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Dietary supplementation of butyrate in growing rabbits

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RIASSUNTO – Integrazione alimentare con butirrato in conigli in accrescimento. *L'effetto dell'inclusione di butirrato nella dieta è stato valutato in 220 conigli svezzati a 28 d e alimentati fino alla macellazione (70 d) con diete sperimentali contenenti 0, 0,5, 1,0 e 2,0 g/kg di butirrato sodico. L'integrazione con butirrato ha diminuito la digeribilità della sostanza secca (P<0,01) e ha tendenzialmente aumentato (P<0,10) l'accrescimento (48,5* vs. *50,0 g/d) e il consumo alimentare, ma non ha modificato l'attività fermentativa ciecale e le caratteristiche della mucosa intestinale a 42 d di età, né la qualità della carcassa e della carne alla macellazione. L'inclusione di butirrato ha rallentato la comparsa di una grave colibacillosi, ma non ha consentito di evitare il trattamento antibiotico, senza effetti significativi su mortalità e morbilità nell'intera prova. In conclusione, l'inclusione di butirrato non ha sostanzialmente influenzato le prestazioni produttive, la fisiologia digestiva, lo stato sanitario e la qualità della carne.*

Key words: rabbits, butyrate, digestive physiology, health, growth performance, meat quality.

INTRODUCTION – The UE restrictions imposed on the antibiotic utilization in animal husbandry have increased the interest on alternative additives capable of improving animal digestive health. Among the numerous tested products, short chain fatty acids stimulated intestinal mucus production at different level and intestinal cells proliferation in rats (Meslin *et al.*, 2001; Moreau *et al.*, 2003). Short and medium chain fatty acids could also modulate intestinal microflora: in rabbits, the antimicrobial activity of caprilic and capric acids was proved on various strains of *Clostridium perfringens* and *Escherichia coli* (Marounek *et al.*, 2002). The present trial aimed to evaluate the effect of butyrate inclusion and level on growth performance, health status, digestive physiology and slaughter traits in growing rabbits.

MATERIALS AND METHODS – At 28 d, 220 rabbits (605±39 g) were weaned, assigned to four groups of 55 animals and fed *ad libitum* until slaughter the experimental diets: C, control diet without any additive and B1, B2 and B3 diets containing 0.5, 1.0 and 2.0 g/kg of sodium butyrate, respectively. Dietary supplementation was realized including a commercial product at 20% of sodium butyrate in substitution of wheat bran. At 42 d, 32 rabbits (8 per diet) were sacrificed to sample ileal mucosa and caecal content. At about 45 d of age, colibacillosis (*E. coli* O-103) appeared and quickly became so aggressive to impose an antibiotic treatment (colistine in water at 100 mg/l) from 55 to 60 d. A total of 34 rabbits died and 20 ones were excluded at the end of the trial weighing less than market weight (<2.3 kg). At 70 d, the 134 remaining rabbits were submitted to commercial slaughter. Carcasses were dissected and meat quality evaluated following the methods detailed by Blasco *et al.* (1993) and Dalle Zotte *et al.* (1996). Diet digestibility and chemical composition of diets, faeces and caecal content were determined as described by Xiccato *et al.* (2003). Growth and carcass data of the 134 slaughtered animals were analysed considering diet and sex (the latter not discussed here) as the main variability factors and using the GLM procedure of SAS. Diet digestibility was analysed by a one-way analysis of

variance, considering the diet effect. The effect of butyrate inclusion was tested by the contrast "C *vs.* B1+B2+B3" (C *vs.* B). The effect of butyrate level was not significant. Mortality, morbidity and sanitary risk (sum of mortality and morbidity) among diets were compared by χ^2 test. Rabbits were considered ill when evidencing diarrhoea or strong live weight/feed intake reductions.

RESULTS AND CONCLUSIONS – Despite a similar chemical composition, the nutritive value of supplemented diets was lower than C diet (DM digestibility: 60.6% in diet C *vs.* 59.0% in diets B; P<0.01) (Table 1). Differently, Welters *et al.* (1996) showed a positive effect of butyrate supplementation on nutrient digestibility and absorption in pigs with short bowel syndrome.

Table 1. Chemical composition and nutritive value of experimental diets.

