INFLUENCE OF COOKING METHOD ON MINERAL AND VITAMIN B COMPOSITION OF EDIBLE LAMB

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Abstract**—to know the composition of local foods is esential in order to recommend daily intakes of a product. With the aim of assessing the content of certain minerals and B-vitamins in 'Ternasco de Aragon', a type of Spanish light lamb, and the influence of cooking method in the edible portion, 30 animals were used. The left leg of each animal was deboned and all remained tissues trimmed and analysed in the raw product. The right legs were also deboned and allocated to one of three cooking methods (roast, stew and grill). Iron, zinc and vitamins B2, B3 and B12 were quantified. Cooking had a stronger effect on mineral composition than the type of cooking used. Both Fe and Zn showed higher levels in the cooked lamb, although roast lamb had even higher levels of zinc than the rest of cooking procedures. Excecpt for vitamin B3, no differences were found between raw or cooked samples in vitamins content. However, cooking provoked the disappearance of B-vitamins in a higher extent than that of minerals, when expressed as a basis of dry matter. Nevertheless, the high levels found, especially of zinc and vitamin B12, supports the inclussion of lamb in the diet as a source of essential micronutrients.**

Index Terms**—Cianocobalamin, Iron, Niacin, Riboflavin, Zinc.**

I. INTRODUCTION

Worldwide, consumers are everyday more concern with the quantity and quality of their food supply. The realization that certain diseases may be related to over-consumption of certain components of foods has increased the need for knowledge of food composition. The decreased in lamb consumption might be indirectly related to the beliefs about the contribution of red meat to the total fat intake, since dietary guidelines recommend a reduction in the consumption of fat, particularly saturated fat. However, lamb is rich in other micronutrients, such as vitamins and minerals, whose intake is also affected by the decreased in meat consumption as a result of the reduction in fat intake.

Water soluble B-vitamins are dispersed throughout the body. They are not stored to any appreciable extent and must be replenished every day. Therefore, they must be present in the daily intake to avoid diseases such as cataracts or anemia (Mataix, 2006). If the diet contains a deficiency of water-soluble vitamins, symptoms from deficiencies may be displayed in as little as 4 weeks; much quicker than for fat-soluble vitamins.

The mineral composition of lamb is affected by many factors, including the method of feeding (Pieta & Patkowski, 2009). Therefore, it is indispensable to analyze products from animals reared under local husbandry systems in order to obtain reliable data that can be used in the recommendations for daily consumption. The original chemical composition of a product can be modified by the technological process that is applied before consumption. In the case of lamb, the different cooking methods may alter the mineral and vitamin content in the intake. The more transformation than the meat might suffer, the more modification of the nutritional status (Rechcigl, 1986).

Therefore to update data on the micronutrients profile of the lamb currently consumed in Spain is of nutritional importance. The aim of this work was to assess the content of certain minerals and B-vitamins in 'Ternasco de Aragon', a type of light lamb reared intensively with concentrate and cereal straw, and the influence of cooking method in the edible portion.

