Use of wrapped hay silage to fatten Charolais bulls in grassland territories

Bernard Sepchat, Isabelle Ortigues Marty, Marie-Madeleine Mialon, Jacques Agabriel

Use of wrapped hay silage to fatten Charolais bulls in grassland territories

B. Sepchat[1*], I. Ortigues-Marty[1], M.M. Mialon[1], P.Faure[2] and J.Agabriel[1]

[1]Inra Clermont-Theix, UMR1213 Herbivores, F-63122 St-Genès-Champanelle (France)
[2] Inra Clermont-Theix, UE1354 Ruminants de Theix, F-63122 St-Genès-Champanelle (France)
*e-mail: bernard.sepchat@clermont.inra.fr

Abstract. Four homogeneous groups of young Charolais bulls have been fattened between 360 and 700 kg with contrasted diets based either on wrapped hay of semi mountain permanent grassland (GW) or corn silage (CS) distributed at two levels of intake (H or L).To be slaughtered at a common carcass weight of 420kg, the GWH animals needed (in average) 33 more days of fattening than CSH and GWL group 38 days more than CSL group. The average daily gain reached respectively 1660 g (CSH), 1570 g (GWH), 1600 g (CSL) and 1400 g (GWL). Whatever the intake level, the intake of GW was lower (*vs* CS) at the beginning of the test (-1kg DM/d *vs* CS) and higher at the end (+1.5 kg DM/d). Adipose tissues of the carcass (67.4 kg) and the 5th quarter (23.8 kg) of CSH were higher than the depots of other groups (58 and 17 kg, respectively). Differences in growth rate had more impact on the dynamics of depots for CS than for GW. The use of haylage (DM=60%) properly complemented allows fattening bulls. But at iso-energy intake, this diet seems to be less efficient than a diet of corn silage. Its use must be reasoned considering all other fattening conditions.

Keywords. Breeding, young bull, fattening, wrapped hay silage, Charolais.

Utilisation de l'enrubannage de prairie naturelle pour l'engraissement de taurillons Charolais.

Résumé. *Quatre lots homogènes de taurillons Charolais ont été engraissés entre 360 et 700 kg avec des rations contrastées à base d'enrubannage de prairie permanente de moyenne montagne (GW) ou d'ensilage de maïs (CS), distribuées chacune à deux niveaux d'apports (H ou L). Pour être abattus à un poids de carcasse commun de 420 kg, le lot GWH a eu besoin de 33 jours d'engraissement de plus que CSH et GWL 38 jours de plus que CSL. Les gains moyens qutidiens ont atteint respectivement 1660 (CSH) 1570 (GWH) 1600 (CSL) et 1400 g/j (GWL). Quel que soit le niveau d'accroissement, l'ingestion des rations GW était plus faible (vs CS) au début de l'essai (-1 kg MS/j vs CS) et plus élevée à la fin de (+1.5 kgMS/j). Les dépôts adipeux de la carcasse (67,4 kg) et du 5ème quartier (23,8 kg) de CSH ont été supérieurs à ceux des autres lots (58 et 17 kg). Les écarts de vitesse de croissance ont eu plus d'effet sur la dynamique des dépôts des lots CS que GW. L'utilisation de l'herbe enrubannée correctement complémentée permet d'engraisser des taurillons mais, à même apports énergétiques mesurés, cette ration semble moins efficace en termes de gains de poids vif et de poids carcasse qu'une ration ensilage de maïs. Son utilisation doit être raisonnée selon les conditions des ateliers d'engraissement.*

Mots-clés. *Conduite, taurillon, engraissement, enrubannage, Charolais*

I – Introduction

In France, 25,000 farms produce fat young cattle at the rate of 444,000 tonnes of carcases/year. Farmers are looking for new strategies to reduce cereals in ruminant diets and to optimize profitability of finishing cattle when use of corn silage is not feasible. Several previous experiments have shown the consequences of grass silage diets (Geay et al 1997) on the amount of fat depots compared to corn silage diets. Corn silage seems a better promoter of fat deposition at different growth rates as reported by Vancoceslos et *al* (2009) with finishing Angus steers. However very good wrapped hay silage could be highly ingestible (INRA 2007) and bring sufficient metabolizable energy to ensure an acceptable daily lipid depot. A study was conducted at INRA Clermont Ferrand / Theix experimental unit (UERT) to measure the effects of the nature of the diet ingested on performance and tissue depots (proteins *vs* lipids) in finishing Charolais bulls. Our experiment aimed at distinguishing the effects of the nature of the diet from those of intake level. Diets based on wrapped grass, little explored till now, were compared with the more common corn silage diets.

