von 6,00 bis 6,17 überschritten; damit werden sie laut Vorschrif in die Kategorie der nicht entsprechenden Erzeugnisse für diesen Typ der Erzeugnisse eingeschlossen. Durch die organoleptische Analyse der Muster von außen und von innen (auf der Fläche und auf dem Durhschnitt) im Präferenztest sind die Muster, behandelt mit KL besser bewertet als die Muster, behandelt mit NaL oder mit der Salzkombination. Hinsichtlich der einzelnen Charakteristiken, die bewertet wurden (Farbe, Diskoloration, Verkaufsaussehen, Intensität fremder Geruche, Annehmbarkeit der Gerüche), sind die Muster, behandelt mit NaL, beim Bewerten des Geruchs bedeutend abgewichen; wo bei beiden Lagertemperaturen die Muster schlechter von unbehandelten (kontroll) Mustern bewertet wurden.

Schlüsselwörter: *Natriumlaktat, Kalilaktat, gehacktes Rindfleisch, modifizierte Atmosphäre, Lagerbedingungen*

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CHEMICAL COMPOSITION OF HORSE MEAT

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SUMMARY

Horse meat has been used in human nutrition for thousands of years and its usage greatly depended on region, customs of the users and available quantities. A trend of an increased production of horse meat in the world is noticeable. Within the member countries of the EU, an average consumption of horse meat per inhabitant is 0.4 kg a year, but because of the insufficient one's own production, the import covers 66.7% of the market needs. Horse meat is considered to be an especially valuable food. A higher content of water, proteins and glycogen, and lesser content of fat in horse meat make it more suitable for nutrition of especially more demanding categories of people in comparison to pork and beef. The Republic of Croatia is modest in production and consumption of horse meat. Geographical position, under- utilization of great pasture grounds and breeding structure of horse population in Croatia give good chances for a profitable production of horse meat with the possible export orientation. Experiences of the leading countries in horse meat production can be used as an example in choosing adequate systems.

Key words: *horse meat, chemical composition*

INTRODUCTION

Regarding the quantity of water, fat, proteins, minerals, carbohydrates and other substances, a chemical composition of meat gives us basic information on its quality, first of all considering its nutritional value. Horse meat is starting to be even more appreciated on the market because of the characteristic share of certain compounds (proteins, fat, glycogen).The share of essential amino acids, the relation of fatty acids, and the content of macro and micro elements in horse meat are favorable for nutrition of even

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more demanding consumers. A high value of proteins, vitamin B12 and iron, then low content of fat (3%) and cholesterol make horse meat easily digested.

The quality of meat is represented by the sum of all nutritional, sensory, hygienic- technological and processing characteristics (Hofman, 1973). Horse meat has a high content of water, proteins, glycogen, iron and vitamins which are soluble in water, also a lower content of lipids and vitamins insoluble in water, which makes it specific in comparison to the meat of ruminants and pigs (Martin- Rosset, 2001). A high content of muscle fibers (≈ 70 %), then a smaller content of fat tissue give a special diet character to horse meat. The share of fat in horse meat is from 0.5 – 3.0 % and the important fact is that unsaturated fatty acids make a larger share (55.67-60.33 %) than saturated fatty acids (39.67-44.33 %) (Makray et al.,1998). It firstly applies to linoleic, linolenic, palmitic and oleinic fatty acid. Dufey (1999) and Segato et al. (1999) determined that by increasing slaughtering- age of horses the share of fat in the meat is increasing, and the share of water and proteins decreasing. Dufey (1999) claims that the share of cholesterol remains constant, i.e. it doesn't change with aging of head.

Martin- Rosset et al. (1980) noticed that male animals achieve a higher final weight than female animals of the same age (for ≈ 50 kg). The authors list that the share of fat tissue is smaller, and the muscle tissue is larger with male than with female animals, but the difference isn't significant. Nutrition is an important factor, as of quantity so of quality of meat. The authors determined certain but insignificant differences in quantity and quality of meat by feeding one group of horses on hay and concentrate. They noticed that horses fed on silage have a larger share of fat and a smaller share of proteins than the head fed on hay. They also noticed that the share of fat tissue in abdomen grows with age from 9.4% (6 months) to 14.2% (30 months). They also determined that together with the age grows the share of subcutaneous fat as the share of fat tissue which amasses in body cavities, but the share of intramuscular fat in the total fat decreases from 51.4% (6 months) to 43.8% (30 months).