II. MATERIALS AND METHODS

Thirty lambs, 6 males and 24 females, with 9.93 ± 0.60 kg of cold carcass weight belonging to the label 'Ternasco de Aragon PGI', were randomly selected 24 hours after slaughtering at an EU-licensed abattoir. Both legs were obtained following commercial procedures. The shank from each leg was discharged and the rest, untrimmed of surface adipose tissue, was individually vacuum packaged and kept at 4 ºC until reaching 4 days of ageing. In order to analyze the composition of the raw product, the left leg from each animal was deboned, cut into pieces and all muscles, together with connective tissue, intermuscular and subcutaneous fats were ground in a cutter SAMMIC-SK3 at 1700 rpm for 30 seconds. Then, a homogeneous sample was taken, vacuum packaged, immediately frozen and kept at -18 ºC until analyzed. The right legs were randomly assigned to one of three cooking procedures, with two males in each treatment: grill, stew and roast. Legs were deboned prior to cooking. Legs used for grilling were sliced into 1cm-thick steaks. Grilling was performed on an industrial single-plate grill at 200 ºC burnished with 10 ml of virgin olive oil for all the steaks, turning over after 30 seconds until reaching 75 ºC of internal temperature. Those legs stewed were cut into pieces, placed individually on a stainless-steel pan simmered with 10 ml of virgin olive oil, 250 ml of water and 30 g of ground almonds, covered with a ladle and kept on a cooker at 180ºC for 1 hour and fifteen minutes approximately until reaching an internal temperature of 75 ºC. Those legs used on the roast were individually placed on a stainless-steel baking tray, covered with 10 ml of virgin olive oil and cooked in a gas oven at 200 ºC for 1 hour and fifteen minutes approximately, turning once, until reaching 75 ºC of internal temperature. All cooked samples were spread with a hitch of salt prior to cooking. Fifteen minutes after cooking and cooling, meat was slightly shaken to avoid excess of juice or any other ingredient, cut into pieces in the case of stewed and roast, and mixed and homogenized, as previously explained for the raw samples. Then, a mixed sample was vacuum packaged, frozen and kept at -18 ºC until analysis was performed.

Dry matter was obtained by dehydration 24 hours at 100 ºC. Minerals were extracted with acidic digestion by nitric acid (Türkmen & Ciminli, 2007) and detection and quantification by ICP-MS (Perkin-Elmer ELAN 6000). Vitamin B3 and B12 were analyzed by microbiological assay (Ball, 2005). Vitamin B3 and B12 were detected by HPLC with UV detection and vitamin B2 with and HPLC with fluorescence detection.

A General Lineal Model was applied with cooking and type of cooking as fix effects using SPSS 14.0. When significant, a Duncan test was used to assess different mean values.

III. RESULTS AND DISCUSSION

The effect of cooking was of greater importance than the type of cooking in all variables analyzed (Table 1), except for the content of Zn in relation to the content of dry matter.

The amount of minerals found were a bit higher than those found in suckling lamb (1.1 mg Fe/100g; 2.2 mg Zn/100g; Miguelez, Zumalacarregui, Osorio, Figueira, Fonseca & Mateo, 2008), since the weight and age at slaughter are higher in light lambs, such as 'Ternasco de Aragón' than in suckling lambs, and this contributes to the mineral status of the animal. On the other hand, they were lower than those found in Australian lamb (1.9 mg Fe/100g; 3.0 mg Zn/100g; Greenfield, Kuo, Hutchison & Wills, 1987) in animals considered heavy lambs, older and heavier than 'Ternasco de Aragón'. All of this supports the need for knowledge of the composition of local products in order to accurately recommend appropriated patterns of consumption. Differences in mineral content among the treatments were more pronounced when related to the total product ($p \leq 0.001$) than to the dry matter content ($p \leq 0.05$ or $p \leq 0.01$). In both minerals analyzed (Table 2), the amount in the fresh leg was significantly lower than in any of the cooked lamb, maybe due to the dehydration during cooking that increased the amount of dry matter per 100g of food. These differences were more important in the case of Zn than in the case of Fe, because no significant differences were found among the different cooking treatments in iron content, and roast lamb showed higher zinc content than stew or grilled lamb. These differences were better explained when referred to the dry matter of the product. Whereas the fresh lamb did not differ significantly from stew or grilled lamb in Fe content with a significant lost of 18% in the roast, the amount of Zn was significantly reduced in a 17.5 % with the stew lamb, but increased in 8.2 % in the roast. This was probably due to some transfer from the oven tray in the roast lamb, although not significantly different from the raw material, or due to the lost of minerals diluted in the water during stewing that did not affect Fe as much as Zn.