II – Materials and methods

The experiment involved 36 young Charolais bulls weaned at 360 ± 33 kg and eight-month-old. Calves received only milk and grass before weaning. Animals were divided in 4 homogeneous groups. They were housed in free-stall on semi-mulched area with electronic cornadis to measure individual intake. A 4 week transition period was applied to accustom animals to their experimental finishing diet. Diets were based on corn silage (CS) (40% DM, 0.88 UFV, 69 g and 52 g PDIE PDIN (INRA 2007)) or grass wrapping (GW) (60% DM, 0.71 UFV, 82 g and 66 g PDIE PDIN), and distributed at two energy density High (H) or Low (L) (Table 1). Low groups were only limited by concentrate amounts. These diets allowed theoretical growth of 1400 and 1600 g/d (INRA 2007). Wrapping GW came from semi-permanent mountain grassland, 1st cut harvested in fine weather at early heading stage completed by citrus pulp and wheat malts (49-57%). The CS diets were supplemented with a cereal mixture (2/3 wheat, 1/3 corn), rapeseed meal and urea (35 to 48% of concentrate). Forages were distributed once a day and concentrate twice a day.

Bulls were slaughtered at a target weight of 700 kg, at the experimental slaughterhouse to obtain a target carcass weight of 420 kg. Ages of bulls at slaughter varied from 15 to 18 months. Throughout the experiment, offered and refused feeds were measured individually. Animals were weighed every two weeks. Rate of fat deposition was measured once monthly by BCS (Agabriel et *al* 1986) and three measurements of subcutaneous adipose cell sizes (Robelin et Agabriel 1986) at beginning, mid-fattening, and slaughter. Feeding behaviour was monitored with electronic troughs and animals' activities with a 24 hour scoring video, which took place at week 2, 12, 24. At slaughter, organs, viscera and separable fats (KPS) were weighed. Carcass yields were calculated, and carcass compositions were estimated from dissection of the 6th rib (Robelin and Geay 1975). From ME intake and initial live weight (LW), rates of gain of viscera and carcass of each group were simulated using MECSIC model (Hoch and Agabriel 2004). We modulated sensitive parameters (α: rate of protein synthesis and aMW: efficient use of metabolizable energy) to fit measurements of empty body weight (EBW), hot carcass weight (HCW) and total fat deposition (TFD). For statistical analysis, we used the SAS linear model procedure (proc GLM, Tukey test).

III – Results and discussion

From the beginning, CS groups ate more than GW (+1 kg DMI/d) and had a better ADG. But intake of CS groups showed a curvilinear evolution whereas intake of GW was more linear. When adjusting DM intake to a power of LW, a power of 0.45 best fitted the CSH group and 0.9 the GW group. Finally during the last month of feeding, intake of CSH was lower than GWH (-1.5 kg DMI/d). Due to a longer fattening period, GW groups ingested respectively 321 kg (H) and 472 kg (L) DM more than CS which represents 233 and 377 more UFV, and 44 and 61 more kg of PDI (Table 1). When quantities of net energy intake were identical between groups counterparts, the GWH animals weight by 43 kg less than the CSH ones, and the GWL weighed 36 kg less than the CSL. The general activity of bulls did not differ according to the diets. Nevertheless feeding behaviour differed between groups: intake time on corn silage was lower (CS 72 *vs* GW 160 min/d) with fewer meals (10 *vs* 14) and higher intake rate (120 *vs* 60 kg DM/mn).

Table 1. Nutritional values of experimental diets and intakes

	Concentrate %	Net energy (UFV/kg DMI)	CP (g/kg DM)	Starch, g/kg DM	NDF g/kg DM	DMI (kg/d)	Total DMI (kg)
CSH	47.5	0.97	139	403	322	9.1	1839[a]
GWH	57.2	0.94	150	27	462	9.2	2160[b]
CSL	35.2	0.92	134	370	348	8.3	1766[a]
GWL	48.6	0.90	146	25	484	8.9	2238[b]

On the same column, two means indexed by different letters (a, b and c) are significantly different at α = 5%

To reach the target weight of 700 kg, animals of GWH needed 33 more days than CSH, while GWL required 38 more days than the CSL (Table 2). After a significantly slower growth period of 60 days (GW *vs* CS -0.6 kg/d), GW groups maintained their growth rate still the end of fattening.

Growth targets of 1.6 kg ADG for high groups and 1.4 kg for low groups were achieved for GW groups and exceeded for CS groups.

