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OXIDATION STABILITY OF COMMINUTED MEAT PRODUCTS WITH OAT ADDITION

Małgorzata Karwowska, Zbigniew J. Dolatowski

Department of Meat Technology and Food Quality, Agricultural University, Lublin

Key words: colour, meat product, redox potential, roasted oat, TBA

The research was undertaken to examine the effect of the addition of comminuted out roasted at a temperature of 100°C on the oxidative stability of comminuted meat products during their chill storage. It was demonstrated that values of the redox potential of oat-supplemented products were lower during 30-day storage period as compared to values obtained for the control product. The products enriched with a plant supplement were additionally characterised by higher colour stability than the control product. Values of TBA obtained for experimental meat products suggest that the applied oat supplement exerted a protective effect on fat, inhibiting its oxidation during storage of meat products.

INTRODUCTION

Oxidation processes of meat constituents and meat products occurring during their storage affect a change in colour through oxidation of myoglobin and oxidative changes of lipids [Morrissey *et al.*, 1998]. Meat products are enriched with compounds exhibiting antioxidative activity in order to increase oxidative stability as well as to obtain products with an enhanced activity of antioxidants [Ahn & Nam, 2004]. An interesting cereal applicable in meat products may be oat, since it contains a rich complex of antioxidants both hydrophobic and hydrophilic in character [Bratt *et al.*, 2003; Mattila *et al.*, 2005; Martěnez-Tomé *et al.*, 2004]. They include, among others, phenolic acids, aventramides, flavonoids, tocopherols, and inositol phosphates.

The study was aimed at evaluating the effect of roasted oat addition on the oxidative stability of comminuted meat products during their 30-day storage. A hypothesis was advanced that natural compounds with antioxidant activity present in oat are likely to inhibit oxidation processes in meat products.

MATERIAL AND METHODS

The experimental material were model comminuted meat products with the following basic recipe formulation: 25% of cured beef, 25% of cured pork, 20% of minced pork fat and 30% of water/ice. The following products were prepared: control products (PK), a product with 0.05% addition of sodium ascorbate (PA), and products supplemented with naked oat grain at a dose of 2% (PO2) and at a dose of 5% (PO5). The naked oat used in the study was previously roasted in an oven to a temperature of 100°C and ground to powder. Meat and trimming fat, after comminution in a grinder through a plate with mesh size diameter of 3 mm, were chopped in a laboratory apparatus Robot-Cupe (model R3V.V.) at 1500 rpm by adding to the chopper's bowl first meat followed by water/ice and fat, and finally roasted oat. The final temperature of the batter obtained in the chopping process did not exceed 14°C. The batter was then transferred into glass jars (50 mm in diameter and 80 mm in height), next the jars were pasteurized in water until internal temperature of the sample has reached 70°C. Than, the products were chilled with cold water, stored under chill conditions for 24 h and subjected to analyses.

Measurement of acidity. Measurements of pH were carried out with a CPC–501 digital measuring instrument (ELMETRON) and a combined electrode type ERH–111 [PN–ISO 2917:2001].

Measurement of redox potential. The redox potential was determined according to the method of Nam & Ahn [2003] using a combined electrode type ERPt-13 and a digital measuring instrument CPC–501 (ELMETRON).

Measurement of colour parameters. Measurements of colour parameters were performed with the reflection method using a spherical colorimeter (X-Rite), using illuminant D65 and 10° observer angle. White reference standard (L*=95.87, a*=-0.49, b*=2.39) was used as a reference. Results were expressed in the CIE L*a*b* system. The total change of samples colour over 30-day storage was computed using the following formula: $\Delta E = \sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2}$ [Kłossowska & Tyszkiewicz, 2000].

Lipid oxidation determinations. The lipid oxidation was determined by assaying values of TBA number according to the method of Pikul *et al.* [1989]. Intensity of colour produced in the reaction of malondialdehyde with 2-thiobar-

Author's address for correspondence: Małgorzata Karwowska, Department of Meat Technology and Food Quality, Agricultural University in Lublin, ul. Skromna 8, 20-704 Lublin, Poland; tel.: (48 81) 462 33 41; fax: (48 81) 462 33 45; e-mail: malgorzata.dudek@ar.lublin.pl

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bituric acid was measured by means of a Nicole Evolution 300 spectrophotometer (Thermo Elektron Corporation) at a wave length of 532 nm. The value of TBA was expressed in mg of malondialdehyde per 1 kg of meat product.

