RED DEER MEAT *(CERVUS ELAPHUS L.)*:
BETWEEN HUNTING AND NECESSITY

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Abstract

The objective of this research was the study of physic-chemical, technological and sensorial red deer meat characteristics (m. longissimus dorsi, m. semitendinosus and m. triceps brachii) (stags and hinds) harvested in the forests of N - E Romania.

Technological parameters for expression of water holding capacity (meat drip losses and cooking losses) were affected by ultimate pH (5.54 – 5.66), while tenderness showed the minimum value at m. longissimus dorsi (LD) collected from hinds carcasses (18.38 N). The colour was affected by packaging and preserving conditions causing a moderate meat storage period, while the sensory analysis showed the specific features of game meat.

Key words: red deer, physico-chemical, technological and sensory meat characteristics, pH

INTRODUCTION

Today, consumers appreciate the diversity of food as an extremely important factor, with direct influence on the choosing alternatives, qualitative and not necessarily quantitative. The increased interest on meat quality, both in terms of nutritional and culinary satisfaction implies the need for complex evaluations of descriptive specific parameters for the sold products.

The superiority and specificity of game meat is given by the ratio between the main chemical components from meat composition, by fatty acid profile which describing the intramuscular fat, by vitamins, micro and macronutrients and by its specific aroma and flavour. Quantitative and qualitative, these properties are determined by the specific conditions of uncontrolled habitat, the objective of this research being to study these parameters under the premise that at global level, deer meat is no longer an exclusively product, the industry of deer being in full development (Hui Y.H. et al., 2001).

MATERIALS AND METHODS
Biological material studied

The biological material consisted of eight red deer carcasses (*Cervus elaphus L.*), 4 stags and 4 hinds harvested by shooting in the forests of north-eastern Romania during the hunting season 2009-2010. The animals aged between two and five years old.

The eviscerated carcasses presented weights ranging between 89 and 132 kg for hinds ($\overline{X}$= 107 kg eviscerated carcass) respectively 95.7 and 133 kg corresponding to stags ($\overline{X}$ = 111.62 kg eviscerated carcass).

At 24 hours after harvest were taken samples from the middle and extremity of the following muscles: *longissimus dorsi* (LD)*, semimitendinosus* (ST) and *triceps brachii* (TB), vacuum packaged and preserved at –20° C until the meat analyses.

Physico-chemical and technological tests

The analyse of basic chemical composition for tissue samples included the determination of water, protein and fat, processing of muscle being done with Food – Check spectrophotometer, which utilise the infrared absorbance characteristics of the sample spectra (AOAC 2007-04), while the total mineral content was determinate according to AOAC 1990.

The pH value was measured with the electrode of Hanna Instruments 98240 pH meter, practicing the successive immersion in a suspension consisting of distilled water and triturate of each studied piece (aqueous extract).

Colorimetric characterization of muscle tissues was achieved through CIELAB coordinate values L*, a*, b*, C, h$^°$ (Stevenson J.M. et al., 1989), colour indicators measurement being performed with Minolta CM-2600d. For reading the values were used the standard angle of 10° and D65 luminescence fascicle in the same colorimetric space.

Before the determinations, muscle samples were maintained for 24 hours at temperature of 2° C for complete thawing and 2 hours at 3° C, before colour measurement, for full oxygenation of myoglobin from the sample surface – blooming effect (Honikel K.O., 1998).

Water holding capacity (WHC) expressed through two technological parameters (cooking losses and drip losses) have followed the methods described by Honikel K.O., 1998.

Before Warner Bratzler shear forces (WBSF) measurement, the meat samples were subjected to heat treatment on water bath for 45 minutes at 75° C, than wrapped in aluminium foil, stored for 24 hours at 4° C and sectioned into cylindrical shapes (3 cylinders with a diameter of 1.5 cm and 2 cm length) in the sense of muscle fibres.

To determine the forces was used a specific blade (angle of 60°, speed of 100 mm/min, cutting force of 1000 N) attached to TA Plus Lioyd Instruments machine.

Cylindrical muscle samples were sectioned perpendicular to the purposes of muscle fibres, the maximum force required for cutting the piece being the indicator of meat tenderness.

