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Influence of household cooking methods on amino acids and minerals of Barrosã-PDO veal

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ABSTRACT

The effect of commonly household cooking methods (boiling, microwaving and grilling) on amino acid and mineral (Fe, Mg, K and Zn) contents was investigated in the *longissimus lumborum* muscle of Barrosã-PDO veal. Fifteen Barrosã purebred calves at 7–8 months of age and an average weight of 177 ± 37 kg were slaughtered. Cooking had a strong effect ($P < 0.05$) on yield, being higher (67.5%) in boiling compared to microwave and grilling (64.0% and 64.5%, respectively). Grilling increased most of the percentage retention of individual amino acids (>100%), in particular for leucine. No significant differences ($P > 0.05$) were observed for iron and zinc retentions among the cooking methods, while the retention of magnesium and potassium was strongly affected, mainly after boiling. Our findings indicate that the different cooking methods clearly affect the chemical composition and nutritional value of meat, which may have a strong impact on the intake of essential nutrients.

1 . Introduction

Red meat is generally recognized as valuable food with relevant nutritional properties due to its content of high-quality proteins, with a balanced content in amino acids, particularly in essential amino acids. In fact, from the twenty amino acids constituting proteins, eight have to be supplied by the diet (isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine) in order to ensure an adequate physical development and well-being (Aristoy & Toldrá, 2009; Wu, 2009). Amino acid content and composition play an important role in meat quality by providing nutritive value and flavor (Cai et al., 2010). Meat is also a major dietary source of complex B vitamins, especially vitamin B12, zinc, selenium, phosphorus and iron, thus contributing significantly to the daily intake of these essential micronutrients (Cabrera, Ramos, Saadoun, & Brito, 2010). The nutritional importance of meat also lies in its essential trace element content, specifically in iron, which is present in the form of heme (hemoglobin and muscle myoglobin), accounting for its high bioavailability in red meats (Alegría, Barberá, Lagarda, & Farré, 2009). Moreover, iron has a crucial role in human health. Iron deficiency is one of the biggest nutrient deficiency concerns in Europe, which can lead to anemia as well as to disturbances in child growth and development (Lozoff & Georgieff, 2006).

Meat becomes more edible and digestible when subjected to cooking (Alfaia, Lopes, & Prates, 2013). During cooking, meat undergoes both physical and chemical changes, such as a decrease in the nutritional value, which are strongly dependent on protein denaturation and water loss (Mora, Curti, Vittadini, & Barbanti, 2011; Tornberg, 2005). It is well known that an increase in core temperature in meat will promote collagen shrinkage, reduce water holding capacity and increase cooking loss that influences its final quality and acceptability (Chiavaro, Rinaldi, Vittadini, & Barbanti, 2009). Cooking loss is a combination of liquid and soluble matter and with increasing temperature, water content decreases while fat and protein contents increase, thus indicating that the main part of cooking loss is water (Heymann, Hedrick, Karrasch, Eggeman, & Ellersieck, 1990). Heating time, temperature, cooking method and muscle composition are all important variables, which may influence the final desirable characteristics of the meat (Alfaia et al., 2010; Christensen, Purslow, & Larsen, 2000). Although meat changes induced by cooking have been studied for many years and extensively discussed (Offer, 1984; Tornberg, 2005), only few reports have specifically dealt with the influence of different cooking conditions on the amino acid and mineral contents (Wilkinson, Lee, Purchas, & Morel, 2014). Moreover, the nutrient composition of cooked meats available in Food Composition databases is quiet limited.

Consumers are increasingly aware of the relationships between diet, health and well-being resulting in choices of foods which are healthier and more nutritious (Banovic, Grunert, Barreira, & Fontes, 2010). Beyond the choice of healthy foods, there is also a concern for healthy cooking. In fact, a better understanding of the complexity of heat treatments used to cook meat and its influence on their nutrients may increase consumer's expectations and acceptance of more convenient and healthy cooking choices (Font-i-Furnols, & Guerrero, 2014). Meats

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with Protected Designation of Origin (PDO) are recognized and valued by the consumers due to their distinctiveness and quality. The PDO policy intends to guarantee to consumers a trustful supply that respects both sanitary rules and the features perceived by consumers as signs of quality (Monteiro et al., 2013). In line with this, the maintenance of meat quality throughout cooking is particularly important for PDO meats.

Therefore, the present study assessed the effect of three cooking methods (microwave oven, boiling and grilling) on amino acid and mineral (iron, magnesium, potassium and zinc) contents of Barrosã-PDO veal. The influence of cooking methods, widely used in household processing, on amino acids and minerals of meat is compared on the basis of nutrient retention. Finally, the contribution of meat cooked under different methods for the recommended daily intake of amino acids and minerals was also evaluated.

2 . Materials and methods

2.1 . Animals and meat sampling

Fifteen Barrosã purebred calves produced in the Northwest of Portugal were kept according to the traditional production pasture-based system following the rules established in the Barrosã-PDO product specifications (Commission Regulation no. 1263/96 of 01/07, EEC). After weaning, the animals were slaughtered between January and February 2008, at 7–8 months of age and an average weight of 177 ± 37 kg. Meat samples were taken from the *longissimus lumborum* (LL) muscle, between the L1 and L4 ribs, two to three days after slaughter (+1 °C), and vacuum packed and frozen at −80 °C until application of heat treatments.