The effect of genotype on efficiency of production and the quality of horse meat is unquestionable. Although there are no horse breeds intended solely for meat production, heavy cold- blooded breeds are appropriate for this kind of production. A smaller share of horse meat is produced of head of warm- blooded breeds which are discharged because of the objective reasons (injuries, old age, etc.). Available researches confirm a significant union of genotype with the quantitative and qualitative parameters of meat at slaughter line. Martin-Rosset et al. (1980) researched slaughter- indicators of five French heavy breeds, aged from 12 to 30 months at slaughter.

Table 1. pH, a_w content of fresh meat after thawing (Paleari et al., 2003)

	Deer	Wild boar	Horse	Bovine	Goat
pH	5.59±0.03	5.75±0.11	5.92±0.06	5.97±0.07	6.27±0.45
a_w	0.96±0.01	0.97±0.01	0.94±0.01	0.96±0.01	0.94±0.01
Moisture (%)	75.0±0.23	74.5±1.07	76.4±0.94	73.6±1.09	78.6±0.23
Proteins (%)	21.7±0.19	21.9±0.65	20.3±0.68	22.2±1.16	17.6±0.49
Fats (%)	2.0±0.22	2.5±1.13	2.1±0.67	2.9±1.35	2.9±0.69
Ash	1.3±0.04	1.1±0.05	1.3±0.09	1.3±0.21	0.9±0.10

Table 2. pH, a_w and an approximate content in final dry- cured products (Paleari et al., 2003)

	Deer	Wild boar	Horse	Bovine	Goat
pH	6.05±0.04	6.30±0.05	5.81±0.15	6.72±0.09	6.48±0.04
a_w	0.90±0.01	0.90±0.01	0.90±0.02	0.95±0.01	0.88±0.01
Moisture (%)	45.8±0.17	48.2±0.31	49.2±0.92	55.4±0.45	47.8±0.42
Proteins (%)	44.6±0.39	39.3±0.40	39.7±0.83	34.6±0.34	38.8±0.41
Fats (%)	2.0±0.26	5.5±0.23	3.4±0.39	4.9±0.31	5.2±0.63
Ash	7.6±0.31	7.0±0.07	7.7±0.22	5.1±0.06	8.2±0.29

Table 3. Levels of cholesterol (mg/100g) in final dry- cured products (Paleari et al., 2003)

	Deer	Wild boar	Horse	Bovine	Goat
Cholesterol	138.3±2.92	155.3±9.57	29.9±0.72	76.5±7.70	121.4±3.34

Table 4. Content of fatty acids (%) of intramuscular fat of final dry- cured products (Paleari et al., 2003)

	Deer	Wild boar	Horse	Bovine	Goat
Fatty acids					
14:0	2.44±0.26	1.22±0.06	1.87±0.36	2.56±0.06	2.50±0.21
16:0	21.4±0.89	23.1±0.82	24.4±1.08	31.4±0.79	22.8±0.64
16:1 n-7	4.71±0.95	2.92±0.15	3.63±0.81	3.14±0.17	1.95±0.22
18:0	21.1±1.66	11.2±0.68	9.3±1.25	13.9±0.58	19.2±1.52
18:1 n-9	20.6±1.24	38.5±1.32	19.0±2.34	38.6±0.56	36.5±1.53
18:1 n-7	5.0±0.55	4.20±0.17	3.43±0.07	1.85±0.14	2.37±0.22
18:2 n-6	8.3±0.63	12.6±0.97	23.0±1.82	4.61±0.47	7.5±1.37
18:3 n-3	5.3±0.43	1.22±0.37	4.50±0.93	0.42±0.03	0.33±0.04
20:4 n-6	2.95±0.59	1.94±0.26	4.84±1.55	1.27±0.17	3.01±0.50
20:5 n-3	2.25±0.26	0.38±0.17	0.51±0.11	0.19±0.02	0.22±0.04
20:6 n-3	0.78±0.16	0.10±0.02	0.48±0.14	nn*	0.12±0.03
Total SFA	44.9±1.81	35.5±1.54	35.6±0.34	47.8±1.00	44.5±2.08
Total MUFA	30.3±2.01	45.7±1.32	26,0±3.13	43.6±0.56	40.9±1.70
Total PUFA	19.6±1.99	16.2±0.80	33.3±2.67	6.5±0.64	11.2±1.87

