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EFFECT OF TIAMULIN OR RESCUE-KIT® ON DIET UTILISATION, GROWTH AND CARCASS YIELD OF GROWING RABBITS

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Abstract: A total of 192 Californian×New Zealand rabbits weaned at 33 d old were used in this experiment. Animals were allocated at weaning to three homogenous treatment groups based on litter size and live weight. Rabbits in control treatment (C) were offered a standard feed (SF) containing Robenidin and Flavomycin. Rabbits in TI treatment were fed SF diet and supplemented between days 33 and 62 with Tiamulin. The third group of rabbits (RK treatment) were fed SF diet and supplemented with Rescue-Kit® (containing *B. licheniformis* and *B. subtilis* (1600×10^9 CFU), betain, vitamins and oligo-elements) in the drinking water from 41 to 50 d of age. Digestibility of the experimental diets was recorded from 47 to 50 d of age, growth performance from weaning to 77 d old and carcass performance at 77 d of age. In the second week after weaning, between days 41 and 50, average daily gain (ADG) and feed intake for the regime including Tiamulin increased by 19 and 7.5% ($P\leq0.051$) compared to those fed C and RK treatments. In this period, animals supplemented with Tiamulin obtained the best feed conversion ratio (FCR) and the highest DM digestibility ($P=0.023$). Rabbits from RK treatment showed the same DM digestibility than those from the C group, but an intermediate FCR between TI and C rabbits. The retrieval of Tiamulin from the diet after day 62 and until day 77 led to a decrease in ADG of the rabbits, which was lower than for animals receiving RK ($P=0.007$), while C animals had intermediate growth traits. It resulted that for the whole fattening period, treatments had no effect on ADG, feed intake and FCR (32.1 and 143 g/d and 4.13 g/g, respectively). Overall mortality rates and dressing out percentage were also similar among treatments (26.6 and 59.8%, respectively).

Key words: additives, growth performance, rabbits.

INTRODUCTION

Rabbits are very sensitive to enteric diseases, especially at weaning time. As a result, caecal microbial fermentation and the digestive processes are affected and, consequently, growth is impaired. Rabbit farmers, to prevent important losses, resort to a wide range of veterinary products, such as antibiotics. The latter category of products can be incorporated in feeds at therapeutic doses to prevent enterocolitis or at low doses to serve as growth promoters. It has been shown (Mateos, 1989) that under both circumstances of uses, incorporation of antibiotics reduces digestive disorders and improves growth performance. However, long-term incorporation of antibiotics in feeds and their oral administration at high doses is now heavily criticized and no longer recommended (Lessard *et al*., 2005). To improve food safety, the addition of antibiotics in rabbits' feedstuffs is being limited to few products (Marzo, 2001) including Tiamulin, which is widely used to combat epizootic rabbit enterocolitis (Coudert *et al*., 2000; 2003). Several research projects have studied the effect of probiotics, prebiotics and yeast, recently reviewed by Falcão-e-Cunha *et al*. (2007). These additives may enhance the digestive micro-organism balance in the caecum, reduce intestinal pH and contribute to enzyme and vitamin production, hence reinforcing

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the immune functions (Fortun-Lamothe and Drouet-Viard, 2002). Commercially available, Rescue-Kit® is a feed complement containing a probiotic BioPlus 2B (*B. licheniformis* and *B. subtilis*), vitamins, betain and amino-acid chelates. It is claimed (Jørgensen, 2004; Gracia *et al*., 2004), that in pigs after weaning, BioPlus may prevent digestive troubles and infections by stimulating the immune response of the intestine and by stabilising the intestinal flora by inhibiting the action of pathogenic bacteria. In rabbits, Kustos *et al*. (2004) showed that adding BioPlus 2B to feed significantly reduced mortality and morbidity rates, tended to increase feed efficiency and also daily weight gain of Pannon White growing rabbits. In view of these different strategies to complement rabbit feed at the challenging stage of weaning, this study aimed to investigate the effectiveness of Rescue-Kit® as an additive administered in drinking water, in comparison to Tiamulin added in feed, on growth performances, digestibility and the dressing out percentage of growing rabbits.

