EFFECT OF DIFFERENT RABBIT PRIME CUTS ON RAW AND COOKED PROXIMATE COMPOSITION, CHOLESTEROL AND FATTY ACIDS CONTENTS AND NUTRIENTS TRUE RETENTION

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Abstract – Despite the nutritive content of rabbit meat is well documented, the relationship between the nutritional profile and the true retention (TR) of different raw and cooked rabbit prime cuts has never been evaluated before. Thus, the aim of this study was to evaluate the effect of two different rabbit prime cuts (Loin, LD, and hind leg, HL) on their raw and cooked proximate composition, cholesterol and fatty acid content, and nutrients TR. The LD had a higher protein and lower lipid and cholesterol contents than the HL (P<0.001). As a consequence of the lower moisture retention, the TR of protein, lipids, ash and cholesterol of the LD were higher than those of the HL. The differences between LD and HL for SFA, MUFA, PUFA, Linolenic acid, DHA, Linoleic acid, Σ *n*-6 and Σ *n*-3 contents were always significant (P<0.001) both in raw and cooked meat, with the HL presenting always higher values than the LD. Also the TR of each FA was greater in the LD than HL prime cut.

Key Words – Fatty Acids, Proximate composition, Rabbit meat, True Retention.

I. INTRODUCTION

Meat represents an essential food rich in many nutrients such as high biological value proteins, vitamins (B group, D and E) and minerals [1]. Rabbit meat, together with its high protein content, provides the greatest quantity of vitamin B_{12} among the most common meats such as pork, beef, veal and chicken. It is also an excellent source of P, K, Zn and Se, and it is favourably low in Na [2]. In addition, rabbit meat can undoubtedly be considered a lean source (about 8.5 % of fat, considering the whole carcass) with a favorable fatty acid profile which can be further improved through diet [3; 4; 5]. To the best of our knowledge, despite the nutritive content of rabbit meat is well documented [2], a detailed nutritional comparison between different raw and cooked rabbit meat portions has never been evaluated before. In fact, literature often considered the effect of different cooking methods on the nutritional quality of meat belonging to the most common species [6; 7; 8; 9; 10]. Thus, the aim of this study, was to compare the nutritional characteristics of the *Longissimus dorsi* muscle (loin prime cut), which is the leanest meat cut in the rabbit carcass, with those of the hind leg, which is the most quantitatively important [2], by considering their proximate composition, cholesterol and fatty acids (FA) content, before and after cooking, and the True Retention (TR) of all analysed nutrients.

II. MATERIALS AND METHODS

A total of 105 loins (*Longissimus dorsi* muscle; LD) and 140 hind legs (HL) of rabbits slaughtered at 11 weeks of age were used. The raw right LD and HL were ground with a Retsch Grindomix GM 200 grinder at 4000 rpm for 10 seconds, then freeze-dried and subsequently used for the analysis of their proximate composition [11], cholesterol [12] and fatty acids contents (FA). The left LD and HL were individually packed under-*vacuum* in plastic bags and cooked. The LD were cooked in a water bath at 80 °C for 1h, whereas HL were cooked in a water bath at 85 °C for 2.5h. Cooked LD and HL were then freeze-dried and also used for the analysis of their proximate composition, cholesterol and FA contents. For the FA analysis 49 LD and 70 HL were used.
Lipid extraction was performed combining the traditional [14] method with that provided by [15] and the Accelerated Solvent Extraction (M-ASE) in which chloroform:methanol (1:2) represented the binary solvent mixture used for extraction. The FAMEs were quantified by gas chromatography (Shimadzu GC17A, equipped with a Omegawax

250 column (30 m x 0.25 µm x 0.25 µm) and FID detector. True Retention (TR) of nutrients was calculated using the formula provided by [16].

Data were analyzed using the General Linear Model procedures of the statistical analysis software SAS 9.1 for Windows [17]. A one-way ANOVA tested the prime cut as fixed effect and the significance level was calculated at the 5% confidence level.

