TECHNICAL NOTE

LowInputBreeds

# Issues and challenges for lamb meat quality from organic and grassland based systems

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## Introduction

Organic farming promotes pasture-feeding and the 'natural rhythm' of animals, and limits feeding of concentrates. This is favourable for the nutritional quality of lamb meat, but may adversely affect its sensorial quality.

This technical note discusses issues and challenges related to organic and other pasture based production of high quality lamb meat investigated in the LowInputBreeds project and describes possible approaches how problems might be overcome.

## Background

Organic farming embodies extrinsic features that are valued by consumers, but studies on the intrinsic properties of organic products are scarce. Organic farmers commit to respect a list of specifications that govern animal care, welfare and feeding, requiring them to provide herbivores with access to pastures during the grazing season and to organic feed (roughage and concentrates) outside the grazing season.

All these factors influence meat quality; however, they are not specific for organic farming. Moreover, there is a great diversity in production practices, in organic as well as in conventional systems, which may limit the robustness and generalization of any given comparison. Most of the studies have actually limited their comparisons to organic vs. very intensive conventional systems or have failed to provide sufficient robustness because of an insufficient description of the production practices.

## Impact of feeding on nutritional quality of lamb meat

Organic farming consciously promotes pasture-feeding, which is favourable for our nutrition, since meat from pasture-fed lambs has been shown to have a more desirable fatty acid (FA) composition than meat from lambs fed concentrate diets (Aurousseau et al., 2004). Meat from pasture-fed lambs meets the recommendations of the European Food Safety Authority with respect to the ratio of omega-6 polyunsaturated FA (PUFA) to omega-3 PUFA of less than 5 and a limited level of 16:0 fatty acids.

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## Sensorial quality of lamb meat

### Flavour

Flavour is of overriding importance, since unacceptable lamb could permanently deter consumers. Yet we see a divergence in preference among consumers. Due to the prevalence of production systems, Mediterranean countries show a clear preference for concentrate-fed lambs, whereas those in Northern Europe favour grass-fed lamb.

The intensity of the flavour of the meat is greater for pasture-fed lambs than for housed lambs (Rousset-Akrim et al., 1997) mainly due to the presence of branched-chain fatty acids, skatole and products of linolenic acid oxidation in the meat (Priolo et al., 2001).

Lamb growth rate and hence age at slaughter can vary considerably, especially with forage feeding creating variability in smell and flavour of meat, as demonstrated by Rousset-Akrim et al. (1997). They compared groups of lambs averaging 101 and 217 days at slaughter and report that the strong flavours of lamb meat were more pronounced with older lambs, especially for pasture based feeding. Since organic farming promotes forage-feeding with limited concentrate feeds, it may be more prone to variability in these sensory characteristics.

The inclusion of legumes such as white clover or lucerne in forage swards is an inevitable consequence of organic production, to compensate for avoiding soluble inorganic fertiliser. The smell and flavour of the meat may be stronger from pasture rich in legumes, since their high degradable protein content has a prominent role in the ruminal synthesis of skatole and indole (Schreurs et al., 2007). This was confirmed by Prache et al. (2011), reporting stronger smell associated with organic chops from pasture-fed lambs compared to those from comparable lambs reared conventionally. Research conducted within LowInputBreeds has investigated a dose-dependent response of lamb meat flavour/odour with the proportion of lucerne in their diet.

### Firmness of subcutaneous fat

Organically-reared pasture-fed lambs can have softer subcutaneous fat (Prache et al., 2011), which may be due to a higher proportion of legumes within the swards. The higher proportion of PUFA and lower proportion of saturated fatty acids (SFA) is nutritionally desirable, but is less favourable for carcass processing and storage, since it leads to softer fat.

### Colour of the meat

Meat from pasture-fed lambs is also darker than meat from more intensive feeding. Priolo et al. (2001) compared pasture-fed and stall-fed lambs with similar growth patterns and slaughter weights and found higher levels of the muscle pigment myoglobin in meat from the former.

Differences in the meat colour between animals may also be due to animal's age, ultimate pH of the meat, intramuscular fat content and physical activity pre slaughter. The animal's age at slaughter is generally higher in pasture-fed lambs, which leads to darker, redder muscles. The ultimate pH of meat after slaughter is generally higher in pasture-fed lambs, which also darkens muscle. In fact, as the pH of meat increases above 5.6, its water-holding capacity increases and light reflectivity decreases. As a result, the meat appears darker and has reduced microbiological stability. Intramuscular fat content is also generally lower in pasture-fed lambs, which is known to decrease muscle lightness. Physical activity may influence meat colour via an increased oxidative metabolism.

On the positive side, since any fresh pasture is very high in natural vitamin E – a potent antioxidant (up to 300 µg of tocopherol per g dry matter), meat from grazing animal is much less vulnerable to oxidation post slaughter than that from concentrate fed lambs on a diet with less than 10 µg of tocopherol per gram of dry matter.

Since organic and other grazing systems rely on pasture (with or without legumes) and may limit concentrate feeding, these production systems tend to produce darker meat with a high ultimate pH and may be variable in these meat quality attributes.