MATERIAL AND METHODS

Animals and treatments

This study was conducted between March and April 2005 at a commercial rabbit production unit in the centre of Tunisia. A number of 192 Californian×New Zealand male and female rabbits were weaned at 33 d of age with an initial body weight of 722±7 g (mean±SE). Upon weaning (33 d of age), animals were individually ear-tagged for identification. Then they were divided by litter size at birth and weaning weight and allocated to three balanced treatment groups. Within each treatment group, the 64 rabbits were dispatched into 8 homogeneous replications. Each replication represented an experimental unit and included 8 rabbits. From weaning to 77 d of age, representing the end of the fattening trial, the rabbits in control treatment (C) were fed a standard feed (SF) that provided per kg DM: 135 and 165 g of crude protein (CP) and crude fibre (CF). Standard feed (SF) also contained Robenidin (66 mg/Kg feed) as a coccidiostat and Flavomycin (4 mg/kg feed) as a growth promoter. Rabbits in TI treatment were fed an SF diet and supplemented the feed between day 33 and day 62 with Tiamulin at 60 mg/kg. Animals in RK treatment were fed the SF diet and supplemented between day 41 and day 50 with Rescue-Kit®, which was administered in the drinking water (0.39 g/d/rabbit) at the concentration of 1 kg/1000 L. Rescue-Kit® mainly contains betain (trimethylglycine) at a level of 500 g/kg, *B. subtilis* and *B. licheniformis* at 1600×10^9 CFU, amino-acids chelates, minerals and vitamins. All diets were pelleted and both diets and water were offered *ad libitum*.

Growth and carcass trial

Every week, feed intake per cage (8 animals) and individual live weight were recorded. In addition, mortality was recorded daily. Feed conversion ratio (FCR) was calculated per cage as feed intake (g)/weight gain (g), adjusting the data for the dead animals and recording feed quantities after every new death. In such case, feed intake and gains of weaned rabbits were measured until removed. Average daily gain (ADG) was calculated individually. The mortality rate (%) was calculated per cage.

At the end of the fattening trial (77 d of age), 20 rabbits per treatment were randomly selected (2 or 3 rabbits per cage) and were weighed and slaughtered after a 16-hour fasting period (feed and water). Hot carcass weight was recorded and it included head, liver, kidneys, lungs, oesophagus, trachea, thymus and heart (Blasco and Ouhayoun, 1993). The dressing out percentage was defined as the hot carcass weight (g)×100/live weight (g).

Apparent diet digestibility trial

In parallel to the fattening trial, an apparent digestibility assay of the above described experimental diets was conducted on another group of weaned rabbits between 33 and 50 d of age and the animals were kept under the same environmental conditions as during the fattening trial. The experiment was performed according to the European reference method reported by Pérez *et al*. (1995). A total of 30 New Zealand×Californian 33 days-old rabbits with an initial average live weight of 881±53 g were allocated randomly to the same previously described treatments (10 per treatment) and housed in individual metabolism wire cages allowing separation of faeces and urine. Diets and water were distributed *ad libitum*. Following a 13-d period of adaptation, feed intake was recorded and faecal collections were made on four consecutive days (age 47-50 d). Faeces produced daily were stored at –20°C.

Housing

Weaned rabbits were housed (8 rabbits/cage) in wire net flat deck cages (760×460×280 mm) in a closed building. Rabbits were exposed to natural light and static ventilation and no vaccines were applied to the animals against any disease. Temperature and relative humidity varied from 21 to 30°C and from 65 to 70%, respectively. The temperature-humidity index (THI), calculated according to LPHSI (1990), ranged between 20.3 and 28.5. Marai *et al*. (2001) reported that a value higher than 28.9 is considered to represent severe heat stress. Accordingly, rabbits were not exposed to severe heat stress during the period of our assay.

Analytical methods

Chemical analysis of dry matter (DM), organic matter (OM), crude fibre (CF) and crude protein (CP) in feed and faeces samples was conducted according to AOAC methods (1984) to determine digestibility coefficients.

Statistical analysis

Data were analysed for each period using the GLM procedures of SAS (1991) with dietary treatment as the main factor. Initial average weaning weight per cage was considered as a covariate in growth performance analysis and the incidence of diet on carcass traits was corrected for live body weight. When the effect of dietary treatment was significant, differences between experimental groups were compared by using the Least Square Means procedure of SAS (1991), and all the values are presented as least square means. The effect of the feeding regime was considered to be significant when $P<0.05$.

