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The quality of fermented sausages of horse meat during the three production seasons

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scientific paper

Summary

*Production of fermented sausages of horse meat in this country has a long tradition that enriches our cuisine. However, there is little data available on such traditional manufacturing and product quality to be able to talk about standardization and protection of authenticity. The aim of this study was to investigate the physicochemical and sensory properties of sausages made from horse meat, depending on the season of production and stage of maturity. Average values of pH in the finished product amounted to 5.83, 19.90% water content, water activity 0.896, the amount of NaCl 3.44% and ammonia 0.42 mg%. Slight differences were detected in sensory properties of sausages in relation to the production season. During ripening, the production season showed statistically significant differences ($p < 0.05$) in physicochemical parameters, but it did not significantly affect the uniformity of quality of the finished products.***Key words:*** *fermented sausages, horse meat, physicochemical changes, quality*

Introduction

As a commercially most valuable sausage manufacturing product, fermented sausages are manufactured of the finest lots of meat of various animal species. In that sense, horse meat, according to its chemical composition and manufacturing values, is a very convenient substrate for the production and obtained fermented sausage is a product of extraordinary quality and exceptional value (Feiner, 2006; Dobranić et al., 2008, 2009). Production of horse meat and horse meat products is specific to individual countries and regions, while in some parts of the world and cultures it is not present at all. During 2005, eight major horse meat producing countries produced over 700 000 tons (FAO-UN Horticultural Database). In Croatia, this activity is reduced to several regional manufacturers, which is probably not sufficient to exploit the potential of horse meat as a quality raw material for the development of specific meat products in the indigenous cuisine (Njari, 2010). In the villages around Pakrac, a tradition of sausage made from horsemeat was brought from their original homeland and preserved by the Italian minority. They produce a homemade durable product, horse meat sausage ("Piketa"). In this area in the past few years there were mainly slaughtered about 1500 horses. Also, in the area of Varazdin there is a long tradition of production of sausage products made of horse meat (registered sausage- butcher's trade Zvonko Šanjek Family Crafts since 1954). Simic and Mioković (2008) point out that horse sausages in our country are produced in homes or small crafts, so there is little data on their composition and quality. Thus, Devic and Stamenkovic (1990) explored the possibility of producing horsemeat sausages cooked and smoked with hot smoke, then dried. They believe that these are the sausages of acceptable organoleptic properties and that

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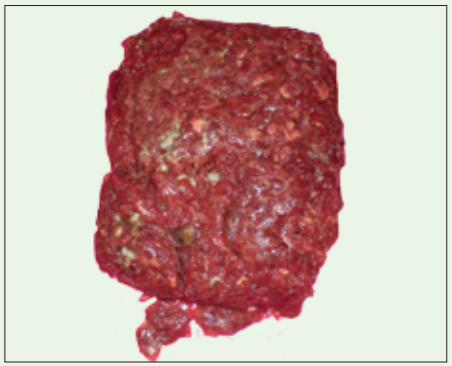


Figure 1 **Horse meat intended for fermented sausages production**

Figure 2 **Pork fat intended for fermented sausages production**

Table 1 **pH during maturing of horsemeat fermented sausages**

Parameter	Batch	Days 0. X	±	SD	14. X	±	SD	28. X	±	SD	36. X	±	SD
pH	April	5,82[a]	±	0,01	5,36[a]	±	0,02	5,04[a]	±	0,01	5,87[a]	±	0,01
	September	6,19[a]	±	0,02	5,60[a]	±	0,03	5,24[a]	±	0,02	5,82[a]	±	0,01
	November	6,09[a]	±	0,01	5,02[ac]	±	0,01	5,53	±	0,02	5,81[c]	±	0,03

[a,b,c] within the same row values marked with the same letter are statistically significantly different (p<0.01)

Table 2 **Water content during maturing of horsemeat fermented sausages**

Parameter	Batch	Days 0. X±SD	14. X±SD	28. X±SD	36. X±SD
Moisture (%)	April	62,08[a]±1,04	34,44[a]±0,93	25,31[a]±0,47	19,69[a]±0,74
	September	60,80[a]±0,69	36,11[a]±0,66	26,28[a]±0,29	20,17[a]±0,64
	November	62,29[a]±0,74	34,17[a]±0,60	25,66[a]±0,67	19,86[a]±1,37

[a,b,c] within the same row values marked with the same letter are statistically significantly different (p<0.01)

Table 3 **Water activity during maturing of horsemeat fermented sausages**

Parameter	Batch	Days 0. X±SD	14. X±SD	28. X±SD	36. X±SD
Water activity	November	0,936[a]±0,002	0,925[a]±0,002	0,899[a]±0,002	0,896±0,001

[a,b,c] within the same row values marked with the same letter are statistically significantly different (p<0.01)

can lead to interest of a wider circle of consumers. Simic and Mioković (2008) reported that horse fat is not suitable for the production of horse meat sausage because of its bad smell and taste and it is perishable.

