51st International Congress of Meat Science and Technology
August 7-12, 2005 – Baltimore, Maryland USA

EFFECT OF DISPLAY CONDITIONS AND ASCORBIC ACID ON COLOR, LIPID OXIDATION AND SENSORY PROPERTIES OF FRESH PORK LOIN CHOP

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Key Words: pork loin chop, fresh meat, color, lipid oxidation, lighting, display

Introduction

The key to retail meat display is to present pork products in an attractive and saleable format. Effective sales depend on fresh appearance, acceptable product quality with an absence of abnormal traits including an unattractive color, excess drip in the package or dehydration. The role of lighting is to show the true quality of the pork product, without detracting from appearance or deceiving the customer about product quality. Lighting can speed up product discoloration but is essential for marketing and presentation of pork, both for traditional and for case-ready sales. The essential philosophy is the satisfied customers are repeat and loyal costumers. Display is defined as the offering of product under lighting in the retail case, usually under refrigeration. Display is not the same as storage, which implies keeping the product in the dark and usually not for sale. Some use the term storage when they really mean display.

Display lighting effects appearance or rate of discoloration of meat, which could result from temperature elevation at the meat surface, photochemical effects and/or differences in color fading because of different spectral energy distribution (Kropf, 1998). Several studies have examined the effect of light on discoloration of fresh meat, although conflicting results have been reported. Djenane et al. (2001) found that the use of a lamp emitting UVA radiation (360 nm) was severely detrimental to the retail life of meat, while the absence of UV radiation, either by lighting with a UV-free lamp or by using a polycarbonate filter, significantly extended beef meat retail life.

The color of meat is a very important quality attribute, and is the primary attribute of fresh meat that affects consumer purchase decision. Consumers expect a uniform appearance within a group of similar pork products and relate any color differences within similar products lower product quality (Faustman and Cassens, 1990; Hood, 1980). Thus, any process that negatively affects the color of fresh meat can lead to lower consumer appeal and marketability.

Lipids are present in muscles as structural components of the muscle membranes, as storage droplets of triacylglycerol between muscle fibers and as adipose tissue (marbling fat). These lipids, or more precisely their fatty acids, contribute to a wide range of quality attributes. For fresh meat these are color stability, drip loss and the development of oxidative rancidity.

With increased consumption of prepackaged raw meat, control of oxidation has become increasingly important. A great variety of substances and conditions may be considered as exerting antioxidant activities (Ladikos and Lougovois, 1990).

In the last 15-20 years, particular attention has been paid to the use of natural antioxidants, because the use of synthetic antioxidants has become less acceptable (Mielche and Bertelsen, 1994). Regarding vitamin C, Wheeler et al. (1996) indicated that it can be very effective for stabilizing color when added to steak surfaces; vitamin C was capable of extending display life even at the highest (9°C) temperature used. Vitamin C has been used as a steak surface treatment either alone or in combination with other antioxidant (Mitsumoto et al., 1991a; Mitsumoto et al., 1991b) to stabilize meat color during display. Depending on conditions, ascorbic acid can act as a prooxidant or an antioxidant (Elliot, 1999).

Objectives

The purpose of this study was to determine the effects of display conditions and addition of ascorbic acid on color fading, lipid oxidation and sensory properties of fresh pork loin chop over-wrapped.

Methodology

Meat

Pork loin chops from carcasses were obtained from the abattoir 48 h post slaughter. Chops were cut at 1.5 cm thick, and exposed to air for 1 h at 2°C to allow blooming; this operation was done aseptically. After blooming, samples were divided into two groups. Each chop in two groups was sprayed with L-ascorbic acid (500 ppm) solution. The other two groups were not sprayed, and named as controls.

Packaging and display conditions

Chops with ascorbic acid and control, were placed on polystyrene trays, before to be over-wrapped. Trays with samples (treated with ascorbic acid and untreated) were displayed at 1°C in a cabinet divided into two sections. One section was illuminated by a standard supermarket fluorescent lamp (F32T8-TL83, Philips Universal Hi Vision, USA). The second section was illuminated by a low-UV, color balanced lamp (Promolux® Platinum L36w, Market Group Ventures Inc., Canada). Packs were displayed up to 17 days. Samples were removed from the cabinet at day 3, 6, 10, 13 and 17 for analysis. All samples were exposed to lighting continuously at 1000 lux at the surface. Light intensity was measured using a Sper Cientific light meter (model 840020, Sper Cientific, Taiwan).

Purge loss

Pork loin chops were weighed at beginning and end of storage. Purge loss was calculated as follows:

$$\% \text{ Purge loss} = \frac{\text{Initial weight} - \text{Post storage weight}}{\text{Initial weight}} \times 100$$

pH

The meat pH was measured using a pH meter (Corning Ion Analyzer 255, Corning Science Products, Corning, N.Y., USA) with an General Purpose Combination electrode (Corning Science Products, Corning, N.Y., USA). Three grams of meat was mixed with 27 ml of water and homogenized before measurements were taken. Three readings were obtained from each pork chop portion.

Water holding capacity

Water holding capacity (WHC) was determined using the method described by Honikel and Hamm (1994).

