# EFFECT OF RESIDUAL OXYGEN AND LIGHTING MODE ON COLOUR AND LIPID OXIDATION OF TURKEY COOKED-HAM STORED IN MAP

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## Introduction

Colour is one of the most important quality parameters at the time of purchase of meat and meat products (Renerre, 2000). For cured meat, the pink, pink-red colour is viewed as an indicator of product freshness. Colour stability is dependent on many factors such as product characteristics, pH, nature of additives, storage temperature, wavelength and intensity of light and packaging mode (Andersen *et al.* 1989; Moller *et al.*, 2002). In the presence of oxygen, nitrosylmyoglobin, the nitrite-cured meat pigment, is transformed after heating in nitrosylmyochrome which is particularly sensible to light and gives denatured metmyoglobin. The change in colour from bright red to grey and brown is unacceptable by the consumer. To avoid the light induced discoloration, which is photo-oxidation, the level of residual oxygen in the package must be very low. Lights used by the retailers can vary between incandescent, fluorescent and metal halide lamps but fluorescent lamps are the most used. In the meat industry, some lights are recommended by commercial firms but often without serious scientific basis. With modified atmosphere packaging (MAP), the critical level of residual oxygen in fresh meat during chill storage must be below 0.1% to avoid discolouration (Rousset and Renerre, 1991). In MAP pasteurised ham, only Moller *et al.*, (2000) have clearly shown that, among other factors, the critical level of residual oxygen must be 0.1% or less to avoid light discolouration. The aim of this work was to study the effect of residual oxygen in MAP of turkey cooked-ham, combined or not with light exposure used in practice, which can cause photo-oxidation of the pigment and greyness at the surface.

## Materials and Methods

In the ADIV laboratory, thawed turkey fillets (Madranges) were roughly minced and meat was injected with brine containing nitrited salt (18g/kg final product), dextrose (10g/kg), erythorbate (0.5g/kg). Then the fillets were packed in cellulose pouches and cooked under vacuum until a core temperature of 69°C. After rapid cooling at 0°C, meat was stored for 3 days in a chill cabinet at 4°C. Turkey fillets were then sliced and packed in modified atmosphere (70% $N_2$ / 30% $CO_2$) (MAP) with a laminate film which OTR was 8 cc/$m^2$/atm./24$^h$ at 23°C (Pechiney-Soplaril R1385). Two levels of residual oxygen were used for the packaging atmosphere: 0% and 1%. Conditioning with about 1% $O_2$ was obtained by using a vacuum pressure equal to -700 mbars before gas reinjection. To obtain a percentage closest to 0% oxygen, after vacuum packing and during MAP, an oxygen scavenger of great capacity (Atco, Standa) was added to the package; the rate of residual oxygen was measured by a gas analyser (Abiss-Tom 12). The packages were placed in forced air chilled cabinets at 0-2°C. Four light sources were tested: a "warm" source (OSRAM, *Lumilux de luxe, Blanc chaud*, **S4**, a "cold" source (OSRAM, *Lumilux de luxe, Biolux*, **S3**), and two light sources recommended by the manufacturers: Philips TLD *Food Pro* (**S2**) and OSRAM *Natura de luxe* (**S1**). Control samples were also kept in darkness (**S5**). At days 3, 10 and 17, packages were opened and tristimulus colour parameters measured (Renerre, 2000) using a spectrocolorimeter. Oxidative rancidity was measured by the 2-thiobarbituric acid (TBARS) index (Lynch and Frei, 1993).

## Results and Discussion

The fluorescent lamps used showed a spectrum containing from 5 to 10 intensity peaks (not shown) in the visible range, with similarities to those showed by Djenane *et al.* (2001) with Mazda fluorescent lights. For Moller *et al.* (2002), the reaction between oxymyoglobin and nitric oxide yields peroxynitrite ($OONO^-$) which may initiate lipid oxidation in the meat product and were significantly influenced by light and oxygen level.