Mathematical and statistical analysis of results. Determinations of the parameters analysed were carried out in 3 replications. The experiment was carried in two replications. The results obtained were analysed statistically. Significance of differences between the mean values was determined at a significance level of $\alpha \geq 0.05$ with the Tukey's t-test.

RESULTS AND DISCUSSION

The results obtained demonstrated a significant ($\alpha \geq 0.05$) effect of roasted oat supplement on values of the examined parameters of meat products during their storage. The pH values of meat products with the addition of oat (PO2 and PO5) were significantly higher after 1 and 15 days than the pH values noted for the control product (PK) and the product with sodium ascorbate (PA), (Figure 1). After 30 days since production, the pH value of products supplemented with oat and sodium ascorbate was observed to decrease, whereas that of the control product – to increase. Acidity is a key parameter determining the quality of meat products, among others their colour. Investigations by Livingston & Brown [1981] demonstrated that a drop in meat pH results in an increased content of metmyoglobin in meat, which affects colour deterioration.

Values of the redox potential (Figure 2) were decreasing for all experimental variants along with the time of storage proceeding. The lowest values of the oxidation-reduction potential, changing negligibly within the 30-day storage period, were reported for the product with 0.05% addition of sodium ascorbate (PA). The addition of oat affected a reduction in the redox potential of comminuted meat products (samples PO2 and PO5). The potential's values were observed to decrease by *ca*. 40 units after 15 and 30 days of storage in the case of the sodium ascorbate-supplemented product as compared to the control one. In addition it was observed that the greater the oat supplement, the lower the value of redox potential. Ahn & Nam [2004] demonstrated that beef supplemented with 0.1% of ascorbic acid was characterised with a lower value of the redox potential than the control sample. In addition they observed that a low level of oxidation-reduction potential affected the maintenance of heme pigments in a reduced form, which resulted in smaller changes in the colour of meat.

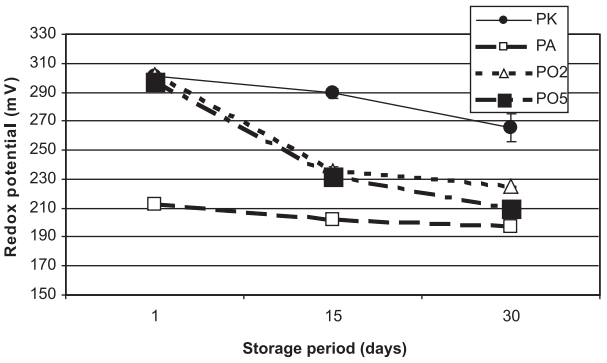

FIGURE 2. Changes in redox potential of comminuted meat products during 30-day storage.

Results of measurements of TBA in the experimental meat products (Figure 3) demonstrated that changes proceeding in fat of the control product were substantially higher as compared to those observed for the products supplemented with oat and sodium ascorbate. It may point to a protective effect of oat components on metabolism of fat of comminuted meat products during their chill storage. After 30 days since production, the lowest value of the fat oxidation index, accounting for 1.1 mg/kg, was reported for the product with 5% addition of roasted oat (PO5). It may be assumed, then, that antioxidants delivered with oat prevent deterioration processes of fat. Thus, it seems advisable to incorporate whole oat grains into meat products since the content of compounds with antioxidative activity is higher in those parts of a kernel which are separated in the milling process [Decker *et al.*, 2002]. A research by Sŕnchez-Escalante *et al.* [2001] demonstrated that the application of ascorbic acid proved ineffective in preventing lipid oxidation in meat products.

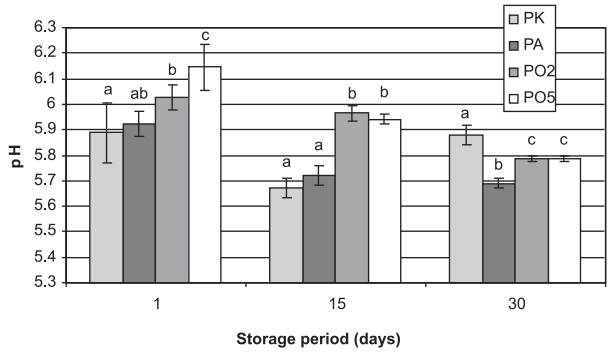

FIGURE 1. Changes in acidity of comminuted meat products during 30-day storage (mean values denoted with different letters are statistically different at $\alpha \geq 0.05$).

