.3	38.3±1.3	41.3±1.3	0.185
63-77	45.3±1.4	45.4±1.4	43.2±1.4	43.8±1.4	0.601
23-77	43.9±0.7	43.5±0.8	42.6±0.7	43.1±0.8	0.634
	Feed intake, g/day				
23-35	68±2	67±2	68±2	71±2	0.638
35-49	131±4	124±4	125±4	131±4	0.342
49-63	142±4	138±4	146±4	144±4	0.541
63-77	176±3	177±3	175±3	175±3	0.969
23-77	130±2	127±2	129±2	130±2	0.609
	Feed conversion ratio (FCR), g/g				
23-35	1.69±0.04	1.66±0.04	1.73±0.04	1.75±0.04	0.316
35-49	2.59 ^a ±0.06	2.68 ^{ab} ±0.06	2.61 ^a ±0.06	2.85 ^b ±0.06	0.021
49-63	3.81 ^b ±0.11	3.44 ^a ±0.12	3.85 ^b ±0.12	3.56 ^{ab} ±0.12	0.036
63-77	3.96±0.12	3.94±0.12	4.17±0.12	4.08±0.12	0.504
23-77	2.97 ^{ab} ±0.03	2.91 ^a ±0.04	3.04 ^b ±0.04	3.03 ^b ±0.04	0.039
	Mortality rate, %				
23-35	0	3.33	3.33	3.33	0.435
35-49	3.33	3.33	6.66	10	0.225
49-63	0	6.66	3.33	6.66	0.309
63-77	0	0	0	0	-
23-77	3.33 ^a	13.3 ^{ab}	13.3 ^{ab}	20 ^b	0.046

The favorable effects of exogenous enzyme addition could manifest in better digestibility of nutrients and improve FCR, due to more efficient fiber digestion (GUTIERREZ *et al.*, 2002) which can contribute to the reduced mortality in relation to digestive tract disorders. GUTIERREZ *et al.* (2002) offered the rabbits from 25 to 39 days of age an enzyme supplemented diet (1g/kg Porzyme[®] tp 100) that also contained NSP digesting

enzymes (xylanase, pectinase) and afterwards fed the animals the control diet until 60 days of age. Similarly to our study, enzymes did not change feed intake from 25 to 39 days of age, but resulted in 3.1 per cent relative increase ($P=0.079$) in weight gain and 3.7 per cent improvement ($P<0.002$) in FCR. Furthermore, mortality tended to decrease ($P=0.083$) from 7.8 per cent to 3.7 per cent in the first two weeks of the treatment, and reduced from 13.9 to 6.9 per cent ($P<0.041$) in the whole fattening period.

The success of dietary enzyme inclusion can vary according to age and applied dose of preparation. With the supplementation of an enzyme complex of Kemzyme[®] (cellulase, amylase, glucanase, protease, lipase) for 28-day-old weaned rabbits EL-MANDY *et al.* (2002) reported a significantly better FCR in response to the improved digestibility coefficients, whereas neither the weight gain nor the slaughter weight was affected by the treatment. However, Kemzyme[®] addition had no effect, when weaning took place at 42 days of age (TAG EL-DIN *et al.*, 2002). This can be explained by later weaning, i.e. the effect of age on caecal fermentation (XICCATO *et al.*, 2003). VALENTE *et al.* (1999) mentioned an advantage only in FCR with supplementation of 0.05% cellulase and protease activity enzyme complex (VEGPRO[®]) in the diet of rabbits weaned at 40 days of age, while no dose-dependent (0%, 0.05%, 0.1%, 0.15% and 0.25%) effect was revealed.

CONCLUSIONS

Based on our results, a cellulase-hemicellulase complex supplementation with an enzyme activity from 35.20 FPU per kg diet might be reasonable for the rabbits weaned at 23 days of age. It means that beside using medicated diets, early weaning can be practiced also with non-medicated feeds when supplemented with exogenous enzymes. In view of food security, in future studies enzyme addition might be compared with antibiotic growth promoters.

ACKNOWLEDGEMENTS

The experiment was supported by the Hungarian Ministry of Agriculture and Rural Development (FVM 68-d/2/2002).

REFERENCES

- EIBEN Cs., SZIJÁRTÓ N., MÉZES M., KUSTOS K., GÓDOR-SURMANN K., RÉCZEY K., 2002. Effect of dietary cellulase enzyme supplementation on the performance of early-weaned rabbits. *14th Rabbit Day*, Kaposvár (Hungary), 77-82.
- EL-MANDY, M.R., SALEM, F.A., EL-HOMELAND, Y.M., 2002. Effect of kemzyme in rabbit rations differing in their protein levels on digestion, blood constituents and carcass traits. *3rd Conf. on Rabbit Prod. in Hot Climates*, Hurghada (Egypt), 495-505.

- GIDENNE T., JEHL N., SEGURA M., MICHALET-DOREAU B., 2002. Microbial activity in the caecum of the rabbit around weaning: impact of a dietary fibre deficiency and of intake level. *Anim. Feed Sci. and Technol.*, 99, 107-118.
- GIPPERT, T., CSÍKVÁRY, L., 1988. Use of the cellulase enzymes „Phylacell” in rabbit feeding. *6th Symp. on Housing and Diseases of Rabbits, Furbearing Animals and Pet Animals*, Celle, (Germany), 147-157.
- GUTIÉRREZ, I., ESPINOSA, A., GARCÍA, J., CARABAÑO, R., DE BLAS, J.C., 2002. Effects of starch and protein sources, heat processing, and exogenous enzymes in starter diets for early weaned rabbits. *Anim. Feed Sci. and Technol.*, 98, 175-186.
- SCAPINELLO, C., GIDENNE, T., FORTUN-LAMOTHE, L., 1999. Digestive capacity of the rabbit during the post-weaning period according to the milk/solid feed intake pattern before weaning. *Reprod., Nutrition and Development*, 39, 423-432.
- STATGRAPHICS® 1992. Reference Manual, Version 6.0, Manugistics Inc., Rockville, MD, USA
- SZIJÁRTÓ N., FAIGL ZS., RÉCZEY K., MÉZES M., BERSÉNYI A., 2004. Cellulase fermentation on a novel substrate (waste cardboard) and subsequent utilization of home-produced cellulase and commercial amylase in a rabbit feeding trial. *Industrial Crops and Products* (in press).
- TAG EL-DIN, T.H., SHERIF, K.E., EL-SAMRA, H., ABO-EGLA, H., HASSAN, A., 2002. Effect of using graded levels of Phaseolus vulgaris straw in growing rabbit diets. *3rd Conf. on Rabbit Prod. in Hot Climates*, Hurghada (Egypt), 643-659.
- VALENTE, S.S., FERREIRA, W.M., SANTIAGO, G.S., DIAS, J.C.C.A., CAVALCANTE, S.G., 1999. Effect of enzymatic supplementation on growth performance of rabbits. *Abstracts of the 1st AB-WRSA Conf. of the Americas*, Montecillo (Mexico) 1998. *World Rabbit Sci.* Vol. 7. (1) pp. 41.
- XICCATO G., TROCINO A., SARTORI A., QUEAQUE P.I., 2003. Effect of weaning diet and weaning age on growth, body composition and caecal fermentation of young rabbits. *Anim. Sci.*, 77. 101-111.