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Nutritional quality of meats from young fallow deer (*Dama dama*) of different ages*

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Titolo
Qualità nutrizionale delle carni di giovani daini (*Dama dama*) di diverse età

Key words
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Summary
Twelve male fallow deer (*Dama Dama*) were slaughtered at 3, 6 and 12 months of age. The productive performances of the animals and the most significant quantitative and qualitative traits on carcasses and meats were assessed. Four animals were slaughtered at 90 days of age, the others, allotted to two groups of four animals each, at 6 and 12 months, respectively. All the animals were kept in paddocks where, besides pasture, they received a supplementary feed 500 g/head/d on the average. From the data available it emerges that the 6-month-old fallow deer as compared to the 12-month-old bucks, present better gains and a reduced chilling loss of the carcass, the cuts of which into leg and loin and their lean fractions do not differ as to age. Moreover, the meats of these animals always in comparison with the 12-month-old bucks do not differ for "a" redness, "L" lightness as well as chemical composition. The meats are also less tough, less resistant and with reduced quantities of free water. At last, the fat extracted from the meat of 6-month-old fallow deer vs the older ones, in spite of a greater content in unsaturated, polyunsaturated and monounsaturated fatty acids, the differences of which have no statistical value, is even richer in ω6 and poorer in ω3 fatty acids.

Riassunto
Sono stati utilizzati 12 soggetti maschi di daini (*Dama dama*), sacrificati a 3, 6 e 12 mesi, sui quali sono stati rilevati le performances produttive in vita e i parametri quanti-qualitativi più significativi sulle carcasse e sulle carni. Quattro soggetti sono stati macellati a 90 giorni, gli altri, suddivisi in due gruppi di quattro capi ciascuno, a 6 mesi e 12 mesi. Tutti i soggetti sono stati allevati in recinti in cui oltre al pascolo hanno ricevuto mediamente 500 g/capo/d di un mangime completo. Dai dati disponibili emerge che i daini di 6 mesi, rispetto a quelli di 12, presentano migliori accrescimenti, un inferiore calo di refrigerazione delle carcasse, i cui tagli di coscio, di lombata e la loro frazione di magro, sono indipendenti dall'età. Inoltre, le carni di questi soggetti sempre rispetto a quelli di 12 mesi presentano un indice del rosso "a", della luminosità "L", ed una composizione chimica non diversi tra loro, le quali sono anche meno dure, meno resistenti e con inferiori quantità di acqua libera. Infine il grasso estratto dalla carne dei daini di sei mesi rispetto a quelli di maggiore età, nonostante un più elevato contenuto di insaturi, di polinsaturi e di monoinsaturi, le cui differenze sono prive di significato statistico, è anche più ricco di ω6 e più povero di ω3.

Introduction

The utilization of wild animals for feeding purposes can be retraced before the introduction of agriculture and animal farming, when men hunted animals in search for noble proteins. As times evolved, the consumers, more and more attentive to the environment pollution, animal manipulation and the use of food additives as anabolic steroids and hormones (1, 2), have attached great interest to the meats from wild and game animals and, in particular, to the meats of fallow deer, poor in fat and cholesterol, but rich in proteins and unsaturated and polyunsaturated fatty acids (3-6). Such attention aroused the interest of farmers for the rearing of these animals, as showed by the number of farms that practice this activity (7). This is also favoured by the availability of inner, mountain and hilly areas, where a modern entrepreneurial and/or profitable agriculture results not very feasible (8, 9). In these areas, more and more available, the rearing of wild and game animals, such as ungulates and deer, can be undertaken, for the production of animals for both restocking and slaughter, thus providing the farmers with a supplementary income (10). The more frequently reared species are deer and fallow deer, since these animals are good transformers of forages (11) even the roughest and able to utilize at best the natural resources (12, 15). During the centuries these animals have evolved by arranging their feeding requirements and reproductive characteristics with the changes of pasture richness (16-21).

As regards the production and consumption of these meats, the Italian official statistical book number them as "rabbits and game animals", but useful indications are found in the paper by Salghetti et al. (1994) that reports a national production of 2,845 t of LW, represented, for the greater part, by wild boars (2,550 t) and fallow deer (176 t). This production is undoubtedly not sufficient to satisfy the inner consumptions and, therefore, it is necessary to resort to massive import for about 6,000 t. This is the reason why it is important to increase such a production with both a greater number of reared animals and the rationalization of farms.

As generally known, the quantitative and qualitative traits of meat depend on the animal genotype, sex, age and weight at slaughter, rearing techniques, feeding, physiological state (entire or castrated), slaughter and preparation techniques, manipulation, storage, carcass sectioning, commercialization of the cuts and at last cooking (23). The factors are valid also for wild ungulates and, in particular, for fallow deer (24).

