Comparison of meat and carcass sensory quality in organically and conventionally pasture-fed lambs at two levels of herbage availability

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Abstract. We compared the sensory qualities of meat and carcasses from pasture-fed lambs reared organically or conventionally (O vs. C) at 2 levels of herbage availability (High H vs. Low L). Mean lamb growth profile was kept similar between the two production systems. The experiment was conducted over 2 years from weaning until slaughter with 12 OH, OL, CH and CL Limousine castrated lambs each year. The O and C treatments differed in the level of on-pasture mineral N fertilisation. The experimental pastures were regrowths; the H and L pastures were rotationnally managed to lead to a mean lamb age at slaughter of 5 and 6 months in the H and L groups respectively. Sensory evaluation indicated that the overall liking of loin chops was lower in the O than in the C treatment. Redness of *longissimus thoracis et lumborum* muscle after 2h blooming was higher in the L than in the H treatment, sheding some light on the potential effect of the intensification of organic farming via an increase in stocking rate.

Keywords. Organic farming – lamb – meat – herbage availability.

Comparaison des qualités sensorielles de la viande et de la carcasse d'agneaux élevés au pâturage en production biologique ou conventionnelle à deux niveaux de disponibilités en herbe

Résumé. *Nous avons comparé les qualités sensorielles des carcasses et des viandes d'agneaux engraissés au pâturage en élevage biologique ou conventionnel (O vs. C) à deux niveaux de disponibilités en herbe (Haut H vs. Bas L). Le profil de croissance a été maintenu similaire entre les deux systèmes de production. L'expérimentation a été conduite pendant deux années avec 12 agneaux mâles castrés de race Limousine dans chaque groupe OH, OL, CH et CL chaque année. Les traitements O et C différaient par le niveau de fertilisation azotée minérale épandu sur les parcelles. Les parcelles expérimentales étaient des repousses après fauche et elles étaient conduites en pâturage tournant pour conduire à un âge moyen des agneaux à l'abattage de 5 et 6 mois dans les lots H et L respectivement. Les côtelettes O ont été moins appréciées que les côtelettes C. L'indice de rouge du muscle longissimus thoracis et lumborum après 2h d'exposition à l'air a été plus élevé chez les agneaux L que chez les agneaux H, indiquant les effets possibles d'une intensification de l'élevage biologique à travers une augmentation du chargement.*

Mots-clés. *Agriculture biologique – agneau – viande – disponibilités en herbe.*

I – Introduction

Organic farming embodies extrinsic features that consumers value, but studies on the intrinsic properties of organic products remain scarce. The organic farming specifications make commitments on pasture-feeding, which is favourable from a nutritional point of view, since meat from pasture-fed lambs has been shown to have a nutritionally more desirable fatty acid composition than meat from lambs fed concentrate diets (Aurousseau *et al*., 2004). However, pasture-feeding may lead to a greater occurrence of off-odour and off-flavour of the meat (Rousset-Akrim *et al*., 1997) and to a less desired meat colour (Priolo *et al*., 2002). The pastoral flavour is mainly due to the branched-chain fatty acids, 3-methylindole (skatole) and some products of oxidation of linolenic acid and its derivates (Schreurs *et al*., 2008). Lamb growth rate

and age at slaughter can also vary strongly in pasture-fed lambs, which may also affect the sensory characteristics of lamb meat (Rousset-Akrim *et al*., 1997). Therefore, as organic farming promotes pasture-feeding and 'natural rhythm' of animals, and limits the incorporation of concentrate within animal diet, this production system may be prone to the occurrence of sensory defects and to high variability in sensory characteristics. Moreover, as the organic products supply in France is lower than the demand, there is also a need to investigate to what extent the intensification of organic farming (via an increase in stocking rate for example) may affect lamb meat and carcass quality.

The odour and flavour of the meat may be even stronger when the pasture is rich in legume species, such as white clover (*Trifolium repens*) or lucerne (*Medicago sativa*), due to their prominent role in the ruminal synthesis of skatole and indole (Schreurs *et al*. 2007 a and b). Moreover, higher proportions of white clover in the lamb's diet may lead to softer subcutaneous fat due to a higher polyunsaturated-to-saturated FA ratio (Lourenço *et al*., 2007). These results were recently confirmed by Prache *et al*. (2011) with lambs reared either organically either conventionally. Although there are strong reasons for having high proportions of legume species in organic livestock systems to compensate for avoiding mineral fertilisers and to reduce reliance on bought-in concentrate feed, the outcome of these studies demonstrates that this may increase the occurrence of sensory defects in meat and carcass sensory quality.

