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TECHNICAL NOTE: ESTIMATION OF REAL RABBIT MEAT CONSUMPTION IN ITALY

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Abstract: As in other livestock species, the annual *per capita* consumption of rabbit meat is currently estimated as the ratio of the total weight of carcasses available for consumption to the number of inhabitants of a certain region. The aim of this work was to establish conversion coefficients from carcass to edible lean meat and estimate real rabbit meat consumption in Italy. Accordingly, a total of 24 rabbits were slaughtered at 2 different ages to obtain carcasses representative of the main market categories in Northern Italy: medium-size (carcass weight of about 1.4 kg) and heavy-size (carcass weight of about 1.8 kg). Chilled carcasses were used to determine offal, dissectible fat, bone and meat weights and yields. Experimentally obtained conversion factors from carcass to edible lean meat and estimated meat waste percentage at retail and consumption levels were subsequently used to estimate the real *per capita* amount of rabbit meat consumed in Italy. The finding of this study revealed that, if compared to the medium-size group, heavy-size carcasses had higher lean meat yield for both intermediate (92.9 *vs.* 92.4%; $P<0.05$) and hind parts (84.3 *vs.* 79.1%; $P<0.001$). On the contrary, the meat yield of fore part was higher in the medium-size group (66.2 *vs.* 65.5%; $P<0.001$) compared to heavy-size carcasses. Eventually, overall meat yield was higher in heavy-size carcasses compared to medium-size ones (64.4 *vs.* 63.2%; $P<0.001$). By using these conversion factors and estimated overall losses at retailing and home-consumption (15%), we estimated that real *per capita* annual rabbit meat consumption is 0.50 kg in Italy, which is only 54% compared to the estimated apparent consumption (0.90 kg).

Key Words: rabbits, chilled carcass, meat joint, meat yield, edible meat, meat consumption.

INTRODUCTION

Currently, the apparent meat consumption *per capita* is expressed as carcass-weight-equivalent (which is usually given by international and national agencies) divided by population number. Therefore, within each country, the meat consumption is usually calculated using a trade balance approach: total production, plus imports, minus exports. However, as animal carcasses include bones, fatty tissues, organs, trimmings and waste of various types, the apparent meat consumption *per capita* strongly overestimates the real lean meat consumption (Hallström and Börjesson, 2013; Smil, 2013). On the other hand, food consumption in the US (including meat) is estimated by food availability data (also known as US Food Supply Data or Disappearance Data) provided by the USDA Economic Research Service (ERS) (Fehrenbach *et al.,* 2016). Since 1970, the ERS food data system has included figures and ratios on the boneless and trimmed edible meat consumption for red meat, poultry and fish, as well as loss-adjusted coefficients (removal of non-edible food parts in addition to food lost through spoilage, plate waste and other losses in the home and marketing system). However, due to its low consumption in the US, the ERS food data system did not include any data on rabbit meat. Several epidemiological studies evidenced a link between the consumption of raw and processed meat and the risk of cardiovascular disease and cancer. For instance, based on a meta-analysis of

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cohort studies, a dose response relationship with bowel cancer was recently established (Boada *et al.,* 2016; Etemadi *et al.,* 2017). Accordingly, estimation of real meat intake is becoming very important for health aspects.

In past decades, some studies were conducted to estimate meat yields in order to evaluate the influence of genetic and environmental factors on carcass traits in rabbits (Pla *et al.,* 1996; Ortiz-Hernandez and Rubio-Lozano, 2001; Hernandez *et al.,* 2006; Capra *et al.,* 2013; Dalle Zotte *et al.,* 2015; Szendrő *et al.,* 2016). In this context, no specific studies have been conducted to establish a conversion factor for determining edible yield of different categories of rabbit meat carcasses that are available in the market. The aim of our study was therefore to determine conversion coefficients to calculate lean meat yield on carcass weight basis for medium- and heavy-sized rabbits in order to estimate the real rabbit meat consumption in Italy.

MATERIALS AND METHODS

Carcass collection

The study was conducted on a total of 24 carcasses obtained from the same rabbit herds (Martini strain) farmed under commercial conditions and fed *ad libitum*, with a diet for fattening rabbits (crude protein 16.8% and crude fibre 15.4%) and free access to water. Rabbits were slaughtered at 2 different ages to obtain carcasses representative of the main market categories in Northern Italy: medium-size (carcass weight of about 1.4 kg) and heavy-size (carcass weight of about 1.8 kg). Prior to transport to the slaughterhouse, rabbits were subjected to total feed withdrawal for 8 h, including a 2 h lairage time at the processing plant. The animals were subsequently slaughtered under commercial conditions using electrocution (100 V, 50 Hz) as the stunning system. After chilling, 12 carcasses per market category were collected, equally distributing females and males and avoiding those with extreme weights compared to the respective average mean value.

