COMPARISON OF MINERAL AND VITAMIN E CONTENT IN BEEF, LAMB AND PIG MEAT

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Abstract
Meat is very important source of minerals. This study was designed to compare mineral (Na, K, Mg, Ca, Fe, Zn) composition (mg/100g of edible portion) and vitamin E (μg of α-tocopherol/g of edible portion) in Longissimus dorsi muscles of 17 Podolian bulls, reared on pasture, 16 naturally suckled male Comisana lambs and 18 Large White barrows, raised in extensive production system, slaughtered at 399.3, 18.6 and 179.3 kg of live weight, respectively. Lamb had significantly ($P < 0.01$) highest level of Zn, Fe and Na. Pork was richer ($P < 0.01$) in K than that of beef and lamb, but poorest ($P < 0.01$) in Fe. Compared to values of pig, beef was similar for Zn and higher for Na ($P < 0.05$) amount. No differences were found for Ca and Mg. Vitamin E content was different ($P < 0.05$) among the three species studied (beef > pig > lamb).

Keywords: beef, lamb, pig, meat, minerals, vitamin E

1. INTRODUCTION

Minerals are essential trace nutrients in humans diet [1]. Meat is very important source of both macrominerals and trace elements and greatly contributes to the daily intake of these nutrients in the diet [2] and it is rich in minerals of high bioavailability like Fe and Zn [3]. The minerals that act as nutrients in the body are absolutely essential to a host of vital processes, from bone and tooth formation to the functioning of neurological and digestive systems and the heart [4, 5]. Also, it is recognized that mineral content can be responsible for technological properties of meat, i.e. colour, tenderness and oxidation [1].
The mineral composition of meat, however, may be influenced by species [6], age, gender [7], muscle [8], feeding regime [9], physiological and environmental factors [1, 3, 10].
Vitamin E is a major lipid-soluble antioxidant, and one of its primary functions is related to the maintenance and protection of biological membranes against lipid peroxidation [11], either by direct removal free radicals [12] or by preventing the induction of peroxisomal *β*-oxidation enzymes and the formation of excess hydrogen peroxide [13], thereby preventing the formation of rancid flavor during storage [11, 14]. Furthermore, it has been reported that Vitamin E enhanced color stability [15, 16] and affect meat tenderness [17]. Vitamin E is mainly stored in liver, skeletal muscle and adipose tissue [18]. It circulates in association with the four major types of serum lipoproteins. Its distribution among these lipoproteins appears to vary between species [17, 19].
In an early study, samples of beef, lamb and pig were analyzed for mineral [1, 20, 21] and vitamin E [14, 22, 23, 24], but the extent to which such differences vary between these species is limited and, in addition, the data are old [10, 25].
The need to constantly update nutrient composition of different meats is well beyond discussion, because of their potential usefulness for food composition databases, research studies, nutritional education and patient counselling. Therefore, the purpose of this investigation was to compare selected mineral and vitamin E (α-tocopherol) content of the M. *longissimus dorsi* (LD) of different domestic species.

2. MATERIALS AND METHODS

To evaluate the contents of some macrominerals such as sodium, magnesium, potassium and calcium, and some trace elements such as zinc and iron, and α-tocopherol (α-olo) LD muscle samples were collected from the chilled (after 24 h at 2 to 4 °C) carcasses of 17 Podolian bulls, reared on pasture, 16 naturally suckled male Comisana lambs and 18 Large White barrows, raised in extensive production system. The different meat samples, obtained from a commercial abattoir, were types of know weight animals classified according to Italian commercial standards (Table 1).

Table 1. Mean values (± s.e.) of the slaughter performance.

	Podolian bull	Comisana lamb	Large White pig
Animal, n.	17	16	18
Age, d	540±7	63±1	300±8
LW[1], kg	393.3±16	18.6±0.4	179.3±5.0
CCW[2], kg	228±11	11.5±0.8	145.4±4.1

[1]Live weight. [2]Cold carcass weight.

The samples were frozen in dark at -20 °C until analyzed. Duplicates of 10.0 g of ground meat were overnight ashed in a furnace at 550 °C. After cooling, the residue (white ash) was subjected to an acid digestion process with 10 ml of a 20% v/v hydrochloric acid solution by heating on a hot plate during 10 min. [26]. Minerals were determined using flame atomic absorption spectrophotometry [26], applying the instrumental conditions recommended by the manufacturer (wave-length: Na, 589.0 nm; K, 766.5 nm; Mg, 285.2 nm; Ca, 422.7 nm; Fe, 248.3 nm; Zn, 213.9 nm).

