Meat Science 99 (2015) 18–24

Contents lists available at ScienceDirect

Meat Science

journal homepage: www.elsevier.com/locate/meatsci

Effects of acerola fruit extract on sensory and shelf-life of salted beef patties from grinds differing in fatty acid composition

C.E. Realini *, M.D. Guàrdia, I. Díaz, J.A. García-Regueiro, J. Arnau

IRTA, Monells, Finca Camps i Armet, E-17121 Monells, Girona, Spain

ARTICLE INFO

Article history:
Received 20 May 2014
Received in revised form 1 August 2014
Accepted 14 August 2014
Available online 23 August 2014

Keywords:
Natural antioxidant
$n-3$
CLA
Hamburgers
Color
Lipid oxidation

ABSTRACT

The effects of added acerola fruit extract on sensory and shelf-life of beef patties were evaluated. Ground beef was obtained from young bulls fed one of four diets (CON: control, LIN: linseed, CLA: conjugated linoleic acid, LINCLA: LIN plus CLA). Pre-salted (1.8% w/w) beef patties (7.7% fat) with (0.15% w/w) or without acerola were packed in modified atmosphere (80%O_2:20%CO_2) and displayed in a retail case for 8 days. There were no interactions between diet and antioxidant treatments. LIN and/or CLA had no effect on color and lipid stability during display. However, LIN increased $n-3$ fatty acids in beef and tended to increase intensity of rancid flavor. Addition of acerola extended shelf-life by at least 3 days by improving color and lipid stability and a decreased trend in intensity of rancid flavor of patties without affecting microbial counts. Thus, the use of acerola as a natural antioxidant can be considered an effective method to retard color and lipid oxidation in beef patties.

1. Introduction

Recent consumer trends indicate increasing demands for healthier meat and meat products with reduced level of fat, cholesterol, decreased contents of sodium chloride and nitrite, improved composition of fatty acid profile and incorporated health enhancing ingredients (Zhang, Xiao, Samaraweera, Lee, & Ahn, 2010). Beef is associated by many consumers as rich in saturated lipids, which has favored research on altering the fatty acid profile of animal tissues through dietary means, in order to match more closely current nutritional recommendations for a healthy diet. Omega −3 ($n-3$) fatty acids play a major role in human health and are involved in the development of brain and retinal tissues and in the progression and prevention of human diseases, including heart disease and some cancers (Connor, 2000; Simopoulos, 1999). Besides the beneficial effects of $n-3$ for human health, conjugated linoleic acid (CLA) is a functional meat ingredient that has received special research attention. Naturally produced by ruminant animals, CLA has the potential to reduce the risk of cancer, cardiovascular diseases, diabetes, and obesity, as well as to boost the immune system (see reviews of Khanal, 2004; O'Shea, Bassaganya-Riera, & Mohede, 2004; Pariza, 2004; Schmid, Collomb, Sieber, & Bee, 2006; Wahle, Heys, & Rotondo, 2004; Wang & Jones, 2004). Thus, animal feeding strategies have been successfully used to significantly increase polyunsaturated fatty acids (Font i Furnols et al., 2009; Morales, Folch, Iraira, Teuber, & Realini, 2012; Raes, De Smet, & Demeyer, 2004; Realini, Duckett, Brito, Dalla Rizza, & De Mattos, 2004; Realini et al., 2009; Wood, Enser, Richardson, & Whittington, 2008), and conjugated linoleic acid in meat (Gillis et al., 2004; Raes et al., 2004; Schmid et al., 2006).

A specific challenge to increasing the tissue concentration of $n-3$ fatty acids is the expected increased susceptibility of fortified muscle food products to lipid oxidation (Lee, Faustman, Djordjevic, Faraji, & Decker, 2006). Increased levels of $n-3$ fatty acids in beef have been related to undesirable off-flavors such as fishy and rancid (Nuernberg et al., 2005; Vatansever et al., 2000; Wistuba, Kegley, & Apple, 2006). Oxidative processes lead to the degradation of lipids and proteins (including pigments) and are one of the primary mechanisms of quality deterioration in meat and meat products (Liu, Dai, Zhu, & Li, 2010). In addition, meat processing such as grinding can exacerbate oxidation (Lee et al., 2006), since ground meat undergoes oxidative changes and develops rancidity more quickly than intact muscle (Mitsumoto, O'Grady, Kerry, & Joe Buckley, 2005). Thus, many attempts have been made to reduce pigment and lipid oxidation in meats through endogenous and exogenous treatments with antioxidants, in particular, vitamin E and vitamin C (Mitsumoto et al., 2005). Moreover, Lee et al. (2006) indicated that an antioxidant combination would provide the greatest overall benefit for maintaining lipid stability of $n-3$ fortified meat products relative to any single antioxidant class alone.