Color measurement

Color changes on the surface of fresh meat samples each 3 or 4 days during display were monitored. CIE L*, a* and b* values were measured 30 min after package opening using a Minolta Spectrophotometer (CM2600d model).

Lipid oxidation

Lipid oxidation in displayed meat samples was measured as thiobarbituric acid-reactive substances (TBARS) as described by Pfalzgraf *et al*. (1995). TBARS values were calculated from standard curve and expressed as mg malondialdehide kg^{-1} meat.

Sensory analysis

A random color, off-odor and appearance test was conducted to evaluate whether panelists could distinguish between treatments. Semi-trained panelists were recruited to carry out the evaluation. Prior to each session meat color and appearance pictures were given to each panelist so they could designed a score. Sensory panelists scored chops for color on a 6-point scale (1= soft and 6= dark red), for off-odor on a 6-point scale (1= very soft and 6= very intense), for appearance on a 7-point scale (1=very unpleasant and 7= pleasant) (Forrest, 2002).

Statistical analysis

The significance of differences among samples at each day of storage was determined by analysis of variance (ANOVA) using the Least Square Difference method of the General Linear Model procedure of SPSS (SPSS 1995). Differences were considered significant at the $p<0.05$ level.

Results & Discussion

Purge loss (%) was significantly increased ($p<0.05$) in all treatments during display time (results not shown). Purge losses were below 4% at end of storage time. Treatments with more purge loss were those displayed under fluorescent light, with 3.67 and 3.79%, with and without antioxidant respectively.

In the present experiment no difference was found in the pH of the samples ($p>0.05$).

The WHC values for all samples were decreased as the display time increased ($p<0.05$) (results not shown). Type of lighting had not effect ($p>0.05$) on WHC values.

Respect to color, before packaging, the pork chops were darker and less red. In general, as the storage time increases the meat tends to have a paler appearance, L* values are increased. This trend is generally and clearly displayed in the results where, at packaging time (day 0), L* values for samples over-wrapped show higher values ($p<0.05$), except for end of storage time, when all samples were lower (results not shown). For a* values (Figure 1), following a considerable initial increase, generally decreased ($p<0.05$) after exposing the meat to the lighting. Between samples exposed to both lamp types, there were differences along displaying time ($p<0.05$). Pork chops exposed to Promolux® had higher a* values. Bertelsen and Skibsted (1987) reported on the comparative effects of certain wavelengths upon photo-oxidation of solutions of oxymyoglobin. Their work provided convincing evidence that ultraviolet wavelengths strongly encourage discoloration. Therefore, reducing the amount of ultraviolet wavelengths that come in contact with the surface meat can result in improved display life. Addition of ascorbic acid like antioxidant was not showed effect ($p>0.05$).

Values of TBARS are shown in Figure 2. TBARS formation was most intense in pork chops displayed under fluorescent light, which showed increasing significant differences ($p<0.05$) with respect to other display condition from the 13^{th} day of display until the end of the display time. Illumination with Promolux® resulted in a significant ($p<0.05$) inhibition of lipid oxidation; however, this effect was evident only after 13 days of display. TBARS formation was not clearly inhibited by treatment with ascorbic.

Results of sensory analysis of pork chops, including evaluation of color, off-odor and appearance, are summarized in Figure 3. Concerning color (Fig. 3a), sensory scores showed that samples subject to Promolux® light and with antioxidant added preserved a good color until day 13 of storage. These results are in agreement with instrumental color measurements. Fresh meat odor (Figure 3b) was preserved for until 10 days under Promolux® light and with addition of ascorbic acid. At day 13 of display only samples with antioxidant preserved fresh meat odor and at end of display time, samples displayed under Promolux® showed best odor. For appearance (Figure 3c), results showed that decreased with similar pattern of evolution to those of odor and color.

Conclusions

According to the results discussed above, it may be concluded that the use of lamp with absence of UV radiation, like Promolux®, together with treatment with an antioxidant significantly could extend meat display life.

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Tables and Figures

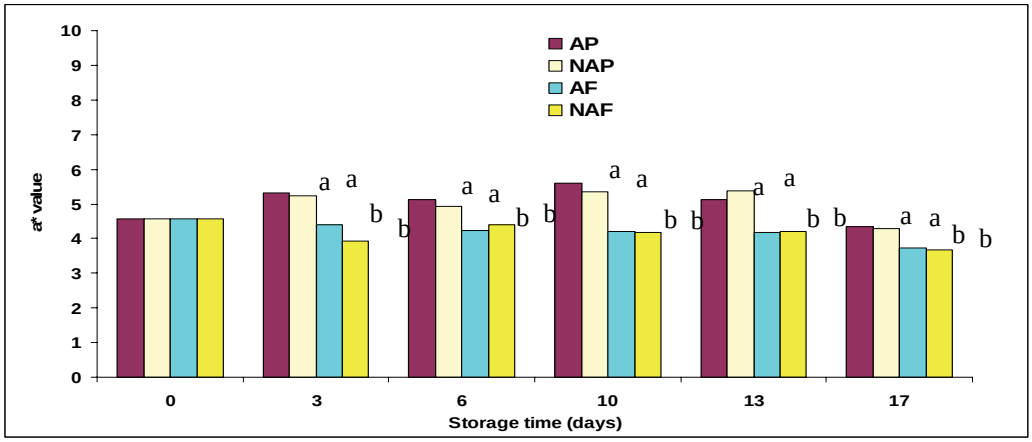

Figure 1: Effect of display conditions and storage time on a* values (redness) of over-wrapped fresh pork loin chops. AP: antioxidant + Promolux® lamp; NAP: no-antioxidant + Promolux® lamp; AF: antioxidant + fluorescent lamp; NAF: no antioxidant + fluorescent lamp. (Columns in the same day of display with different letters differ significantly (P<0.05).