Table 2. Weight and average daily gain at different stages of the fattening period

Group	Fattening period (d)		Initial weight (kg)		Slaughter weight (kg)		ADG (0-60d) kg/d		ADG (60-120d) kg/d		ADG total (kg/d)	
	Mean	**SD***	**Mean**	**SD***	**Mean**	**SD***	**Mean**	**SD***	**Mean**	**SD***	**Mean**	**SD***
CSH	202[b]	34	362	43	708	27	1.760[a]	0,303	1.780	0,230	1.660[a]	0,242
GWH	235[ab]	32	362	37	708	15	1.090[b]	0,223	1.680	0,164	1.570[ab]	0,146
CSL	213[b]	20	357	34	694	26	1.640[a]	0,254	1.790	0,148	1.600[a]	0,163
GWL	251[a]	28	368	20	711	16	1.110[b]	0,164	1.520	0,215	1.400[b]	0,139

On the same column, two means indexed by different letters (a, b and c) are significantly different at α = 5%
[*]SD: standard deviation.

The feed conversion ratio, ADG/DMI, showed that CS groups were more efficient than GW with no effect of diet density (+24 g CSH/GWH and +37 g CSL/GWL). But when efficiency was expressed in ADG/UFV, CSL was more efficient than the 3 other groups ($p<0.01$). GWL had a lower protein efficiency (307 g *vs* 380 g for CSH) whatever the ratio (fixed protein/UFV or /PDI).
Carcass composition was not different between groups. The CSH group had significantly higher total adipose tissue (total (TFD): +2%; 5th quarter (DA5Q) +1%). Adipose tissues of the carcass (DACA), significantly differed between CSH and GWH only (1.4%) (Table 3). Group CSH was fatter than the other groups, but the animals of 4 groups had deposited the same quantities of protein. In fact, since the middle of fattening, the size of the adipocytes was significantly greater for CSH (97 μ^2) compared to GW (81 and 74 μ^2) for GWH and GWL, respectively and (89 *vs* 74 μ^2) for CSL compared to GWL. At slaughter, CSH was different from all other groups. CSL was also different from GWL. Simulations underlined a different carcass gain in CSH animals relative to the other groups. They also reflected a rapid gap in the total fat tissue depots between corn silage groups (2.0 kg/week *vs* 1.7 kg), which was not observed with GW (1.3 kg/week).

Table 3. Slaughter results and fat distribution in the carcass

Groups	EBW (kg)		Carcass weight (kg)		Carcass yield %		DA5Q kg/100kg EBW		DACA kg/100kg EBW		TFD kg/100kg EBW	
	Mean	**SD***	**Mean**	**SD***	**Mean**	**SD***	**Mean**	**SD***	**Mean**	**SD***	**Mean**	**SD***
CSH	648	34	425	14	61.3	0.7	3.67[a]	0.78	10.4[a]	0.79	14.2[a]	1.5
GWH	649	59	419	11	60.9	1.6	2.70[b]	1.95	8.9[b]	2.56	11.6[b]	4.5
CSL	635	40	412	11	60.8	0.1	2.77[b]	0.18	9.9[ab]	0.39	12.6[b]	0.5
GWL	640	35	424	8	60.7	1.1	2.59[b]	0.83	9.5[ab]	1.59	12.2[b]	2.4

On the same column, two means indexed by different letters (a, b and c) are significantly different at α = 5%
[*]SD: standard deviation

It is possible to modulate the fat deposition by changing the nature of the diet (starch *vs* fiber) and by choosing adapted feeding levels. At a determined amount of net energy supply (UFV), the type of diets modifies the nature of carcass depots as in Micol et *al* (2007) or Geay et *al* (1997). In the latter, where three diets (corn silage, grass silage and hay) were compared, the "hay" diet produced significantly leaner carcasses than corn silage. The diet based on grass silage directly induced more yellow fat. In our work, wrapped hay silage diets seem to behave like hay diets, differing from corn silage diets. GWH and CSL had the same growth rate but CSL deposited more fat, and the difference (5 kg DAT) could be directly related to the nature of the diet. Our study also revealed that the difference in ADG of groups H and L seems more noticeable in GW than in CS groups. However, total protein depots are not different, although we strongly dissociated energy inputs from starch and cell walls. It is hypothesized that a more glucogenic diet favours directly through glucose precursor supply or indirectly through hormonal status intramuscular fat depots (Sharman et *al* 2013).
Feed intake in the finishing phase shows an almost linear increase in ingestion for group GWH (1.68 kg/100kg PV/day) and a lower ingestion rate for CSH, as shown by Micol et *al* (2007) with

corn or hay diets. Evolution of feed intake capacity of bulls receiving grass silage is similar to those which have lower growth rate (the allometry coefficient to LW was 0.9, like that for heifers in INRA 2007). It is not the case for both corn groups, where the power was 0.45, close to the 0.6 value used for fattening animals. The decrease in intake within corn group at end of fattening could be explained by a rapid negative feedback on intake and satiety. Diets also induced differences in intake behaviour (intake rate, number of meals) but not enough to cause alimentary pathologies like sub-acidosis that could affect animal welfare.