Due to concerns about toxicological safety of synthetic antioxidants, meat products containing natural antioxidants are more desirable from a consumer point of view (Mitsumoto et al., 2005; Yen, Chang, Lee, & Duh, 2002). Natural plants are considered an important target to investigate in order to provide new sources of natural antioxidants, and their use is becoming highly relevant to muscle foods. Acerola is a fruit with a

* Corresponding author. Tel.: + 34 972 63 00 52.
E-mail address: carolina.realini@irta.es (C.E. Realini).

http://dx.doi.org/10.1016/j.meatsci.2014.08.008
0309-1740/

high content of phytochemicals with proven antioxidant activities, and it is well known as an excellent food source of vitamin C (Mezadri, Villano, Fernandez-Pachon, Garcia-Parrilla, & Troncoso, 2008). Many reports are found in the literature describing the chemical composition of acerola fruit (Mezadri, Perez-Galvez, & Hornero-Mendez, 2005; Mezadri et al., 2008; Vendramini & Trugo, 2000) or its antioxidant activity (Mezadri et al., 2008), but very few studies on the lipid and color protection effect of acerola or its impact on sensory traits in meat products. The objective of this study was to evaluate the effects of acerola fruit extract on sensory and shelf-life of salted beef patties from grinds differing in fatty acid composition.

2. Materials and methods

2.1. Preparation, packaging and display of beef patties

Beef samples were obtained from thirty six Holstein entire males fed with one of four dietary treatments. Animal diets were isoenergetic and isoproteic, supplemented with vitamin E (110 mg/kg concentrate), and differed in their amount of whole linseed and rumen-protected CLA (Lutrell© pure, BASF, Ludwigshafen, Germany): control (CON: 0% linseed and 0% CLA), linseed (LIN: 10% linseed and 0% CLA), CLA (CLA: 0% linseed and 2% CLA), and linseed plus CLA (LINCLA: 10% linseed plus 2% CLA). Composition of the experimental diets, feedlot performance, and carcass characteristics of the animals used in this study have been reported by Albertí et al. (2013). Animals were slaughtered with an average live weight of 458.4 ± 16.6 kg at an EU-licensed commercial abattoir following standard procedures. Carcasses were chilled at 4 ± 2 °C for 24 h under commercial conditions. The left chuck was removed from each carcass at 24 h post-mortem, vacuum packed, transported refrigerated to IRTA-Monells, Spain, and frozen at −20 °C until processing. The study was conducted in three batches with 12 animals (3 animals per dietary treatment) in each batch (36 animals total). There was no mixing of beef from different animals within each diet and the identity of each individual animal was maintained throughout the study. After thawing, each individual chuck was trimmed to remove surface fat, cut into approximately 4 cm^3 pieces, and coarse ground using an 8 mm plate followed by fine ground with a 4 mm plate in a grinder (Monobloc Castellvall PM-160, Riudellots de la Selva, Spain). Ground beef from each individual animal was divided into two halves. One half was treated with salt (1.8% w/w) and was used as CONTROL (0% antioxidant), and the other half was treated with salt (1.8% w/w) and with antioxidant (0.15% w/w ACEROLA, INTERQUIM, S.A., Barcelona, Spain). To ensure even distribution of the additives throughout, salt and antioxidant were dissolved in 60 and 30 ml of distilled water, respectively, and sprayed onto ground meat, which were then thoroughly mixed. Beef patties (85 g) were produced in molds using a conventional burger-maker to give average ellipse dimensions of 11 (major axis) and 8 cm (minor axis), and 1.5 cm of thickness. Patties for each display time (1, 3, 6, 8 days) and treatment (CONTROL vs. ACEROLA) were packed individually in MAP (80% O_2: 20% CO_2; Carburos Metalicos, Barcelona, Spain). Five cm-thick polystyrene foam trays BFT1523-20 (OTR < 0.5 cc/tray/24 h 23 °C, 50% HR, COV E-603), coextruded multilayer barrier top film LID2050 (OTR 24 cc/m^2/24 h/bar 23 °C, 0% HR, ASTM D-3985), both from Cryovac Sealed Air Packaging SL (Milano, Italy), and a gas-to-meat ratio of 2:1 were used for MAP. After packaging, all trays were displayed in a display case (EURO LX 334, ISA, Perugia, Italia) with an internal average temperature of 4 ± 1 °C, 12 h of an 800 lux commercial light, and 12 h of darkness each day.