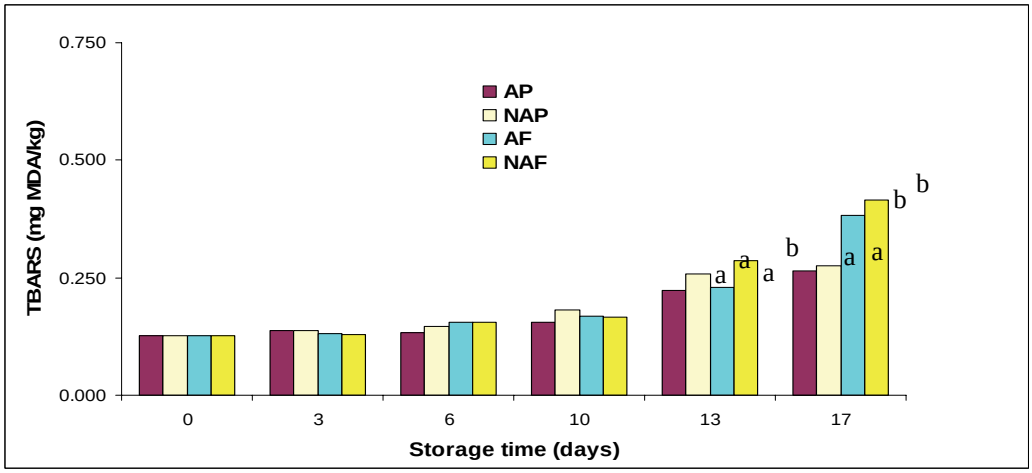

Figure 2: Effect of display conditions and storage time on TBA formation of over-wrapped fresh pork loin chops. AP: antioxidant + Promolux® lamp; NAP: no-antioxidant + Promolux® lamp; AF: antioxidant + fluorescent lamp; NAF: no antioxidant + fluorescent lamp. (Columns in the same day of display with different letters differ significantly (P<0.05)

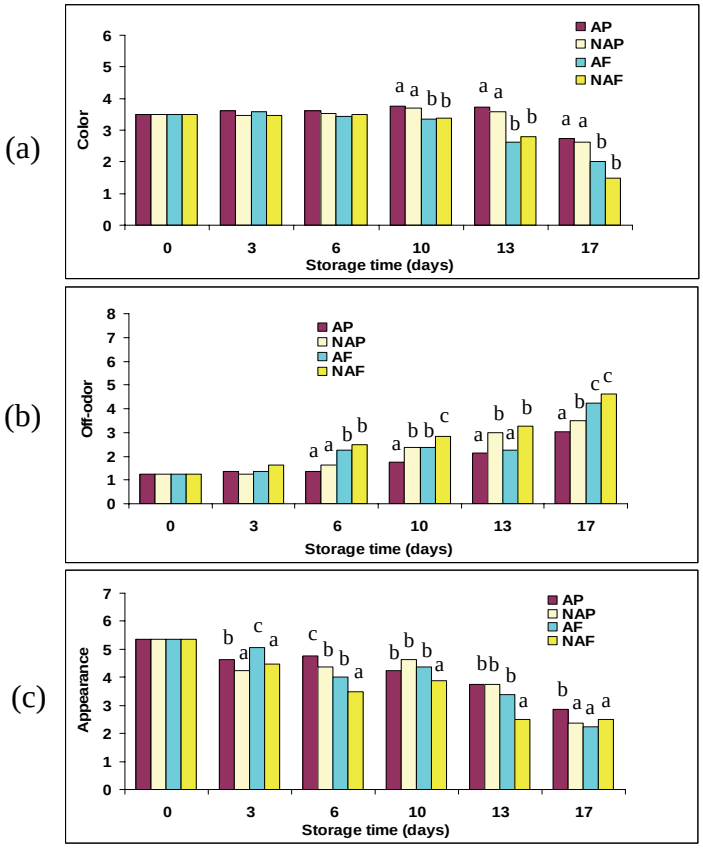

Figure 3: Effect of display conditions and storage time on sensory attributes: a) color, b) off-odor and c) appearance, of over-wrapped fresh pork loin chops. AP: antioxidant + Promolux® lamp; NAP: no-antioxidant + Promolux® lamp; AF: antioxidant + fluorescent lamp; NAF: no antioxidant + fluorescent lamp. (Columns in the same day of display with different letters differ significantly (P<0.05).