The levels of Vitamin E in the meat were determined according to the method described by Zapel and Csallany [27] and then quantified by HPLC (Kontron Instruments, Milan, Italy) model 535 equipped with a C18 reverse-phase column (250cm x 4.6mm x 5µm) (Phenomenex, Torrance, CA). The mobile phase was 100% methanol at a flow rate of 1.5 mL/min. The detection wavelength was 292 nm and retention time was 4.1 min. The analyses were performed in duplicate.

Data were analysed by analysis of variance using a general linear model procedure of SPSS version 17.0 statistical package [28]. Differences among means were determined using the Scheffé's test. All values are reported as means ± S.E. and significant differences among means were indicated when $P < 0.05$ or $P < 0.01$.

3. RESULTS AND DISCUSSION

Comparison of mineral content for beef, lamb and pig are reported in Table 2. Compared to beef and pig meat, that of lamb had higher ($P < 0.01$) level of Zn (+52.9 and +35.3 %, respectively), Fe (+19.05 and +42.86 %, respectively) and Na (+43.53 and +56.27 %, respectively). In addition, when compared to values of pig, beef meat was similar for Zn ($P > 0.05$) and higher for Fe ($P < 0.01$) and Na ($P < 0.05$) amount. Whereas, pig meat was richer ($P < 0.01$) in K than that of beef and lamb. No significant differences ($P > 0.05$) were found for Ca (ranging from 7.7 to 10.5 mg/100g) and Mg (ranging from 24.8 to 26.5 mg/100g) level. By comparison with data extracted from the Italian Food Composition Tables [29]), was observed a similar mineral composition, except for Zn and Ca of beef meat, that were highest and lowest, respectively. As expected and in agreement with the literature [6], these results reveal the variability in the mineral meat composition among the three species studied, probably due to the different feeding system [9], physiological and environmental factors [1, 3, 10]. The lower and higher amounts of Na found in the pork (41.2 mg/100g) and in the lamb (94.2 mg/100g), respectively, are consistent with the findings reported by Purchas et al. [8], in *longissimus lumborum* muscle of pig, and Osorio et al. [1], in *brachiocephalic* muscle of suckling lambs. In addition, both macrominerals and microminerals contents of beef found in the present study are consistent with the mineral levels reported by Ramos et al. [30] for beef.

Vitamin E content (Table 2) was different ($P < 0.05$) among animals: was higher for beef, lower for suckling lamb and intermediate for pig. These findings confirm that pasture remain the most reliable and abundant source of vitamin E for ruminant. In fact, fresh forages naturally contain high concentrations of α-tocopherol [24]. In addition, our results suggest that the bovine meat should have a best protection from oxidation and a better condition to delay metmyoglobin formation and discoloration. In fact, meat sensitivity to lipoperoxidation is inversely correlated with muscle vitamin E concentration [14]. The low concentration of vitamin E in the lamb may be related to the low levels of vitamin E in the milk consumed by suckling lambs [31]. Vitamin E concentration in milk is affected by diet [15].

Table2. Mean values (± s.e.) of minerals (mg/100g) and α-tocopherol (μg/g) of *longissimus dorsi* muscle.

	Podolian bulls	Comisana lamb	Large White pig
Zinc	1.6 ±1.1 ^{B}	3.4 ±1.1 ^{A}	2.2±0.5 ^{B}
Iron	1.7±0.3 ^{B}	2.1±0.3 ^{A}	1.2±0.3 ^{C}
Potassium	347±41.1 ^{B}	365±22.4 ^{B}	430±53.2 ^{A}
Calcium	10.5±4.6	10.0±3.4	7.7±3.6
Magnesium	24.8±5.7	25.5±3.3	26.5±1.5
Sodium	53.2±10.5 ^{Ba}	94.2±15.4 ^{A}	41.2±5.7 ^{Bb}
α-olo	3.43±0.5 ^{a}	1.41±0.4 ^{c}	2.99±0.7 ^{b}

Different superscript letter, within a row, stand for significant differences (A, B, C: $P < 0.01$; a, b, c: $P < 0.05$).

4. CONCLUSION

These results revealed the variability of the meat in the mineral composition and vitamin E concentration, among Podolian beef, Comisana suckling lamb and Large White pig. The lamb meat seems to be a very good nutritional source of Zn and Fe but too much rich of Na, with disadvantages from the human nutritional point of view. Pork seems to be a good nutritional source of K but poorest in Fe; however, it had a lower amount of Na, with advantages from the human nutritional point of view. Compared to lamb, Podolian beef would provide consumers meat poor in Na. Moreover, beef was rich in α-tocopherol content, with the likely benefits for the quality of meat: both less lean discoloration and meat oxidation during display case storage.

5. ACKNOWLEDGMENTS

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