EFFECT OF PASTURE OR GRAIN MIXTURE FEEDING ON MEAT COLOUR AND LIPID STABILITY OF CHAROLAIS HEIFERS

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Background

Meat colour and lipid stability are main factors limiting the quality and acceptability of meat in refrigerated storage. Production of free radicals in the muscle is the result of lipid oxidation (cause of off-flavors) and myoglobin oxidation (cause of discoloration). The oxidative stability in meat depends upon balance between anti-oxidants such as enzymatic anti-oxidants (SOD, catalase, glutathion peroxidase) vitamins (E and C), carotenoids, flavonoids…… and pro-oxidants such as haeminic and free iron (Renerre, 1999).

Pasture feeding has been reported to affect several meat quality characteristics in bovine, in particular colour, flavour, lipid stability and fatty acid composition, when compared with grain feeding (Yang et al., 2002b). Effect of diet on other meat qualities such as juiciness or tenderness has not yet been so investigated. Studies have shown that pasture feeding can lead to increased concentrations of polyunsaturated fatty acids (PUFA's) in beef, compared to grain feeding (Melton et al., 1982 ; Larick and Turner, 1989 ; Yang et al., 2002b), with meats more prone to oxidation. In addition, these two diets (pasture / grain) may offer differences in anti-oxidants content especially vitamins, carotenoids and flavonoids which can affect meat quality. These anti-oxidants cannot be synthesized in animals. Moreover there is an increasing consumer interest in dietetic aspect. Saturated FA are considered as harmful to human health and, on the contrary, unsaturated FA (n-6 and n-3, conjugated linoleic acid) would play a favorable role in the prevention of some human diseases (cancer, obesity and cardiovascular diseases), so increasing the proportion of unsaturated FA in meat by means of animal diet is of great importance from the view point of human health.

Objectives

A research has been conducted by Institut Charolais with the aim to characterize Charolais bovine meat. The effects of animal type (steer, heifer and cow), age and feeding on meat qualities were evaluated by different laboratories in France. Our laboratory was particularly concerned by the evaluation of meat colour and lipid oxidation. To complete this study, the estimation of antio-oxidant status (enzymatic antioxidants and total antioxidant status) will be done also in our laboratory. Lipid composition will be evaluated elsewere.

The aim of this present publication was to estimate the effect of finishing mode, pasture or grain feeding, on meat colour stability and lipid oxidation in M. *longissimus dorsi* from Charolais heifers after vacuum + air packaging.

Methods

This study was carried out with 40 Charolais heifers fed alternatively with grass during summer and with a grain mixture during winter. Just before slaughter (average age of 36 months), 20 Charolais animals were fed exclusively grass for about 100 days and the other 20 Charolais animals were fed exclusively cereals mixture (essentially maize, wheat, soya bean and linseed meal) in different private farms from Bourgogne. One day after slaughter, *longissimus dorsi* muscle was cut, removed from the carcasse and meat was vacuum packaged and refrigerated at 4°C during 14 days. After opening of the packs, steaks were cut, placed on fibreboard trays, overwrapped with oxygen permeable (10,000 cm^3 O_2 /m^2/24 h) polyvinyl choride (PVC) film and stored at 4°C in darkness until 6 days.

Colour measurements were done by reflectance with an Uvikon 933 spectrocolorimeter (Kontron instrument, France) equipped with an integrating sphere. Reflectance spectra were recorded from 360 to 760 nm and colour coordinates (lightness L*, redness a* and yellowness b*) were calculated in CIELAB system (1976)). Meat discoloration was measured as R_{630}-R_{580} (Van den Oord and Wesdorp, 1971) and metmyoglobin content was determined according to Krzywicki (1979).

Lipid oxidation was measured on meat extract by the thiobarbituric acid–reactive substances (TBARS) content method (Lynch and Frey, 1993). The results were expressed as mg of malondialdehyde (MDA) by kg of meat on the basis of absorbance at 535 nm. Colour parameters and lipid oxidation were measured after an aerobic storage at 4°C for 2 hours and 6 days and results are presented as mean +/- standard deviation. Results of the two groups were compared with student *t*-test.

Results and discussion

Colour measurements :

The three colour coordinates L*, a*, b* were measured in these studies but only a* values are discussed here. Figure 1 showed a decrease of redness (a*) during aerobic storage which was more pronounced in grains-fed animals. After a 6 days storage ($p<0.01$), meat from grass-fed animals was significantly redder than meat from grain-fed animals. Same effects were measured on meat discoloration (R_{630}-R_{580}) (figure 2) indicating that the decrease of oxymyoglobin was more pronounced with grain than with pasture feeding. A value of 12.5 for the R_{630}-R_{580} value corresponds to equal sales of discolored and bright-red beef (Gatellier et al., 2001). After a 6 days storage, some samples of pasture group can still reach this value while all samples of grain group are below this limit. A slight increase of metmyoglobin concentration was observed after a 6 days storage (figure 3) and myoglobin oxidation was significantly higher in grains-fed animals ($p<0.05$). By visual assessment obtained with a trained panel (results not shown) a significant and positive effect of pasture feeding was also noted on meat colour at the end of retail display.

It may be concluded that pasture feeding was conductive to a less rapid oxidation of myoglobin during refrigerated storage in aerobic conditions thus inducing a greater colour stability of Charolais heifers meat.

The effect of feeding reported by most of the authors, often based on subjective measurements, reveals that meat from animals finished on pasture is darker than meat of animals finished on concentrate. In contrast with our results, Yang et al (2002b) reported that fresh grain-fed beef had better meat colour (more redness) compared with meat from grass-fed cattle but these differences in redness were not apparent after a vacuum packaging and a storage at 0°C during 47 days. The specific effects of diet on meat quality are not easy to evaluate because effects of feeding may be influenced by many genetic, biological or technological factors (Renerre, 1990) such as differences in physical activity (between animals allowed to move freely and restricted animals), age at slaughtering or treatment of the carcass rapidly post-mortem. Nature of pasture may also have an important effect on meat quality (Priolo et al., 2001).