Recent microbiological study of fermented sausages of horse meat in Croatia has shown that there is room for the improvement and standardization of these products (Alagić et al., 2008, Markov et al., 2010; Alagić et al., 2011, submitted). In this paper we present the results of research on physicochemical and sensory properties of horse meat sausage, depending on the season of production and stage of maturity.

Material and methods

Sausage production and sampling

Horse meat sausages were produced in Varazdin Crafts house by the standard procedure that it applies. Sausages were made from horse meat (75%, Figure 1), solid pork fat (25%, Figure 2), and added ingredients (salt, pepper, paprika, garlic, nitrite salt). After filling of the intestine and draining on a stick, followed by cold smoking for 2-3 days, the sausages were left to mature in fermentation chamber until the 36th day.

Three sausages were sampled on day 0, 14, 28 and 36 (Figure 3-5). At the beginning of the production process, raw materials were also sampled, i.e. horse meat and pork fat tissue. Samples were sent to the laboratory in a portable refrigerator (+ 4 ° C). All samples were subjected to physical and chemical tests and sensory evaluation in triplicate.

Physico-chemical and sensory tests

pH values were determined in meat extract by digital pH meter (WTW, Germany), and the amount of salt and water during the ripening of sausages according to standard AOAC (2002) methodology. For the determination of water activity (aw), the sample was previously fragmented, and according to the manufacturer's instructions for portable aw - meter (Rotronic, Switzerland), aw value was measured: the vessel for the sample was filled, placed in the cradle and the measuring probe was put on it. The amount of ammonia was determined by microdiffusion quantitative method by Schmidt (Zivkovic, 1986). The sample mass of 1 g is chopped up and concentrically distributed in the outer chamber of Conway diffusion dish and poured with potassium carbonate. The solution of boric acid mixed with the indicator is poured in the interior chamber. Ammonia released from the meat reacts with boric acid and converts to ammonium-borate, and the amount of released NH3 is proved by titration with hydrochloric acid. The end of titration is reflected in the emergence of a stable reddish liquid titrated. The amount of ammonia in mg% was calculated using the formula: consumption of HCl x 0.17 x 100 = mg% NH3.

Sensory properties were evaluated according to proceedings of Cocolina et al. (2005).

1 Before the tasting:
a) Color grade
poor (1 to 10) well

b) assessing the appearance of cross-section
poor (1 to 10) well

c) assessing connection of stuffing (association of fat and muscle tissue)
poor (1 to 10) well

2 Rating fragrance of products
Is there an odor?
YES NO

If YES:
Describe
Quit Evaluation

If NO, to evaluate
poor (1 to 10) well

3 Taste the product and assess:
a) rancidity
poor (1 to 10) well

b) quality of fat
poor (1 to 10) well

c) acidity
poor (1 to 10) well

d) juiciness
poor (1 to 10) well

e) tenderness
poor (1 to 10) well

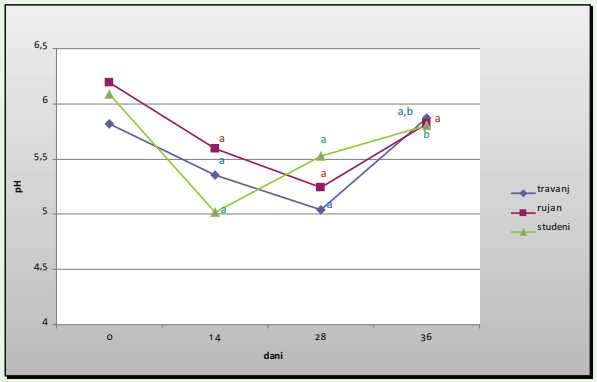
f) general taste
poor (1 to 10) well

4 Assessment 10 minutes after tasting:
poor (1 to 10) well

5 Evaluating the overall sensory impression:
poor (1 to 10) well

Statistical data analysis

Data were analyzed using statistical software Statistica 8 (StatSoft, 2008). After the primary statistical analysis normality of distribution was checked by Kolmogorov-Smirnov normality distribution test. To determine the significance of the difference values determined during the ripening of sausages (and after each season) one-way analysis of variance was used (One way ANO-



