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Effects of different gas compositions on the color estimations of MAP packaged pork chops

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Abstract

This study was conducted to observe effects of different gas compositions on color of pork chops packaged in modified atmospheres. Gaseous compositions used were: MAP1 (75% O_2:25% CO_2); MAP2 (70% O_2:30%CO_2) and MAP3 (80% O_2:20% CO_2). Sensory evaluations of meat color and chemical properties (acid number, peroxide value, a_w, pH, TVB-N and TBARs), were carried on the 1st, 5th, 7th, 9th and 12th day of storage. The sensory evaluations of chop color in different MAP compositions are analyzed in relation to storage period, measured chemical properties and instrumental determination of meat color using linear and multivariate linear regression analysis.

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Keywords: MAP; pork chops; meat color; sensory evaluation; chemical changes

1. Introduction

Modified atmosphere packaging (MAP) is widely used to maximize meat shelf life and maintain its attractive fresh appearance. During the past two decades MAP has become significant and increasingly popular technology in the area of retail meat packaging.[1] There are three gases which are mainly used in MAP, i.e. oxygen (O_2), carbon

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dioxide (CO_2) and nitrogen (N_2). Meat purchasing decisions are influenced by color more than any other quality factor because consumers use discoloration as an indicator of freshness and wholesomeness.[2] Color, lipid oxidation, and microbial criteria are the most important quality criteria for storage of fresh red meat. Therefore, the modified atmosphere packaging must stabilize both the color and oxidation, as well as retard the microbial growth. It is common that 20–30% CO_2+70–80% O_2 in conventional gas composition of modified atmosphere is used for packaging of fresh red meat.[3] Oxygen is required for myoglobin−the principle protein responsible for the meat color[2] to keep it in oxygenated form, which gives the bright cherry red color to meat. While the use of high oxygen concentration is known to prolong the color stability by promoting the formation of oxymyoglobin, it is also expected to increase the rate of lipid oxidation[4] which causes undesirable changes in color and flavor.

In this research, the aim was to determine the effects of three different gas compositions on color properties and chemical changes of pork chops.

2. Materials and methods

For analyses in this study, *Mm. longissimus dorsi* of normal quality, from the left and right halves of pigs ($n = 7$), were used. After processing, approximately 24 h post mortem, muscle without bone and fat was cut into 20mm thick chops. Packaging units used for pork chops were: the upper foil, F type LID HB-S (producer: Spektar–Gornji Milanovac, Serbia); Characteristics of lid film: Oxygen Transmission Rate (OTR) <15 cm^3/m^2, 24 h, atm; Water Vapour Transmission Rate (WVTR) <15 g/m^2 24 h, atm and polystyrene containers (HIPS, LDPE and XPS) with EVOH layer, black coloured, 290 x 215 x 40 mm, produced in Italy. Packaging was conducted in the apparatus CAVECO LC1. Compositions of the gas mixture were: (MAP1) 75% O_2:25% CO_2; (MAP2) 70% O_2:30% CO_2 and (MAP3) 80% O_2:20% CO_2. Applied pure gasses were of food grade (Messer, Austria).

Packed chops harvested from the pig halves were stored between 1.5°C and 4°C. Color evaluation of packaged fresh meat was performed on the day of packaging (1) and after 5, 7, 9 and 12 days of storage.

Sensory color evaluation of fresh meat was performed by a panel of seven experienced members. Color was evaluated using a point system of analytical descriptive tests with a scale of 1 to 5, according to ISO 6658:2001[5] where the optimal color was given a 5 (reddish pink) and unacceptable color was given a 1 (pale pinkish grey).

During the storage of the meat, parameters that show hydrolytic and oxidative rancidity were determined. Acid number (AN) was determined by standard method EN ISO 660:2009[6], peroxide number by standard method EN ISO 3960:2010[7], and thiobarbituric acid reactive substances (TBARS) were detected by help of tests for determination of oxidative rancidity in foods[8,9]. pH value of samples was measured by laboratory pH-meter, model Cyber Scan, pH 510 Meter (EUTECH Instruments, Netherlands) according to standard method ISO 2917:1999[10], and a_w value was measured by hygrometer (aw meter FAst/1, GBX Scientific Instruments) according to standard ISO 21807:2004(E) method.[11] TVB-N (Total Volatile Basic Nitrogen) was determined according to the method proposed by Official Journal of the European Union[12] (2005).

The instrumental (objective) surface color of fresh meat was measured after opening the packaging units, in triplicate on each sample, by a Minolta Chroma Meter CR-400 (Minolta Co., Ltd., Osaka, Japan) using D-65 light source, a 2° standard observer angle and an 8mm aperture in the measuring head.

Color characteristics are given in the Commission Internationale de l'Éclairage's[13] (CIE) L*a*b* system. Results were expressed as lightness (L*), redness (a*) and yellowness (b*).

2.1. Statistics

Results of sensory, instrumental and chemical evaluations of packaged pork chops were processed using descriptive statistics (MS Excel). Linear regression and multivariate regression were used to examine relationships among chemical parameters to the value of sensory estimations of color during storage periods. For each variable, regression coefficients were calculated, as well as their statistical significance. The effect of each predictor (chemical and instrumental color parameters) on the dependent variable (sensory evaluation of meat surface and cut color) was estimated. Results of descriptive statistics were expressed as a mean value±standard deviation (SD). Statistical significance of means between data sets determined using ANOVA and post-hoc Tukey`s test. Statistical analysis was performed by the JMP 10 software package (SAS Institute, USA).