Sensory analysis

Before analysis, tissue samples (*m. longissimus dorsi*) were frozen in vacuum atmosphere at -20$^°$ C, then slowly thawed and maintained at 4$^°$ C for 24 hours. To highlight the sensory properties, them were subjected to conventional baking at 150$^°$ C to an internal sample temperature of 67 – 72$^°$ C (Hutchison C.L. et al., 2010). After cooking the samples were immediately cut into 2 x 2 cm thick slices and served to panellists without delay.

The cooked meat sensory characteristics (colour, flavour, texture, juiciness, overall assessment) were rated on a scale of 10 points regarding their intensity of expression, defining all the parameters used for sensory meat evaluation being performed according to the protocol described by Rødbotten M. et al., 2004.

Processing and interpretation of data on sensory evaluation parameters included three key decision factors related to the tasters:
➢ panellists gender (♂, n = 15), (♀, n = 15);
➢ age group (25 – 34 years, n = 26), (35 – 50 years, n = 4),
➢ tasters game meat eating experience in general and red deer meat consumption in particular ("previous experience", n = 2; "no experience, n = 28).

Statistical analysis

Statistical data processing was done in Microsoft Excel, using ANOVA dispersion analysis test, comparison model including the effect of gender on studied parameters

RESULTS AND DISCUSSION

The chemical composition of tissue samples is presented in table 1. As general image it has been noted the slightly higher content of total lipids, the minimum value recorded for each muscle group being assigned to stags.

The difference of 0.19% for the total mineral content in dorsal muscles of hinds carcasses is distinct significant (P=0.008314), while at the other muscle samples were insignificant differences (P≥0.05).

The average value of total protein ranged from a maximum of 21.82% at LD muscles taken from hind's carcasses, while the lower limit of 21.42% was calculated for hinds ST muscle.

The quality of raw material is often analysed in view of the proportions between particular chemical components, for instance the water/protein ratio (W/P) is an indicator used to assess the nutritional composition of meat – raw material.

The average values calculated for LD muscle (3.45 vs. 3.37) were slightly higher than those obtained by Daszkiewicz et al., 2007, but are maintaining their proportionality (3.42 vs. 3.32).

Table 1 Chemical composition of red deer meat (*Cervus elaphus L.)* ($\overline{x} \pm s_{\overline{x}}$)

Specification	M. longissimus dorsi		M. semitendinosus		M. triceps brachii	
	♂	♀	♂	♀	♂	♀
Water (%)	74.87 ± 0.165	73.7 ± 0.645	74.69 ± 0.410	74.33 ± 0.562	73.77 ± 0.503	73.63 ± 0.346
Ash (%)	1.015[a] ± 0.029	1.205[c] ± 0.39	1.035 ± 0.032	1.01 ± 0.244	1.117 ± 0.072	1.039 ± 0.049
Proteins (%)	21.7 ± 0.122	21.82 ± 0.110	21.57 ± 0.047	21.42 ± 0.047	21.7 ± 0.07	21.52 ± 0.085
Lipids (%)	2.4 ± 0.216	3 ± 0.348	2.7 ± 0.108	3.22 ± 0.265	3.0 ± 0.616	3.7 ± 0.177
Water:Proteins	3.45 ± 0.013	3.37 ± 0.038	3.46 ± 0.013	3.47 ± 0.022	3.39 ± 0.029	3.42 ±0.023

ANOVA test: for each studied muscle and parameter, compared by gender:
[ac] distinct significant differences ($P \le 0.01$)

Table 2 Physico-chemical and technological properties of red deer meat *(Cervus elaphus L.)* ($\overline{x} \pm s_{\overline{x}}$)