		Diet C	Diet B1	Diet B2	Diet B3
Dry matter	%	90.3	90.2	90.3	90.3
Crude protein	% DM	18.5	18.3	18.4	18.3
Ether extract	% DM	3.9	3.8	4.0	3.9
NDF	% DM	39.2	39.6	40.0	40.1
ADF	% DM	20.1	20.7	20.5	20.3
ADL	% DM	4.8	4.8	4.7	4.8
Starch	% DM	16.0	16.3	16.3	16.4
DM digestibility[1]	%	60.6	58.8	59.5	58.7
Digestible energy (DE)	MJ/kg DM	11.27	10.88	10.82	10.72
Digest. protein/DE ratio	g/MJ	12.1	11.9	12.3	12.2

[1] Eight rabbits per diet. Diet effect: P=0.02; Contrast "C *vs.* B ": P<0.01; RSD=1.4%.

The inclusion of butyrate tended (P=0.08) to increase daily weight gain and feed intake in comparison with the control diet, while feed efficiency was similar among groups (Table 2). The higher performance of the treated rabbits can be attributed to a later appearance (1 week on average) of colibacillosis in these rabbits than in the control rabbits. During the 3rd week of trial, daily weight gain was lower in C rabbits than in B rabbits (49.8 *vs.* 54.6 g/d; P=0.03) as well as feed intake (137 *vs.* 145 g/d; P=0.05). In the entire trial, however, mortality, morbidity and sanitary risk were similar among groups.

Table 2. Growth performance from 28 to 70 d of age.

		Diet				Probability		RSD
		C	B1	B2	B3	Diet	C *vs.* B	
Animals[1]	no.	34	35	31	34			
Initial live weight	g	604	606	604	605	n.s.	n.s.	39
Final live weight	g	2643	2714	2701	2706	n.s.	0.09	185
Daily weight gain	g/d	48.5	50.2	49.9	50.0	n.s.	0.08	4.3
Daily feed intake	g/d	138	143	143	143	n.s.	0.08	12
Feed conversion		2.85	2.84	2.87	2.85	n.s.	n.s.	0.13
Mortality[2]	%	14.9	19.2	21.3	17.0	n.s.		
Morbidity[2]	%	38.3	27.7	34.0	31.9	n.s.		
Sanitary risk[2]	%	53.2	46.9	55.3	48.9	n.s.		

[1] Excluded rabbits below market weight (<2.3 kg) at slaughter; [2] Probability of χ^2 test.

Despite sampling was performed only few days before the appearance of the first symptoms of colibacillosis (42 d), caecal content characteristics were typical of healthy rabbits, with low N-ammonia level and VFA concentration and molar proportions similar among diets. Also ileal mucosa morphometry confirmed the good condi-

tion of gut in all experimental groups. Differently, in pigs the administration of a diet with low-degradable starch, capable of increasing gut butyrate concentration, reduced the number of apoptotic intestinal cells and increased crypt depth by 15% (Mentschel and Claus, 2003). Moreover, in colitis-induced rats, butyrate supplementation increased caeco-colic mucosa integrity and functionality (Moreau *et al.*, 2003).

Table 3. Caecal fermentation activity and mucosa morphometry at 42 d of age.

		Diet				Probability		RSD
		C	B1	B2	B3	Diet	C *vs.* B	
pH		6.25	6.26	6.18	6.14	0.67	0.59	0.23
$N\text{-}NH_3$	mmol/l	5.13	4.15	5.24	4.97	0.91	0.79	3.14
VFA	mmol/l	39.0	44.1	38.1	43.6	0.54	0.46	9.6
C_2	% VFA	81.7	81.7	81.2	81.7	0.99	0.90	3.2
C_3	% VFA	3.2	3.9	3.1	3.2	0.19	0.55	0.8
C_4	% VFA	14.3	13.8	14.9	14.4	0.91	0.95	3.0
C_5	% VFA	0.80	0.62	0.81	0.63	0.55	0.39	0.32
C_3/C_4		0.23	0.29	0.22	0.23	0.27	0.54	0.08
Villi height	µm	421	412	346	393	0.20	0.25	41
Crypt depth	µm	87.7	83.7	87.7	88.4	0.63	0.74	7.8

Slaughter results were not affected by the treatments (data not reported). Once excluded the rabbits severely affected by colibacillosis that did not reach the market weight (2.3 kg), average live weight and dressing percentage (58.4%) were satisfactory for rabbits aged 70 d. The carcasses showed little fat depots (3.7%) and good muscularity (5.78 muscles to bones ratio of hind leg), with a high overall commercial quality. Similarly, meat traits, pH and colour of *biceps femoris* and *longissimus dorsi* were not affected by dietary treatments.
In conclusion, despite butyrate supplementation delayed the occurrence of digestive problems, it could not replace antibiotherapy when the disease became severe and did not substantially affect growth performance, digestive physiology, sanitary risk and meat quality.

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