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Effect of turmeric powder (*Curcuma longa* L.) and ascorbic acid on physical characteristics and oxidative status of fresh and stored rabbit burgers

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ABSTRACT

The objective of this study was to evaluate the effect of *Curcuma longa* powder and ascorbic acid on some quality traits of rabbit burgers.
The burgers (burgers control with no additives; burgers with 3.5 g of turmeric powder/100 g meat; burgers with 0.1 g of ascorbic acid/100 g meat) were analyzed at Days 0 and 7 for pH, color, drip loss, cooking loss, fatty acid profile, TBARS, antioxidant capacity (ABTS, DPPH and FRAP) and microbial growth.
The addition of turmeric powder modified the meat color, produced an antioxidant capacity similar to ascorbic acid and determined a lower cooking loss than other formulations.
Turmeric powder might be considered as a useful natural antioxidant, increasing the quality and extending the shelf life of rabbit burgers.

1. Introduction

Changes in eating habits have led people to consume processed products such as ready-to-cook and ready-to-eat meals, and simultaneously, the food industry has developed new formulations to improve the shelf life and food safety of these products. In an attempt to control the deterioration and lipid oxidation of food, synthetic additives with antioxidant properties are widely used. However, because synthetic antioxidants may have toxic effects and consumers are concerned with safety, the interest in products with natural antioxidants has increased (Dalle Zotte & Szendrö, 2011; Petracci & Cavani, 2013; Selani et al., 2011).

Rabbit meat is characterized by excellent nutritive and dietetic properties associated with high protein content, high essential amino acid levels, low lipid content and high (60% of the total) unsaturated fatty acid (UFA) and polyunsaturated fatty acid (PUFA) contents (Dalle Zotte, 2002); therefore, it is a useful food in human diets. However, rabbit meat is susceptible to lipid oxidation and tends to produce an off-flavor more than other meat products, and consequently, the use of rabbit meat in processed products is very limited (Petracci & Cavani, 2013).

Different studies have evaluated the effect of dietary supplementation of natural antioxidants on rabbit performance and meat quality (Botsoglou, Florou-Paneri, Christaki, Giannenas, & Spais, 2004; Dal Bosco et al., 2012, 2014; Eid, 2008; Sgorlon, Stradaioli, Stefanon, Altimer, & Della Loggia, 2005; Zhang, Xiao, Samaraweera, Joo Lee, & Ahn, 2010), although none have evaluated the shelf-life or effect of natural antioxidants in processed food products derived from rabbit meat.

Among the natural antioxidants, *Curcuma longa* L. (turmeric), a herbaceous perennial plant of the *Zingiberaceae* family, is a medicinal plant extensively used in Asian countries.

Turmeric powder is prepared by drying and grinding the plant's rhizomes and is commonly used as a spice for its flavor and color and as a preservative. Recently, *C. longa* has been widely studied for its high antioxidant capacity and significant medical potential; it has been found to have anti-inflammatory, anti-infectious and anti-tumor properties (Jain, Shrivastava, Nayak, & Sumbhate, 2007). The curcuminoids are the major antioxidative compounds of turmeric, and the most widely studied is curcumin. Curcumin is a potent quencher of singlet oxygen species (Das & Das, 2002) and has the ability to inhibit lipid peroxidation and scavenge the superoxide

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anion and hydroxyl radicals (Motterlini, Foresti, Bassi, & Green, 2000; Ruby, Kuttan, Babu, Rajasekharan, & Kuttan, 1995). Additionally, curcumin (E 100) is a dicinnamoylmethane dye authorized as a food additive in the EU (EFSA, 2010) and is commonly used in the food industry as a yellow dye.

Several *in vitro* studies have analyzed the antioxidant effect of turmeric (Motterlini et al., 2000; Ruby et al., 1995); however, only a few studies have evaluated its effect on the shelf-life and antioxidant properties in meat (Daneshyar, 2012; Sharma, Pazhaniandi, Tanwar, Das, & Goswami, 2012).

The aim of this study was to evaluate the antioxidant effects of turmeric powder and ascorbic acid on the physical characteristics, FA profile, antioxidant status and microbial growth of fresh and stored rabbit burgers.

2. Materials and methods

2.1. Animals and sampling

In total, 36 hybrid rabbits weighing an average of 2.5 ± 0.10 kg, reared under intensive conditions, and fed a commercial pelleted feed were slaughtered in a farm abattoir. The farm was located near the Department of Veterinary Science of Pisa. The slaughter method was electrical stunning followed by cutting of the carotid arteries and jugular veins.

After chilling for 24 h at 4 ± 0.5 °C, the hind legs were carefully dissected from the carcasses and deboned following standard procedures (Blasco & Ouhayoun, 1996).