This study was therefore conducted to compare meat and carcass sensory quality in organically and conventionally pasture-fed lambs at two levels of herbage availability. The two production systems mainly differ in the level of on-pasture mineral N fertilization (0 vs. 100 U par ha for the organic and the conventional pasture respectively). It was hypothesized that the level of mineral N fertilization used on swards may affect lamb meat and carcass quality by modulating the proportion of legumes in the diet, and that the level of herbage availability may affect lamb meat and carcass quality via an effect on i) diet composition, with animals being more or less able to express a degree of selectivity for legume species during grazing, ii) lamb growth rates and thus age at slaughter.

II – Materials and methods

This study was carried out over 2 years (2010 and 2011) at the Unité Expérimentale des Monts d'Auvergne experimental farm at Orcival, France, run by the INRA's Clermont-Ferrand Theix Center and located at 950 m high. The animals were handled by specialized personnel in accordance with the list of specifications of organic farming.

The experiment used 96 Limousine weaned castrated male lambs from weaning until slaughter in the following 2 x 2 experimental design: production system (organic O *vs.* conventional C) x herbage availability (high H *vs.* low L). The experimental pastures were grazed rotationally and herbage availability was managed using weekly lamb weighings to ensure a mean age at slaughter of 5 months and 6 months for H and L lambs respectively. Each O and C treatment comprised 24 lambs per year over 2 years using the same experimental pastures. The two production systems differed in terms of mineral N fertilization level (0 *vs.* 100 U per ha for O pasture and C pasture, respectively). The differential in mineral N fertilisation started from year 2000 onwards.

1. Animals and diets

The lambs were born between 9 March and 15 April in 2010 and between 17 March and 5 April in 2011. Each year, 24 Limousine lambs from a conventional flock and 24 Limousine lambs from an organic flock were classified into 12 blocks according to birth weight, ADG between birth and weaning and birth date, and then assigned to 1 of the 4 treatments (OH, OL, CH, CL). Weaning occurred at a mean lamb age of 90 d and a mean liveweight of 24.8 kg. All the lambs were finished at pasture. All lambs were treated against internal worms at weaning

(i.e. the beginning of the experiment). The level of parasite infection was then individually surveyed every 15 days and controlled using faecal samples to enable manipulation of growth rate via herbage availability and avoid bias linked to parasitism level. Lambs with a number of parasites eggs per gram faeces higher than 550 received an anthelminthic treatment.

C and O lambs grazed a non-fertilised natural pasture between turning out (10 May 2010, 2 May 2011) and weaning (21 June 2010 and 17 June 2011). After weaning, the lambs were fattened without any supplementation on the experimental plots (regrowths after herbage mowing and harvesting). We used the same experimental plots for both experimental years.

2. Methods

Lambs were weighed once a week in order to manage herbage availability to ensure similar average growth patterns between O and C lambs. The botanical composition of the pastures was visually assessed just before the beginning of the experimentation using the method described in Daget and Poissonet (1971).

Lambs were slaughtered when they attained 35 kg LW for H lambs and 36 kg LW for L lambs to take account for differences in carcass weight/liveweight ratio. The lambs had access to food and water until roughly 1 h before slaughter, and were transported by truck to the abattoir 25 km from the experimental site. Immediately on arrival at the abattoir, the animals were electrically stunned and slaughtered by throat cut. The carcasses were placed in a chill at 4°C until 24 h post-mortem.

At 24 h *post mortem*, the carcass was weighed, graded for conformation and assessed for external fat using the methods described by Priolo *et al*. (2002). The perirenal fat and the kidneys were then removed from the cold carcass. Fat was separated from the kidneys and then weighed. The reflectance spectrum (from 400 to 700 nm) and colour variables of subcutaneous caudal fat were measured using a MINOLTA CM-2002 spectrophotometer equipped with a protective glass visor (2° viewing angle and D65 illuminant). Colour coordinates were calculated in the CIE-L*a*b* (1976) system. The results were expressed as lightness (L*), redness (a*) and yellowness (b*), hue angle and chromaticity. Five reflectance measurements were taken. Firmness of subcutaneous dorsal fat was measured by a trained assessor on a 15-point scale from 3, 'very soft', to 15, 'very hard', using a finger test.

The left *longissimus thoracis et lumborum* (LI) muscle was excised 24 h post mortem and the ultimate PH was measured. Two centimetre-thick slices were placed on polystyrene trays, wrapped in air-permeable film (10,000 cm^3 O_2/m^2/24 h, polyvinyl chloride film) and stored in darkness at 4° C. Colour measurements were performed 2 h post-sampling. The reflectance spectrum (from 360 to 760 nm) and colour variables (lightness, redness, yellowness, chromaticity and hue angle) were measured using an Uvikon 933 (Kontron) spectrophotometer equipped with an integrating sphere of Teflon (2° viewing angle and D65 illuminant). *

Data were subjected to ANOVA, the model including the production system, the level of herbage availability, the experimental year and the interaction between production system and level of herbage availability.