III. RESULTS AND DISCUSSION

Results presented in Table 1 confirmed literature reports: both LD and HL had very lean meat (average lipid content < 3 g /100 g raw meat) and high protein level (> 22 g/100 g raw meat), thus also the energy content of the meat was moderate and mostly attributable to proteins (< 115 Kcal/100 g raw meat). The cholesterol content of the raw meat didn't exceed the 65 g/100 g meat in both raw portions. Comparing the two main prime cuts at their raw state, we could observe that the LD had a higher protein content than the HL (22.9 *vs* 22.2 g/100 g meat for LD and HL, respectively), lower lipids (0.79 *vs* 2.86 g lipids/100 g meat), and cholesterol contents (51.0 vs 65.1 g/100 g meat for LD and HL, respectively). As a consequence also the energy content of the two raw meat cuts significantly differed (98.6 *vs* 115 Kcal/100 g meat for LD and HL, respectively). The above indicated differences were not surprising as *Longissimus dorsi* is a muscle with prevalent fast glycolytic metabolism, whereas HL muscles contain a balanced oxidative and glycolytic fibres proportion. The differences observed in the raw meat were confirmed also after cooking for each of the examined nutrients that, overall, tended to concentrate as a consequence of the moisture loss. Differently from the proximate composition in itself, True Retention (TR) of rabbit meat nutrients has not been widely studied until now, and values showed in the present trial revealed interesting differences between the two examined prime cuts. As a general consideration, the LD tended to concentrate its nutrients more intensely than the HL, because LD lost more moisture (67.9 *vs* 74.7 % of moisture TR for LD and HL, respectively). The high and significant difference in terms of lipid TR between the two prime cuts (155.3 *vs* 109.4 % for LD and HL, respectively) was partly explained by the different LD and HL moisture retention values, and partly by the extremely low lipid content of the raw LD meat (0.79 g/100 g meat).

Table 1 Energy content (kcal/100 g), proximate composition (g/100 g), cholesterol content (mg/100 g) and true retention (TR, %) of rabbit's loin (LD) and hind leg (HL) prime cuts

		Prime cut		*P*-value	RSD[1]
		LD	HL		
No. samples		105	140		
Energy content	Raw	98.6	115	***	3.74
	Cooked	134	144	***	6.11
	TR	101	103	***	3.29
Moisture	Raw	75.1	73.7	***	0.5
	Cooked	66.3	67.6	***	1.2
	TR	67.9	74.7	***	3.1
Protein	Raw	22.9	22.2	***	0.6
	Cooked	30.2	27.4	***	1.1
	TR	103	101	**	3.9
Lipids	Raw	0.79	2.86	***	0.49
	Cooked	1.47	3.79	***	0.59
	TR	155	109	***	35.0
Ash	Raw	1.38	1.26	***	0.14
	Cooked	1.59	1.20	***	0.19
	TR	89.5	78.3	***	13.6
Cholesterol	Raw	51.0	65.1	***	3.3
	Cooked	78.1	87.6	***	4.4
	TR	118	110	***	8.7

[1]Residual Standard Deviation; **: $P<0.01$; ***: $P<0.001$

The LD lipids, being probably almost exclusively structural lipids, they were not lost with cooking. In fact, heating can denature the muscle lipoproteins and thus release high extractable bound lipids [10]. Furthermore, the effect of the cooking procedure might have favoured lipids concentration: LD and HL meat samples were vacuum-sealed in PVC bags thus fats, after melting on heating, could have diffused along the concentration gradient into the meat [9]. This could explain the particularly high TR percentages of both LD and HL. Our results, even if on a different animal species, agreed with those of [18] considering the effect of cooking on the chemical composition of beef meat products. Those authors observed that, independently to the cooking procedure and to the meat cut or product, it was the initial fat content that mostly influenced fat loss during cooking. In fact, as the fat content increases, the probability of fat coalescing and then leaking from the product also increases, as the mean free distance between fat cells decreases. A study by [6] evaluated the effect of different cooking procedures on the nutritional quality of rabbit LD meat, but the boiled LD meat samples showed higher nutrients loss than our LD and HL meats. Specifically, in LD the TR values for protein and lipids were 93.6 and 93.5% *vs* 102.6 and 155.3% in [6] and in our study, respectively. The cooking parameters and the size of the meat samples were probably responsible of such different results. Temperature is known to be a key factor in the eating quality of meat: the higher is the central temperature of the sample, the lower is its water content as the protein denaturation caused by high temperatures lowers their capability of retaining water. But differently from the water, protein and lipids should concentrate [19], thus also the type of meat samples probably played a role. We used half of the LD muscle, minimizing tissue damage, whereas the other study [6] considered samples of 20 g each whose original structural integrity had been compromised. The content of the FA classes found in raw and cooked rabbit LD and HL meat are reported in Table 2 and, for the first time in rabbit meat species, also TR values have been considered. In general, such results confirmed the high natural PUFA content of rabbit meat (203.4 vs 679.5 mg/100 g raw meat for LD and HL, respectively) corresponding to the 30.8 and the 29.5 % of the total raw meat lipid content, for LD and HL, respectively. The SFA accounted for the 39.0 and the 39.5 % and MUFA for the 30.3 and the 31.1 % of the total raw meat lipids content, for LD and HL, respectively. Such proportions were in line with the data found in literature [5]. The differences between LD and HL for SFA, MUFA, PUFA, Linoleic acid, Linolenic acid, DHA, Σ *n*-6 and Σ *n*-3 were always significant ($P<0.001$) both in raw and cooked meat, with the HL presenting always higher values than the LD. Only EPA content of the cooked meat didn't differ between LD and HL meat cuts.

