AMINO ACID COMPOSITION IN THE WILD BOAR (*Sus scrofa ferus*) MEAT ORIGINATING FROM DIFFERENT PART OF CARCASS.

SKŁAD AMINOKWASOWY MIĘSA DZIKÓW (*Sus scorfa ferus*) POCHODZĄCYCH Z RÓŻNYCH CZĘŚCI TUSZY.

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ABSTRACT

The aim of this study was to determine the amino acid composition and its comparison in different muscles *musculus longissimus lumborum* (MLL) and *musculus semimembranosus* (MS) in wild boars with a comparable body weight and representing the same age class. The research involved 10 wild boars. Samples for testing were taken from the central part of the following muscles: MLL, MS. The content of amino acids in the samples was determined with the automatic amino acid analyzer AAA-400 (INGO's). The levels of respective amino acids in muscle MLL were within the range from 5.33 (Tyr) to 22.67 (Glu) g • kg^{-1}, and in muscle MS – from 6.24 (Tyr) to 24.77 (Glu) g • kg^{-1}. It was found that the total content of essential amino acids was higher in muscle MS as compared with muscle MLL. The significant differences (at $p \leq 0.05$) were found for Ser, Gly, Ala, Asp, and Glu. Analyzing the differences in the amino acid composition between muscles MLL and MS, it was found that the average level of all the amino acids in MS was higher.

KEY WORDS: wild boar, muscles, amino acid composition

STRESZCZENIE

Celem badań było określenie i porównanie składu aminokwasowego mięśni *musculus longissimus lumborum* (MLL) i *musculus semimembranosus* (MS) dzików o zbliżonej masie ciała w klasie wiekowej przelatków. Badania prowadzono na 10 dzikach. Próby do badań zostały pobrane ze środkowych partii mięśni MLL i MS.

Skład aminokwasowy w mięśniach oznaczono przy pomocy analizatora AAA 400 (INGO's). Poziomy poszczególnych aminokwasów w mięśniu MLL zawierały się w przedziale od 5,33 (Tyr) do 22,67 (Glu) g.kg^{-1}, w mięśniu MS od 6,24 (Tyr) do 24,77 (Glu) g.kg^{-1}. Wykazano, że ogólna zawartość aminokwasów egzogennych była wyższa w mięśniu MS. Wykazano istotne różnice statystyczne w przypadku Ser, Gly, Ala, Glu. Stwierdzono, że średni poziom wszystkich aminokwasów w mięśniu MS był na wyższym poziomie w porównaniu z mięśniem MLL.

SŁOWA KLUCZOWE: dzik, mięśnie, skład aminokwasowy

STRESZCZENIE SZCZEGÓŁOWE

Celem badań było określenie składu aminokwasowego i jego porównanie w różnych mięśniach (*musculus longissimus lumborum i musculus semimembranosus)* dzików o zbliżonej masie ciała w tej samej klasie wieku. Badania przeprowadzono na 10 dzikach (*Sus scrofa ferus*) o zbliżonej masie ciała w klasie przelatków (w 2 roku życia), odstrzelonych jesienią na terenie o analogicznych warunkach pokarmowych (obszarze leśnym, graniczącym z polami uprawnymi). Bezpośrednio po odstrzale pobierano próbki ze środkowych partii następujących mięśni: *musculus longissimus lumborum* (MLL)*, musculus semimembranosus* (MS). Oznaczenia zawartości aminokwasów w próbkach wykonywano przy użyciu automatycznego analizatora aminokwasów AAA-400 firmy INGO's. Określono zawartości aminokwasów: kwasu asparaginowego (Asp), treoniny (Thr), seryny (Ser), kwasu glutaminowego (Glu), proliny (Pro), glicyny (Gly), alaniny (Ala), waliny (Val), izoleucyny (Ile), leucyny (Leu), tyrozyny (Tyr), fenyloalaniny (Phe), histydyny (His), lizyny (Lys) i argininy (Arg). Każdą próbkę analizowano w 2 powtórzeniach. Wnioskowanie statystyczne prowadzono na poziomie istotności α = 0,05. Zgodność rozkładów cech ilościowych z rozkładem normalnym oceniano za pomocą testu Shapiro –Wilka. W przypadkach rozkładu normalnego, do oceny istotności różnic średnich w tych grupach wykorzystywano test parametryczny t-Studenta dla zmiennych zależnych. Gdy założenia wymagane do zastosowania testów parametrycznych nie były spełnione wykorzystywano test Wilcoxona będący alternatywą testu t- Studenta. Poziomy poszczególnych aminokwasów w mięśniu MLL zawierał się w przedziale od 5.33 (Tyr) do 22.67 (Glu) g·kg^{-1}, natomiast w mięśniu MS od 6.24 (Tyr) do 24.77 (Glu) g·kg^{-1}. Jak pokazują wyniki (Tab.1.) poziom wszystkich aminokwasów był wyższy w mięśniu MS. Stwierdzono, że ogólna zawartość aminokwasów egzogennych była wyższa w mięśniu MS (55.58 g·kg^{-1}) w porównaniu z mięśniem MLL (51.65 g·kg^{-1}). Różnice statystycznie istotne ($p \leq 0.05$) stwierdzono w przypadku Ser, Gly, Ala, Asp, Glu, pozostałe różnice nie były statystycznie istotne. Zaobserwowano, że suma aminokwasów w mięśniu MLL dzików wynosiła 141,4 g·kg^{-1} (aminokwasów egzogennych – 51,56 g·kg^{-1}, względnie egzogennych 23,89 g·kg^{-1} oraz endogennych 65,95 g·kg^{-1}). Natomiast w mięśniu MS 156,43 g·kg^{-1} (aminokwasów egzogennych – 55,58 g·kg^{-1}, względnie egzogennych – 27,23 g·kg^{-1} oraz endogennych 73,62 g·kg^{-1}).