[a,b] values marked with the same letter (at same day of maturing) are statistically significantly different (p<0.05)

Graph 1 **pH during maturing of horsemeat fermented sausages through three seasons**

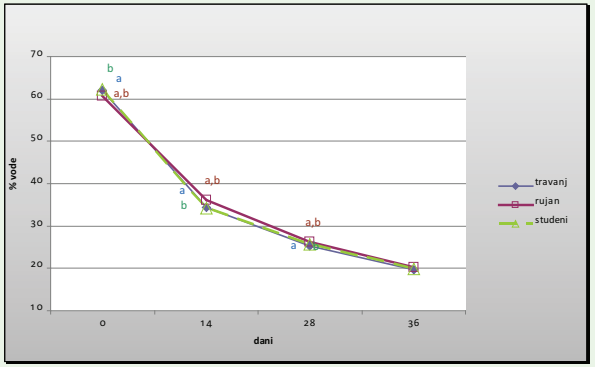
VA) with Tukey-HSD test for starting post-hoc analysis.

Results and discussion

The results are shown in tables 1-5 and figures 1-5. Tables (modified physicochemical parameters during ripening) have shown significant difference between the average values determined for individual days (but within the same series that month). The significance of differences between the individual series (months), keeping in mind the days, is indicated on the graphs.

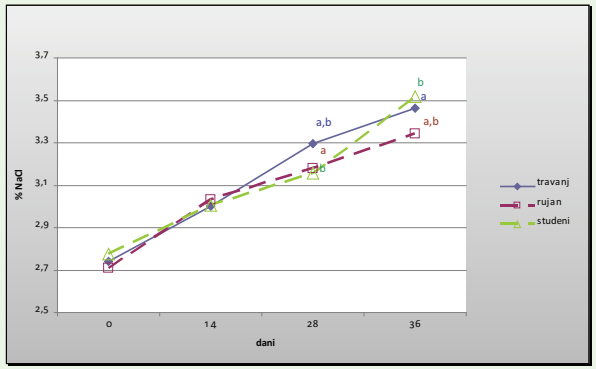
The average pH value of horse meat and pork fat tissue amounted to 5.72 or 6.29. During ripening, the pH value of sausage filling was decreasing for the first and second series (April and September) to day 28, and in the third series (November) to day 14 (Table 1). The final pH of sausages, compared to baseline values, decreased slightly (about 0.2 units). However, by day 28 of sausage ripening there was a significant acidification, which is characteristic for horse meat sausage. Specifically, Feiner (2006) points out that horsemeat acidifies much more than beef or pork because of their naturally higher amounts of glycogen. In processing beef and pork, the pH of the fermented sausages decreases by about 0.15 to 0.3 pH units as a result of degradation of natural sugar (glycogen).

Applying only lean horse meat, stuffing acidification is much more evident and the pH decreased to 0.7 to 0.8 pH units, which in our case is confirmed, but until day 28 of ripening. The average pH in the finished product was 5.83, which is within the results of Palearia et al. (2003). On the other hand, Markov et al. (2010) in domestic fermented sausages of horsemeat determine pH of 4.94, which is significantly lower than in our study. The differences are probably caused by the duration of



[a,b] values marked with the same letter (at same day of maturing) are statistically significantly different (p<0.05)

Graph 2 **Water content during maturing of horsemeat fermented sausages through three seasons**



[a,b] values marked with the same letter (at same day of maturing) are statistically significantly different (p<0.05)

Graph 3 **NaCl content during maturing of horsemeat fermented sausages through three seasons**

ripening and other influential factors. Graph 1 shows that pH differed significantly by the individual days of ripening in relation to the production season. It is commonly found in traditional manufacturing because it is difficult to ensure a standard quality of raw materials and continuous microclimate conditions. Feiner (2006) notes that the main difficulty during the production of fermented sausages is a hardly predictable degree of acidification of lean meat. The reason is that neither the initial pH value, nor the share of sugar in the meat are never equal, and therefore buffering system of amino acids is not present in the meat (even the same kind of meat).