**Pasture-fed lambs from an organic flock in INRA Clermont-Ferrand Research Centre in France. (Photo: Marc Benoit)**

**Experiment conducted within LowInputBreeds investigating the dose-dependent response of lamb meat quality with the proportion of lucerne in the diet. (Photo: Thais Devincenzi)**

## Other aspects of lamb meat quality

In addition to their primary function in food production, animal production systems now face new challenges such as reducing their contribution to climate change, maintaining biodiversity, responding to societal demand in terms of ethics, quality and safety of animal products, and contributing to the socio-economic sustainability of agriculture. Pasture-based systems, such as organic, are favoured because, beyond their nutritional advantages and 'natural' image, they maintain and preserve pastures that play a key role on the environment by mitigating greenhouse gases through carbon sequestration, maintaining open landscapes and biodiversity.

Consumers, particularly those who purchase organic products, are increasingly environment-conscious and studies urgently need to address the issue of carbon footprint of meat produced under organic or conventional production systems. The main factors that enable a low level of non-renewable energy per kg of meat in sheep production are (i) a high proportion, if not all of the animal requirements are covered by forages, primarily by grazing, (ii) a high self-sufficiency, and (iii) limited use of mineral nitrogen. The challenge in organic systems is therefore to combine high pasture utilisation (to lower use of non-renewable energy per kg of meat produced and to preserve pastures) with high animal productivity, in order to offset methane emission per ewe (Benoit and Laignel, 2010).

The organic production and its reliance on legumes is further favoured, because it avoids the use of synthetic fertilisers that are non-renewable and energy-consuming. All these factors contribute to reducing the carbon footprint of the meat produced, water pollution, the reliance on purchased (possibly imported) concentrate and the sensitivity to input costs volatility.

Beyond the intrinsic quality of the meat, consumers and therefore the retail chain demand a regular supply of organic meat all year round. This may be an issue for sheep production systems, as sheep are seasonal breeders, and the prohibition in the use of hormonal treatments can make year round supply of organic lamb meat challenging. This issue creates a bottleneck in organic lamb meat production, requiring additional research on the methods for the natural control of reproduction in sheep.

## Authentication of meat products from grassland-based production systems

Authentication is of interest because of the nutritional advantages offered by meat from pasture-fed and organic animals.

The first approach is based on quantifying specific compounds in animal tissues that are transferred directly from the diet to the end product or transformed/produced by rumen micro-organisms under the effect of specific diets. Likely, options include carotenoid pigments, volatile compounds such as terpenes and 2,3-octanedione, meat fatty acid composition and meat isotopic composition (Prache, 2007).

The second approach is the use of 'fingerprints', since differences in meat composition due to the nature of the diet induce differences in its optical properties, which can also be used for diet authentication. Promising breakthroughs have been made in the use of visible and near-infrared reflectance spectroscopy (VIS-NIRS). As an example, Dian et al. (2008) obtained correct classification of 97 % of perirenal fat samples from 120 pasture-fed lambs and 98 % of the fat samples from 139 stall-fed lambs using VIS-NIRS. The reliability of these methods for the discrimination of intermediate feeding conditions (grain supplementation at pasture, stall-finishing) is under investigation.

## Outlook

The challenge for pastoral production of organic lamb meat is to guarantee consistent quality, as far as it is economically possible. The potential danger from a meat sensory quality perspective comes from relatively slow growth rate of lambs making them older at slaughter. Most quality traits that consumers seek (at least in southern Europe) are actually enhanced in the meat of young animals.

Potential ways of promoting animal growth rate, reducing slaughter age and variability are:

- Offer high allowances of good quality (relatively short and leafy) pasture.
- Minimise parasite and other disease challenges.
- Consider grain supplementing within the limits of orga-nic specifications, if conditions are not ideal.
- Provide feed supplements that contain condensed tannins such as sainfoin or fava bean.

Studies were conducted within LowInputBreeds to examine the effects of these production practices on lamb sensorial and nutritional quality.

Although additional financial and environmental costs are associated with this practice, dietary supplementation with grains may make it possible to

- improve lamb growth rate and lower the age at slaughter,
- minimise the flavour problems arising from skatole formation in the rumen, and
- minimise the problem of high ultimate pH and the subsequent darker colour and lower microbiological stability.

Supplementation of pasture-fed lambs with forage containing condensed tannins like sainfoin may also improve organic lamb meat quality, in addition to controlling parasitism in lambs. It may, in fact, improve lamb growth rate, reduce age at slaughter, and protect ingested protein in the rumen therefore minimising the flavour problems arising from skatole biosynthesis (Vasta and Luciano, 2011).

Since the sensory defects are of particular concern for lambs with slow growth rates slaughtered at later ages, one way of limiting sensory defects without undue economic cost is to sort animals on the basis of growth rate and target specific practices to each group. This may help to reduce variability and to increase meat quality without having a negative impact on self-sufficiency and costs. However, this approach increases the number of lamb batches hence labour and should not be done at the expense of pasture management to ensure good quality pastures.

An alternative solution to this ‘challenge’ would be to educate consumers that pastoral flavour is not a defect but a positive attribute associated with ‘natural’ pasture diets, and to take advantage of the full flavour of grassland-based meat products - as in many areas of Europe. In this regard, it is worth noting that some sensory quality criteria considered as defects in commodity or standard products may well be accepted by consumers in premium or differentiated products such as those that bear the organic label.

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## Imprint

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### Title photo

Organic shepherd at the INRA Clermont-Ferrand Research Centre in France. Photo: Sophie Prache

### LowInputBreeds


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