Identification of horses as a possible factor of safety of horse meat

Summary

Horse meat can be a valuable substitute for beef in cookery, firstly because of its chemical composition, i.e., the fact that due to low content of fat (3%) horse meat is easy to digest and it is suitable even for a diet. The goal of this paper was to determine the factors which can affect the safety of horse meat, so there was considered legislation on transportation of equidae and traceability and on one example from the practice there was performed simulation of control of delivery of horses to slaughterhouse processing into an approved slaughtering facility for equidae for the period of one calendar year. A conclusion was made from the obtained results that by applying of the Regulation for identification and registration of equidae (ANON, 2009) there was established an uninterrupted traceability from the farm of birth to slaughtering facility and shipments were accompanied by the information on the food chain. A problem could appear by opening of the market toward the EU, from the aspect of unevenness of the approach of implementation of Commission Regulation (EC) No. 504/2008 in member countries of the EU, due to which there is a need for strengthening the capacity in terms of marking and identification of equidae in the Republic of Croatia and creating a base of equidae migration modeled after the one for cattle.

Keywords: *identification and marking of horses, horse meat, safety of horse meat*

Identifikation von Pferden als möglicher Faktor der Sicherheit von Pferdefleisch

Zusammenfassung

Pferdefleisch kann ein werter Ersatz für Rindfleisch in der Kochkunst sein, in erster Linie wegen seiner chemischen Zusammensetzung und der Tatsache, dass Pferdefleisch wegen seiner niedrigen Fettmenge (3 %) leicht verdaulich ist. Es ist sogar für die Diäternährung geeignet. Das Ziel dieser Arbeit war, Faktoren festzustellen, die auf die Sicherheit des Pferdefleisches einen Einfluss haben können. Deshalb wurde die Legislative über den Verkehr von Huftieren und deren Folge in Betracht gezogen. Auf einem Beispiel aus der Praxis wurde die Simulation der Kontrolle der Pferdeanlieferung zur Schlachtverarbeitung in das dafür genehmigte Schlachtobjekt für Huftiere für die Periode von einem Kalenderjahr durchgeführt. Aus den bekommenen Resultaten wurde der Beschluss gefasst, dass durch die Anwedung der Dienstvorschrift über die Identifikation und Registration von Huftieren (ANON, 2009) laufendes Folgen hergestellt worden ist, u.zw. vom Wirtschaftshof der Geburt bis zum Schlachtobjekt. Diese Lieferungen wurden mit den Angaben über die Fütterungskette versehen. Mit der Eröffnung des EU-Marktes könnte das Problem entstehen, u.zw. vom Aspekt der Nicht-Ausgeglichenkeit bezüglich Durchführung der Vorschriften der Kommission (EC) Nr. 504/2008 in den EU-Staaten. Deshalb besteht das Bedürfnis nach der Stärkung von Kapazitäten im Sinne der Kennzeichnung und der Identifikation von Huftieren in Kroatien, und das Bedürfnis nach Schaffung der Migrationsbasis für Huftiere laut jener für die Rinder.

Schlüsselwörter: *Identifikation und Kennzeichnung der Pferde, Pferdefleisch, Sicherheit des Pferdefleisches*

Individuazione del cavallo come possibile fattore di sicurezza della carne equina

Sommario

La carne equina può essere un valido sostituto della carne bovina in cucina, soprattutto per la sua composizione chimica, ossia per il suo basso contenuto di grassi (3%) che ne fa una carne facilmente digeribile, anzi adatta a un'alimentazione dietetica. Lo scopo di questo lavoro consiste nell'individuare i fattori che possono influire sulla sicurezza della carne equina. In questo senso è stata analizzata la normativa vigente in materia di commercio degli equidi e di tracciabilità, e su un esempio pratico è stata effettuata la simulazione dei controlli del trasporto dei cavalli al macello in una struttura di macellazione autorizzata per equidi nell'arco di un anno solare. Dai risultati ottenuti si conclude che, con l'applicazione del Regolamento sull'identificazione e la registrazione degli equidi (ANON, 2009), è possibile l'assoluta tracciabilità dell'animale dall'azienda di nascita alla struttura della macellazione, e che ogni carico è accompagnato dai dati sulla filiera agroalimentare. Problemi in questo senso potrebbero insorgere con l'apertura del mercato all'Unione europea, nel senso dell'eterogeneità dell'approccio all'attuazione del Regolamento della Commissione (EC) numero 504/2008 nei paesi membri dell'UE, per cui esiste la necessità di rafforzare le capacità nel senso della marcatura e dell'identificazione degli equidi in Croazia, e della creazione di una banca dati sulla migrazione degli equidi sul modello di quella creata per i bovini.

