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Nutritional properties and consumer evaluation of donkey bresaola and salami: Comparison with conventional products

R. Marino *, M. Albenzio, A. della Malva, A. Muscio, A. Sevi

Dipartimento di Scienze Agrarie, degli Alimenti e dell'Ambiente, University of Foggia, Via Napoli, 25, 71121 Foggia, Italy

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ABSTRACT

Nutritional properties and consumer evaluation were performed in bresaola and salami from donkey meat compared with respective conventional products. Donkey bresaola and salami showed higher content of protein and lower content of fat than beef bresaola and pork salami. Significant differences in the unsaturation level of fatty acids were found. Particularly, donkey meat products showed lower saturated fatty acids, higher polyunsatured fatty acid content and better nutritional indices than conventional beef bresaola and pork salami. Furthermore, donkey meat products, especially bresaola, showed the highest content of essential amino acids. Both donkey meat products resulted to be more tender than conventional products, in addition donkey bresaola showed also higher consumer acceptability. Our investigation demonstrates the possibility of processing donkey meat into products comparable to traditional ones with a high nutritional value.

1. Introduction

In the last years several studies highlighted the favorable nutritional profile of meat and meat products from different animal species such as buffalo, goat (Paleari, Moretti, Beretta, Mentasti, & Bersani, 2003; Madruga & Bressan, 2006) and game (Hoffman & Wiklund, 2006; Hoffman, 2008; Van Schalkwyk, McMillin, Booyse, Witthuhn, & Hoffman, 2011) suggesting an alternative in the beef and pork markets.

Donkey (*Equus asinus*) rearing plays a central role for eco-sustainable development of internal and marginal areas in many countries of the world. In particular, the use of autochthonous donkey breeds has the advantage that these animals are closely related to the environment and maintain biodiversity. Although the interest in donkey milk, due to its beneficial nutritional properties for infant nutrition (Salimei et al., 2004), has increased in the last years, on the other hand, the consumption of donkey meat and meat products is relatively unknown.

For this reason, the production of typical processed meat products could be a tool to increase the value of donkey meat. Traditional salting, fermenting and drying technologies have been used since ancient times to produce dry cured meat products available throughout the year and consumed in many countries.

Salami is a very popular fermented meat product, its quality depends on the variations in raw meat, formulation, and manufacturing processes. Eleven Italian salami are registered as a protected designation of origin (PDO) and geographical indication (PGI), according to Council Regulation (EC 510/2006). Among cured meat products, bresaola is a PGI product (EC 1263/96) produced in different areas of north Italy (Valtellina, Val Chiavenna in Lombardy region) since the 15th century as a way of preserving meat. Furthermore products similar to bresaola are consumed in Brazil (known as "charqui", "manta de carne de sol"), Spain (known as "cecinas" or "cecina de leon"), Canton of Grisons, Switzerland (known as "Viandes des Grison" or "Bindenfleisch") and France, Doubs region (known as "Bresi").

Since bresaola and salami have already found a niche both in national and international markets it raises the possibility of using donkey meat to prepare similar products. To achieve this goal, there are some aspects that could be highlighted such as the valuation of the nutritional and organoleptic properties of donkey meat products and to compare these properties with those of traditional products according to the healthier concept (e.g. minor saturated fatty acid content, major ω3 polyunsaturated fatty acids and essential amino acid content).

The present study aimed to evaluate the possibility to obtain both bresaola, using three different commercial cuts, and salami from donkey meat and to compare their nutritional and organoleptic properties with those of conventional products.

2. Materials and methods

2.1. Meat and donkey meat products processing

The bresaola and salami from donkey meat were prepared in a sausage industry (Carni SUS, Foggia, Italy) by using traditional protocol production. To make a comparative evaluation of these products an equal number of samples of conventional bresaola and salami from cattle and pork meat, respectively, were manufactured.

* Corresponding author. Tel.: +39 0881 589330; fax: +39 0881589502.
E-mail address: rosaria.marino@unifg.it (R. Marino).

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Six asses and six cows slaughtered in the last of their milk producing life were utilized for bresaola processing. The samples of meat investigated for bresaola were collected from three different first quality commercial lean cuts as eye of round (*semitendinosus* muscle), rump (*gluteus* and *tensor fasciae latae* muscles) and knuckle (*vastus* and *rectus femoris* muscles). A total of 36 bresaola (18 for each animal species) were produced. The meat was trimmed by fat and tendinous external parts, the raw material showing abnormal color or that was too fatty was discarded. Then meat was covered with salt (25 g/kg), pepper (1 g/kg), juniper, nutmeg, laurel and garlic for at least 8–10 days at 2–4 °C to allow the mixture to penetrate the muscle and to give it flavor. At the end of the salting phase, each bresaola was washed and dried and stuffed into casing and enclosed in a net at 20–24 °C and R.H. 65–68% for 4–5 days. After the drying phase, the temperature of the chamber was reduced to 3 °C every day and the relative humidity was increased until it reached a temperature of 13–15 °C and a R.H. of 75–80%, the samples were ripened for 40–45 days. Finally, after the curing time, the casing and the net were removed and the bresaola washed and vacuum packed.

Six asses and six pigs (slaughtered at about 170 ± 5.22 SE of weight) were used for salami processing. A total of 24 salami (12 for each animal species), about 250 g in weight, were produced. Fresh boneless meat from shoulders, hams, belly and neck of ass and pig, respectively, were used. Each type of meat and fresh pork backfat (10% w/w) were minced in a cutter to a particle size of about 3 mm and mixed with salt (26 g/kg), pepper (1 g/kg), fennel seeds (3 g/kg), powdered milk (12 g/kg), and EUROSAL (dextrose and saccharose, natural flavoring, E301 and E252, Europrodotti, Milan, Italy; 6 g/kg) and left overnight at 2 °C. After filling in the natural casing, the salami were placed at 4 °C for 3 days and then stored in a ripening room for 20 days. During the first 5 days of ripening, the temperature and the relative humidity (RH) progressively decreased from 25 °C to 15 °C and from 90% to 65%, respectively, while, the final step of ripening was carried out at 13 °C and 75–80% of R.H. Cured and fermented products were analyzed at the end of their respective ripening period to evaluate their chemical and physical properties and consumer preference.