The literature we consulted reports interesting results as concerns both the ungulates management (25-30), and rearing and the production and quality of the meat (1-3, 6, 25, 31-33) in relation to age and feeding supplementation. The literature is poor when we consider the influence of slaughter age of fallow deer when the animals are slaughtered within one year of age. Such practice could reveal itself useful in confined rearing since it contributes to manage better the year scheduled livestock presence/ha within the limits of the environment trophic capacity and would limit the use of expensive feeding supplementations. For this reason it seemed useful to us to investigate the influence of the slaughter age on some quantitative and qualitative traits of the meat of young fallow deer (*Dama Dama*) when the animals are slaughtered at 3, 6 and 12 months of age.

Material and methods

Four this purpose 12 bucks were utilized. Four of them were slaughtered at 90 days of age, the others allotted to two groups of four animals each, weaned at 90 days, homogeneous for age and weight and kept in paddocks of 2,000 sqm, where, besides pasture, they received a complete fodder of approximately 500 g/head/d the 6-month-

old group and 600 g/head/d the 12-month-old one, respectively. The chemical composition of the feeds (Table 1) was evaluated according to ASPA recommendations (1980). The first group was slaughtered at 6 months, the second at 12. On all the alive animals, the live weight at the typical ages and the daily weight gains were recorded; the slaughter data were taken according to local habits, approaching as much as possible ASPA recommendations (1991).

The carcass of each animal was divided into two half sides and from the warm half side the pH (pH1) was recorded and, after 24 h of chilling at 4°C, on the right half side the cut composition (picture 1) and the pH from cold carcass (pH2) were detected (Table 7). Moreover, on the muscles *Longissimus dorsi* (LD) and *Quadriceps femoris* (QF) of all animals, the following indexes were evaluated: lightness "L", redness "a" and yellowness "b" (Hunter Lab System), the cooking losses (effected in oven at a core temperature of 75°C), of free water (determined by crushing) and the shear force (W.B.S.) evaluated also on cooked meat samples from both muscles (Tables 6 and 7).

From a sample of LD muscle from each half side the chemical composition was determined following ASPA (1980) suggestions and from a peri-intramuscular fat part extracted from them (36), after methylation, the acid composition was evaluated by means of gas-chromatography with 60 m sylicated glass capillary column with 100% cyanoprile stationary phase. To identify the single fatty acids, we referred to the retention time of the palmitic acid ($C_{16:0}$) and in doubtful cases, to known standards. The method of inner normalization was utilized for the calculus. Moreover, the indexes of atherogenicity and thrombogenicity (37) and the ratio PCL (*plasma cholesterol lowering*)/*PCE* (*plasma cholesterol elevating*) were calculated (38). The obtained data were subjected to statistical processing by utilizing the GLM (39) procedure by adopting in the linear model the diet effect. All the data obtained were subjected to the variance analysis by GLM procedure (40). The differences between the estimated means were evaluated with Student's "t".

Table 1 - Feed composition of pasture

		Mixed feeds[1]	Pasture
Dry matter	%	91.80	28.80
Crude protein (N x 6.25)	%	17.06	11.42
Ether extract	%	4.73	3.50
Ash	%	8.21	10.36
Crude fibre	%	9.87	27.28
N-free extract	%	60.13	47.44
ME	MJ/Kg DM	10.67	9.47

[1] Ingrediens: soybean meal (17%), maize (20%), oats (6%), barley (19%), alfaalfa (3,5%), wheat middling (8%), molasses (1,7%), hulls of grapes (20%), grape-seed oil (1%), calcium carbonate (1,8%), dicalcium phosphate (1%), sodium chloride (0,5%), vitamin-mineral premix (0,5%)

Results and discussion

Live performances

Beside the final live weight, that increases with the slaughter age (42.45 Kg *vs* 30.10 Kg e 20.78 Kg), significant differences (P<0.01) were found in the average daily gains that were reduced with the older age, higher in the 3-month-old bucks and lower in the older ones (0.198 Kg *vs* 0.151 Kg e 0.109 Kg). This is justified by the animal approaching to the complete somatic development, characteristic of the species (Table 2).

Data at slaughter

At slaughter (Table 3), in the oldest animals (12 months) it can be observed, besides a higher and significative (P<0.01) net live weight vs the younger bucks (35.24 Kg *vs*

Table 2 - Productive traits (Kg)

Months	Age at slaughter 3	6	12	ESD
N. Animals	4	4	4	(GL=9)
Live weight at birth	3.00	2.95	3.10	0.163
Preslaughter live weight	20.78 C	30.10 B	42.45 A	1.807
Weight gain (kg/d)	0.198 A	0.151 B	0.109 C	0.013

A, B, C: P<0.01

Table 3 - Slaughtering data (% on net live weight)

Months	Age at slaughter 3	6	12	ESD
N. Animals	4	4	4	(GL=9)
Net live weight (Kg)	18.15 C	28.12 B	35.24 A	1.389
Stomachs and intestine	5.96 b	4.74 B	7.52 Aa	0.946
Heart, lung, liver, spleen, kidney	5.06	5.44	5.52	0.350
Warm dressing proportion	69.05	70.68	69.63	2.787
Head	5.06 a	4.29 b	4.96	0.468
Shins	0.94 A	0.86 B	0.61 B	0.065
Chilling loss	4.64 a	2.50 b	3.63	1.070

