EFFECT OF COOKING METHOD ON THE NUTRITIONAL VALUE OF PIEMONTESE BEEF

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Abstract –This study was carried out to evaluate the effect of two cooking methods on the nutritional value of *semitendinosus* muscle of Piemontese breed. The muscle was cut into three steaks: the first was used as raw reference, the second was roasted and the third was grilled. On raw and cooked steaks proximate analyses were carried out. Energy value, contribution to the nutrient requirements and Index of Nutritional Quality for protein and fat were calculated. Cooking loss, cooking yield, true nutrients retention, and gain or loss of water, protein and fat were also calculated.

The two cooking methods modified the chemical composition and nutritive value of the meat but no differences between cooking methods were found. Cooked meat showed lower water contents and consequently higher energy values than raw meat.

The Piemontese meat showed a high protein density and exhibited also a very high true protein retention in the cooked meat.

The true fat retention values were higher than 100%. Nevertheless, in a meat with a very low fat content and consequently a reduced proportion of saturated fatty acids, the high true fat retention could be considered a positive aspect both for nutritional value and organoleptic characteristics.

Key Words – grilling, proximate composition, roasting, true nutrient retention.

I. INTRODUCTION

The term “nutritional quality” refers to all the nutrients that a food is able to provide for growth and for the maintenance of life and health of the body tissues.

Data in most food composition tables are based on nutritional value of raw meat even if only in a few cases the meat is consumed raw. For example, a part from “Carpaccio”, the Italian famous raw beef dish, or “Albese”, a traditional dish of raw Piemontese beef cut by hand with a sharp knife and served with an oil, lemon and garlic dressing, the meat is normally eaten cooked or prepared.

Cooking of meat is essential to achieve a palatable and safe product [1]. In fact, heat treatments applied to meat in different ways, improve its hygienic quality by inactivation of pathogenic microorganisms and enhance its flavour and tenderness. However, cooking methods as well as cooking conditions, like heating rate, cooking time and temperature or end-point temperature, modify the chemical composition of meat with a consequent change of its nutritional value due to nutrient losses.

As accurate knowledge of the nutrient intake of individuals requires information on the nutrient content of cooked meat, this study was conducted to evaluate the effect of two commonly used cooking methods on the nutritional value of Piemontese beef.

II. MATERIALS AND METHODS

The *semitendinosus* muscle was excised after seven days of aging from the right side of ten young bull carcasses, The hypertrophied Piemontese bulls were fattened on the same farm and slaughtered at the same slaughterhouse.

The centre section of each muscle was cut into a 1.5 cm thick steak that was retained as the raw reference. Two adjacent 2 cm and 4 cm thick steaks were cut and weighed. The first steak was cooked on a double contact grill preheated to 280°C. The second steak was cooked in an electric air-convection oven preheated to 180°C. Both steaks were cooked to an internal temperature of 70°C. An iron/constantan thermocouple was inserted into the geometric centre of each steak to monitor internal temperature during cooking. The steaks required approximately 6 and 50 min for the grill and oven cooking, respectively, to reach the desired internal temperature. After cooking, the steaks were cooled to room temperature and reweighed. On raw and cooked steaks, proximate analyses (water (W), protein (P), and fat (F) content) were carried out according to AOAC methods [2] and the energy value (kcal) was calculated by multiplying the amount of protein and fat by the conversion factors 4 and 9, respectively [3]. Kilocalories values were converted to kilojoules using the conversion factor of 4.184.

The contribution of 100 g of raw and cooked meat to the nutrient requirements was calculated as follows:

- Protein contribution = Grams protein/50 grams x 100;
- Fat contribution = Grams fat/65 grams x 100;
- Energy contribution = Energy/2000 kcal x 100.

The Index of Nutritional Quality (the ratio between the percentage of the reference intake of each nutrient and the percentage of the average requirement for energy provided by the meat) separately for protein and fat was calculated according to the formula:

INQ= (g of nutrient/GDA for that nutrient)/(total kcal meat/2000). Adult Guideline Daily Amounts (GDA) were based on a daily intake of 2000 kcal, 50 g of protein and 65 g of fat [4].