2.2. Ground beef composition and fatty acid profile

Composition (moisture, protein, fat) and fatty acid profile were determined from the initial ground beef mixture used for the preparation of the patties, before the addition of salt and antioxidant. Ground beef composition was determined using a FoodScan™ analyzer (Type 78800, FOSS, Hilleroed, Denmark) (Anderson, 2007). Lipids were extracted using the chloroform–methanol procedure of Folch, Lees, and Stanley (1957). After evaporation of the extract, fatty acids were converted to fatty acid methyl esters (FAME) following the method ISO 5509-1978 (E) by using 14% BF_3 in methanol, and analyzed by gas chromatography (Hewlett-Packard 5890 Series II GC, Avondale, PA, USA; fused silica capillary column: 120 m × ID, 0.25 mm ID, 0.25-μm film thickness, BPX 70-SGE Analitycal Science, Austin, Texas 78758, USA) in duplicate using glyceryl trinonadecanoate (4632, Sigma-Aldrich Ltd., St. Louis, MO, USA) as internal standard. Individual fatty acids were identified by retention time with reference to standards (Sigma 05632: linoleic acid and conjugated methyl ester: CLA, a mixture of cis- and trans-9,11- and -10,12-octadecadienoic acid methyl esters from Sigma-Aldrich Ltd., St. Louis, MO, USA; and Supelco 37 Component FAME Mix 47885-U from Supelco Inc., Bellefonte, PA, USA).

2.3. Instrumental color and discoloration value ($R_{630} - R_{580}$)

Initial color measurements (day 1 of display) were taken after 30 min of bloom time from patty preparation and packaging. Subsequent color measurements were taken at 3, 6 and 8 days of display immediately after opening the MAP package and before conducting TBARS analysis. Color measurements were carried out using a Minolta CM-2002 spectrophotometer (Konica Minolta, Osaka, Japan) in the CIE-LAB space (Commission Internationale del'Eclairage, 1976) with illuminant D65, 2° standard observer and an aperture diameter of 4 mm. Lightness (L^*), redness (a^*), and yellowness (b^*) were recorded, and chroma and hue angle calculated as $[(a^{*2} + b^{*2})^{1/2}]$ and (b^*/a^*), respectively. Meat surface reflectance data from 360 to 740 nm were also recorded to estimate the degree of meat discoloration by the difference in reflectance at 630 and 580 nm as reported by Renerre and Mazuel (1985). Results were reported as the average of three consecutive measurements from random locations of each patty.

2.4. Visual color evaluation during display

Eight panelists, trained on visual color evaluation according to AMSA guidelines (AMSA, 2012), determined how ground beef color changed throughout simulated retail display at 1, 3, 6 and 8 days of storage of beef patties packed in MAP. Panelists evaluated each beef patty for product discoloration using 8- and 5-point category scales. Product discoloration: 8 = very bright red, 7 = bright red, 6 = dull red, 5 = slightly dark red, 4 = moderately dark red, 3 = dark red to dark reddish tan, 2 = tannish red, and 1 = tan to brown. Product percentage discoloration: 1 = none (0%), 2 = slight (1–10%), 3 = small (11–20%), 4 = moderate (21–60%), and 5 = severe (61–100%).

2.5. Lipid oxidation

Lipid oxidation was determined by measuring 2-thiobarbituric acid reactive substances (TBARS, Jo & Ahn, 1998) at 1, 3, 6 and 8 days of display, and was expressed as milligram of malonaldehyde produced per kilogram of ground beef sample.

2.6. Microbial analysis

Microbial analysis of beef patties was carried out on days 1, 3, 6 and 8 of display in MAP. Samples of 10 g of patties were transferred into stomacher bags, diluted with 90 ml of 0.1% sterile peptone water and stomached for 2 min (Bagmixer 400, Interscience, France) resulting in a 10^{-1} dilution used for analysis. Ten fold serial dilutions were prepared and 0.1 ml aliquots from each dilution were plated onto standard plate count agar (PCA; Merck, Darmstadt, Germany). Plates were incubated at 30 ± 1 °C for 72 h and total viable counts (TVC) enumerated. Results were expressed as $\log_{10}$ CFU (colony forming units) g^{-1} ground beef.