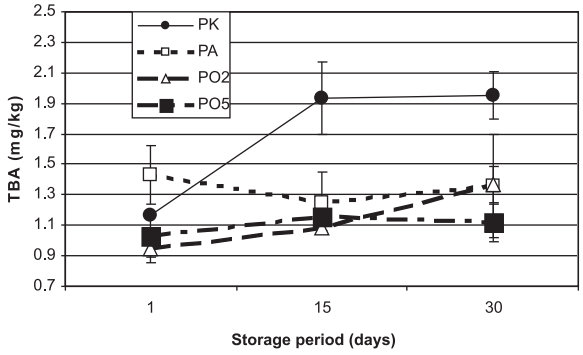

FIGURE 3. Changes in TBA index of comminuted meat products during 30-day storage.

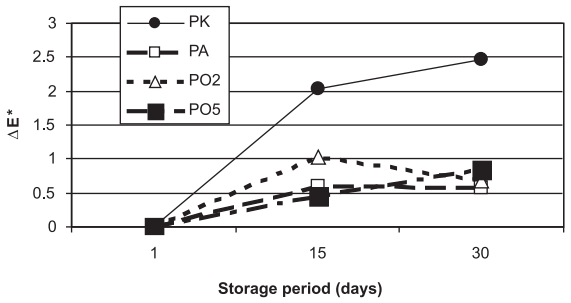

FIGURE 4. Total colour change (ΔE*) of comminuted meat products during 30-day storage.

The obtained ΔE* values (Figure 4) demonstrated that during storage the most stable colour was observed in the products enriched with oat components (PO2 and PO5) and those with the addition of sodium ascorbate (PA). This may prove the inhibiting effect of oat on myoglobin transformation during chill storage, which in turns determines the colour of meat products. The total change of colour in the control product was observed to increase along with the time of storage, to reach a value of 2.5 after 30 days since production; which was higher by over 1.5 unit as compared to the other experimental variants. The effect of the action of antioxidants used in the experiment (sodium ascorbate and antioxidants delivered with oat grains) appeared to intensify along with the time of storage; the smallest changes of colour were observed in the period between day 15 and 30 since production.

SUMMARY

Results obtained in the reported study enable concluding that addition of oat (2 and 5%) in the production of comminuted meat products allows obtaining products with a higher oxidation stability as compared to the control product (without oat supplement). In addition, it was demonstrated that the greater addition of roasted oat resulted in a higher stability of the products during their chill storage. The oat-supplemented products were characterised by a lower degree of lipid oxidation, a lower redox potential and more stable colour in reference to the control product. It should be also emphasized that the examined parameters of oat-containing products quality do not differ from parameters of products enriched with sodium ascorbate – a compound with confirmed antioxidant properties, used in meat and meat products as an agent stabilizing colour and preventing lipid peroxidation. The results obtained in this study suggest that the application of oat grains already at a dose of 2 and 5% yields similar effects on the oxidation processes proceeding in meat products to those evoked by 0.05% addition of sodium ascorbate.

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STABILNOŚĆ OKSYDACYJNA DROBNO ROZDROBNIONYCH WYROBÓW MIĘSNYCH Z UDZIAŁEM OWSA

Małgorzata Karwowska, Zbigniew J. Dolatowski

Katedra Technologii Mięsa i Zarządzania Jakością, Akademia Rolnicza, Lublin

Oceniano wpływ dodatku rozdrobnionego owsa poddanego prażeniu w temperaturze 100°C na stabilność oksydacyjną drobno rozdrobnionych wyrobów mięsnych podczas ich chłodniczego przechowywania. Wykazano, że wartości potencjału oksydoredukcyjnego wyrobów z udziałem owsa były niższe podczas 30-dniowego okresu przechowywania w porównaniu do wartości uzyskanej dla wyrobu kontrolnego. Wyroby wzbogacone w dodatek roślinny charakteryzowały się ponadto wyższą stabilnością barwy w porównaniu do wyrobu kontrolnego. Uzyskane wartości wskaźnika TBA doświadczalnych wyrobów mięsnych sugerują, że zastosowany preparat owsa działa ochronnie na tłuszcz, hamując jego utlenianie w czasie przechowywania wyrobów mięsnych.