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PHYSICOCHEMICAL EVALUATION OF BADGER (*MELES MELES*) MEAT

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ABSTRACT

The aim of the work was to evaluate the colour and basic chemical composition (% of water, protein, fat and cholesterol) of the muscles: back (*m. longissimus dorsi* - MLD), shoulder (*m. deltoideus* - MD) and thigh (*m. semimembranosus* - MSM) (n=12) of the European badger. The L* values of the European badger ranged from 31.02 (MLD) to 36.81 (MSM) and significant differences (P≤0.05) were observed between the MSM and MD, respectively MLD. The a* value ranged from 12.60 (MD) to 13.80 (MSM). By evaluating the b* parameter, we observed a similar tendency as with the L* value. The highest values were measured in the MSM (11.17) and lower in the MD (8.58), respectively MLD (8.10). The water content varied from 73.13% (MLD) to 74.11% (MD) with no significant differences between the monitored muscles of the European badger (P≥0.05). The average protein content of MD, MLD and MSM was 22.67 g.100 g^{-1}, whereas the highest content of protein was recorded in MLD (22.77 g.100 g^{-1}) (P≥0.05). The highest fat content was measured in MSM (2.06 g.100 g^{-1}) and the lowest (0.95 g.100 g^{-1}) in MD. We observed significant differences (P≤0.05) in fat content of MLD and MD compared to MSM. The cholesterol content in meat from wild European badgers hunted in Slovakia ranged from 0.52 g.100 g^{-1} (MD) to 0.61 g.100 g^{-1} (MSM). The significant differences (P≤0.05) were between the MSM and MD.

Keywords: badger, meat, colour, chemical composition

INTRODUCTION

The European badger (*Meles meles* L.) belongs to class *Mammalia*, order *Carnivora* of the family *Mustelidae*. It is a medium-sized, social carnivore that is locally abundant across Eurasia (**Aulagnier *et al.*, 2008**). Unlike other mustelids, has a facultative social structure that ranges from solitary to social, depending on food availability (**Kruuk & Parish, 1987**). The badger is present in almost all European countries, from the British Islands eastwards to the west bank of the river Volga. It is a generalist, highly adaptive, species which can exploit a wide variety of habitats (**Feore & Montgomery, 2006; Kauhala & Auttila, 2010**). It is only absent from arctic zones, high altitude regions and some islands (**Griffiths & Thomas, 1993**).
The feed of the badger can be both of animal and plant origin, so it is considered an omnivorous species. The badger feeds on invertebrates, such as: insects, molluscs, and ringworms; small vertebrates, e.g., amphibians, reptiles, birds and their brooders, insectivorous mammals, rodents; hares, offspring other larger mammal species; honey and larvae from bumblebee nests and wasp larvae and carrion. Significant badger's food source are also plants, mainly underground parts, such as roots, tubers, rhizomes and berries, fruits, seeds, mushrooms and even grass (**Sapundzhiev, Chervenkov & Hristakiev, 2019**). It has been investigated that food selection varies seasonally. In autumn, badgers mainly feed on plant food, on the other hand, animal food is preferred by badgers during spring and winter times. The high diversity of the food sources and wide geographical spread of European badger species can influence composition of its meat. Although the high nutritional value of game meat and its positive impact on human health and body functioning have been documented (**Kudrnáčová *et al.*, 2018; Tarricone *et al.*, 2020**), there are very little available information about meat chemical composition of other wild animals.
The badger has been subjected to various genetic and ecological studies on its origin, structure distribution and behaviour. However, there are very few scientific reports related to evaluation of physicochemical properties and nutrition composition of its meat. The information about chemical composition of European badger meat is not readily available, as it is not a commonly consumed or commercially available. However, we can assume that badger meat has a very similar composition to other types of game meat. Game meats tend to be leaner and have a different nutrient profile compared to meat of domesticated animals like beef or pork. They are typically lower in fat and higher in protein. The objective of our study was to perform physicochemical analysis of various badger muscles. Also, we were interested in comparison of badger meat with meat of wild animals that are commonly hunted and consumed.

MATERIAL AND METHODS

Biological material

As biological material for our study, we used a total of 12 individuals of wild European badger, both males and females. Animals were shot and harvested from hunting ground of Nové Zámky and Rožňava, Slovakia. The eviscerated carcasses were transported to Institute of Food Sciences (SUA in Nitra) and stored at 4 °C. After 24 hours' samples were taken from the following muscles: *m. deltoideus* (MD), *m. semimembranosus* (MSM), and *m. longissimus dorsi* (MLD).