A. B. C: P<0.01; a. b: P<0.05

28.12 Kg e 18.15 Kg), a higher and significative incidence of the gastro-enteric apparatus (7.52% *vs* 4.74% and 5.96%). Moreover, as regards the live weight at slaughter it should be stressed that the animals of our research are heavier and present more incident carcasses than the fallow deer of the same age studied by Mojto and Kartusek (1995). Actually, the yield at slaughter dressing percentage, that approximately corresponds to 70%, in spite of the observed differences, so not seem to be influenced by the age of the animals and is clearly higher than the one described by Giorgetti et al. (1984) for 10-month old animals. On the contrary, the chilling loss is significantly higher (P<0.05) in the carcasses of the 3-month-old bucks (4.64% *vs* 2.50%) and the same significance is found in the incidence of the weight of the head and the net live weight (5.06% *vs* 4.29%).

Data at dissection

The weight of the reconstituted half side is obviously greater (P<0.01) in the oldest animals (10.44 kg *vs* 8.68 kg and 5.39 kg). The cut percent composition is significantly influenced by the slaughter age except for certain cases even though not always supported by statistical value. In particular, significant differences (P<0.01; P<0.05) are observed for the shoulder that results greater in the youngest animals half side (17.84% *vs* 17.67% and 15.40%), of the kidney (0.56% *vs* 0.34%), of the bacon, greater in 12-month-old animals (4.26% *vs* 3.24% and 2.84%). Besides showing a more incident brisket (7.97% *vs* 7.57% and 6.68) and presenting a greater storage of perirenal fat (0.93% *vs* 0.46%) also show a higher percent of the neck (8.93% *vs* 7.70%) (Table 4). The loin presents values different from the ones reported by Giorgetti et al. (1984), but very similar to the ones found by Volpelli et al. (2002).

Data at fleshing

At fleshing (Table 5), apart from the significant data observed for the weights of the main cuts (leg, shoulder and loin), clearly higher in the oldest animals, it can be evidenced that the slaughter age has significantly influenced (P<0.05) the fat percent in the leg, more pre-

Table 4 - Data at dissection (%)

Months	Age at slaughter 3	6	12	ESD
N. Animals	4	4	4	(GL=9)
Weight of reconstituted half-side (kg)	5.39 C	8.68 B	10.44 A	0.482
Neck	7.96	7.70 b	8.93 a	0.758
Leg	41.65	40.38	40.02	1.038
Loin	7.87	8.66	8.19	1.303
Shoulder	17.84 A	17.67 B	15.40 B	0.576
Abdominal region	2.84 B	3.24 B	4.26 A	0.346
Cutlets	14.09	13.80	13.96	0.772
Brisket	6.68 B	7.57 B	7.97 A	0.346
Perirenal fat	0.50 b	0.46 B	0.93 Aa	0.201
Kidney	0.56 A	0.52 A	0.34 B	0.065

A, B, C: P<0.01; a, b: P<0.05

Table 5 - Composition of crop (%)

Months	Age at slaughter 3	6	12	ESD
N. Animals	4	4	4	(GL=9)
Weight of reconstituted leg (kg)	2.24 C	3.50 B	4.18 A	0.187
Lean	77.25	76.85	78.10	0.850
Fat	1.90 b	4.04 a	2.80	0.987
Bone	20.85 a	19.11 b	19.10 b	0.863
Weight of reconstituted shoulder (kg)	0.96 B	1.53 A	1.61 A	0.074
Lean	58.53 B b	71.00 a	74.80 A	5.806
Fat	19.05 a	4.69 b	2.93 b	8.647
Bone	22.42	24.31	22.27	5.512
Weight of reconstituted loin (kg)	0.42 B	0.76 A	0.86 A	0.122
Lean	75.05 a	70.13	64.31 b	5.725
Fat	4.06	3.94	6.41	2.149
Bone	20.89	25.93	29.29	6.340

A. B. C: P<0.01; a. b: P<0.05

sent in the 6-month-old bucks than in the younger ones (4.04% *vs* 1.90%) and in the bone percent of the same cut that presented higher values in the 3-month-old animals than in the others (20.85% *vs* 19.11% and 19.10%). Moreover, the shoulder cut in the oldest bucks (12 months) resulted (P<0.01) richer in lean (74.80% *vs* 71.00% and 58.53%) than in the youngest (3 months), which is (P<0.05) fatter (19.05% *vs* 4.69% and 2.93%). The 3-month-old bucks half sides, besides presenting a leg with higher percentages of bone (20.85% *vs* 19.11% and 19.10%) and lower fat (1.90% *vs* 4.04% and 2.80%), show a leaner loin (75.05% *vs* 70.13% and 64.31%).

Physical traits

Generally, even if the pH of the considered muscles (raw LD and QF) is not influenced by the slaughter age, some physical traits, even though with different level of statistical significance (P<0,01; P<0,05) present some differences due to the slaughter age of the animals (Tables 6 and 7).