* - not found
C14:0 – miristinic fatty acid; C16:0 – palmitic fatty acid; C16:1 – palmitolenic fatty acid; C18:0 – stearic fatty acid; C18:1 – oleinic fatty acid; C18:2 – linoleic fatty acid; C18:3 – linolenic fatty acid; C20:4 – arachidonic fatty acid; C20:5 – eicosapentaenoic fatty acid; C20:6 – docosahexaenoic fatty acid; SFA –saturated fatty acids; MUFA – monounsaturated fatty acids; PUFA – polyunsaturated fatty acids

CHEMICAL COMPOSITION OF HORSE MEAT AND PRODUCTS

Paleari et al. (2003) were determining chemical composition of fresh meat of bovine, deer, wild boar, goat and horse, and dry- cured meat of these animals.

In dry- cured meat of deer, wild boar, horse and goat, the aw values suit appropriately dry- cured products, so it can be noticed that pH- values are high, except for the pH of horse and deer (Table 2). It indicates an assumption that there are processes of proteolysis under the influence of endo- and exo- enzymes originating from microorganisms responsible for the process of ripening.

In comparison to other products, it can be concluded from these values that the smallest quantity of cholesterol, and in a significant value, is in the horse meat product.

The values of saturated fatty acids in dry- cured products of wild boar and horse are smaller in relation to the products of deer, bovine and goat. While the products of wild boar, goat and bovine had higher values of monounsaturated fatty acids, polyunsaturated fatty acids are represented in the horse meat product in the highest degree, medium represented in the deer product, and the least represented in the bovine product. By keeping in mind different groups of fatty acids, there was noticed an increased value of C16:0 (palmitic fatty acid) in bovine meat, while the meat of deer, bovine and goat had a higher quantity of C18:0 (stearic fatty acid). Therefore, the products of the meat of deer, bovine and goat had an increased quantity of total fatty acids (SFA). In wild boar, bovine and goat there was a higher quantity of C18:1 n-9 (oleinic fatty acid) which has an increased entire quantity of monounsaturated fatty acids as a consequence. Horse

Table 5. Free amino acids (mg/100g) in final dry- cured products (Paleari et al., 2003)

	Deer	Wild boar	Horse	Bovine	Goat
TAU	69±9.33	53±4.42	67±8.11	28±0.46	43±2.25
ASP	25±6.02	77±11.37	96±5.35	77±3.07	8±1.31
THR	65±6.69	70±12.16	71±2.15	55±3.37	56±4.82
SER	58±5.44	72±5.94	71±3.98	62±6.04	36±4.00
GLU	254±31.93	385±54.06	303±25.24	167±15.28	396±19.11
PRO	108±7.65	104±11.00	56±0.92	76±3.03	137±15.90
GLY	110±14.55	104±9.54	82±12.05	60±3.92	103±11.87
ALA	305±27.93	174±13.92	199±20.43	177±20.95	367±45.07
VAL	197±13.83	146±24.01	164±19.96	93±9.59	181±22.14
CYS	1.8±0.22	1.3±0.32	2.3±0.12	1.6±0.46	2.1±0.49
MET	96±10.47	66±9.56	74±6.27	42±4.18	92±8.66
ILE	121±17.89	96±12.47	122±10.46	73±8.45	136±27.30
LEU	317±47.77	225±8.55	241±25.35	116±12.35	280±57.32
TYR	32±2.32	19±3.13	33±3.94	6±0.64	9±3.79
PHE	135±14.43	113±14.56	140±13.52	51±9.21	126±20.10
ORN	82±8.31	68±7.75	20±0.19	49±3.88	58±1.82
LYS	432±68.32	351±36.36	251±28.55	162±11.19	423±59.78
HIS	132±15.05	89±6.24	55±8.05	44±3.14	110±7.92
ARG	In traces	In traces	In traces	In traces	In traces
TOTAL	2539±289.8	2315±238.73	2047±129.6	1338±76.80	2562±290.02
Essential amino acids (%)	1494±189.9 (58.8%)	1158±123.16 (50%)	1116±81.58 (54.5%)	634±49.31 (47.4%)	1404±205.35 (54.8%)