Parameter	M. longissimus dorsi		M. semitendinosus		M. triceps brachii	
	♂	♀	♂	♀	♂	♀
pH$_{24}$	5.59 ± 0.055	5.58 ± 0.034	5.54 ± 0.032	5.59 ± 0.065	5.66 ± 0.037	5.64 ± 0.041
L$^{\cdot}$ (lightness)	28.07 ± 1.014	25.21 ± 1.641	21.39 ± 2.275	18.20 ± 1.671	23.98 ± 1.64	20.49 ± 1.414
a$^{\cdot}$ (redness)	9.35 ± 0.242	12.59 ± 1.379	13.69 ± 1.844	16.60 ± 1.882	11.92 ± 1.35	13.035 ± 1.523
b$^{\cdot}$ (yellowness)	10.4 ± 0.571	12.72 ± 0.649	12.00 ± 0.605	11.62 ± 0.393	12.93[a] ± 0.736	10.66[b] ± 0.537
C$^{\cdot}$ (Chroma)	13.99 ± 0.511	17.98 ± 1.323	18.30 ± 1.744	20.44 ± 1.671	17.63 ± 1.44	16.92 ± 1.44
h$^{\cdot}$ (Hue angle)	47.95 ± 1.445	45.94 ± 2.429	42.46 ± 2.708	36.90 ± 2.925	48.035[a] ± 1.787	40.11[b] ± 2.431
Collagen (mg/g)	4.32 ± 0069	4.24 ± 0.02	4.38 ± 0.02	4.30 ± 0.056	4.31[a] ± 0.024	4.16[b] ± 0.006
Warner Bratzler shear forces (N)	20.73[a] ± 0.329	18.38[d] ± 0.454	35.9[a] ± 0.49	24.67[d] ± 0.498	37.06[a] ± 0.75	30.59[d] ± 0.677
Cooking losses (%)	29.88[a] ± 0.429	26.25[c] ± 0.471	34.29[a] ± 0.671	29.73[d] ± 0.289	31.22 ± 0.563	29.99 ± 0.379
Drip losses (%)	3.01 ± 0.022	2.92 ± 0.044	3.04 ± 0.054	3.2 ± 0.109	3.1 ± 0.054	3.22 ± 0.098

ANOVA test: for each studied muscle and parameter, compared by gender:
[ab] significant differences ($P \le 0.05$);
[ac] distinct significant differences ($P \le 0.01$);
[ad] very significant differences ($P \le 0.001$)

Description of meat quality through physical and technological parameters is presented in table 2.

Average acidity at 24 hours postharvest has fluctuated between a low value of 5.54, corresponding to ST muscle (♂) and an upper limit of 5.66 in TB muscle (♂), the acidity of muscle samples from hinds carcasses having an intermediary values.

The values from the present research are confirmed by extensive literature studies, carried out by Pollard et al., 2002 (5,54 – 5,60), Wiklund et al., 2001, 2003 (5,71) and Wiklund et al., 2003 (5,59 -5,64).

Meat colour is one of the key parameters in assessing its quality, stability of this being a point of interest for the field experts. Zmijewski T. et al., (2009) highlights the differences between the colorimetric parameters of meat preserved in vacuum atmosphere compared to the normal atmosphere, showing the shelf life extension of vacuum-packed muscles with at least 15 days.

The researches done by Wiklund E. et al., (2006) demonstrate the superiority of colour stability of deer meat subject to a food system of grazing compared to the group who received a diet based on cereals.

In this study, psychometric clarity (L *) describe a dark colour of muscle tissues for each sex, the minimum values being recorded at ST muscle (21.39 - ♂ vs. 18.20 - ♀).

Complementary red-green coordinate (a*) varies insignificantly (P≥0.05) between gender in the muscle, while the differences of b* parameter between sexes have values significantly higher (P=0.032004) at stags compared to hinds for TB muscle.

The Hue angle (h°), resulting from the processing of orthogonal coordinates a* and b* follow the same trend at this muscle (TB), the differences being significantly higher at stags (P=0.025371) compared with hinds.

Biological value of meat proteins include and the total amount of connective tissue, the most abundant being collagen.

The total amount of collagen (Table 2) was higher than 4.15 mg/g for all tissue samples, being recorded significantly higher differences (P=0.016158) between gender (4.31 - ♂ vs. 4.16 - ♀) in the right of *triceps brachii* muscles.

The obtained values in LD muscles (4.32 vs. 4.24) are similar but slightly higher (4.6 vs. 3.78) than those obtained by Daszkiewicz T. et al., 2007.