More in detail, on raw LD of 3-month-old bucks, a higher value of "L" index (28.59 *vs* 24.57 and 24.00) and "a" index (11.85 *vs* 8.46 and 8.39) is observed; the same is observed also in QF where "L" and "a" decrease with age. This muscle shows a lower "b" index in the ani-

Table 6 - Physical traits (raw)

Months		Age at slaughter 3	6	12	ESD
N. Animals		4	4	4	(GL=9)
LD:	L	28.59 A	24.57 B	24.00 B	1.135
	a	11.85 A	8.46 B	8.39 B	0.688
	b	10.82	11.55 a	10.62 b	0.552
QF:	L	31.52 A	27.36 B	26.98 B	0.227
	a	11.33 A	8.76 B	8.57 B	0.296
	b	11.64	10.82 a	10.67 b	0.582
pH1:	LD	6.21	6.16	6.23	0.059
	QF	6.58	6.42	6.31	0.051
pH2:	LD	6.29	6.37	6.44	0.124
	QF	6.03	5.79	6.13	0.195
LD:	*WBS*				
	Toughness (Kgf/cm²)	1.60 B	1.72 b	1.93 Aa	0.092
	Shear strength (cm)	2.46	2.36 b	2.51 a	0.084
QF:	*WBS*				
	Toughness (Kgf/cm²)	1.47 B	2.56 b	2.80 A a	0.105
	Shear strength (cm)	2.55 b	2.47	2.66 a	0.061
LD:	cooking loss (%)	15.77	15.54	9.05	6.807
	free water (%)	18.48	12.87 b	21.73 a	5.293
QF:	cooking loss (%)	16.85	16.65	16.34	8.345
	free water (%)	15.88	12.14 b	21.05 a	3.979

A. B: P<0.01; a. b: P<0.05

mals of 6 and 12 months. Moreover, the cut shear seems to increase significantly (P<0.01 and/or P<0.05) with age, in both LD and QF. In fact, the 12-month-old animals present a tougher (1.93 Kgf/cm² *vs* 1.72 Kgf/cm² and 1.60 Kgf/cm²) and more resistant (2.51 cm *vs* 2.36 cm and 2.46 cm) raw LD. The same trend has been observed, even though with different values, on QF. It has also been noticed that the cooking loss of these muscles is not affected by age, the latter having significant value on their content in free water certainly higher in the oldest bucks, where in both muscles it approaches 21%.

When considering the cooked muscles, even though with different statistical values, the parameters are influenced by the age of the fallow deer, the values of which seem to increase with age. In fact, the 12-month-old bucks present both a tougher (4.54 Kgf/cm² *vs* 4.33 Kgf/cm² and 1.46 Kgf/cm²) and more resistant LD (3.20 cm *vs* 2.14 cm and 1.34 cm) and a QF with higher values of cut shear (2.80 Kgf/cm² *vs* 2.56 Kgf/cm² and 1.47 Kgf/cm²) and resistance (2.66 cm *vs* 2,47 cm and 2.55 cm).

Meat chemical composition

As concerns the chemical composition of the meat (Table 8), no significant differences are observed due to the age of the animals with the exception of N-free extract, more present in the six-months bucks.

Fatty acids composition

As concerns the percent distribution in fatty acids of raw meat fat (Table 9) valid differences (P<0.01 and/or P<0.05) are observed in both saturated and unsaturated acids. In particular, as regards the saturated ones, significant differences are observed (P<0.05) for $C_{6:0}$, the percent of which resulted higher in the animals of 6 months than in the animals of 12 months, of $C_{14:0}$ and $C_{16:0}$, more present in

Table 7 - Physical traits (cooked)

Months	Age at slaughter 3	6	12	ESD
N. Animals	4	4	4	(GL=9)
LD: WBS				
Toughness (Kgf/cm²)	1.46 C	4.33 B	4.54 A	0.100
Shear strength (cm)	1.34 C	2.14 B	3.20 A	0.045
QF: WBS				
Toughness (Kgf/cm²)	1.47 C	2.56 B	2.80 A	0.105
Shear strength (cm)	2.55 b	2.47 B	2.66 Aa	0.061

A, B, C: P<0.01; a, b: P<0.05

Table 8 - Chemical composition of raw meat LD (%)

Months	Age at slaughter 3	6	12	ESD
N. Animals	4	4	4	(GL=9)
Moisture	76.06	75.76	76.29	0.426
Proteins	20.87	20.67	20.93	0.518
Fat	1.22	1.35	1.08	0.543
Ashes	1.15	1.24	1.27	0.131
N-free extract	0.68	0.97 a	0.43 b	0.288

a, b: P<0.05

the fat of the older animals than in the 6 month ones (8.21% *vs* 3.29%; 28.79% vs 23.80%) and $C_{18:0}$, that has a lower incidence in the 3 month fallow deer than in the other two groups (11.83% *vs* 17.38% and 17.91%).

