

Effects of the use of Gustor XXI® as a substitute of growth promoters in the intensive fattening of lambs

D. Garin*, G. Caja* and J. Mesia**

*Unitat de Producció Animal, Universitat Autònoma de Barcelona, 08193 Bellaterra, Spain

**Nature S.A., 08185 Lliçà de Vall, Spain

SUMMARY – One hundred and eight lambs were used to evaluate the effects of Gustor XXI®, an additive based on dicarboxylic acid salts (malate, etc.) together with a yeast culture, as an alternative to the use of growth promoters. The experimental design consisted of a 3x3 factorial with three doses of additive in the concentrate (C, control; G02, 0.2%; and, G03, 0.3% as feed) and three equilibrated plots of 12 lambs each per treatment. Average daily gain (ADG), concentrate intake (CI) and feed/gain ratio (FGR) were calculated during the whole fattening period (13-23 kg). Carcass weight and grading were recorded after slaughter. Rumen pH and apparent parakeratosis were also measured. The use of Gustor XXI® reduced FGR (C, 3.27; G02, 3.03; and, G03, 3.17; $P < 0.05$) and CI (C, 27.2; G02, 24.2; and, G03, 26.3 kg; $P < 0.05$), but ADG was not affected (260 g/d). Carcass weight (11.5 kg), conformation (2.57) and subcutaneous (2.76) and kidney (2.69) adiposity, and rumen pH (6.69) were unaltered by treatments. A better use of energy and an interest in Gustor XXI® as a substitute of growth promoters in the intensive fattening of lambs are concluded.

Key words: Organic acids, malate, growth promoters, fattening lambs.

RESUME – "Effets de l'utilisation de Gustor XXI® comme substitut des promoteurs de croissance en engraissement intensif des agneaux". Cent huit agneaux ont été utilisés pour évaluer les effets de Gustor XXI®, un additif à base de sels d'acide dicarboxylique (malate...) avec une culture de levures, comme alternative à l'utilisation de promoteurs de croissance. Le dispositif expérimental a consisté en une factorielle 3x3 avec trois doses d'additif dans le concentré (C, témoin ; G02, 0,2% ; et G03, 0,3% comme aliment) et trois lots équilibrés de 12 agneaux chacun par traitement. Le gain moyen quotidien, l'ingestion de concentré (CI) et le rapport aliment/gain (FGR) ont été calculés pendant toute la période d'engraissement (13-23 kg). Le poids de la carcasse et la classification ont été déterminés après abattage. Le pH ruminal et la parakérose apparente ont également été mesurés. L'utilisation de Gustor XXI® a réduit le FGR (C, 3,27 ; G02, 3,03 ; et G03, 3,17 ; $P < 0,05$) et CI (C, 27,2 ; G02, 24,2 ; et G03, 26,3 kg ; $P < 0,05$), mais le gain moyen quotidien n'était pas affecté (260 g/j). Le poids de la carcasse (11,5 kg), la conformation (2,57), le gras sous-cutané (2,76), le gras rénal (2,69), et le pH ruminal (6,69) n'étaient pas modifiés par les traitements. On en conclut à une meilleure utilisation de l'énergie et un effet positif avec Gustor XXI® comme substitut des promoteurs de croissance en engraissement intensif des agneaux.

Mots-clés : Acides organiques, malate, promoteurs de croissance, agneaux en engraissement.

Introduction

The use of organic acid salts jointly with yeast cultures has demonstrated in *in vitro* ruminal conditions that it increases the uptake of L-lactate (L) by *Selenomonas ruminantium* HD4 (SR) when high concentrations are present (Nisbet and Martin, 1991, 1994; Callaway and Martin, 1997). Moreover, an improvement in the yielding and feed/gain ratio has been observed, in steers fed high concentrate diets, when increasing levels of malate (M) were included in the diet (Kung *et al.*, 1982; Martin *et al.*, 1999). Reported results agreed in a rise of acetate (C2), propionate (C3) and total volatile fatty acids (VFA), with an increase of the C3/C2 rate.

Different SR strains can account for 22 to 51% of bacteria in the rumen (Caldwell and Bryant, 1966) with high non-structural carbohydrate diets. SR strains, can use L as a substrate to produce C2, C3 and CO₂ when metabolic growth factors (L-aspartate, biotin, etc.) are available (Stewart and

Bryant, 1988). Linehan *et al.* (1978) also reported that M is an intermediate key in different ruminal pathways and that it can replace aspartate as a growth factor and stimulate SR when oxalacetate is limiting. In this case, C3 is produced by the dicarboxylic pathway, where succinate is an intermediate product (Owens and Goetsch, 1988). Based on the ability of SR for growing in the rumen in the presence of M and extracellular H₂ which may produce succinate, Nisbet and Martin (1991) suggested that M acted as a sink for free ionized H. Otherwise, yeast cultures have been considered as an alternative source of growth factors for the consumption of L by SR (Nisbet and Martin, 1991). The main implication of L consumption in the rumen is a higher ruminal fluid pH (Martin and Streeter, 1995) and, consequently, ruminal acidosis (Martin *et al.*, 1999) and the excessive keratinization of forestomach mucosa must be avoided (Linklater and Smith, 1993).

The aim of this work was to study the effects of Gustor XXI[®], a formulated additive based on dicarboxylic acid salts (including malate) and yeast cultures, on the performances of fattening lambs.