Corn groups have been more efficient, especially the low level group whose restrictions of concentrated feed have led to a better conversion ratio of energy intake (206 g/UFV). The slight restriction could reduce the rate of transit and improve digestibility. The energy value of the diets, recalculated on the basis of recorded performances (ADG), was 0.96 and 0.94 UFV/kg DMI for the two GW diets, slightly higher than the values calculated from chemical analysis (0.94 and 0.90). This suggests no loss of energy value related to digestive interactions. However corn silage diets were much better used (1.00 and 1.06 *vs* 0.97 and 0.92 UFV/kg DM). UFV value of corn silage in the 2007 INRA tables is reduced by 5% in order to take account of these digestive interactions. It seems that, as in Micol et *al* (2007), this reduction is too important. Finally, for the corn diets, the ratio PDI/UFV (94), although in the standards, is 11% lower than that of wrapped hay diets (105). It could be considered that in GW groups, protein growth is optimized for energy intake. If this energy level is sufficient for this protein growth, the excess of energy in the CS groups would be oriented towards lipid synthesis

V. - Conclusion

This study has shown that high growth rates, near 1600 g/d, can be reached with diets devoid of starch and based on wrapped hay. However diets based on wrapped hay required a longer transition period before animals reached their highest level of intake (relative to their body weight). Growth in the first 60 experimental days was affected. If the delay is not overcome, it can be a strong constraint which reduces profitability in specialized fattening. Conversely it can be an opportunity for low-mountain farms that only fatten a few animals each year. The use of this type of diet, based on fodder (grazed or preserved) and produced on the farm, is an interesting alternative to corn silage in grasslands regions.

Acknowledgments to the staff of the experimental farm (UERT) and to Isabelle Constant for laboratory analysis

References

Agabriel J., Giraud J.M., Petit M., 1986. Détermination et utilisation de la note d'état d'engraissement en élevage allaitant. In: Bull. tech. CRZV Theix, 66, 43-50

Geay Y.,Picard B., Jailler R.D., Jailler R.T., Listrat A ., Jurie C., Bayle M.C. , Touraille C., 1997. Effets de la nature de la ration sur les performances, les caractéristiques musculaires et la qualité de la viande de taurillons salers*. In: Renc. Rech. Ruminants*, 4, 307- 311

Hoch T., Agabriel J., 2004. A mechanistic of dynamic model to estimate beef cattle growth and body composition. In: *Agricultural systems*, 81, 1-15

INRA., 2007. Table d'alimentation des bovins, ovins et caprins

Micol D., Dubrroeucq H., Martin C., Garcia F., Mialon M.M., Agabriel J., 2007. Utilisation de rations de valeur contrastée pour la finition de jeunes bovins de race Blond d'Aquitaine*. In: Renc. Rech. Ruminants*, 14, 233- 236

Robelin J., Geay Y., 1975. Estimation de la composition de la carcasse des taurillons à partir de la composition de la 6éme côte. In: *Bull. Tech. CRZV Theix, Inra*., 22, 41-43

Robelin J., Agabriel J., 1986. Estimation de l'état d'engraissement des bovins vivants à partir de la taille des cellules adipeuses. In: *Bull; tech. CRZV Theix, Inra*., 66, 37-41

Sharman E., Lancaster A., McMurphy C.P., Garmyn A.J., Pye J., Mafi G.G., Goad L., Phillips W.A., Starkey J.D., Krehbiel C.R., Horn G.W., 2013. Effect of rate of body weight gain in steers during the stocker phase. I. Growth, partitioning of fat among depots, and carcass characteristics of growing-finishing beef cattle. In: J.A.S., 91, 2264-2277

Vasconcelos J.T., Sawyer J.E., Tedeschi L.O., McCollum F.T., Greene L.W., 2009. Effects of differents growing diets on performance, carcass characteristics insulin sensitivity, and accretion of intramuscular and subcutaneous adipose tissue of feedlot cattle. In: J*. Anim. Sci*., 87, 1540-1547