Certain differences (P<0.01) are found when considering C12:0, C14:0 and C16:0, the percentages of which greatly (P<0.05 and/or P<0.01) influence the acid composition of the fat from the 3-month-old bucks vs the 6-month-old ones (0.55% *vs* 0.16%; 10.63% *vs* 3.29%: 30.05% *vs* 23.80%). Moreover, C16:r is surely (P<0.01) more represented in the fat of 6-month-old bucks, in comparison with both the 3-month-old and the 12-month-old ones (11.24% *vs* 2.60% and 5.21%). At last, the fat of 3-month-old bucks presents lower percentages (P<0.05) of $C_{18:0}$ (11.83 *vs* 17.38 and 17.91).

When considering the unsaturated fatty acids, significative differences (P<0.05) are observed for $C_{17:1}$, more present in the fat of the 6-month-old animals than in the 3-month old ones (1.85% *vs* 0.85%), which is richer in $C_{18:3\omega6}$ (0.25%), $C_{20:4\omega}$ (0.13) and $C_{22:6\omega3}$ (0.13%). The same significance is found in $C_{18:3\omega3}$ more incident in the 1-year-old animals than the 6 month (0.87% *vs* 0.48%) ones, as well as $C_{22:5\omega3}$ more represented in the animals of 3 months and 1 year than in 6-month bucks (0.75% and 0.67% *vs* 0.10%).

Higher percentages (P<0.01) are observed for $C_{18:2\omega6}$ with higher levels in the animals slaughtered at 6 months than in the other two groups (7.46% *vs* 4.75% e 3.84%) and $C_{22:5\omega6}$ present with higher percentages in the animals slaughtered at 6 months than the ones of 3 months (0.16% *vs* 0.03%).

Moreover, the total ω6 result more present in the fat of the bucks slaughtered at 6 months as compared to both the 3-month group (8.15% *vs* 5.55%; P<0.05) and 12 months one (8.15% *vs* 4.46%; P<0.01). The ω3 are more incident on the acid composition of younger animals than of 6 months ones (5.63% *vs* 2.14%). The ω6/ω3 ratio registered higher and significative (P<0.01) values in the fat of the 6

Table 9 - Fatty acids composition (%) and qualitative indexes of the intramuscular fat (LD)

Months	Age at slaughter 3	6	12	ESD
N. Animals	4	4	4	(GL=9)
$C_{6:0}$	0.13	0.22 a	0.00 b	0.127
$C_{8:0}$	0.05	0.00	0.00	0.033
$C_{10:0}$	0.25	0.13	0.11	0.163
$C_{12:0}$	0.55 A	0.16 B	0.36	0.154
$C_{14:0}$	10.63 A	3.29 Bb	8.21 a	2.783
$C_{15:0}$	1.98	2.01	2.00	0.289
$C_{16:0}$	30.05 A	23.80 Bb	28.79 a	2.652
$C_{16:r}$	2.60 B	11.24 A	5.21 B	1.694
$C_{17:0}$	1.98	2.64	2.41	0.628
$C_{18:0}$	11.83 b	17.38 a	17.91 a	3.410
$C_{20:0}$	0.25	0.08	0.30	0.219
$C_{22:0}$	0.05	0.00	0.06	0.053
$C_{24:0}$	0.03 B	0.00 B	0.24 A	0.074
$C_{14:1}$	0.40	0.37	0.52	0.130
$C_{15:1}$	0.28	0.16	0.11	0.142
$C_{16:1}$	2.45	2.15	2.26	0.288
$C_{17:1}$	0.85 b	1.85 a	0.89	0.634
$C_{18:1\omega9}$	19.55	20.99	19.91	1.764
$C_{18:1\omega7}$	2.30	1.39	1.36	0.813
$C_{18:2\omega6}$	4.75 B	7.46 A	3.84 B	1.060
$C_{18:3\omega6}$	0.25 a	0.00 b	0.13	0.132
$C_{18:3\omega3}$	0.80	0.48 b	0.87 a	0.238
$C_{20:1\omega9}$	0.35	0.26	0.31	0.190
$C_{18:2}$ - CLA	0.35	0.17	0.13	0.210
$C_{20:2\omega6}$	0.23	0.28	0.21	0.148
$C_{20:3\omega3}$	0.10	0.05	0.15	0.065
$C_{20:3\omega6}$	0.18	0.17	0.17	0.112
$C_{20:4\omega6}$	0.13	0.08	0.08	0.070
$C_{20:4\omega3}$	0.13 a	0.00 b	0.05	0.065
$C_{20:5\omega3}$	1.30	1.18	1.14	0.558
$C_{21:5\omega3}$	2.43	0.33	0.75	1.368
$C_{22:1\omega9}$	0.08	0.05	0.13	0.052
$C_{22:5\omega3}$	0.75 a	0.10 b	0.67 a	0.327
$C_{22:5\omega6}$	0.03 B	0.16 Aa	0.05 b	0.053
$C_{22:6\omega3}$	0.13 a	0.00 b	0.05	0.065
$C_{24:1\omega9}$	0.10	0.00	0.03	0.073
Other acids	1.77	1.42	0.67	
Total saturated	60.35	60.94	65.58	3.907
Total unsaturated	37.88	37.64	33.75	3.942
monounsaturated	26.35	27.19	25.51	2.933
polyunsaturated	11.53	10.45	8.24	2.600
ω6	5.55 b	8.15 Aa	4.46 B	1.199
ω3	5.63 a	2.14 b	3.66	1.975
ω6/ω3	1.24 B	4.21 A	1.46 B	0.905
Unsaturated/saturated	0.63	0.62	0.52	0.098
Atherogenicity index	1.99 a	1.00 b	1.89 a	0.488
Thrombogenicity index	1.57	1.87	2.23	0.527
saturated/polyunsaturated	5.36 b	6.05	8.97 a	2.216
PCL/PCE	0.62 b	0.89 a	0.58 b	0.154