Materials and methods

One hundred and eight Ripollesa breed lambs of both sexes were used in a 3x3 factorial design (treatment x plot) fattening trial conducted at the Experimental Farm of the Universitat Autònoma de Barcelona. Lambs were weaned from their mothers at 13 kg live weight (LW) and intensively reared in straw bedded pens with an *ad libitum* diet based on concentrate pellets and barley straw. The concentrate was formulated (as feed) with: barley, 47%; corn, 11%; soybean meal-44, 19%; manioc pellets, 8%; gluten-feed meal, 8%; cane molasses, 2%; protected fat, 1%; and, vitamins and minerals premix, 0.2% (Fimsa S.A., La Bisbal del Penedés, Spain). Nutritional composition of the concentrate is shown in Table 1. Fresh water was always available by mean of automatic drinkers.

Table 1. Nutrient composition of the experimental diets (dry matter basis)

Nutrients	C	G02	G03
Dry matter (%)	89.1	88.8	88.7
CP (%)	20.2	20.1	19.5
CF (%)	5.0	5.1	4.9
NDF (%)	17.0	15.5	15.6
ADF(%)	5.2	5.0	5.0
EE(%)	4.6	5.0	4.5
NEf [†]	1.1	1.1	1.1
Malic acid (%)	0.20	0.25	0.28

[†]Net Energy for fattening estimated as UFV (1 UFV = 1820 kcal NE) according to INRA (1989).

After an adaptation period of 1 week, the lambs were divided into 9 groups (12 animals/group) equilibrated by sex, type of birth and weight; and intensively fattened until they reached the slaughtering weight as light "Pascual" type lambs (23.0 kg LW). Groups were randomly assigned to the experimental treatments consisting of different levels of inclusion of the additive Gustor XXI[®] (Nature S.A., Lliça de Vall, Spain) in the concentrate pellets (as feed): C (Control, 0%), G02 (0.2%) and G03 (0.3%). Three representative samples of each concentrate were collected during the experiment and composited for analysis. Nutrient composition was analysed in triplicate according to AOAC (1984) methods. Malate was analysed as malic acid after HCl hydrolysis by using HPLC.

Individual LW of lambs were recorded and concentrate refusals per group weighed weekly throughout the experiment. Average daily gain (ADG) was estimated by linear regression. Concentrate intake (CI) and feed/gain ratio (FGR) were calculated for each experimental group. Lambs were slaughtered when they reached the slaughtering weight after 12 h fasting and carcass hot weight was recorded. Conformation and subcutaneous and kidney adiposity were evaluated according to the EUROP grading system (Colomer-Rocher, 1979). Rumen pH was measured in the dorsal sac by using a portable pH-meter (Crison, Alella, Spain) and keratinization of the ruminal

mucosa evaluated subjectively by using a parakeratosis index (1 = light to 4 = severe).

The PROC MIXED of SAS (version 6.12; 1990, SAS Institute Inc., Cary, NC) was used for the statistical analysis of ADG taking into account the effects of treatment, group, sex, week, their interactions and the residual error. Lambs weight at the start of the experiment was included as a covariable. For the remaining variables the PROC GLM of SAS was used and the carcass weight considered as co-variable when significant. Significant differences were defined at $P < 0.05$.

Results and discussion

Significant differences were observed ($P < 0.05$) in FGR and CI, despite similar ADG and fattening length, as shown in Table 2. Values of ADG were very satisfactory for Ripollesa lambs as reported by Torre (1991). Treatment G02 significantly reduced ($P < 0.05$) the FGR (-7.1%) and the CI (-10.8%) when compared to C. The same tendency was observed in G03. Obtained results suggest a greater use of nutrients in feed (especially energy), due to the addition of Gustor XXI®.

Carcass performances were not significantly affected ($P > 0.05$) by the treatments. However, significant differences were detected for sex, group and carcass hot weight ($P < 0.05$). Carcass data were in concordance with data previously reported for the breed (Torre, 1991). Rumen pH (6.7) was not affected by the addition of Gustor XXI®. However, as measurements were obtained after fasting (12 h) differences could not be appreciated. Finally, index of parakeratosis of ruminal mucose was also not affected by treatments, although a tendency to reduce the grade of severe parakeratosis was observed for treatment G03. The lack of differences in carcasses and rumen parameters suggest that the improvement of energy utilization was obtained without stronger changes in VFA ratios.

Table 2. Effects of Gustor XXI® on the performances of fattening lambs

Items	C	G02	G03	Effect (P<)
Fattening performances				
ADG (g/d)	262	263	254	0.531
FGR (kg/kg LW)	3.26 ^a	3.03 ^b	3.17 ^{ab}	0.049
CI (kg/lamb)	27.15 ^a	24.23 ^b	26.32 ^{ab}	0.050
Duration (d)	32.1	32.6	32.7	0.921
Carcass performances				
Hot carcass weight (kg)	11.4	11.4	11.6	0.558
Yield (%)	49.1	49.0	48.8	0.801
Conformation	2.74	2.47	2.58	0.253
Dorsal fat	2.77	2.75	2.84	0.458
Kidney fat	2.75	2.71	2.79	0.671
Rumen				
PH	6.71	6.68	6.68	0.904
Parakeratosis	2.31	2.32	2.10	0.611

^{ab}Letters in same row refer to significant differences at ($P < 0.05$).

Our results indicate a significant improvement in feed/gain ratio of the diet as a consequence of the inclusion of Gustor XXI®. This could be the result of the changes that occurred in the rumen metabolic pathways used by the microbial population, in accordance with Martin and Streeter (1995), with an increase in the synthesis of C3 from L as a result of the stimulation of SR changes in VFA and the reduction of methane synthesis (Callaway and Martin, 1996).

Conclusions

Gustor XXI® is an interesting alternative as a substitute for growth promoters in the intensive fattening of lambs with positive effects on feed/gain ratio and fattening costs. The effect of Gustor XXI® seems to be produced by an improvement of the activity of rumen microbial population, and this finally increases the energy utilization of the diet. More research is needed to confirm some of the suggested pathways.

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