meat is richer in C18:2 n-6 (linoleic fatty acid) as the products of deer and horse meat in C18:3 n-3 (linolenic fatty acid). It is valuable to mention that deer meat products show a significantly higher quantity of C20:5 n-3 (eicosapentaenoic acid) and C22:6 n-3 (docosahexaenoic acid) than the products of other types of meat. It is considered that such positive values are due to free grazing of these animals on grazing lands and by that a better contribution of fresh plants in feeding.

It is visible from Table 5 that all dry- cured products have a large content of free amino acids, except for bovine which has a significantly smaller content. In any case, all the final products of different types have a high share of essential amino aids in comparison to the content of the total amino acids. The researched products had a significantly decreased content of fat which was characterized by significant values of unsaturated fatty acids. Especially important factor with the products of all the researched animal species is a quantity of polyunsaturated fatty acids, some of which have a very important role, e.g. they act as precursors of antithrombotic factors (Kinsella, 1998, Simopoulos, 1989). A high nutritional value has also been confirmed by a high portion of free amino acids, especially essential amino acids which have unquestionable nutritional value (Harper, 1999, Matthews, 1999). Products with such values are especially appropriate for people who need diet nutrition, exactly because they are easy to digest. The possibility of using the same technological processes in the production of dry- cured, fermented products of meat of different animal species by changing only time parameters for each production step (the larger piece of meat, the longer production lasts) can result in the appearance of those products on the market, which have been insufficiently represented so far.

CONCLUSION

Horse meat is starting to be even more appreciated on the market because of the characteristic share of certain compounds (proteins, fat, glycogen). The share of essential amino acids, the relation of fatty acids and the content of macro and micro elements in horse meat are even favorable for nutrition of more demanding consumers. A high content of proteins, vitamin B12 and iron, then a small share of fat (3%) and cholesterol make horse meat easy digested. Its dark red color indicates a high content of iron, 4 mg per 100 g of meat, significantly more than in beef and pork. Energetic value of horse meat of medium fatness is 472 KJ, i.e. 110 kcal per 100 g. The same as the other proteins of animal origin, proteins from horse meat have a high nutritional value. They contain optimal quantity of essential amino acids which are necessary for the processes of regeneration and synthesis of all the cells in an organism, and the organism doesn't produce them by itself. Also, proteins from horse meat are better than the proteins from veal, pork or beef by their quantity and quality (because of a smaller content of connective tissue it is easier to digest). Meat is one of the most important sources of fat in nutrition of a large share of human population, then it makes around 20% of an average human body weight, and it is an essential ingredient of human nutrition. The content and the fatty- acid composition of fat, which are the lipids in muscle tissue, affect the whole range of characteristics, such as the color, oxidative stability, taste, structure or juiciness. Nutritional quality of meat, as well as the effect on human health, also depends on the content and the composition of lipids in the meat. In comparison with other types of meat, horse meat is soft, delicious, easy to digest, and contains relatively small amount of fats in the meat. Horse meat is a very valuable source of many nutritional compounds necessary for an organism, and it also contains all the vitamins and minerals in optimal quantities. It is easier to digest than beef or mutton. Considering its content and characteristics, it is recommended to the sick people who have problems with cholesterol, people with a heart condition, those with a poor blood count, especially to the anemic people because of the high content of iron. Horse meat represents a special and valuable food of animal origin. Although the production of horse meat in the world and in Europe is in a constant and slight growth, the EU market is still open for this type of meat because it doesn't produce sufficient quantities by itself. The production of horse meat as an alternative production which would include cold- blooded breeds and great unused grazing grounds can take hold in Croatia. Export orientation gives safety on the market. It is important that the proper choice of breed and the system adjusted to specified ecological conditions influence the profitability of the production the most significantly.