The amount of water is properly and continuously decreased during ripening, regardless of the season, from the initial 60% to 20% in the finished product (Table 2, Figure 2). Alagić et al. (2008) warned that a too

Figure 3 **Horsemeat fermented sausages after stuffing (day 0)**

Figure 4 **Horsemeat fermented sausages at the end of maturing**

Table 4 **NaCl content during maturing of horsemeat fermented sausages**

Parameter	Batch	Days 0.	14.	28.	36.
		X±SD	X±SD	X±SD	X±SD
NaCl (%)	April	2,74 [a]±0,07	3,00 [a]±0,08	3,30 [a]±0,06	3,46 [a]±0,04
	September	2,71 [a]±0,08	3,03 [a]±0,03	3,18 [a]±0,08	3,34 [a]±0,05
	November	2,78 [a]±0,06	3,01 [a]±0,03	3,16 [a]±0,08	3,52 [a]±0,06

[a,b,c] within the same row values marked with the same letter are statistically significantly different (p<0.01)

Table 5 **Ammonia content during maturing of horsemeat fermented sausages**

Parameter	Batch	Days 0.	14.	28.	36.
		X±SD	X±SD	X±SD	X±SD
Ammonia (mg%)	April	0,82 [a]±0,04	1,57 [a]±0,05	0,52 [a]±0,01	0,32 [a]±0,03
	September	0,56 [a]±0,04	1,52 [ab]±0,07	0,52 [b]±0,02	0,62 [ab]±0,01
	November	0,63 [a]±0,05	1,45 [bc]±0,05	0,52 [b]±0,08	0,31 [ac]±0,06

[a,b,c] within the same row values marked with the same letter are statistically significantly different (p<0.01)

long duration of horse sausage drying (42 days) results in a too dry and too hard final product (toughness, hard consistency, water content <20%). Markov et al. (2010) found twice as high water content in the domestic horse meat sausage. Studies of the chemical composition of fermented sausage meat from other species showed an average value of 25% (Zdolec et al. 2007; Pleadin et al., 2009).

Water activity was measured only in the third series of sausages, where we recorded an average value of 0.896 (Table 3), and Paleari et al. (2003) state that fermented products of horse meat have about 0.94 water activity. By reducing the amount of water, the amount of salt is increased from the initial 2.7 to 3.3 to 3.5% in all production batches (Table 4). The content of salt is consistent with the results reported by other authors (Kozačinski et al., 2008, Markov et al., 2010). The amount of ammonia in all production batches doubled until day 14 of ripening, after which there was a decrease towards the end of its maturity (Table 5). Sausages produced in September to the end of ripening had a significantly higher amount of ammonia in comparison with the sausages from the season in April and November (p <0.05; graph 4). The research on fermented sausages showed that intense proteolytic processes occurred in the initial stages of ripening, which can be explained by activation of tissue proteases due to a lower pH (Hughes et al., 2002; Zdolec et al., 2008). Among other compounds, ammonia is a product of proteolysis, so our results were consistent with the foregoing. Sensory evaluation detected slight differences in sensory properties of sausages in relation to the season of production (Figure 5). The properties with the highest scores were connection of filling, the quality of fat and acidity, and the lowest properties of color, layout section, tenderness and juiciness.

In conclusion, based on the results of sensory index, we can conclude that the physicochemical changes in horse sausage filling during ripening resulted in quality products. Looking at seasonally-dependent movement of certain parameters, there are significant differences during ripening, which, however, did not significantly affect the uniformity of quality of finished products.

* The results are a part of the PhD thesis of Damir Alagic "Factors of

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fermentation in sausages filling from horse meat" Mentor: prof. PhD. Lidija Kozačinski (dissertation was prepared under the project of the Ministry of Science, Education and Sports of the Republic of Croatia 053-0531854-1853). We thank Mr. Zvonko Šanjek, the owner of sausage butcher's trade from Varazdin, who enabled us with his contribution to realize this work.

