HEME IRON AND B VITAMINS AS QUALITY MARKERS IN COOKED MEATS

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Background

Meat consumption greatly contributes to the daily intakes of both heme iron and B vitamins in the diet (Lombardi-Boccia et al., 2003; Lucarini et al., in press). Meat represents the main source of highly available iron. An accurate knowledge of the levels of heme iron in meats and diets is of great importance because of the significant difference between heme and non-heme iron in bioavailability. As far as the vitamin B complex is concerned, meat is one of the main sources of niacin in the average Italian diet (Lucarini et al., in press), one serving of pork provides the daily thiamine requirement (LARN, 1996). Thermal processes which meat undergoes represent an important factor strongly affecting the nutritional value of meats and meat-based dishes. Losses of both heme iron and B vitamins occur during cooking processes of meat, and therefore, the amount of these micronutrients ingested may vary greatly.

Objectives

The present study focuses on how different cooking procedures (frying, stewing, roasting, "escalope") influence the retention of heme iron and B vitamins (thiamine, riboflavin, niacin) in meat cuts of beef, veal, chicken and turkey. Furthermore, the possibility of using heme iron and /or B vitamins as markers of the nutritional quality of cooked meats was also undertaken.

Materials and methods

The following meat cuts were analysed: beef (sirloin, fillet, roast beef, topside, flank), veal (fillet), chicken (breast, leg-lower part, leg-thigh, wing), turkey (breast, leg-lower part, leg-thigh). The meat cuts were cooked according to preparation protocols of some Italian recipes: poultry legs and wings were roasted in oven at 180°C for 50 min; breast and all the other meat cuts were hand-trimmed of all visible fat and fried (without the addition of fat or salt) in an iron-free pan with medium heat until red colour disappeared (beef fillet and roast beef were underdone); beef flank was stewed and turkey breast was also cooked as "escalope". To calculate weight loss, the cuts and the meat-based dishes were weighed before and after cooking, the latter after resting for 20 min at room temperature. Bones were removed, wherever necessary, and both raw and cooked meats were freeze-dried and then ground in a food blender (equipped with stainless steel blade) to ensure homogeneous and representative samples for analysis. Three samples for each meat cut and two preparations for each recipe (comprehensive of all the raw ingredients) were analysed for total iron, heme iron, thiamine, riboflavin and niacin content.

Iron content

Analysis of total iron were performed by ICP-Plasma on a Perkin-Elmer Optima 3200XL, following liquid ashing of the samples (4ml HNO3+1ml H2O2) in a microwave digestion system. Standard Reference materials: Bovine muscle (BCR 184, Community Bureau of Reference, Brussels) and Bovine liver (NBS 1577a, National Bureau of Standards, Gathersburg, MD 20899) were analysed to verify the accuracy of the analysis. Heme iron was determined following the analytical conditions described by Lombardi-Boccia et al. (2002a).

B vitamins

Thiamine and riboflavin were separated and quantified by HPLC after acidic and enzymatic (Takadiastase) hydrolysis of the samples, following the procedure described by Arella et al. (1996). Niacin was extracted following the method of Lahély et al. (1999) and quantified by HPLC following the method of Ward and Trenerry (1997). Identification of the correct peaks was performed by comparison with retention times of external standards: thiamine hydrocloride and riboflavin were obtained from Sigma Chemical Co. (St Louis, NO, USA), niacin was obtained from Fluka Chemie (Buchs, Switzerlands).

Results and discussion

The effect of heat treatments on total iron and heme iron content are presented in table 1. Cooked meats showed a higher iron concentration compared to the raw samples, this was due to the moisture losses occurred upon cooking. A previous study carried out on heme iron concentration in meats (Lombardi-Boccia et al., 2002b) showed that heat treatments did not cause losses in total iron content but modified the heme:non-heme iron ratio. Our present findings showed that frying caused losses in heme iron ranging from 3% (roast beef) to 24% (topside) (Tab.1). Less severe losses in heme iron content were found in poultry breast (both fried and cooked as escalope) (Tab.1). However, when meat was roasted (poultry meat), a substantial reduction in heme iron content was induced with losses ranging from 22% (turkey) to 43% (chicken wing) (Tab 1). The concentrations of B vitamins in raw and cooked meat cuts are presented in Table 2. Thiamine concentration varied greatly among cuts of the same species ($p<0.05$), in raw beef ranging from 0.02 mg/100g (sirloin) to a maximum of 0.14 mg/100g (flank). In the case of chicken and turkey, only breast samples were analysed, and the thiamine concentration was very low in both (Tab.2). Riboflavin content among cuts of beef varied from 0.09 to 0.17 mg/100g, fillet showing the highest concentration (Tab.2). Chicken breast showed the lowest riboflavin concentrations. Niacin content was almost identical in the various meat cuts of the same species. The highest amounts of niacin were found in poultry. The effect of cooking on the content of B vitamins in meat is also presented in Table 2. Heat treatments decreased the content of B vitamins. Among the vitamins analysed, thiamine was the most susceptible to thermal degradation, and ended up undetectable in most samples (Tab.2). Riboflavin, generally more resistant to heat, showed losses ranging from 37 to 60%. Comparable losses of riboflavin have been reported by Bodwell et al.(1986) and by Chan (1995). Complete retention of riboflavin was found in roast beef, a meat cut subjected to only a short cooking. Cooking induced less severe losses in niacin content, varying from 26% (turkey breast) to 42% (beef fillet). The values of thiamine and riboflavin found in literature (Bodwell et al., 1986; Chan et al., 1995, Leonhardt et al., 1997) are very similar to ours in both raw and cooked red meats, but markedly higher than ours in chicken and turkey breast.