2.2. Chemical analysis

Each sample was ground to homogeneous consistency using a food processor. Moisture, protein, lipid and ash contents were determined according the to AOAC (1995) methods. All the chemical determinations were performed in duplicate.

Lipids were extracted according to Bligh and Dyer (1959). Briefly, 5 g of sample was mixed with 15 ml of chloroform: methanol (1:2, v/v). The mixture was homogenized for 2 min at 13,500 rpm with an Ultra Turrax homogenizer (IKA T18 basic) and centrifuged (10 min, 1500 rpm), the upper aqueous phase was eliminated, while, the lower chloroformic phase was filtered through anhydrous sodium sulfate and collected. Then, chloroform was evaporated using a rotary evaporator (Büchi Rotavapor R200/B490, Flawil, Switzerland) at 37 °C under vacuum. Duplicate samples of chloroform extract, corresponding to 100 mg of lipid, were methylated by adding 1 ml of hexane and 0.05 ml of 2 N methanolic KOH according to ISO-IDF (2002). Gas-chromatograph analysis was performed using an Agilent 6890N instrument equipped with a HP-88 fused-silica capillary column (length 100 m, internal diameter 0.25 mm, film thickness 0.25 μm). Operating conditions were: a helium flow rate of 0.7 ml/min; a FID detector at 260 °C; a split–splitless injector at 220 °C with an injection rate of 120 ml/min and an injection volume of 1:l. The temperature program of the column was: 4 min at 140 °C and a subsequent increase to 220 °C at 4 °C/min. Retention time and area of each peak were computed using the 6890N NETWORK GC system software. Individual FAME peaks were identified by comparing their retention times with those of standards (FIM-FAME-37-Mix, Matreya, Pleasant Gap, USA).

Atherogenic and thrombogenic indices were calculated according to Ulbricht and Southgate (1991) as follows: $\text{Atherogenic index} = (C12:0 + 4 \times C14:0 + C16:0)/[(\Sigma MUFA + \Sigma PUFA(\omega{-}6) \text{and} (\omega{-}3)]$; $\text{Thrombogenic index} = (C14:0 + C16:0 + C18:0)/[(0.5 \times \Sigma MUFA + 0.5 \times \Sigma PUFA(\omega{-}6) + 3 \times \Sigma PUFA(\omega{-}3) + (\omega{-}3)/(\omega{-}6)]$.

2.3. Amino acid analysis

The extraction of amino acids was performed using 6 N HCl for 75 min at 160 °C in glass tubes (Thermo Scientific Pierce, Rockford, USA), the hydrolyzed sample was filtered with Whatman 0.45 μm, and 50 μl of the sample was transferred into a vial and added with 950 μl of ultrapure water.

Analysis of amino acids was performed combining both the derivatization reaction and HPLC chromatographic separations according to the Agilent Technologies Protocol (Henderson, Ricker, Bidlingmeyer, & Woodward, 2000). An HPLC system Agilent Technologies 1100 Series (Waldbronn, Germany) was used. All the separations have been performed by using Zorbax Eclipse AAA column (150 × 4.6 mm i.d., particle size 3.5 μm, Agilent Technologies); the column temperature was set at 40 °C. The elution of samples has been performed operating at a flow-rate of 2.0 mL/min by a gradient elution, the total run time is 30 min. Individual amino acid peaks were identified by comparing their retention times with those of standards. Results are expressed as g amino acids / 100 g total amino acids.

Furthermore, the amino acid score (AAS) was calculated by a comparison of the content of the amino acid in the protein in relation to the reference on pattern protein proposed by FAO/WHO/UNU (2007), as follows:

$$\text{AAS} = \frac{\text{g of amino acid in 100 g total amino acid in tested protein}}{\text{g of amino acid in pattern protein}} \times 100.$$

2.4. Physical analysis

The texture properties of cured and fermented donkey meat products were tested using two different instrumental measurements. Ten parallelepipeds for each sample (1 cm^2 in cross-section) were cut longitudinally. An Instron 3343 universal testing machine (Instron Ltd., High Wycombe, United Kingdom) was used in both instrumental tests. Warner–Bratzler Shear (WBS) force evaluation was assessed using a Warner–Bratzler device, which measures the peak force (kg/cm^2) required to cut the parallelepiped in half perpendicular to the its length at 100 mm/min crosshead speed using 100 kg load cell. Texture profile was analyzed using a compression device, each sample underwent two cycles of 80% compression, force by time data was used to calculate the following parameters: hardness, cohesiveness, springiness, gumminess and chewiness.

2.5. Sensory analysis

Two consumer tests (one for bresaola and another for salami) were carried out in two different days with a panel composed of students and staff of the University of Foggia. The consumer analysis consisted of eighty subjects equally distributed for sex and selected on the basis of age (18–55 years) and consumption frequency of meat products: the selected consumer assessor included subjects that reported consumption of meat products at least once a month. Evaluation was conducted in individual booths (located away from the sample preparation area), under red-filtered incandescent lighting. Each sample was assigned with four digit random numbers and for each consumer one slice (1 mm thick for bresaola and 4 mm for salami) of each meat product was presented. Consumers were provided with a glass of water, as well as unsalted crackers, to cleanse the palate among samples and they were instructed to take a small bite of cracker