Table 2 Fatty acids content (mg/100 g meat) and TR (%) of rabbit's *L. dorsi* (LD) and hind leg (HL) meat portions

		Prime cut		*P*-value	RSD[1]
		LD	HL		
No. samples		49	70		
Σ SFA	Raw	257.8	911.1	***	153.3
	Cooked	514.4	1183.7	***	192.3
	TR	155.4	107.0	***	23.0
Σ MUFA	Raw	200.2	717.1	***	155.6
	Cooked	383.6	903.4	***	187.8
	TR	147.8	104.0	***	22.3
Σ PUFA	Raw	203.4	679.5	***	101.0
	Cooked	402.2	943.9	***	119.6
	TR	150.1	114.8	***	23.1
C18:3 *n*-3	Raw	13.0	65.9	***	11.5
	Cooked	24.6	95.5	***	15.3
	TR	145.2	119.9	***	26.1
C20:5 *n*-3 (EPA)	Raw	1.16	1.34	*	0.41
	Cooked	2.28	2.17	ns	0.43
	TR	161.8	138.7	*	53.0
C22:6 *n*-3 (DHA)	Raw	0.47	1.02	***	0.31
	Cooked	0.91	2.26	***	0.53
	TR	143.2	171.9	ns	59.9
C18:2 ct *n*-6	Raw	149.6	546.3	***	81.6
	Cooked	298.3	749.5	***	94.4
	TR	153.7	113.3	***	24.1
Σ *n*-6	Raw	185.1	601.9	***	88.8
	Cooked	366.5	828.8	***	101.9
	TR	152.1	113.8	***	24.0
Σ *n*-3	Raw	14.9	69.8	***	11.9
	Cooked	28.6	102.2	***	16.1
	TR	146.9	121.1	***	25.7

[1]Residual Standard Deviation; ns: not significant; *: $P<0.05$; ***: $P<0.001$

TR values of each FA followed the general pattern already discussed for the general lipid content of the prime cuts (Table 1), with LD showing greater TR of FA than HL ($P<0.001$). An exception to this well defined difference between prime cuts, was represented by the DHA whose TR didn't differ in the cooked meat. The already good FA profile of the two rabbit prime cuts, with specific focus on those FA of special interest for human nutrition, can be further improved through diet by increasing the meat *n*-3 content, thus improving the *n*-6/*n*-3 ratio, as it was successfully demonstrated by other authors [5].

IV. CONCLUSION

Rabbit meat confirmed to be an optimal and healthy meat source for the modern consumer thanks to its extremely low fat and cholesterol, and high protein contents. Proximate composition and FA content of raw and cooked LD and HL meat significantly differed, with the LD being leaner and by consequence proportionally less rich in FA compared to the HL. Also nutrient TR values differed between the two prime cuts and were generally higher in the LD compared to the HL, as a result of a higher moisture loss during cooking. Considered the large differences in nutrients content emerged between raw and cooked prime cuts, the nutritional value of the rabbit meat should be always expressed on cooked.