Table 1. Total iron, heme iron and % of heme iron to total iron in raw and cooked meats (f.w.).

	Total Fe mg/100g	Heme Fe mg/100g	Heme %		Total Fe mg/100g	Heme Fe mg/100g	Heme %
Beef				**Chicken**			
Sirloin, raw	2.07±0.1	1.72±0.1	83	Breast, raw	0.40±0.1	0.12±0.1	30
Sirloin, fried	3.59±0.1	2.64±0.2	74	Breast, fried	0.58±0.1	0.16±0.1	28
Fillet, raw	2.35±0.2	2.11±0.3	90	Leg, raw	0.63±0.1	0.29±0.1	46
Fillet, fried	3.38±0.2	2.86±0.2	85	Leg, roasted	1.20±0.2	0.42±0.1	35
Roastbeef, raw	2.04±0.1	1.77±0.1	87	Thigh, raw	0.70±0.1	0.20±0.1	30
Roastbeef, fried	3.74±0.1	3.14±0.1	84	Thigh, roasted	1.34±0.1	0.30±0.1	22
Topside, raw	1.93±0.1	1.68±0.2	87	Wing, raw	0.63±0.2	0.28±0.1	44
Topside, fried	2.88±0.2	1.89±0.2	66	Wing, roasted	0.92±0.2	0.23±0.1	25
Thick flank, raw	1.81±0.2	1.61±0.1	88				
Thick flank, stewed	2.45±0.2	1.34±0.1	55				
Veal				**Turkey**			
Fillet, raw	0.85±0.3	0.71±0.3	84	Breast, raw	0.50±0.1	0.14±0.1	28
Fillet, fried	1.58±0.4	1.33±0.6	83	Breast, fried	0.79±0.1	0.21±0.1	27
				Breast, raw	0.51±0.1	0.20±0.1	39
				Breast, escalope	0.74±0.1	0.36±0.2	48
				Leg, raw	0.88±0.2	0.43±0.1	49
				Leg, roasted	1.51±0.2	0.58±0.2	38
				Thigh, raw	0.99±0.3	0.49±0.1	50
				Thigh, roasted	1.46±0.2	0.57±0.1	39

Values are Mean ± STD of three replicates.

Table 2. Thiamine, riboflavin and niacin content in raw and cooked meat cuts (f.w.).

	Thiamine	Riboflavin	Niacin		Thiamine	Riboflavin	Niacin
		(mg/100g)				(mg/100g)	
Beef				**Veal**			
Sirloin, raw	0.02±0.01	0.12±0.01	5.0±0.35	Fillet, raw	0.11±0.02	0.08±0.01	6.9±0.35
Sirloin, fried	tr	0.07±0.01	3.2±0.09	Fillet, fried	tr	0.05±0.01	4.3±0.18
Fillet, raw	0.08±0.01	0.17±0.01	5.7±0.25				
Fillet, fried	tr	0.07±0.01	3.3±0.09	**Chicken**			
Roastbeef, raw	0.05±0.01	0.10±0.01	5.5±0.21	Breast, raw	0.04±0.01	0.03±0.01	8.0±0.30
Roastbeef, fried	tr	0.10±0.02	3.3±0.08	Breast, fried	tr	0.01±0.01	5.0±0.28
Topside, raw	0.08±0.01	0.09±0.01	6.5±0.14				
Topside, fried	tr	0.05±0.01	4.2±0,12	**Turkey**			
Flank, raw	0.14±0.02	0.13±0.01	5.3±0.16	Breast, raw	0.02±0.01	0.06±0.01	7.2±0.28
Flank, stewed	0.12±0.02	0.07±0.01	2.8±0.16	Breast, fried	tr	0.03±0.01	5.3±0.90
				Escalope, raw	0.09±0.01	0.08±0.01	7.5±0.13
				Escalope, fried	0.06±0.01	0.07±0.01	5.9±0.44

Values are Mean±STD of 3 replicates.

Conclusions

This study updated some data concerning heme iron and vitamin B content in cuts of beef, veal and poultry and evaluated how cooking procedures affect their concentration. The knowledge of variations in the concentration of both heme iron and some B vitamins among raw and cooked meats is of utmost importance for two reasons: firstly, it allows the correct calculation of the actual nutrient intake at consumer level, and secondly, some of the micronutrients can be used as biochemical indicators of the nutritional quality of cooked meats. Our findings show in particular, that heme iron concentration vary greatly among the procedures analysed because its retention was strictly dependent on the severity of the heat treatment utilized. Therefore, heme iron concentration might serve as a useful index of the nutritional quality of cooked meats.

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