The following parameters were also calculated:

- Cooking loss (CL) = (raw meat weight-cooked meat weight)/raw meat weight x 100;
- Cooking yield (CY) = (cooked weight/raw weight) x 100;
- True retention of nutrients (TR) = [(nutrient content per g of cooked meat x g of meat after cooking)/(nutrient content per g of raw meat x g of meat before cooking)] x 100 [3];
- Gain or Loss of water or protein or fat = W or P or F (wt%) in raw meat – W or P or F (wt%) in cooked meat x ((100-cooking loss (%))/100 [5].

Data were analyzed using descriptive statistics and general linear model procedures to calculate least-square means. Linear regression was used to examine the relationships between fat content (g/100g) in raw meat and fat retention in cooked meat (%). All statistical analyses were performed using SPSS software package [6].

III. RESULTS AND DISCUSSION

Table 1 shows proximate composition (g/100g) and energy data of raw and cooked meat.

The results of the proximate analysis of raw meat were in agreement with previous studies on chemical composition of meat from Piemontese double-muscled animals [7]. It is well-known that double-muscled animals produce protein-dense meat, a higher proportion of lean meat and a more favourable polyunsaturated/saturated fatty acids ratio than normal cattle. In this study, the protein/dry matter ratio was very high (91,84) and the intramuscular fat showed a very low content (0.46%).

Table 1 Proximate composition, energy value, contribution to the nutrient requirements and nutrient density (INQ) of 100 g edible portion of Piemontese raw and cooked meat. Least square means with standard error of means in parentheses. A, B: $P<0.01$; a, b: $P<0.05$

	Raw meat	Cooking methods	
		Roasting	Grilling
Water, g	75.93 A (0.40)	63.96 B (0.40)	64.73 B (0.40)
Protein, g	22.10 B (0.34)	33.60 A (0.34)	33.29 A (0.34)
Fat, g	0.46 B (0.13)	1.14 A (0.13)	1.00 A (0.13)
Protein/dry matter, %	91.84 B (0.41)	93.26 A (0.41)	94.40 A (0.41)
Fat/dry matter, %	1.91 b (0.38)	3.14 a (0.38)	2.80 ab (0.38)
Protein energy, kJ	369.85 B (5.70)	562.36 A (5.70)	557.21 A (5.70)
Fat energy Fat, kJ	17.43 B (4.85)	43.04 A (4.85)	37.51 A (4.85)
Total energy, kJ	387.28 B (9.20)	605.4 A (9.20)	594.72 A (9.20)
Protein average contribution, %	44.2 B (0.68)	67.2 A (0.68)	66.59 A (0.68)
Fat average contribution, %	0.71 B (0.20)	1.76 A (0.20)	1.53 A (0.20)
Energy average contribution, %	19.36 B (0.46)	30.27 A (0.46)	29.74 A (0.46)
Protein, INQ	9.56 (0.08)	9.30 (0.08)	9.38 (0.08)
Fat, INQ	0.15 (0.03)	0.24 (0.03)	0.21 (0.03)

Since the total amount of energy in meat depends on the content of the organic components such as proteins and especially fat, the meat showed also a very low energy value.

Both the oven and grill cooking methods significantly decreased water content. This was matched by both a significant increase in the protein and fat content and a consequent rise in the energy value, without significant differences between the cooking techniques.

In order to evaluate the possible protein, fat and energy contribution of Piemontese beef, the GDA were used as reference. Therefore, regardless the cooking method, one serving (100 g) of cooked meat supplied an average value of more than 66% of protein, less than 2% of fat and 30% of energy.