Meat colour measurement

Instrumental colour measurements of meat samples were performed using a spectrophotometer (Konica Minolta CM-2600d, Osaka, Japan) with the setting Specular Component Included (SCI). D65 light source and a 10° observer, with a port 8 mm in diameter were used. The white plate calibration was performed at 23 °C, as suggested by the manual. The results were coordinates in the colour interface of the Commission International de l'Eclairage (CIE) L* a* b* system (L*=0, black; L*=100, white; 100 +a*=redness; -a*=greenness; +b*=yellowness; -b*=blueness). Using the optically passive glass aperture cover that came with the colorimeter to ensure a consistently level sample surface, colour measurements were made at three random positions on each sample **(Bianchi, Fletcher & Smith, 2005)**. A white tile was used to calibrate the colorimeter (Minolta calibration plate: C: Y=93.66, =0.3150, y=0.3217).

Meat chemical composition measurement

The samples of muscle from shoulder (MD), thigh (MSM), and back (MLD) were analysed for basic chemical composition (water, crude protein, fat, and cholesterol content in g.100 g^{-1}) performed with INFRATEC 1265 device (Germany) as suggested by **Trembecká *et al.* (2016).**

Statistical analysis

The collected results were statistically analysed using the analysis of variance (ANOVA) method using the XLSTAT program **(Addinsoft, Paris & France, 2017)**, which produced baseline values that are displayed as mean standard deviation. Duncan test was employed to assess the statistical evidence between

each experimental group, and differences were deemed significant at P≤0.05.

RESULTS AND DISCUSSION

Colour evaluation

One of the important characteristics of meat is its colour. The darker colouring of the game is caused mainly by the fact that the game is not slaughtered, but hunted, and therefore usually shows a higher proportion of blood in the muscles. In addition, venison has a higher content of myoglobin, a muscle dye, compared to the meat of farm animals **(Winkelmayer *et al.*, 2005)**. The colour of the meat of wild animals is usually darker and more intensive compared to the slaughtered animals **(Kwiatkowska, Zmijewski & Cierach, 2009)**. If the game is exposed to high stress and suffers a shock during hunting, then its meat is darker, stiff, and dry, but if everything is fine, the game has a normal colour (neither too dark nor too light) **(Pipek, 1998)**. Results of badger meat colour evaluation are listed in Table 1.

Table 1 Evaluation of badger meat colour

Muscle	L*	a*	b*	C*
Shoulder (MD)	31.74 ± 2.40^{b}	12.60 ± 1.83^{a}	8.58 ± 2.02^{b}	15.27 ± 2.57^{b}
Thigh (MSM)	36.81 ± 3.59^{a}	13.80 ± 1.66^{a}	11.17 ± 2.31^{a}	17.80 ± 2.52^{a}
Back (MLD)	31.02 ± 3.04^{b}	12.75 ± 1.81^{a}	8.10 ± 1.79^{b}	15.14 ± 2.32^{b}
p-value	<0.0001	0.084	<0.0001	0.002

Notes: mean ± S.D. (standard deviation); a, b = means significant differences between column (P≤0.05) determined with Duncan test.

The L* values of the European badger muscle samples ranged from 31.02 (back) to 36.81 (thigh) and significant differences (P≤0.05) were found between the thigh and shoulder, respectively back. The a* value varied from 12.60 (shoulder) to 13.80 (thigh) without differences between the monitored muscles (P≥0.05). By evaluating the b* colour parameter, we observed a similar tendency as with the L* values. The highest values were measured in thigh (11.17), lower in shoulder (8.58), respectively back (8.10). For a better comparison, we present the average results of European badger meat colour compared to other game species **(Klupsaite *et al.*, 2020)** (Table 2).

Table 2 Comparison of colour meat different animals

Meat	L*	a*	b*
Badger	33.19 ± 3.01	13.05 ± 1.77	9.28 ± 2.04
Roe deer	37.874 ± 2.71	12.96 ± 1.48	5.12 ± 0.92
Wild boar	36.53 ± 1.85	13.65 ± 2.33	5.77 ± 1.88
Red deer	40.34 ± 0.36	14.15 ± 1.68	8.56 ± 0.62
Beaver	31.40 ± 3.67	15.12 ± 3.02	4.84 ± 1.40

Notes: mean ± S.D. (standard deviation).