RESULTS AND DISCUSSION

Overall results indicated that average feed intake, ADG, FCR and mortality rates recorded for the entire fattening trial period (33-77 d) were similar for all the groups ($P\geq0.20$), on average, 143 and 32.1 g/d/rabbit, 4.13 g/g and 26.6%, respectively (Table 1). At the first stage of the fattening period (33-40 d), treatments had no effect on ADG, feed intake, FCR and the mortality rate (33.5 and 74.5 g/d, 2.25 and 1%, respectively). Between 41 and 50 d of age, average feed intake and ADG of TI animals increased ($P\leq0.051$) by 7 and 19% compared to those from RK and control treatments, whereas FCR improved by 14% with respect to rabbits from the control group ($P=0.011$). Rabbits from RK treatment showed intermediate FCR values between TI and C rabbits. No differences were detected between the treatments in the mortality rate in this period. Apparent digestibility data corresponded to this period (47-50 d) (Table 2), and it showed that when the diet was supplemented with Tiamulin DM digestibility improved by 2.6 points of percentage ($P=0.023$) (and OM digestibility by 2.3 points of percentage, $P=0.056$). The antibiotic did not affect CF and CP apparent digestibility, which were on average 9.9 and 72.0%, respectively.

These findings suggest that between 41 and 50 d of age, Tiamulin supplementation increased digestibility of the diet, enhancing the feed intake, ADG and the feed conversion ratio. Similar effects, with the

Table 1: Growth traits, feed intake, feed conversion ratio and mortality rate from weaning (33 d old) to 77 d of age, of the experimental groups.

		Treatment[1]				
		C	RK	TI	SEM[2]	*P*-value
33-40 d	Initial live weight, g	722	723	721	7.0	0.97
	Average daily gain, g/d and rabbit	33.8	33.3	33.5	1.19	0.96
	Feed intake, g/d and rabbit	76.8	74.4	73.1	1.41	0.14
	Feed conversion ratio, g/g	2.31	2.24	2.20	0.099	0.72
	Mortality rate (%)	0.00	1.56	1.56	0.457	0.47
41-50 d	Average daily gain, g/d and rabbit	28.6^{b}	30.5^{b}	35.2^{a}	1.0	0.001
	Feed intake , g/d and rabbit	115	113	122	3.2	0.051
	Feed conversion ratio, g/g	4.04^{a}	3.76^{ab}	3.46^{b}	0.030	0.011
	Mortality rate , %	3.12	3.12	1.56	0.882	0.88
51-62 d	Average daily gain, g/d and rabbit	36.2	34.5	35.0	0.76	0.22
	Feed intake, g/g	156	155	154	4.3	0.84
	Feed conversion ratio, g/g	4.36	4.55	4.47	0.034	0.69
	Mortality rate, %	14.10	6.25	6.25	1.850	0.49
63-77 d	Average daily gain, g/d and rabbit	31.4^{ab}	33.4^{a}	28.9^{b}	0.77	0.007
	Feed intake, g/d and rabbit	180	178	170	4.3	0.078
	Feed conversion ratio, g/g	5.75	5.39	5.90	0.053	0.24
	Mortality rate %	10.9	10.9	20.3	2.28	0.51
Overall	Final live weight, g	2143	2170	2076	23.4	0.20
	Average daily gain, g/d and rabbit	32.4	32.9	30.9	0.53	0.20
	Feed intake, g/d and rabbit	144	143	141	3.8	0.47
	Feed conversion ratio, g/g	4.18	4.09	4.12	0.086	0.74
	Mortality rate, %	28.1	21.9	29.7	2.84	0.82

[1]Treatment: C, standard feed (SF); RK, SF supplemented with Rescue-Kit®; TI, SF supplemented with Tiamulin.
[2]n=8 (number of cages per treatment).
Means in the same line with different superscripts are significantly different (P<0.05)

addition of chlortetracycline on feed utilization, have been reported by Abecia *et al*. (2005). Dupraz (2004) also reported that the antibiotic adjunction to the rabbits' feed improved its digestive utilization by inhibiting the action of pathogenic bacteria and through reinforcement of the caecal microflora balance and consequently, the digestive enzymatic production. In our study, we recall that measures of feed digestibility were undertaken on kits aged between 47 and 50 d when the effect of Tiamulin on growth performances was important and further digestibility trials were not feasible during other stages of the fattening trial.

At the third control period (51-62 d of age), once the Tiamulin and RK supplementation was suspended, ADG, feed intake and FCR were not affected by treatments. Finally, between 63 and 77 d of age, the situation observed during the 41-50 d period was reversed. Feed intake tended to be slowed by the retrieval of Tiamulin, and TI animals tended to ingest lower quantities (P=0.078) than C animals, whereas rabbits

Table 2: Apparent faecal digestibility coefficients of dry matter, organic matter, crude fibre and crude protein of the experimental diets.