A, B: P<0,01; a, b: P<0.05

months bucks than in the other two groups (4.21% *vs* 1.24% and 1.46%), the latter also showing an atherogenicity index surely (P<0.05) less favourable (1.99 e 1.89 *vs* 1.00). The saturated/unsaturated ratio resulted significantly higher (P<0.05) in the 1 year bucks than in the 3-month ones (8.97 *vs* 5.36), whereas the PCL/PCE ratio significantly higher (P<0.05) for the 6-month fallow deer than for the other two groups (0.89 *vs* 0.62 and 0,58). At last, when comparing the chemical composition of fallow deer meat with the composition of other animal species (Table 10) we can affirm that it presents a lower incidence of fat, a higher water content and a protein level comparable to rabbit meat.

Conclusions

From the data obtained it emerges that the slaughter of fallow deer at 6 months of age should be preferred to the 3 month one for the higher final weight and is more appropriate than the slaughter at 1 year. In fact, the 6 months bucks, as compared to the older group animals, present higher daily gains, a reduced chilling loss of the carcass, the cuts of which into leg, loin and their lean fractions are not statistically different. Moreover, the 6-month bucks meat in comparison with the 12 months animals meat is

Table 10 - Comparison in the content of proteins, fat and moisture of different animal species

months	Moisture	% Proteins	Fat	Authors
Fallow deer	76,04	20,82	1,22	Present research
Wild boar	73,41	22,50	2,00	Marsico et al., 2007
Hare	73,86	20,25	3,14	Vicenti et al., 2003
Fattening calf	74,0	22,0	2,51	Cutrignelli, 2000
Lamb	74,57	18,56	4,10	Marsico et al., 1995
Swine	71,1	22,1	7,0	Serrano et al., 2008
Rabbit	74,6	20,7	3,7	Pascual e Pla, 2007
Turkey	71,60	24,95	1,39	Vicenti et al., 1994
Horse	70,28	22,96	5,12	Pinto et al., 2004
Donkey	71,83	21,80	4,54	Pinto et al., 2007

less tough and resistant and presents similar red "a" index, "L" lightness, chemical composition as well as a lower quantity of free water. At last, the fat extracted from it vs the older animals one, in spite being poorer in ω3 fatty acids, presents a greater but not significative content in unsaturated, polyunsaturated and monounsaturated fatty acids.