The nutrient density (INQ) showed values higher and lower than 1 for protein and fat, respectively. The INQ values > 1 may be desirable or not, depending on the nutrient. For example, INQ values > 1 may be desirable for protein but undesirable for fat and especially for saturated fat [8]. Therefore, from a nutritional point of view, the Piemontese beef can be evaluated very positively for the high content of protein, the low content of fat and thus for the low energy supply. Moreover, beef with a low fat content has generally a low concentration of saturated fatty acids which are well known for their harmful effects on human health.

In table 2 cooking loss, cooking yield, true retentions and loss or gain of nutrients of cooked meat are reported.

Table 2 Cooking loss, cooking yield, true nutrient retention, water and protein losses and fat gain of cooked meat. Least square means with standard error in parentheses. No significant differences were found between cooking methods.

	Cooking methods	
	Roasting	Grilling
Cooking loss, %	35.15 (0.75)	35.44 (0.75)
Cooking yield, %	64.85 (0.75)	64.56 (0.75)
Water TR, %	54.65 (0.98)	55.08 (0.98)
Protein TR, %	98.54 (0.99)	97.17 (0.99)
Fat TR, %	184.46 (24.97)	161.86 (24.97)
Water Loss, g	-34.44 (0.78)	-34.12 (0.78)
Protein Loss, g	-0.32 (0.22)	-0.62 (0.22)
Fat Gain, g	0.28 (0.09)	0.18 (0.09)

All these parameters were not affected by cooking methods.

The meat cooked on the grill showed slightly higher cooking loss and lower cooking yield in comparison with meat cooked in the oven, even though the cooking time of the two methods were very different.

In order to evaluate the true increase or loss of meat components during cooking, the true retention was calculated since meat releases not only water but also protein and fat when cooked.

Water showed the greatest loss during cooking (retention = 55%) compared to the other nutrients. Protein retention was 98% and fat was the most retained nutrient at > 162%. One explanation for this exceptionally high value could be that the retention of lipid within the boundaries of muscle is very high, if not totally complete. As reported by Renk et al. [9], this seems reasonable because intramuscular lipids are stored in the interfascicular spaces of the muscle; because these spaces are not necessarily continuous from one end of the muscle to the other, fat could not easily escape when it is rendered during cooking. The only loss of intramuscular lipid would be from depots transected preparing the retail meat cuts. As reported by Johansson and Laser [10], fat losses increase as meat thickness decreases. For this reason, in our study, the higher thickness of the steak cooked in the oven could explain the higher retention value.

The high retention of fat could be also due to some fat migrating into lean during the cooking process. Some studies indicated that the presence of an external fat layer on meat may results in fat retention values greater than 100% in cooked lean [11]. Therefore, it is important to remove subcutaneous fat before cooking in order to reduce any opportunity for fats melted during cooking to migrate into lean.

Literature data for true retention of beef lipids vary remarkably: from 90 to 122% for braising, from 91 to 160% for broiling and from 71 to 125% for roasting [12]. This variability has been attributed to the presence of variable levels of subcutaneous and intermuscular fat, whose rendering and subsequent infiltration into the lean tissue during cooking lead to TR values higher than 100%. When only intramuscular fat is present, a 100% TR is expected, unless fat is partially lost as drip or cooking [12]. Some studies have shown that cuts with subcutaneous fat and intermuscular fat can lose some fat during cooking, whereas intramuscular fat generally remains in the meat [13].

A significant negative relationship between fat content in raw meat and fat retention of the two cooking methods was observed. The regression equation for the meat cooked in the oven was: $y=-144.56x+251.39$ and the correlation coefficient was $r = 0.50$ ($P<0.10$).

A significant negative relationship was also observed between fat retention of grilled meat and fat content. The regression equation for the meat cooked on the grill was:

$y=-138.96x+226.19$ and the correlation coefficient was $r = 0.57$ ($P<0.10$).

IV. CONCLUSION

The two cooking methods modified the chemical composition and nutritive value of the meat, but no differences between cooking methods were found. Cooked meat showed lower water contents and consequently higher energy values than raw meat.

The Piemontese meat showed a high protein density and exhibited also a very high true protein retention in the cooked meat.

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