III – Results and discussion

The proportion of white clover was 14.0, 8.5, 26.7 and 16.9 in OH, OL, CH, CL pastures in 2010 and 8.5, 8.5, 10.8 and 4.6 in OH, OL, CH, CL pastures in 2011. Against our expectation, the differential in N mineral fertilisation therefore did not induced corresponding differences in the proportion of legume in the swards. Moreover, the contribution of white clover in these pastures, which was measured every year since more than 10 years, seemed to be somewhat cyclic.

As planned, lamb growth rate between birth and slaughter and age at slaughter were affected

by herbage availability (P < 0.001), but were not different between production systems or experimental years. There was therefore no confounding effect between production system and lamb age and weight at slaughter. Mean lamb growth rate between birth and slaughter was 201 and 163 g/d for H and L lambs respectively, and mean age at slaughter was 158 and 197 d for H and L lambs respectively.

The mean number of anthelminthics treatments per lamb during the experiment was higher in year 2 than in year 1 (2.3 *vs.*1.2, P < 0.001) and, as expected, it was higher for L lambs than for H lambs (2.0 *vs.* 1.5 , P < 0.001). However, it remained at a low level.

As planned, cold carcass weight was not different between the 2 levels of herbage availability, between the 2 production systems and between experimental years. It averaged 14.72 kg. As expected, perirenal fat weight and dorsal fat thickness were not affected by the experimental factors (level of herbage availability and production system), but they were slightly higher in the second experimental year. We therefore avoided potential bias linked to carcass fatness in the loin chops sensory evaluation.

Carcass conformation and morphology were not affected by the experimental factors (level of herbage availability and production system) and was not different between experimental years (data not shown).

There was no effect of experimental factors on subcutaneous dorsal fat firmness and colour. Subcutaneous dorsal fat firmness averaged 8.73 (medium) and it was not different between years. Yellowness of subcutaneous dorsal fat was not different between years, but its ligthness and redness were higher in the second year.

There was no effect of experimental factors on *longissimus lumborum* (Ll) muscle PH, but there was an effect of herbage availability on Ll muscle redness after 2h blooming, redness being higher for lambs raised on the low level of herbage allowance than on those raised on the high level of herbage allowance (21.28 vs. 19.45, P < 0.005). There was no effect of experimental factors on the other Ll muscle colour parameters, nor on Ll muscle lipid oxidation intensity (Table 1).

Table 1. *Longissimus thoracis et lumborum* muscle colour and lipid oxidation intensity after 2h blooming, and chops overall liking in organically-reared and conventionally-reared pasture-fed lambs at two levels of herbage availability

	Organic		Conventional			P-value			
	High	Low	High	Low	s.e.m.	PS[1]	HE[2]	PS x HE	Y[3]
n	24	24	24	24					
L*	34.24	34.27	36.04	33.89	3.452	NS	NS	NS	*
a*	19.15	21.36	19.76	21.20	3.052	NS	***	NS	**
b*	7.38	7.97	8.27	7.75	2.094	NS	NS	NS	*
TBARS (mg mDA/kg meat	0.57	0.59	0.56	0.61	0.096	NS	NS	NS	***
Chops overall liking	3.92	3.95	4.12	4.54	1.44	***	NS	NS	-

[1]: Production System, [2]: Level of herbage availability, [3] : Experimental year; *: P < 0.05; ** P < 0.01; *** P < 0.005

For lambs produced in year 1 experiment, the overall liking of the experienced panellists was lower for O chops than for C chops (P < 0.001). This result is in line with a previous study (Prache *et al*., 2011). In the latter paper, the explanation that was put forward for the higher

level of abnormal fat odour in O chops was the higher proportion of white clover in the diet because of differences in the corresponding pastures (37.3% vs 20.7% in the O and C pastures respectively). The reason for differences in the present study is less clear, as white clover represented a low proportion of total biomass in both pastures and was not different between the O and the C pasture. The lamb chop sensory evaluation is still being processed for lambs produced in year 2 experiment.

The distribution of fatty acids in LI muscle is also being processed.

IV – Conclusions

The low level of herbage availability led to a higher redness of the meat and a higher use of chemical anthelminthics, which shed some light on the potential effects of the intensification of organic farming via an increase in stocking rate. The chops' overall liking was lower for organically-reared than for conventionally-reared pasture-fed lambs, confirming results obtained in a previous study. Further experiment will investigate i) the effect of concentrate supplementation on lamb meat and carcass quality in organically and conventionally-reared pasture-fed lambs and ii) the dose-response curve of lamb meat and carcass quality to the proportion of legume:grass species in the diet, using lambs individually penned indoors.

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