Analizując różnice w składzie aminokwasowym między mięśniami MLL i MS stwierdzono, że średni poziom wszystkich aminokwasów w mięśniu MS był na wyższym poziomie. Podejmowane coraz częściej przez nowoczesnych konsumentów próby dywersyfikacji asortymentu spożywanego mięsa prowadzą do poszukiwań, których owocem powinien być produkt o wysokiej zawartości dobrze

przyswajalnego białka, a co za tym idzie wysokiej zawartości aminokwasów egzogennych. Produktem takim niewątpliwie jest mięso zwierząt dziko żyjących.

INTRODUCTION

Over the last few years there has been observed an increased interest in wild boar meat, which is special thanks to its high culinary, health and technological value. The material derived from wild animals is characterized by a lower content of fat and cholesterol, higher levels of protein, essential amino acids, vitamins, mineral salts and unsaturated fatty acids as well as their higher beneficial ratio, as compared with the meat of farm animals (Dzierżyńska-Cybulko et al., 1997; Font et al.,1999; Hoffman 2008; Hoffman et al., 2006; Marchiori et al., 2003; Műller et al., 2000; Ramanzin et al., 2010; Stevenson et al., 1992). The morphological composition, physical and chemical properties, including the amino acid composition of meat, are a consequence of a specific lifestyle of wild animals (Żochowska et al., 2006). The modern conscious consumer more often pays attention to the biological, nutritional and culinary value of meat material, which is mainly related to the content of fat, water, collagen and their mutual proportions, and also the protein content and it biological value (Moore and Stein 1963; Żmijewski and Korzeniowski 2000). The biological value of protein is primarily determined by the amino acid composition, the content of minerals, vitamins and biostimulators, which enhance the nutritional meat value (Postolache et al., 2010). The applicable literature offers reports on the content of micro- and macronutrients in meat, liver and kidneys, pesticides in fat, the content of vitamins, and describing the culinary value of wild boar meat (Petkov 1985; Petkov 1988; Schwaegele et al., 1995). The differences in the composition of wild boar meat, in comparison with pig meat, in relation to the content of fat and cholesterol were described by Sundom et al. (1994). Skewes et al. (2009) demonstrated a higher level of polyunsaturated fatty acids in meat of wild boars as compared with the hybrid of wild boar and pig. However, there is relatively little coverage on the amino acid content in wild boar meat. One of such reports which cover this problem is the one by Paleari et al. (2003), the authors showed significantly higher levels of free amino acids in wild boar meat as compared with goat and cattle meat. Much more often one can find the reports on the analysis of amino acids in pig meat (Aristoy and Toldra 1998; Cornet and Bousset 1999; Okrouhlá et al., 2006). Due to the tremendous consumer interest in high quality wild boar meat, it is important to determine the amino acids composition to define the potential nutritional value of meat (Young et al.,1984). As reported Khatataev (2007) the amino acid composition, as a determinant of protein quality, characterizes the meat quality in a very accurate way. Moreover Dzierżyńska-Cybulko and Fruziński (1997) reported on the analysis of protein composition in different parts of the carcass showing that its respective parts should be exposed to different technological processes. The amino acid composition of meat depends, to a great extent, on e.g. the species, age and location of the muscle (Lawrie 1985). The aim of this study was

to determine the amino acid composition and its comparison in different muscles (*musculus longissimus lumborum* and *musculus semimembranosus*) in wild boar with a comparable body weight and representing the same age class.