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References

1. Duranti E, Casoli C. La produzione di carne di daino (*Dama dama*) allevato in ambiente confinato. Atti Conv. "Allevamenti di selvaggina a scopo alimentare", 1993; 16: 45-62.
2. Volpelli LA, Valusso R, Morgante M, Piasenter E. Carcass quality in male fallow deer (*Dama dama*): effects of age and supplementary feeding. Meat Science 2002; 60: 427-32.
3. Casoli C, Duranti E, Rambotti F. Rilievi alla macellazione e caratteristiche quanti-qualitative della carne di daino. Zoot Nutr Anim 1986; 12: 411-22.
4. Duranti E, Casoli C, Martillotti F, Terramoccia S, Morgante M, Pauselli M. Caratteristiche del pascolo e comportamento alimentare di daini (*Dama dama*) maschi in accrescimento. Atti Simp. Int. Zootecnica 1993; 28: 233-42.
5. Duranti E, Casoli C, Coli R, Cardinali A, Donnini D. Carne di daino: aspetti produttivi, qualitativi e nutrizionali. Atti XIII Convegno Gruppo di Studio per Allevamenti di Selvaggina, Nocera Umbra, Italia, 1994: 51-67.
6. Volpelli LA, Valusso R, Morgante M, Pittia P, Piasenter E. Meat quality in male fallow deer (*Dama dama*): effects of age and supplementary feeding. Meat Science 2003; 65: 555-62.
7. Istat. Annuario Statistica Italiano, 2001.
8. Cardinali A, Casoli C, Duranti E. Pascolo per daini (*Dama dama*): aspetti agronomici e valore nutritivo di un cotico naturale in una collina umbra. Atti Conv. «Allevamenti di selvaggina a scopo alimentare», Bastia Umbra (PG), 1990; 12: 205-16.
9. Bigliardi E. Ungulati selvatici e agriturismo. Un'azienda per Bardi. Anagritur, Cusl, Bologna, 1990.
10. Summer A, Sussi C, Martuzzi F, Catalano AL. Rilievi di macellazione, prove di sezionamento e composizione chimica della carne di daino (*Dama dama*) e di cervo(*Cervus elaphus*), 1997. http://www.unipr.it/arpa/facvet/annali/1997/summer/summer.htm
11. Hofmann RR. L'adattamento dell'apparato digerente nei cervi (*Cervus elaphus*). Atti Conv. «Allevamenti di selvaggina a scopo alimentare», Nocera Umbra (PG), 1984; 5: 213-9.
12. Talamucci P, Biagioli O, Cardinali A, et al. Proposta di metodologia per la valutazione delle disponibilità alimentari per ungulati selvatici. Atti Conv. «Allevamenti di selvaggina a scopo alimentare», Bastia Umbra (PG) 1990; 12: 27-44.
13. Semiadi G, Barry TN, Wilson PR, Hodgson J, Purchas RW. Growth and venison production fromred deer (*Cervus elaphus*) grazing red clover (*Trifolium pratense*) or perennial ryegrass (Lolium perenne) white clover (*Trifolium repens*) pasture. Journal of Agricultural Science, Cambridge, UK, 1993; 121: 265-71.
14. Casoli C, Duranti E, Buttazzo C, Donnini D. Utilizzazione del pascolo da parte di femmine di daino (Dama dama) in accrescimento. Atti Soc It Sc Vet 1996; 50: 597-8.
15. Mattiello S, Mattiangeli V, Bianchi L, Carenzi C. Feeding and social behavior of fallow deer (*Dama dama L.*) under intensive pasture continement. J Anim Sci 1997; 75: 339-47.
16. Ulyatt MJ. The feeding value of herbage. In Chemistry and Biochemistry