2.2 . Cooking methods and preparation of samples

Frozen muscle samples were thawed overnight at 4 ± 2 °C. Once the meat was thawed, each sample was sliced into cuts with 1.5 cm thickness (5 × 5 × 1.5 cm), weighed (around 38 g) and subjected to each of the following cooking methods: microwaving, boiling and grilling, while the raw cuts were sampled directly as the uncooked control.

Microwave oven (Mod. AVM 559, Whirlpool, USA) samples were placed in a Pyrex container. Cooking was performed in a 2450 MHz at 750 W using two heating cycles of 45 s and turned over between cycles. Boiling was performed in a water bath with samples completely submerged for 40 min at 81 °C. In electric grill (Mod. ES/FOFTES), the samples were placed on the center of the thermal resistance and approximately 4 cm from heat source and cooked for 30 min at 225 °C. The samples were turned every 5 min. The cooking temperature and time used for each method resulted from a series of tests, which showed the best value for temperature/time cooking samples without a trace of blood. The final cooking temperature was determined beforehand by inserting thermocouples (Type K — Lufft C100 Series Digital Instruments, USA) into the approximate geometric center of each steak.

2.3 . Determination of yield

After cooking and cooling (30 min at 20–22 °C), the samples were wiped with a paper towel to remove visible exudates and the cooking yield was calculated by the weight difference before and after cooking.

2.4 . Determination of amino acids

2.4.1 . Hydrolysis and derivatization of samples

Meat cooked samples were lyophilized (−60 °C and 2.0 hPa) until constant weight using a lyophilisator Edwards Modulyo (Edwards Hight Vacuum International, UK). Dry samples (0.2 g) were hydrolysed with 5 mL of HCl 6 N solution (containing 1% phenol, w/v) for 24 h at 110 °C according to the procedure described by Pellet and Young (1980). After hydrolysis, 25 mL of HCl 0.01 M was added and the extract was filtered and evaporated in a rotary evaporator (R110 BUCHI) at 60 °C to a final volume of 5 mL. Then, 500 μL was withdrawn and the pH was adjusted by the addition of approximately 1 mL of NaOH 1 N. Then, 100 μL of internal standard (norleucine, 1 mg/mL) and 800 μL of ethanol were added to 100 μL of the extract. The extracts were centrifuged at 14,500 rpm for 2 min. The supernatant was led to dryness at 70 °C under a nitrogen stream. The derivatization was carried out using 250 μL of N,O-bis(trimethylsilyl)trifluoroacetamide (BSTFA) plus 1% trimethylchlorosilane (TMCS), during 2.5 h at 130 °C (Multi-Blok Heater Lab-line). After derivatization, 300 μL of acetonitrile was added (Quaresma et al., 2003).

2.4.2 . Gas chromatography analysis

The separation of amino acids was achieved by gas chromatography (Hewlett 5890 Packard Series II) with flame ionization detection. A DB-17 fused-silica capillary column (Agilent Technologies, Palo Alto, CA, USA) with 30 m × 0.25 mm was used. The analysis conditions were as follows: column temperature programmed from 80 °C (3 min), up to 210 °C with a rate of 5 °C/min; injector and detector temperatures, 275 °C and 300 °C, respectively. Helium was the carrier gas (70 kPa). The amino acids were identified by their retention times and by comparison with a standard amino acid solution (Sigma-Aldrich AA-S-18). Quantification was based on the internal standard method.

2.5 . Determination of minerals

The determination of ash content was carried out according to the procedures described in AOAC (2000). The mineral elements (iron, magnesium, potassium and zinc) were determined by atomic absorption spectrophotometry (PU 9100X Philips) based on the method proposed by Hermida, Gonzalez, Miranda, and Rodríguez-Otero (2006).

2.6 . Determination of retention

The retention of amino acids and minerals was calculated according to Murphy, Criner, and Gray (1975), using the following equation: $TR\ (\%) = (A \times B / C \times D) \times 100$, where A — nutrient content (g) of cooked meat; B — meat weight (g) after cooking; C — nutrient content (g) of raw meat and D — weight (g) of raw meat.

2.7 . Statistical analysis

As variance heterogeneity was detected for most parameters, the data were analyzed using the PROC MIXED with variance heterogeneity analysis of SAS (2009) software package (version 9.2; Statistical Analysis Systems Institute, Cary, NC, USA). The statistical model evaluated included the treatment effect as repeated measure. Data were reported as mean ± standard error (SE). Least squares means (LSMEANS), with the option PDIFF adjusted with Tukey–Kramer, were determined to compare groups. Differences were considered significant at a *P*-value below 0.05.

3 . Results and discussion

3.1 . Final cooking temperature and cooking yield

Meat is considered cooked when the temperature reached inside the sample is kept at 65–70 °C for 10 min (Bender, 1992). Furthermore, the end of the cooking process is generally indicated by change of the meat color and by the development of flavors. In current study, the internal endpoint temperature of meat was significantly different ($P < 0.001$) among the three cooking processes (Table 1). The highest value was observed for microwaving (93.9 ± 0.32 °C), followed by boiling (74.1 ± 0.54 °C) and grilling (70.0 ± 1.21 °C). This internal endpoint temperature for each heating treatment enabled the meat to attain a medium