2.2. Burger manufacture and experimental design

For the experiment, six batches of meat (B), consisting of ground meat from the hind legs of six rabbits, were generated, and the chemical composition was assessed. Three different types of meat formulations (F) were prepared from each batch: meat with no additives (control, C), meat with turmeric powder (3.5 g of turmeric powder per 100 g of meat, Tu) and meat with ascorbic acid (0.1 g of ascorbic acid per 100 g of meat, AA). The quantities of Tu and AA were chosen after preliminary evaluation of the antioxidant capacity of the two additives using ABTS, DPPH and FRAP methods to make them comparable.

Turmeric powder (commercial composition; protein 12.2%, fat 3.4%, ash 5.8%, and moisture 9.4%) and ascorbic acid were immediately added to the minced meat, and the batch was thoroughly mixed.

Six burgers (approximately 50 g each) per formulation from each batch were formed in Petri dishes (85 mm diameter) to obtain a total of 36 burgers per formulation (18 burgers per batch, for a total amount of 108 burgers).

The burgers were packaged in Styrofoam trays with polyethylene overwrap film and stored at 4 ± 1 °C for 0 and 7 days (Day 0, Day 7).

The samples (C, Tu, AA) were analyzed at Days 0 and 7 for pH, color, drip loss, cooking loss, fatty acid (FA) profile, TBARS, antioxidant capacity (ABTS, DPPH and FRAP) and microbial growth.

For each formulation per batch two burgers were used for the determination of pH, color and drip loss, two burgers were used for TBARS, antioxidant capacity, FA profile and microbial growth and two burgers were cooked to quantify the cooking loss, at Days 0 and 7.

2.3. Chemical composition and pH determination

Moisture, ether extract and ash were determined according to the AOAC (1995) method. Protein content was calculated by difference.

pH was determined for each formulation using a pH meter (Hanna pH 211, Hanna Instruments, Padova, Italy) equipped with a glass electrode (Hanna FC 200B, suitable for meat penetration) and an automatic temperature compensator.

2.4. Drip loss

The drip loss was measured as the percentage of weight loss of burgers held under standardized conditions (4 ± 0.5 °C for 24 h and 7 days, Lundström & Malmfors, 1985) and was expressed as follows:

$$\text{Drip loss} = [(W_b - W_a)/W_b] \times 100,$$

where W_b and W_a are the weights of the burgers at Day 0 and Day 1 or Day 7, respectively, during refrigerated storage.

2.5. Cooking loss

The burgers were weighed and then cooked in a preheated oven at 163 °C to an internal temperature of 71 °C. The burgers were turned every 4 min to prevent excess surface crust formation. After cooking, the burgers were held at room temperature for a few minutes, and the surfaces were dried slightly with blotting paper before weighing. Cooking losses (%) were calculated as follows:Cooking loss = $[(W_b - W_a)/W_b] \times 100$,where W_b and W_a are the weights of the burgers before and after cooking, respectively (AMSA, 1995).

2.6. Color determination

Meat color was expressed as L* (lightness), a* (redness), and b* (yellowness) according to the CIElab system (CIE, Commission Internationale de l'Eclairage, 1976) and was measured in raw burgers using a Minolta CR300 chroma meter (Minolta, Osaka, Japan).

The illuminant was D65, and an incidence angle of 0° was used. Each data point was the mean of three replications measured on the surface of the burgers at randomly selected locations.

Prior to each session, the chroma meter was calibrated for the CIE color space system (CIE, Commission Internationale de l'Eclairage, 1976) using a white tile (L* = 98.14, a* = −0.23 and b* = 1.89). The L* value indicates lightness (0 = darkness, 100 = lightness), the a* value indicates redness (+60 = red, −60 = green) and the b* value indicates yellowness (+60 = yellow, −60 = blue). From these coordinates, hue (H*) and chroma (C*) were calculated as follows:

$$\text{Hue} = \tan^{-1} b^*/a^*$$

$$\text{Chroma} = \left(a^{*2} + b^{*2}\right)^{0.5}.$$

The numerical total color difference (ΔE) between burgers was calculated by:

$$\Delta E_{\beta-\alpha} = \left[\left(L^*_\beta - L^*_\alpha\right)^2 + \left(a^*_\beta - a^*_\alpha\right)^2 + \left(b^*_\beta - b^*_\alpha\right)^2\right]^{0.5},$$

where L^*_α, a^*_α, b^*_α, and L^*_β, a^*_β, b^*_β are the values at Days 0 and 7, respectively, for each batch's formulation or the values at the same time (Days 0 or 7) of two different formulations within the same batch. A variation in color (ΔE) equal to 2.3 units corresponds to a just-noticeable difference (JND) for the human eye; higher variation is considered discernable (Sharma, 2003).

2.7. Microbial assay

For microbial assay 10 g of samples were used. The samples were analyzed for enumeration of total aerobic plate counts (ISO 4833:2003) and the presence of beta glucuronidase-positive *Escherichia coli* (ISO,