MATERIAL AND METHODS

The research involved 10 wild boars (*Sus scrofa ferus*) with a comparable body weight in the second year of life, shot in autumn, in the area with similar food conditions; the forest area, bordering with cultivated fields. Immediately after shooting samples were taken from the central part of the following muscles: *musculus longissimus lumborum* (MLL)*, musculus semimembranosus* (MS). The content of amino acids in the samples was determined with the automatic amino acid analyzer AAA-400 (INGO's) using the methodology described by Moore and Stein (1963). The amino acids, aspartic acid (Asp), threonine (Thr), serine (Ser), glutamic acid (Glu), proline (Pro), glycine (Gly), alanine (Ala), valine (Val), isoleucine (Ile), leucine (Leu), tyrosine (Tyr), phenylalanine (Phe), histidine (His), lysine (Lys) and arginine (Arg), were determined following the method proposed by INGO's company (Czech Republic). The freeze-dried wild boar muscle tissue samples were subjected to hydrolysis 6 N HCl for 22 hours at 110° C, exposed to nitrogen. Once the hydrolyzate got evaporated, the amino acids were dissolved in buffer at pH 2.2 and subjected to the chromatographic analysis using the amino acid analyzer. Each sample was analyzed in two reps. The data were statistically verified at the significance level $\alpha = 0.05$. The statistical analysis was facilitated by the Statistica 7.0 application. The compliance of the distribution of quantitative traits with the normal distribution was verified using the Shapiro-Wilk test. Whenever the distributions of quantitative variables for the two groups analyzed did not differ from the normal distribution, to assess the significance of differences in the mean values in those groups, the parametric Student's t-test dependent variables was used. When the assumptions for the application of parametric tests were not met, the Wilcoxon test was applied as an alternative for Student's t test.

RESULTS

The study involved confronting the amino acid composition in *musculus longissimus lumborum* (MLL) and *musculus semimembranosus* (MS) in wild boars with a comparable body weight and age. The results are given in Table 1. The levels of respective amino acids in muscle MLL fell within the range from 5.33 (Tyr) to 22.67 (Glu) g • kg^{-1}, and in muscle MS – from 6.24 (Tyr) to 24.77 (Glu) g • kg^{-1}. As provided in Table 1, the level of all the amino acids was higher in muscle MS.

Table 1. The amino acid composition in MLL and MS
Tabela 1. Skład aminokwasowy w MLL i MS

Amino acid **Aminokwasy**	**MLL (g*kg^{-1})**	**MS (g*kg^{-1})**
Thr	8,25 ± 0,85	8,99 ± 1,05
Ile	7,00 ± 0,53	7,89 ± 0,64
Leu	10,61± 0,57	11,05 ± 0,81
Phe	6,89 ± 0,70	7,71 ± 0,83
Lys	11,86 ± 0,45	12,38 ± 1,00
Val	6,95 ± 0,47	7,56 ± 1,48
Σ exogenous aminoacids **Σ aminokwasów egzogennych**	**51,56**	**55,58**
Ser	7,11 ± 0,42^{a}	7,82 ± 0,59^{b}
Gly	5,82 ± 0,84^{a}	7,10 ± 0,56^{b}
Ala	6,28 ± 0,68^{a}	7,25 ± 0,44^{b}
Asp	15.50 ± 1,36^{a}	17,43 ± 1,35^{b}
Glu	22,67 ± 1,25^{a}	24,77 ± 1,96^{b}
Pro	8,57 ± 0,65	9,25 ± 1,04
Σ endogenous aminoacids **Σ aminokwasów endogennych**	**65,95**	**73,62**
Tyr	5,33 ± 0,87	6,24 ± 0,70
Arg	12,40 ± 1,61	14,02 ± 1,57
His	6,16 ± 0,76	6,97 ± 0,63
Σ relatively exogenous aminoacids **Σ aminokwasów względnie egzogennych**	**23,89**	**27,23**

Average ± standard deviation.
$^{a, b}$ - different superscripts indicate significant ($P \leq 0.05$) differences between amino acid level in different muscles.