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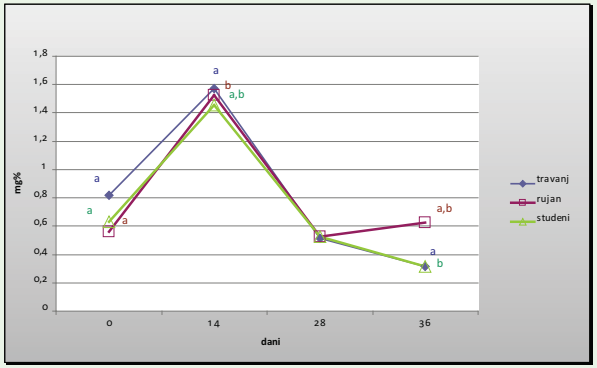
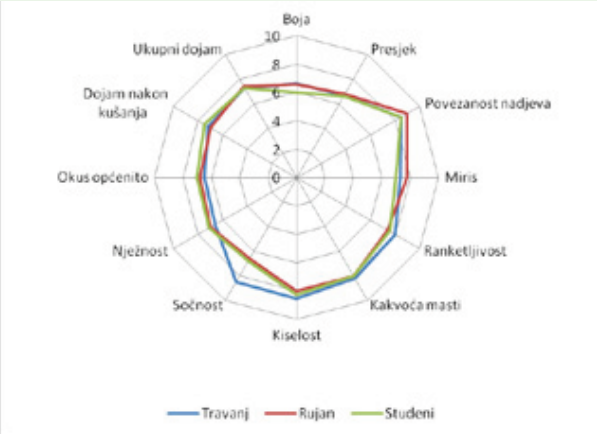


[a,b] values marked with the same letter (at same day of maturing) are statistically significantly different (p<0.05)

Graph 4 **Ammonia content during maturing of horsemeat fermented sausages through three seasons**



Graph 5 **Ammonia content during maturing of horsemeat fermented sausages through three seasons**

Figure 5 **Cross-section of horsemeat fermented sausages at the end of maturing**

Qualität der fermentierten Würste aus Pferdefleisch während drei Herstellungssaisons

Zusammenfassung

Die Herstellung der Würste aus Pferdefleisch hat in unserem Land eine lange Tradition, die unsere gastronomische Tradition bereichert. Es gibt aber zu wenig zugängliche Angaben über diese traditionelle Herstellung und Qualität der Erzeugnisse, um von Standardisation und Schutz des Originalerzeugnisses sprechen zu können. Deshalb war das Ziel dieser Arbeit physikalisch-chemische und sensorische Eigenschaften der Würste aus Pferdefleisch zu untersuchen, dies im Zusammenhang von der Herstellungssaison und Reifephase. Die durchschnittlichen pH-Werte im fertigen Erzeugnis betrugen 5,83, Wasseranteil 19,90 %, Wasseraktivität 0,896, NaCl-Menge 3,44 %, Ammoniakmenge 0,42 mg%. Durch sensorische Bewertung wurden unbedeutende Abweichungen bei sensorischen Eigenschaften der Würste in Bezug auf die Herstellungssaison beobachtet. Während des Reifeprozesses wurden je nach Herstellungssaison statistisch bedeutende Unterschiede (p<0,05) der physikalisch-chemischen Indikatoren festgestellt, die aber trotzdem keinen Einfluss auf die Ausgeglichenheit der Qualität von fertigen Erzeugnissen hatten.

Schlüsselwörter: *fermentierte Würste, Pferdefleisch, physikalisch-chemische Veränderungen, Qualität*

Qualità delle salsicce fermentate fatte di carne di cavallo nel corso di tre stagioni produttive

Sommario

La produzione delle salsicce fermentate fatte di carne di cavallo ha una lunga tradizione nel nostro paese il che arricchisce la nostra offerta gastronomica. Ci sono però troppo pochi dati su tale produzione tradizionale e su tale qualità del prodotto per poter parlare della standardizzazione e protezione dell'originalità. Lo scopo di questo lavoro era perciò di fare una ricerca sulle caratteristiche fisico-chimiche e quelle sensoriche delle salsicce fatte di carne di cavallo che dipendevano dalla stagione produttiva e dalla fasi di maturazione. I valori pH medi del prodotto finale facevano 5,83, la percentuale dell'acqua faceva 19,90 %, l'attività dell'acqua 0,896, la percentuale del NaCl 3,44 % e dell'ammoniaca 0,42 mg%. La valutazione sensorica ha mostrato le minime differenze nelle caratteristiche sensoriche delle salsicce rispetto alla stagione della produzione. Durante la maturazione le differenze degli indici fisico-chimici notevoli quanto alla statistica (p<0,05) sono state confermate che però non hanno avuto un influsso evidente sull'uguagliamento della qualità del prodotto finale.

Parole chiave: *salsicce fermentate, carne di cavallo, cambiamenti fisico-chimici, qualità*

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