Lipid oxidation:
Figure 4 showed that lipid oxidation in beef, measured by TBA-RS, was also affected by diet. After 2 hours of reoxygenation TBA-RS values were already significantly higher ($p<0.001$) in grains-fed beef compared to pasture-fed ones. After a 6 days storage, TBA-RS values increased rapidly in grain-fed group so that TBA-RS values were approximately two fold compared with pasture-fed group. In pasture-fed animals, TBARS values are maintained to a value near of 1 which is corresponding to a little oxidation, with no influence on flavour, contrary to grains-fed group. Next results will show how difference in lipid oxidation between the two diets is dependent on the nature of the fatty acid composition of phospholipids and/or the amount of anti-oxidants, such as α-tocopherol, of the meat. Even if PUFA's of the pasture feeding are more oxidative, this diet may considerably increase anti-oxidant status by containing high amount of α-tocopherol and carotenoids and other anti-oxidants (Yang et al., 2002a) which can prevent lipid and myoglobin oxidation during meat storage.
These results support previous studies, obtained in our laboratory on Montbeliard bulls (Legrand et al., 1997) and on Charolais cattle (Gatellier et al., 2001) showing that increasing anti-oxidant status (by dietary vitamin E supplementation) increased colour stability and reduced lipid oxidation during an air- and / or modified atmosphere-packaging meat storage.

Pertinent literature

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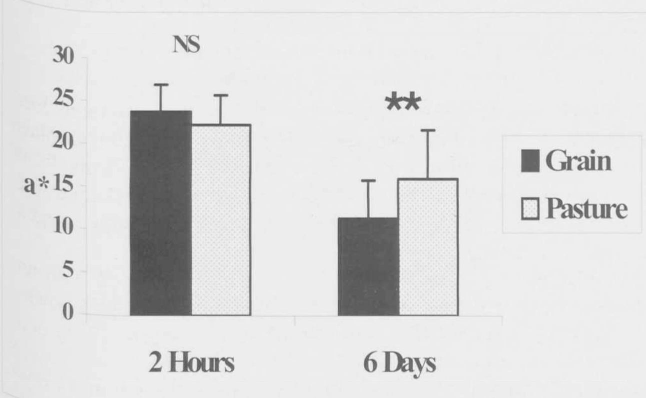

Figure 1: Effect of feeding systems on redness (a*) during refrigerated storage of meat.

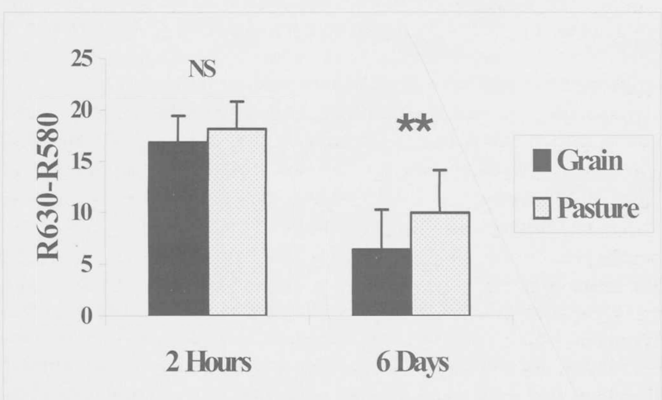

Figure 2: Effect of feeding system on meat discoloration (R630-R580) during refrigerated storage of meat.

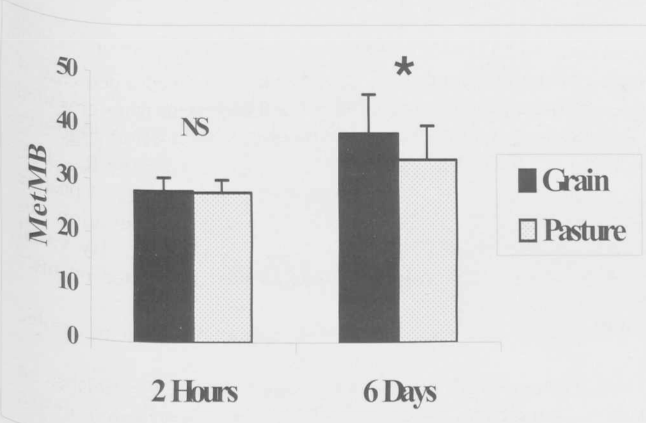

Figure 3: Effect of feeding systems on myoglobin oxidation during refrigerated storage of meat.

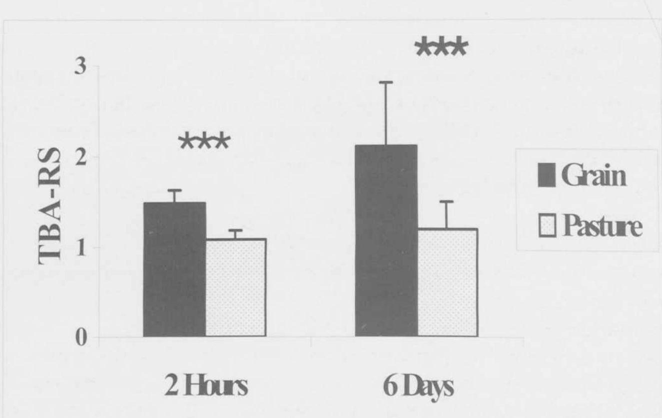

Figure 4: Effect of feeding system on lipid oxidation (TBA-RS) during refrigerated storage of meat.