Colour measurements: Firstly, whatever the treatments, neither the residual oxygen nor the lighting mode had influence on lightness (L*) during meat storage (not shown). For redness, with 0% oxygen in MAP, during the 17 days storage (Figure 1), no important decrease in a* was observed whatever the treatment. Conversely, with 1% oxygen (Figure 2), lighting of samples induced an important decrease in redness (4> a*> 2) compared to samples stored in darkness (a* > 6) ($P< 0.001$) except with S1 at day 10. Among the tested lights, S4 source gave the worst results with the lowest a*. These differences in redness index are well correlated to sensorial analysis according to the results of Djenane *et al.* (2001). By calculation of hue (results not shown), in the presence of 1% oxygen, hue value was near 40 in darkness and near 100 for illuminated samples indicative of an important oxidation. As shown respectively in Figures 3 and 4, the accumulation of metmyoglobin was near 30% whatever the lighting conditions in 0% oxygen packs. With 1% oxygen, the metmyoglobin percentage was near 30% in the darkness, but from 50 to more than 60% (between day 3 and day 17 of storage) when meat, of a grey colour, was displayed under varying wavelengths. It was found that 40%

metmyoglobin on meat surface was synonymous with meat rejection by the consumers (Renerre, 2000). For Andersen *et al.* (1989), photooxidation of nitrosomyoglobin showed little wavelength dependence.

Lipid oxidation: Firstly, it was observed that with 0% oxygen in the package, the TBARS of turkey fillets were very low whatever the treatments (0.5 < TBARS < 0.8) but less than 0.5 for meat stored in darkness even after 17 days in MAP (Figure 5). In the presence of 1% residual oxygen and in darkness, TBARS values remained equal to about 0.5-0.8 even after 17 days storage (Figure 6). Conversely, with different lighting conditions, TBARS increased significantly ($P<0.05$) between day 3 and day 17 of storage. Mean TBARS of all samples showed values near to 0.8 at day 3 but equal to about 1.2 at day 10 and comprised between 1.2 and > 2, for some of them, after a 17 days storage indicating the appearance of off-odours and off-flavours.

Conclusion: it can be concluded that lighting and quantity of residual oxygen on slices of turkey cooked-ham will influence the colour and lipid stability after MAP. In the absence of residual oxygen, the lighting mode has no detrimental influence on colour, compared to darkness, and TBARS values remain largely under 1 (acceptable limit) until day 10 indeed day 17. With residual oxygen (near to 1%), myoglobin oxidation is important, colour is grey (sometimes even at day 3), and TBARS value can be three fold higher than the control in darkness, with development of off-flavours. Globally, sources S1 and S2 are not better than the other two.

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**Figure 1.**

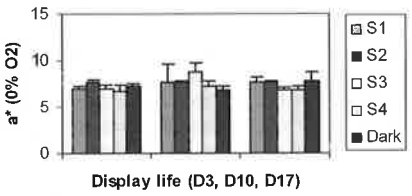


**Figure 2.**

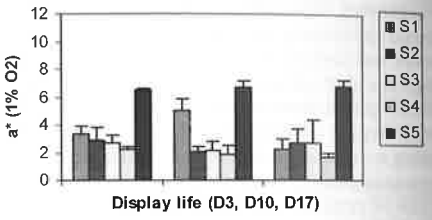


**Figure 3.**

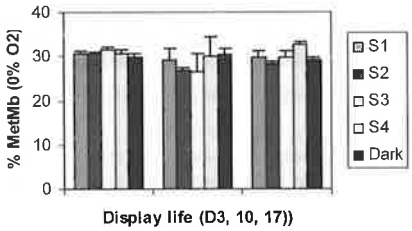


**Figure 4.**

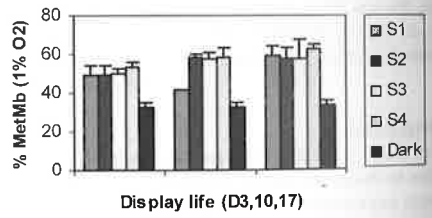


**Figure 5.**

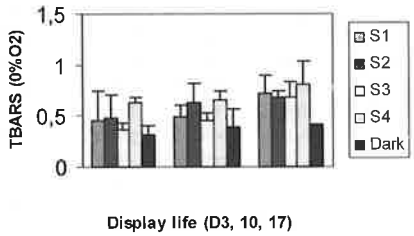


**Figure 6.**