of herbage (Eds G.W. Butler & R.W. Bailey). London, Academic Pres, 1973; 3: 131-78.
17. Barry TN, Suttie JM, Milne JA, Kay RNB. Control of food intake in domesticated deer. Physiological Aspects of Digestion and Metabolism in Ruminants (Eds. T. Tsuda, Y. Sasaki, R. Kawashima). San Diego, Academic Press, 1991: 385-401.
18. Barry TN, Wilson PR. Venison production from farmer deer. Journal of Agricultural Science, Cambridge 1994; 123: 159-65.
19. Duranti E, Cardinali A, Casoli C, Mehrabi H. Metodi di stima della produttività foraggera e della capacità di ingestione in daini (*Dama dama*) allevati in ambiente confinato. Atti Conv. Europeo «Allevamenti di selvaggina» 1991; 1: 287-303.
20. Suttie JM, Corson ID, Webster JR, Woodfort KB. Photoperiodism and growth. In Proceedings of a Deer Course for Veterinarians, Deer Branch NZVA (Ed. P.R. Wilson). New Zealand, Massey University, 1992; 9: 136-42.
21. Pedrotti L, Dupré E, Preatoni D, Toso S. Distribuzione, Gestione, Prelievo e Potenzialità delle Popolazioni di Ungulati. Daino. Banca degli Ungulati, 2007. http://digilander.libero.it/urcalomb/Menu.htm
22. Salghetti A. Un primo censimento degli ungulati selvatici allevati in Italia. Atti XIII Convegno Gruppo di studio per allevamenti di selvaggina, Nocera Umbra, Italia 1994: 1-35.
23. Giorgetti A, Poli BM. Alimentazione animale e qualità della carne. In: Quaderni Accademia dei Georgofili. Alimentazione animale e qualità dei prodotti zootecnici. Ed. Parenti, Firenze, 1990: 45-90.
24. Mojto J, Kartusek V. Fallow deer from reserves chemical composition and phisico technological quality of the MM *Longissimus dorsi* and Semimembranosus in various age groups Fleischwirtschaft 1995; 75 (3): 331-3.
25. Duranti E, Casoli C, Coli R, Rambotti F. Rilievi alla macellazione e prime indicazioni sulla valutazione commerciale dei diversi tagli della carcassa di daino. Bastia Umbra, Italia, 1987: 69-78.
26. Giorgetti A, Poli BM, Biagioli O, Ponzetta MP, Funghi R. Capacità digestive e fabbisogni di mantenimento del daino e del cervo. Atti Convegno "Gruppo di Studio per Allevamenti di Selvaggina", Grado, Italia, 1991: 255-61.
27. Lucifero M, Biagioli O. Quale indirizzo per gli allevamenti faunistici. Atti IX Convegno "Gruppo di studio per allevamenti di selvaggina", Bastia Umbra, Italia, 1987: 63-8.
28. Reinken G. Esperienze sugli allevamenti di daino. Atti II Convegno "Gruppo di studio per allevamenti di selvaggina a scopi alimentari". Bastia Umbra, Italia, 1981-1982: 28-37.
29. Bovolenta S, Saccà E, Biasizzo E. Attualità e prospettive dell'allevamento degli ungulati selvatici. Notiziario ERSA, 2000; 15 (3): 21-4.
30. Volpelli LA, Valusso R, Morgante M, Piasenter E. Produzione delle carni e del prosciutto di daino. In: E. Sacca, S. Bovolenta. Ungulati Selvatici, esperienze di allevamento a scopo alimentare in Friuli Venezia Giulia. ERSA, Editoriale Lioyd, San Dorlingo della Valle, Italia, 2004: 63-73.
31. Russo C. Relazione sulla qualità della carcassa e della carne di daino (*Dama dama*). Ann Fac Med Vet Pisa 2005; LVIII: 213-8.
32. Volpelli LA, Failla S, Sepulcri A, Piasenter E Calpain system in vitro activity and myofibril fragmentation index in fallow deer (*Dama dama*): effects of age and supplementary feedin. Meat Science 2005; 69: 579-82.
33. Fajardo V, Gonzales I, Lopez-Calleja, et al. Identification of meats from red deer (*Cervus elaphus*), fallow deer (*Dama dama*), and roe deer (*Capreolus capreolus*) using polymerase chain reaction targeting specific sequences from the mitochondrial 12S rRNA gene. Meat Science 2007; 76: 234-40.
34. Aspa. Commissione valutazione alimenti. Valutazione degli alimenti di interesse zootecnico. 1. Analisi chimiche. Zoot Nutr Anim 1980; 6: 19-34.
35. Aspa. Metodologie relative alla macellazione degli animali di interesse zootecnico ed alla valutazione e dissezione della loro carcassa. ISMEA, Roma, 1991: 66-70.
36. Folch J, Less M, Sloan-Stanley H. A simple method for the isolation and purification of total lipids tissues. J Biol Chem 1957; 226: 497-509.
37. Ulbricht TLV, Southgate DAT. Coronary heart disease: seven dietary factors. Lancet 1991; 338: 985-92.
38. Reiser R, Shorland FB. Meat fats and fatty acids. In: Pearson AM, Dutson TR (Ed.) Meat and Health, Advances in meat research. Elsevier Science Publishers Ltd, London, UK, 1990; 6: 21-62.
39. Sas. SAS/SAT User's Guide, Version 6. 4ª ed. vol. 1, SAS Insitute, Cary, NC, USA, 1991.
40. Sas-Sas/Stat. - User's Guide. Sas Inst. Inc. Cary NC, USA, 1996.
41. Giorgetti A, Lucifero M, Campodoni G, et al. Caratteristiche di macellazione e di sezionatura della carcassa di daino. Atti V Convegno "Gruppo di studio per gli Allevamenti di Selvaggina a Scopo Alimentare", 1984: 207-13.
42. Marsico G, Forcelli MG, Tarricone S, et al. Qualità delle carni di cinghiale allevato e selvatico, Progress in Nutrition 2007; 9 (4): 248-52.
43. Vicenti A, Ragni M, di Summa A, Marsico G, Vonghia G. Influence of feeds and rearing system on the productive performances and the chemical and fatty acid composition of hare meat. Foof Sci Tech Int 2003; 9 (4): 279-6.
44. Cutrignelli MI. Caratteristiche del ta-

glio campione di mezzene di vitelloni podolici sottoposti a differenti sistemi di allevamento. Atti Conv. Naz. "Parliamo di… allevamenti nel 3° millenio", 12-13 ott., Fossano (Italy), 2000: 127-34.
45. Marsico G, Ciruzzi B, Vonghia G, et al. Effetto dell'olio di cartamo sulle performances, sulla composizione chimica della carne e su quella acidica del grasso di agnelli di genotipo diverso. Zoot Nutr Anim 1995; 21 (6): 345-57.
46. Serrano MP, Valencia DG, Nieto M, Lazaro R, Mateos GG. Influence of sex terminal sire line on performance and carcass and meat quality of Iberian pigs reared under intensive production systems. Meat Sci 2008; 78: 420-8.
47. Pascual M, Pla M. Changes in carcass composition and meat quality when selecting rabbits for growth rate. Meat Sci 2007; 77: 474-81.
48. Vicenti A, Marsico G, Pinto F, Moramarco V, Tateo A, Ragni M. L'impiego dell'olio di Cartamo nei mangimi per tacchini. 1) Influenza sulle prestazioni produttive e sulle caratteristiche delle carcasse e delle carni. Rivista di Avicoltura 1994; 6: 35-40.
49. Pinto F, Schiavone M, Marsico G. Effects of diets containing ω-3 fatty acids on productive performances and meat quality of "Murgese" foals. Progress in Nutrition 2004; 2: 122-31.
50. Pinto F, Schiavone M, Marsico G. Effects of dietary ω-3 fatty acids content on productive performances and meat quality of Martina Franca donkey foals. Progress in Nutrition 2007; 9 (1): 29-38.