The amount of riboflavin (vitamin B2) found in 'Ternasco de Aragón' was half of that found in Australian lamb, but the amount of niacin (vitamin B3) was three-fold the amount found in Australian lamb (Greenfield et al., 1987). The different techniques used in each analysis may explain these findings (Ball, 2005). Differences in vitamin B content among treatments were no significant when referred to the whole product (Table 2), with the exception of vitamin B3, which showed higher content in the cooked leg than in the raw leg. The lack of differences and similar values among all the treatments, coincidentally with the findings of Heerden, Schönfeldt, Kruger, and Smit (2007) in South African lamb, would imply the same rate of disappearance of B-vitamins during cooking than the increase in dry matter, since they are water-soluble. This fact is supported by their content in relation to the dry matter of the food. No significant differences were found among the different methods of cooking lamb, but all samples were different from the raw product, which shows the lost during the cooking process. However, cooking would not affect the disappearance of vitamins in the same rate, due to their instability to heat or light and liquid (Lombardi-Boccia, Lanzi, & Aguzzi, 2005). Harris and Karmas (1975) observed a reduction of 10% of vitamin B12 and up to 70% of vitamin B2 after cooking. In our study, although lamb cooked at different methods did not show different levels of those two vitamins, shorter cooking length (grilled) had lower losses than long cooking length (roast or stew), with a lost of 25% in the amount of Vitamin B2 or 20% in vitamin B12 in the case of grilled versus the content of the raw leg of lamb. However, when compared to other meat products, lamb is a good source of vitamins, especially B12 (Badiani, Nanni, Gatta, Bitossi, Tolomelli, & Manfredini, 1998).

IV. CONCLUSION

Cooking had a strongest effect in mineral and B-vitamins composition than the type of cooking used. Minerals were more affected than vitamins by cooking, increasing the amount in the edible portion due to an increase in dry matter whereas, except for vitamin B3, the amount of vitamins did not differ from that of the raw product. However, cooking provoked the disappearance of B-vitamins in a higher extent than that of minerals, when expressed as a basis of dry matter. In any case, lamb is a good source of minerals and vitamins, especially Zinc and vitamin B12.

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Table 1. F values of cooking and type of cooking

	Cooked vs Raw	**Type of cooking**
% DM	306.97***	149.25***
Fe mg/100g food	27.74***	10.64***
Zn mg/100g food	46.26***	41.94***
Vit B2 mg/kg food	0.16 ns	0.27 ns
Vit B3 mg/kg food	122.35 ***	42.25 ***
Vit B12 µg/kg food	3.47 t	1.61 ns
Fe mg/100g DM	5.15 *	3.36 *
Zn mg/100g DM	2.01 ns	6.52 **
Vit B2 mg/kg DM	66.87 ***	22.16 ***
Vit B3 mg/kg DM	31.18 ***	11.46 ***
Vit B12 µg/kg DM	74.21 ***	26.39 ***

DM: Dry matter
ns= no significant; t = p≤0.1; * = p≤0.05; ** = p≤0.01; *** = p≤0.001

Table 2. Dry matter, minerals and vitamin B content of the leg of light lambs fed on concentrates

	Raw	**Roast**	**Stew**	**Grilled**	**RMSE**	
% DM	28.48 c	41.62 a	41.62 a	37.42 b	728.634	***
Fe mg/100g food	1.22 b	1.46 a	1.66 a	1.55 a	0.622	***
Zn mg/100g food	2.51 c	3.98 a	3.04 b	3.03 b	5.488	***
Vit B2 mg/kg food	1.11	1.16	1.13	1.10	0.084	ns
Vit B3 mg/kg food	126.97 b	156.80 a	158.50 a	151.40 a	64.664	***
Vit B12 µg/kg food	19.13	19.70	20.80	20.00	2.737	ns
Fe mg/100g DM	4.31 a	3.53 b	4.00 ab	4.18 a	1.252	*
Zn mg/100g DM	8.88 ab	9.61 a	7.32 c	8.15 bc	3.206	**
Vit B2 mg/kg DM	3.93 a	2.79 b	2.72 b	2.94 b	2.503	***
Vit B3 mg/kg DM	447.78 a	377.79 b	381.06 b	405.80 b	138.941	***
Vit B12 µg/kg DM	67.51 a	47.40 b	50.11 b	53.58 b	39.167	***

DM: Dry matter
RMSE: root mean square error
ns= no significant; * = p≤0.05; ** = p≤0.01; *** = p≤0.001
a, b, c: mean values in the same row with different letters differ significantly (p≤0.05);