	Treatment[1]				
	C	RK	TI	SEM[2]	*P*-value
Dry matter	51.2[b]	51.0[b]	53.8[a]	0.59	0.023
Organic matter	53.6	53.5	55.9	0.62	0.056
Crude protein	71.5	73.6	70.8	0.98	0.27
Crude fibre	9.36	8.50	11.9	1.70	0.48

[1]Treatment: C, standard feed (SF); RK, SF supplemented with Rescue-Kit®; TI, SF supplemented with Tiamulin.
[2]n = 10
Means in the same line with different superscripts are significantly different ($P<0.05$).

in the RK treatment group had an intermediate level of intake. TI animals had an ADG of 28.9 g/d, lower ($P=0.007$) than RK animals (33.4 g/d) and statistically similar to control animals (31.4 g/d). The different dietary treatments did not cause differences in FCR, which averaged 5.68. In this period the incidence of mortality in the TI group doubled and reached similar levels as in the C group, though this variation was not significant. By the end of the experiment, more than 68% of deaths in the TI treatment group occurred after withdrawal of the antibiotic.

These results demonstrate that after withdrawing Tiamulin 15 d prior to slaughter, which is a required measure to prevent accumulation of residues of the antibiotic in the carcasses, TI rabbits had growth performances similar to those in the C group and strictly lower than those of RK animals. These results suggest that the efficacy of Tiamulin in improving performances is strictly linked to the period of its addition to the diet. This is in agreement with Coudert *et al*. (2000), who also observed that mortality appears as early as 5 d after withdrawal of Tiamulin (32 mg/kg) from the feed. This also means that in our case, the diet containing only Robenidin and Flavomycin after withdrawal of Tiamulin did not diminish mortality.

Our findings also indicate that addition of *B. licheniformis* and *B. subtilis* in Rescue-Kit®, as well as its other constituents, for as short as 10 d (41 - 50 d) does not seem to exert any effect on the rabbits' performance since the ADG of RK animals was similar throughout the fattening period to that of C animals. It could be due to the short supplementation period or to the negative effect of antimicrobials on probiotic activity. However, highly variable results have been obtained with probiotics. Maertens *et al*. (1994) when incorporating Paciflor®, containing Bacillus CIP 5832, a strain similar to *B. subtilis*, as a probiotic in feed, did not obtain any difference in ADG under favourable and unfavourable housing

Table 3: Live body weight, hot carcass weight, dressing out percentage and proportion of digestive tract of the experimental groups at 77 d of age.

	Treatment[1]				
	C	RK	TI	SEM[2]	*P*-value
Live body weight, g	2087	2144	1975	36.0	0.075
Hot carcass weight, g	1247	1298	1163	7.91	0.12
Dressing out percentage, %	59.7	60.7	58.9	0.375	0.13
Digestive tract weight, % body weight	17.6[b]	17.5[b]	19.5[a]	0.306	0.020

[1] Treatment: C, standard feed (SF); RK, SF supplemented with Rescue-Kit®; TI, SF supplemented with Tiamulin.
[2]n=20.
Means in the same line with different superscripts are significantly different ($P<0.05$).

conditions. However, De Blas *et al*. (1991) reported that Paciflor® improved the growth rate and tended to improve FCR. In contrast, Gippert *et al*. (1992) noticed a 3% improvement of ADG for the probiotic Lacto-Sacc supplemented animals compared to control animals under poor conditions (commercial unit and in summer period) but an 8% increase in more favourable facilities (experimental farm).

Live body weights of slaughtered rabbits in the TI group tended to be lower (P=0.073) than C and RK rabbits (Table 3). Carcass weight was similar (P=0.12) in all the treatments, 1230 g on average, and the dressing out percentage was not affected by treatments (P=0.13) and averaged 59.8%. Finally, in comparison to Tiamulin, RK supplemented and C animals had a lower proportion of the digestive tract (P=0.020), which might be partially explained by their higher live weight at slaughter (Deltoro and López, 1985).

CONCLUSION

The efficacy of Tiamulin on growth performance and digestibility of the diet was only noticeable when the antibiotic was incorporated in the diet. All these beneficial effects disappear as soon as Tiamulin is withdrawn. Rescue-Kit® yielded very similar results to those obtained with C animals supplemented with Flavomycin and the coccidiostat Robenidin. However, and in view of the consumer's reticence to the use of antibiotics, further studies are needed to assess the effectiveness of RK.

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