Carcass portioning and deboning

At 24 h *post-mortem*, the chilled carcasses were weighed (with head, heart, lungs, liver, kidneys and dissectible fat depots) and subsequently portioned following the procedures suggested by Blasco and Ouhayoun (1996). First, the reference carcass was obtained by removing head and organs (liver, kidneys, heart and other thoracic organs including thymus, trachea, oesophagus and lungs) and each part was weighed. Subsequently, dissectible fats were removed (periscapular, perirenal, perivisceral and perithoracic) and carcasses were divided into technological joints as recommended by Blasco and Ouhayoun (1996). Carcass parts (fore, intermediate and hind part) were weighed. Fore and hind-parts were further cut into fore-legs and thoracic cage, and hind legs and coccyx, respectively. Finally, each meat cut was carefully deboned to determine the respective bone and meat weights.

Statistical Analysis

Data were analysed using a one-way factorial analysis of variance (GLM; SAS, 1988) by testing the main effect of market class (medium- and heavy-size). Factors for conversion from carcass to edible meat were subsequently used to estimate meat consumption in Italy and some of the main EU producer countries (Spain, France and Germany). Data from FAO food balance sheets (FAO, 2018) for the last available year (2016) were used to calculate apparent meat consumption, while meat waste percentage at retail and consumption levels were also considered to estimate the actual consumption (FAO, 2011).

RESULTS AND DISCUSSION

Conversion factors from carcass to edible lean meat

Weights of medium- and heavy-sized chilled and reference carcasses as well as proportion for offal, dissectible fats and meat cuts are shown in Table 1.

Medium- and heavy-sized animals enabled us to obtain chilled carcasses with an average value of 1810±39 and 1370±58 g (mean±standard error), respectively. Total offal yield was significantly lower in heavy-size carcasses

(14.6 *vs.* 16.1%; $P<0.001$) compared to the medium-size carcasses. In detail, offal exhibited lower yield in heavy-size carcasses with the only exceptions being heart and kidney, which did not show any difference between the market categories. As for dissectible fats, the heavy-size carcasses exhibited an overall higher proportion of fats (4.3 *vs.* 2.8%; $P<0.001$) ascribable to an increased percentage of periscapular, perirenal and perithoracic fats, whereas no differences were found concerning the perivisceral fat deposition. In addition, although the total meat cut yield did not differ between market categories, the only differences were found in fore leg (11.3 *vs.* 10.8%; $P<0.01$) and coccyx (0.8 *vs.* 0.7%; $P<0.01$) when medium and heavy-size carcasses were compared. Overall, the proportion of different carcass parts are in agreement with earlier studies (Pla *et al.,* 1996; Ortiz-Hernandez and Rubio-Lozano, 2001; Hernandez *et al.,* 2006; Capra *et al.,* 2013; Dalle Zotte *et al.,* 2015; Szendrő *et al.,* 2016) and confirm previous findings when carcasses of different size were compared (Szendrő *et al.,* 1998).

The findings concerning meat yields of each cut are reported in Table 2. Even heavy-size carcasses exhibited higher meatiness percentage for both mid- (92.9 *vs.* 92.4%; $P<0.05$) and hind-parts (84.3 *vs.* 79.1%; $P<0.001$), but meat

Table 1: Carcass weight and proportion of offal, dissectible fats and meat cuts in medium- and heavy-size rabbit carcasses.

	Carcass size			
	medium	heavy	SEM	Significance
Chilled carcass weight (g)	1 370	1 810	46.9	***
Reference carcass weight (g)	1 150	1 546	42.3	***
Offal				
head (%)	9.89	9.07	0.13	***
liver (%)	4.01	3.60	0.09	**
kidney (%)	0.97	0.88	0.03	ns
heart (%)	0.45	0.44	0.01	ns
thoracic organs (%)	0.70	0.61	0.02	**
total (%)	16.1	14.6	0.2	***
Dissectible fat				
periscapular (%)	0.52	0.81	0.04	***
perirenal (%)	1.22	2.31	0.15	***
perivisceral (%)	0.66	0.41	0.07	ns
perithoracic (%)	0.36	0.82	0.07	***
total (%)	2.8	4.3	0.2	***
Fore part				
fore legs (%)	11.3	10.8	0.1	**
thoracic cage (%)	19.3	19.9	0.1	ns
total (%)	30.6	30.6	0.2	ns
Intermediate part				
total (%)	20.9	21.2	0.12	ns
Hind part				
hind legs (%)	28.9	28.6	0.2	ns
coccyx (%)	0.8	0.7	0.02	**
total (%)	29.7	29.2	0.1	ns
Meat cuts				
total (%)	81.1	81.1	0.2	ns

% calculated on basis of chilled carcass weight; ***$P<0.001$; **$P<0.01$; ns: not significant.
SEM: standard error of mean.