ZUSAMMENFASSUNG

CHEMISCHE ZUSAMMENSETZUNG DES PFERDEFLEISCHES

Das Pferdefleisch wird in der menschlichen Ernährung seit Jahrtausenden verwendet, und sein Verbrauch hing von der Region, Gewohnheiten der Verbraucher und verügbaren Mengen ab.

Das Pferdefleisch ist ein besonderes und wertvolles Ernährungsmittel. Man kann einen Trend der Vergrößerung von Herstellung des Pferdefleisches in der Welt bemerken.

In den EU Ländern beträgt der durchschnittliche Verbrauch des Pferdefleisches pro Kopf der Einwohner 0,4 kg jährlich. Da die eigene Herstellung nicht genügt, wird der Bedarf auf dem Markt durch den Einfuhr zu 66,7 % gedeckt. Das Pferdefleisch enthält einen größeren Teil von Wasser, Proteinen und Glykogen, was es zu einem günstigeren Bestandteil in der Ernährung bei der anspruchsvolleren Kategorie der Menschen gegenüber vom Schweine- und Rindfleisch macht. Kroatien ist bescheiden in Bezug auf Herstellung und Verbrauch vom Pferdefleisch. Geographische Lage, große Weideflächen und Rassenstruktur der Pferdepopulation in Kroatien bilden gute Aussichten für eine rentabile Herstellung des Pferdefleisches, mit der Möglichkeit einer Ausfuhrorientation. Die Erfahrungen der führenden Länder in Pferdefleischherstellung können als Beispiel bei der Auswahl der entsprechenden Systeme dienen.

Schlüsselwörter: *das Pferdefleisch, chemische Zusammensetzung*

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LACTOBACILLI IN FOOD HYGIENE

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SUMMARY

In hygiene and technology of foods, almost all the species within the group of lactic acid bacteria have their meaning, as in the positive (fermentation, antimicrobial activity, sensory characteristics of products, probiotic effect), so in the negative sense spoilage bacteria, biogenic amines producers, antimicrobial resistance). Certain species of lactobacilli are "specialized" for use in some fermented dairy or meat products, where they display their positive effect in terms of creating aimed finished products. Except for that, by synthesizing substances which act competitively to other bacteria, lactobacilli improve microbiological stability of products. These mechanisms of microbial inhibition can also be used in conserving "unfermented" food, which significantly prolongs its expiration date.

Key words: *lactobacilli, food, hygiene*

INTRODUCTION

Lactic acid bacteria are constituent part of natural microflora of different food of animal origin. During fermentation they produce metabolites and reductive products which can significantly affect sensory characteristics, but also microbiological safety of products. Regarding microbiological safety, it is known that lactobacilli are those which most often make up the majority of all lactic acid bacteria, and they are competitive towards many spoilage bacteria and pathogens. Thus different authors have reported on antimicrobial effect of lactobacilli toward the bacteria *Listeria monocytogenes*, *Escherichia coli*, *Salmonella spp.*, *Clostridium spp.*, *Staphylococcus aureus* and others (Leroy et al., 2006). Researches have confirmed inhibitory effect toward the listed bacteria under laboratory conditions, but similar results were also got in some of our researches which apply to course of food production or storage, e.g. in fermented sausages, fish or raw meat (Zdolec et al., 2007). Such cognitions nowadays lead to development of an increasing number of the new so- called functional starter cultures comprised of species with known metabolic profile and proved antimicrobial effect.

Antimicrobial activity of lactobacilli is expressed through synthetized organic acids (lactic, acetic), hydrogen peroxide, carbon dioxide, enzymes, reuterine, dyacethil and bacteriocins (Holzapfel et al., 1995). Creating higher quantities of some of the listed substances still isn't desirable in some food, despite the possible microbial activity. It mostly applies to hydrogen peroxide, CO_2, dyacethil or acetic acid in fermented meat products (Kozačinski et al., 2006). The spectrum of their activity will depend on genetic- phenotypic characteristics of species, i.e. on ability of synthetizing products with antimicrobial activity.

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