Meat tenderness, objectively expressed through Warner Bratzler shear force indicates significant differences between gender for all studied muscles, the forces registered at muscle samples from stags carcasses being higher than those from hinds (P=0.000194 – m. LD.; P=1.94E-17 – m. ST.; P=2.58E-07 – m. TB.).

Water holding capacity is the technological parameter which gives information about meat weight losses during storage and its ability to retain water during the heat treatment.

The heat treatment has caused a greater loss in weight of muscle samples taken from males carcasses compared to those sampled from females carcasses, at level of LD muscle (29.88 vs. 26.25) and ST muscles (34.29 vs. 29,73) being recorded distinct significant (P=0.001479) respectively highly significant differences (P=0.000796).

The differences between drip losses values of muscle samples taken from males and females were not significant (P ≥ 0.05).

Horsfield and Taylor (1976) quoted by Hutchison C.L. et al., (2010) are supporting the idea that the list of sensory attributes describing the texture of meat can be reduced to three basic descriptors without any loss of information. These descriptors are: toughness – tenderness, succulence – juiciness and flavour – aroma.

Studies regarding the quality of deer meat showed that physiological changes at males, triggered by the increase in testosterone secretion during the mating period had negative effects on meat tenderness (Stevenson-Barry et al, 1992).

These effects are confirmed by sensory evaluation results of this study. The average score obtained at sensory evaluation with panellist showed in Table 3 points significant differences between males and females for aroma and flavour intensity of the game.

Overall, muscle samples from hinds carcasses had obtained a higher score than those taken from stag's carcasses (8.66 vs. 8.09), the difference between them being significant (Table 3, Figure 1).

Table 3 Sensory properties of red deer meat (*Cervus elaphus L.*) ($\overline{x} \pm s_{\overline{x}}$)

Specification	Sex		Statistical significance
	Males n = 4	Females n = 4	P <
Colour	8.02 ± 0.119	8.29 ± 0.124	n.s.
Aroma	8.50[a] ± 0.102	8.84[c] ± 0.07	0.01, P = 0.00913
Aroma intensity	8.86[a] ± 0.110	8.43[c] ± 0.081	0.01, P = 0.00317
Game flavour	8.07 ± 0.256	7.51 ± 0.216	n.s.
tenderness	7.47 ± 0.195	7.49 ± 0.170	n.s.
Juiciness	7.26 ± 0.153	7.47 ± 0.133	n.s.
Taste desirability	8.32[a] ± 0.163	8.73[b] ± 0.110	0.05, P = 0.04222
Global assessment	8.09[a] ± 0.210	8.66[b] ± 0.135	0.05, P = 0.02585

ANOVA test: pentru fiecare parametru studiat şi muşchi în parte, comparativ pe sexe:
[ab] diferenţe semnificative (P ≤ 0.05)
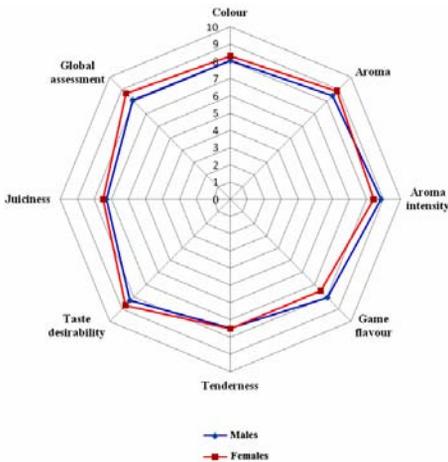[ac] diferenţe distinct semnificative (P ≤ 0.01)

Fig. 1 Sensory evaluation of red deer meat
(n = 8)

CONCLUSIONS

Although chemical analysis of meat showed a slightly decreased content in protein and high in total fat, the report of chemical constituents highlights the particularity of game meat.

Relatively low collagen content and slightly higher in total fat, water/protein ration and Warner Bratzler force values reflect the average score for each sensory parameter, muscle samples taken from carcasses of hinds having superior chemical, technological and culinary quality.

Particular conditions of the animal, harvesting, carcasses handling and their transport caused a moderate meat storage period, the colour being affected by packaging conditions.

Through this sensory evaluation has showed the influence of gender on sensory parameters and the acceptability of the game as an alternative protein source among young occasionally consumers.

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