Table 2: Meat percentage of cuts in medium- and heavy-size rabbit carcasses.

	Carcass size			
Cut	Medium	Heavy	SEM	Significance
Fore part				
fore legs (%)	77.5	76.2	0.4	ns
thoracic cage (%)	60.7	59.7	0.5	ns
total (%)	66.2	65.5	0.3	*
Intermediate part				
total (%)	92.4	92.9	0.1	*
Hind part				
hind legs (%)	79.4	84.0	0.6	***
coccyx (%)	69.9	70.2	0.7	ns
total (%)	79.1	84.3	0.6	***
Chilled carcass				
total (%)	63.2	64.4	0.2	**

***$P<0.001$; **$P<0.01$; *$P<0.05$; ns: not significant.
SEM: standard error of mean.

yield of fore-part was superior in the medium-size group (66.2 *vs.* 65.5%; $P<0.001$). Thus, as expected, meat yield was higher in heavy-size carcasses compared to the medium-size ones (64.4 *vs.* 63.2%; $P<0.001$). Total meat yield percentages are in line with previous findings from Ortiz-Hernandez and Rubio-Lozano (2001), who found values ranging from 62.2 to 68.8% in rabbits of different breeds.

Estimation of meat consumption

Coefficients to calculate meat yield on a carcass weight basis were employed to estimate the real meat consumption in Italy by using statistics reported by FAO on the last available year, which was 2016. By considering that FAO

Table 3: Estimation of real rabbit meat consumption in Italy and the other main EU producer countries (Spain, France and Germany).

		Other EU Countries		
	Italy	Spain	France	Germany
Inhabitants ($\times 10^3$)[1]	61 211	47 333	65 316	82 453
Production and trade exchanges[1]				
Number of slaughtered rabbits ($\times 10^3$)	26 916	47 357	33 247	22 652
Production (t)	54 347	50 552	48 396	35 971
Average carcass wt (kg)	2.02	1.07	1.46	1.59
Import (t)	2 619	498	2 323	5 427
Export (t)	816	5 624	5 272	333
Balance (t)	1 803	–5 126	–2 949	5 094
Amount of rabbit meat available for consumption				
Apparent (t)	56 150	45 426	45 447	41 065
Conversion factor from carcass to edible meat[2]	0.644	0.632	0.632	0.638
Edible (t)	36 161	28 709	28 723	26 199
Per-capita rabbit meat consumption				
Apparent (kg)	0.92	0.96	0.70	0.50
Edible (kg)	0.59	0.61	0.44	0.32
Real (kg)[3]	0.50	0.52	0.37	0.27

[1]FAO (2018); [2]different conversion meat yield factors were used based on average carcass weight; [3]calculated by considering overall meat waste (15%) from retail to home-consumption estimated by FAO (2011) in Europe.

estimated an average carcass weight in Italy of 2.0 kg (FAO, 2018), the conversion factor obtained on heavy (1.8 kg) carcasses were used (0.644). Consequently, the estimated amount of edible rabbit meat (by excluding inedible and non-meat parts) available for consumption was 36 161 instead of 56 150 t (Table 3).

For real meat consumption estimation, waste from retail (i.e. supermarket, retail shop) to home-consumption must be also taken into account. Nowadays, as the majority of rabbit meat is sold as fresh meat (carcass or cut-up) (Petracci and Cavani, 2013), the major cause of waste during retailing is shelf-life expiry, while deterioration and uneaten food are the major sources of waste at home. Recently, it was estimated that meat waste in the EU reaches 4% in retail and 11% in consumption (FAO, 2011). By applying these figures, real *per capita* annual rabbit meat consumption was calculated. In Italy, it was estimated at 0.50 kg, well below the estimated apparent consumption, which is 0.92 kg (Table 3).

As an example, the same estimations were carried out for the other main EU producer countries (Spain, France and Germany) by using conversion factors based on respective average carcass weight (Table 3). For more precise estimations, representative market categories within each country should be considered.

CONCLUSIONS

This study represents a first attempt to estimate real *per capita* consumption of rabbit meat based on the approach used in the US, where the food data system includes the boneless, trimmed (edible) and loss-adjusted data (removal of non-edible food parts and food lost through spoilage, plate waste, and other losses in the home and marketing system). By using conversion factors from carcass to edible meat (excluding offal, dissectible fats and bones) and estimated losses at retailing and home-consumption, it was possible to estimate that real *per capita* annual rabbit meat consumption in Italy is only 54%, compared to estimated apparent consumption (0.50 *vs.* 0.92 kg).

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