EFFECT OF DIFFERENT ANTIOXIDANTS (VEGETABLE EXTRACTS) ON MEAT COLOUR STABILITY AND LIPID OXIDATION OF MINCED BEEF

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Introduction

One of the most important quality traits of fresh beef in the decision to purchase by the consumer is the appearance of the meat and more particularly its colour. The colour of meat depends on many factors and particularly of the haeminic pigment level and the chemical state of these pigments (purple-red myoglobin, bright-red oxymyoglobin and gray-brown metmyoglobin) (Renerre, 1999). During meat storage, lipid oxidation is another cause of loss of quality with, particularly after cooking, the production of off-flavours. Lipid oxidation is a chain reaction which involves the production of free radicals, particularly from polyunsaturated fatty acids, and affects the nutritional quality of meat. These oxidative processes are more important with minced meat due to its loss of structure and high quantity of lipids. In France, minced beef is an important product which represents nearly 30% of slaughtered animals. To prolong the meat shelf-life, and preserve its red colour, the use of modified atmosphere (with O_2 and CO_2) was developed; however, O_2 also increases oxidation. The combined use of antioxidants and modified atmosphere packaging represents an attractive strategy to increase the shelf life of fresh meat and, perhaps, nutritional quality. Some years ago, many antioxidants from herbs and spices were discovered and tested in many foods and some of them, such as particularly rosemary extracts, are always tested. To overcome the problems of odour, colour and taste, a more refined rosemary extract can be developed and used. The phenolic diterpenes, carnosol and carnosic acid, make up 90% of its antioxidant activity (Offord *et al.*, 1997).The aim of this work was to evaluate the effectiveness of different vegetable extracts to delay oxidative reactions and thus extend the shelf life of minced beef packaged in a modified atmosphere.

Materials and Methods

Minced beef, with 15% lipids, was used for this experiment and was divided into 13 batches with either no addition (control) or many rosemary extracts (*Rosmarinus officinalis*), as liquid or powder, green tea (*Camellia sinensis L.*) extract, grape seed extract or onion extract as powder. For some of them, extraction techniques were different. Twelve extracts were tested and only seven were kept with respect to their origin, form, odour, concentration and solubility. The concentration of each antioxidant product was chosen with respect to industrial recommendations and varied between 0.4 and 1.5 g / kg meat.

Minced meat for each treatment was placed in modified-atmosphere packaging (MAP) composed of 70% O_2 / 30% CO_2, under artificial lighting during 16h / 24h, and stored at 4°C for a maximum of 9 days. Lipid oxidation was measured by the 2-thiobarbituric acid method of Lynch & Frei (1993) by measuring absorbance at 535 nm. The analyses were performed on fresh samples stored 3, 6 or 9 days. After 6 days storage, some steaks were cooked at 55°C during 2min 30s and analysed for TBARS. The results were expressed as equivalent mg MDA / kg sample. Colour measurement was performed at the surface of meat using a reflectance spectrophotometer equipped with an integrating sphere. Colour coordinates were calculated in the CIELAB (1976) system. The results were expressed as lightness (L*), redness (a*), yellowness (b*), hue (h*) and chroma (C*). The rates of meat discoloration were determined using R_{630}-R_{580} (Renerre, 2000).

Results and Discussion

The final choice of different antioxidants was done after sensorial analysis; if the meat developed pleasant tastes (results not shown), the vegetable extracts were kept and their antioxidant activity was tested. Only seven extracts were chosen in relationship with their good flavour.

Lipid oxidation: Figure 1 showed the changes in TBARS values for all samples throughout the storage, indicative of lipid oxidation. For the majority of the samples, storage time had a low effect on TBARS values particularly for control. Whatever the time of storage, control samples had the highest values throughout ($P < 0.0001$) while all steaks with added vegetable extracts had the lowest ones. At day 3 (Figure 1), extract n° 4 (grape seed) was the most efficient with a mean inhibition of lipid oxidation near of 56%, while this inhibition was 47% for extracts n° 7 (rosemary) and n° 20 (onion) and only 36% for extract n° 3 (rosemary). If the most efficient sample seemed to be n° 4 (grape seed), it was not statistically different from rosemary extracts (n°s 7, 9, 11) and onion extract (n° 20). After 6 days storage, no difference in TBARS values was noted between extracts but all were significantly lower than control sample. At day 9, the majority of the extracts showed an important inhibition of TBARS values close to 60%. After meat cooking at day 6 (55°C in core), it was observed that antioxidant extracts were all efficient to significantly lower the TBARS values compared to control (Figure 2) with extracts n°s 4, 7 and 9 as the most efficient ($P < 0.0001$). These results are in agreement with those of Sanchez *et al.* (2001), Ahn *et al.* (2002), Djenane *et al.* (2003) and Guiavarc'h *et al.* (2004).

Colour measurement: During a 9 days storage, a low loss of redness (a*) was observed but it differed between samples (Figure 3). The best results to stabilise red colour were obtained with samples n°3 (rosemary), better than control ($P<0.0001$), and n°9 (rosemary). Direct addition to minced packaged beef of rosemary gave good results for colour stability and better than those obtained with a dietary supplementation of animals (Maher *et al.*, 2002). Whatever the storage time, the worst results were obtained with the extract n°20 (onion) and particularly at days 6 and 9 of storage ($P<0.001$) with a loss of redness and the oxidation of oxymyoglobin (Renerre, 2000). Similarly, by using R_{630}-R_{580} ratio (Figure 4), the best results were obtained with extracts n°4 (grape seed) at day 3 ($P< 0.05$), extracts n° 3 and n° 9 (rosemary) at day 6 and extracts n° 9 and n° 11 at day 9. The worst results were observed with extracts n° 17 (not communicated) and n° 20 (onion). Other works have shown the positive effect of added rosemary (as essential oil, powder extract…) on colour stability of beef patties (Mc Carthy *et al.*, 2001, Sanchez *et al.* 2001; Ahn *et al.*, 2002;).

Conclusion

Direct addition of rosemary and grape seed extracts improve lipid stability, and to a lesser extent, colour of minced beef during a 9 days storage in MAP; further research is needed to know the exact levels and different forms of vegetable extracts to use for a better enhancement of beef quality during storage. The phenolic antioxidants found in rosemary can be used in the food industry as stabilizing agents but also with beneficial effects on human health.

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Figure1

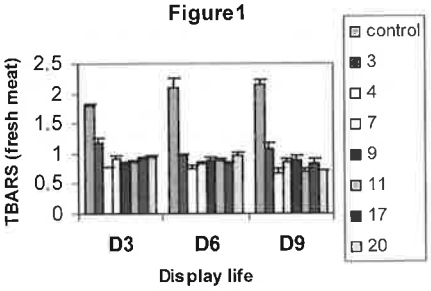

Figure 2

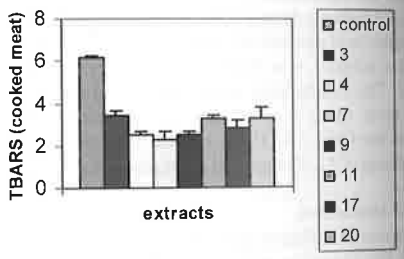

Figure 3

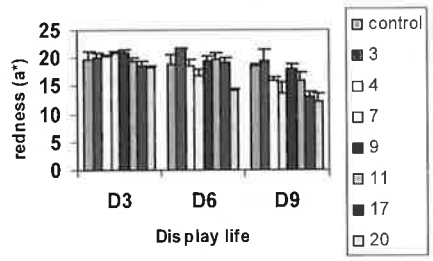

Figure 4