Chemical composition

Results of European badger meat chemical composition are listed in Table 3.

Table 3 Chemical composition of badger muscle (g.100 g^{-1})

Muscle	Water	Protein	Fat	Cholesterol
Shoulder (MD)	74.11 ± 1.26^{a}	22.56 ± 0.56^{a}	0.95 ± 0.48^{b}	0.052 ± 0.007^{b}
Thigh (MSM)	73.38 ± 1.30^{a}	22.68 ± 0.44^{a}	2.06 ± 0.95^{a}	0.061 ± 0.012^{a}
Back (MLD)	73.13 ± 0.66^{a}	22.77 ± 0.53^{a}	1.34 ± 0.54^{b}	0.058 ± 0.006^{ab}
p-value	0.118	0.626	0.002	0.102

Notes: mean ± S.D. (standard deviation); a, b = means significant differences between column (P≤0.05) determined with Duncan test.

Fat content

The highest fat content was measured in thigh muscle (2.06 g.100 g^{-1}), and the lowest (0.95 g.100 g^{-1}) in shoulder muscle. We find significant differences (P≤0.05) in fat content in back and shoulder muscles compared to thigh muscles. Based on the fat content in the most valuable parts of the carcass, we can conclude that after removing the abdominal fat, badger meat is highly dietary, i.e., below the 5% threshold. This is also in line with other authors **(Petracci *et al.*, 2019; Haščík *et al.*, 2022).** By comparison with other types of game, or farm animals (Table 4), we observed that European badger meat has the lowest average fat content (1.45 g.100 g^{-1}) **(Williams, 2007; Florek *et al.*, 2017; Klupsaite *et al.*, 2020).**

Cholesterol content

The cholesterol content in meat from wild badgers hunted in Slovakia was from 0.052 g.100 g^{-1} (shoulder) to 0.061 g.100 g^{-1} (thigh). The significant differences (P≤0.05) were between the thigh and shoulder. The results of our investigation are similar to other research about cholesterol content in animals (Table 4) **(Strazdina *et al.*, 2015; Klupsaite *et al.*, 2020).**

Water content

Water is one of the important constituents of all food materials. The percentage of naturally occurring water in meat varies with the type of muscle, the kind of meat, the season of the year, and the pH of the meat, from 56 to 73% **(URL 1)**.
The water content measured in our samples varied from 73.13% (back) to 74.11% (shoulder) with no significant differences between the monitored muscles of the European badger (P≥0.05). When compared, water content in European badger meat do not significantly differ (P≥0.05) from other wild animal species. **(Florek *et al.*, 2017; Klupsaite *et al.*, 2020)**.

Protein content

The average protein content in European badger muscles was 22.67 g.100 g^{-1}, whereas the highest content of protein was recorded in back muscle (22.77 g.100 g^{-1}). The differences between muscles were minimal and not significant (P≥0.05). Based on our findings, we can conclude that badger meat has relatively high protein content and can be a good source of amino acids with a high biological value. We confirmed the opinions of other authors **(Palearia *et al.*, 2003; Schley & Roper, 2003; Williams, 2007; McAfee *et al.*, 2010; Postolache *et al.*, 2011; Strazdióa, Jemeljanovs & Šterna, 2013)** that raw red muscle meat contains around 20 - 25% protein.

Table 4 Average chemical composition of different animals' meat (g.100 g^{-1})

Muscle	Water	Protein	Fat	Cholesterol
Badger	73.54	22.67	1.45	0.057
Roe deer	74.54	22.62	1.99	0.068
Wild boar	74.91	22.17	2.36	0.095
Red deer	73.58	23.15	2.78	0.049
Beaver	73.11	21.34	4.32	0.055
Mutton	73.20	21.50	4.00	0.066
Beef	73.10	23.20	2.80	0.050
Veal	74.80	24.80	1.50	0.051
Lamb	72.90	21.90	4.70	0.066

Notes: mean.

CONCLUSION

To our knowledge, this study is the first assessment of the chemical composition of wild European badger meat. Based on our findings we can conclude that it is high-quality and dietetic meat. Nowadays, only abdominal fat of badger is considered valuable and is utilized in medical practice. Our study suggest that its meat can also be used and consumed as a culinary specialty. In the future, it is

necessary to determine the content of amino acids, or fatty acids in valuable parts of the carcass and sensory evaluation of its meat quality.

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