It was found that the total content of essential amino acids was higher in muscle MS (55.58 g • kg^{-1}) as compared with muscle MLL (51.65 g • kg^{-1}). The significant differences (at $p \leq 0.05$) were found for Ser, Gly, Ala, Asp, and Glu; the other differences were not significant. It was observed that the sum of amino acids in wild boar muscle MLL amounted to 141.4 g • kg^{-1} (essential amino acids – 51.56 g • kg^{-1},

semi-essential amino acids – 23.89 g • kg^{-1} and endogenous – 65.95 g • kg^{-1}), while in muscle MS – 156.43 g • kg^{-1} (essential amino acids – 55.58 g • kg^{-1}, semi-essential amino acids – 27.23 g • kg^{-1} and endogenous – 73.62 g • kg^{-1}). Analyzing the differences in the amino acid composition between muscles MLL and MS, it was found that the average level of all the amino acids in MS was higher.

DISCUSSION

Meat is the main source of protein and essential amino acids (Higgs 2000). The comparison of the present results with other literature reports is quite difficult since the applicable literature does not cover the problem directly; there is only fragmentary coverage available. Żmijewski and Korzeniowski (2001) observed differences in the technological properties of wild boar meat originating from different parts of the carcass. Marchiori and Felicio (2003) show differences in varied qualities of wild boar meat in different muscles and compared with the qualities of pork meat and found wild boar meat more valuable. Postolache et al. (2010) identified differences in the chemical composition of wild boar meat, depending on the muscle type. Similarly, Skewes et al. (2009) compared the chemical composition of wild boar meat, e.g. due to the muscle type, including the level of cholesterol and fatty acids. Similar differences can be observed in the resent results regarding the amino acid composition. It was observed that amino acid content in respective locations of the carcass depended on the muscle type and in it was higher in MS than in MLL. Proteins are the key meat components both from the nutritional and the technological perspective; many of the amino acids they are built of are of paramount importance in shaping both the taste and other meat properties. The differences in the amino acid composition in respective muscles can affect the difference in the taste of meat. Moreover, the differences noted confirm that it is recommended to expose various parts of the carcass to different technological processes to optimize the preparation. Comparing the amino acid composition of wild boar meat originating from various parts of the carcass, despite no significant differences, there can be observed a more favorable profile of exogenous amino acids in MS meat than in MLL meat. The wild boar diet is varies considerably and it depends largely on the habitat [6]. The quality of the meat differs significantly from the farm animal meat and is affected by seasonal fluctuations, living conditions and the diet composition (Hoffmann et al., 2005; Lachowicz et al., 2008). Different habitat conditions of wild and farm animals account for the differences in the chemical composition of meat (Tudor et al., 2009). Of the total of 18 amino acids, crucial in human nutrition, 8 – 10, depending on the age, cannot be synthesized by the human body and as such they must be supplied with food; the essential amino acids: isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, valine and arginine and histidine for infants. In the present research the content of most essential amino acids was reported to be higher in MS than in MLL, which makes that part of the carcass include higher quality protein and, as such, offer a higher nutritional value. Amino acids such as Asp, Gly,

Glu, the content of which was recorded higher in MS than in MLL, play the key role in wound healing (Zasadowski et al., 1988). Despite no significant differences, a higher level of Arg, a precursor of nitrogen oxide in the body, involved in immunological processes, in MS, is noteworthy. Similarly, Arg is the primary substrate for the synthesis of polyamines and creatine (Wu and Morris 1998). Thr, a higher level of which was also reported in MS, is particularly important for the synthesis of mucins and maintaining the integrity of the intestinal barrier (Bertolo et al., 1998).
As reported by Wójcik et al. (2010) characteristic features and properties of the game make it a valuable complement and enrichment of the diet. The modern consumer makes more and more effort to diversify the range of consumed meat, which leads to a search for a product with a high content of easily digestible protein and, consequently, a high content of essential amino acids, which makes the meat of wild animals a perfect solution to that search. The present paper is yet another contribution to the existing knowledge of the amino acid composition in different parts of the wild boar carcass.

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