REFERENCES

1. Jiménez-Colmenero, F., Carballo, J., & Cofrades, S. (2001). Healthier meat and meat products: their role as functional foods. Meat Science 59: 5-13.
2. Dalle Zotte, A., & Szendrő, S. (2011). The role of rabbit meat as functional food. Meat Science 88: 319-331.
3. Dalle Zotte, A. (2002). Perception of rabbit meat quality and major factors influencing the rabbit carcass and meat quality. Livestock Production Science 75: 11-32.
4. Dal Bosco, A., Castellini, C., Bianchi, L., & Mugnai, C. (2004). Effect of α-linolenic acid and vitamin E on the fatty acid composition, storage stability and sensory traits of rabbit meat. Meat Science 66: 407-413.
5. Kouba, M., Benatmane, F., Blochet, J. E., & Mourot, J. (2008). Effect of a linseed diet on lipid oxidation, fatty acid composition of muscle, perirenal fat, and raw and cooked rabbit meat. Meat Science 80: 829-834.
6. Dal Bosco, A., Castellini, C., & Bernardini, M. (2001). Nutritional quality of rabbit meat as affected by coking procedure and dietary vitamin E. Journal of Food Science 66: 1047-1051.
7. Badiani, A., Stipa, S., Bitossi, F., Gatta, P. P., Vignola, G., & Chizzolini, R. (2002). Lipid composition, retention and oxidation in fresh and completely trimmed beef muscles as affected by common culinary practices. Meat Science 60: 169-186.
8. Maranesi, M., Bochicchio, D., Montellato, L., Zaghini, A., Pagliuca, G., & Badiani, A. (2005). Effect of microwave cooking or broiling on selected nutrient contents, fatty acid patterns and true retention values in separable lean from lamb rib-loins, with emphasis on conjugated linoleic acid. Food Chemistry 90: 207-218.
9. Kumar, S., & Aalbersberg, B. (2006). Nutrient retention in foods after oven-cooking compared to other forms of domestic cooking. 1. Proximates, carbohydrates and dietary fibre. Journal of Food Composition and Analysis 19: 302-310.
10. Alfaia, C. M. M., Alves, S. P., Lopes, A. F., Fernandes, M. J. E., Costa, A. S. H., Fontes, C. M. G. A., Castro, M. L. F., Bessa R. J. B., & Prates, J. A. M. (2010). Effect of cooking methods on fatty acids, conjugated isomers of linoleic acid and nutritional quality of beef intramuscular fat. Meat Science 84: 769-777.
11. AOAC (Association of Official Analytical Chemists) International. (1995). Official Methods of Analysis of AOAC International, 15th Edition. Washington, DC, USA: Association of Official Analytical Chemists
12. Casiraghi, E., Lucisano, M., Pompei, C., & Dellea, C. (1994). Cholesterol determination in butter by high performance chromatography. Milchwissenschaft-Milk International 49: 194-196.
13. AOAC (Association of Official Analytical Chemists) International. (2006). Official Methods of Analysis of AOAC International, 18th Edition. Gaithersburg, Maryland, USA, AOAC International.
14. Folch, J., Lees, M., & Sloane Stanley, G. H. (1957). A simple method for the isolation and purification of total lipids from animal tissues. Journal of Biological Chemistry 226: 497-509.
15. Lee, C. M, Trevino, B., & Chaiyawat, M. (1996). A simple and rapid solvent extraction method for determining total lipids in fish tissue. Journal of AOAC International 79: 487-492.
16. Murphy, E. W., Criner, P. E., & Gray, B. C. (1975). Comparisons of Methods for Calculating Retentions of Nutrients in Cooked Foods. Journal of Agricultural and Food Chemistry 23: 1153-1157.
17. SAS. (2004). SAS/STAT User's Guide (Release 9.1) SAS Inst. Inc., Cary NC, USA.
18. Sheard, P. R., Nute, G. R., & Chappell, G. (1998). The effect of cooking on the chemical composition of meat products with special reference to fat loss. Meat Science 49: 15-191.
19. Aasling, M. D., Bejerholm, C., Ertbjerg, P., Bertram, H. C., & Andersen, H. J. (2003). Cooking loss and juiciness of pork in relation to raw meat quality and cooking procedure. Food Quality and Preference 14: 277-288.