Parole chiave: *identificazione e marcatura dei cavalli, carne equina, sicurezza della carne equina*

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Physico-chemical, colour and textural properties of horse salami

Kovačević, D. [1], K. Mastanjević[1]*, J. Frece,[2], J. Pleadin[3]

scientific paper

Sažetak

A study of physico-chemical properties and instrumental measurement of colour and texture was carried out on seven different brands of traditional homemade dry fermented horse salami from Pakrac area. Basic physico-chemical properties, pH values and salt content showed significant variability (p = 0.05), except for the values of aw. Textural and colour parameters (L, a* and b*) also showed significant (p = 0.05) variability, especially hardness and a* value. This can be related to different recipes (different mass fraction of pork back fat used in recipes) and casing (different diameter) used by different producers and with different drying - ripening stages of the investigated samples.*

Keywords: *Horse salami, traditional manufacturing technology, physico-chemical properties, texture profile analysis (TPA), colour (L*, a*, b*)*

Introduction

Traditional production of Horse salami is related to Italian minority in villages in the surroundings of towns Pakrac and Lipik (Western Slavonia region). This product in the past was "the dish of the poor", today it is highly appreciated autochthon Croatian meat product with great potential for the protection of geographical indications and/or designations of origin. Although horse meat has a high nutritional and mineral value, its use for human consumption is negligible due to the feeling of a sort of "cannibalism" towards an animal loved as a pet or a sport companion (Martuzzi el al., 2001). Horse meat used for the production of Horse salami was obtained from horses that were slaughtered at the end of their working life. The meat had no appreciable organoleptic and nutritional characteristics revealed by a very dark red colour and fat possessed a yellow colour and was tough due to maturation of connective tissue (Tateo et al., 2008). Horse salami has specific sensorial properties (smell and taste), which mainly originate from being dried and smoked, and from ripening, enzymatic, lactic acid bacteria and moulds activity. The recipe for Horse salami is 130 years old and the only difference from producer to producer is in mass fraction of pork back fat used in the recipe (12 – 15%). The production of traditional Horse salami mainly takes place on small farms in small amounts and it is seasonal in character and characterised by weather condition from one year to another.

Because of that, there is a great need for the standardization of production. Similar dry sausages from Spain (Chorizo de Pamplona and Salchichón) and Italy (Felino and Milano salami) have been intensively studied for their physical-chemical composition, colour and textural properties (Dellaglio et al., 1996; Perez-Alvarez et al., 1999; Gimeno et al., 2000; Bruna et al., 2003). There is no existing information in scientific literature on this dry sausage, which could contribute efficiently to its characterization

The aim of this study was to examine, for the first time textural and colour properties of Horse salami from Pakrac area, which can be a starting point for the protection of geographical indications and designations of origin, and receiving the protected geographical indication (PGI) or protected designations of origin (PDO), according to the EU Council Regulation (EC) No 510/2006 and EU Commission Regulation (EC) No 1898/2006.

MATERIAL AND METHODS

The manufacturing process

Seven samples of traditional horse salami with highest grades were collected from different producers

[1] **dr.sc. Dragan Kovačević**, full professor, **dr. sc. Krešimir Mastanjević**, assistant professor, Faculty of Food Technology, University of J. J. Strossmayer in Osijeku, Department of Food Technology, Kuhačeva 20, 31 000 Osijek

[2] **dr. sc.. Jadranka Frece** associate professor, Faculty of Food Technology and Biotechnology, University of Zagreb-Croatia, Laboratory for General Microbiology and Food Microbiology, Pierottijeva 6, 10000 Zagreb

[3] **dr. sc. Jelka Pleadin** assistant professor, Laboratory for Analytical Chemistry, Croatian Veterinary Institute, Savska 143, HR-10 000 Zagreb, Croatia.

(Western Slavonia) during the annual competition held in city Pakrac. All samples had been prepared according to the traditional processing procedures without any additives such as nitrites or ascorbic acid added. The traditional production starts at the end of November and lasts until March or April. Horse salami is made from the meat of older (more than 5 years) worn out horses, mainly Hrvatski posavac breed. After the slaughtering the fat and connective tissue are carefully removed from horse meat.

This is especially important for fat, because horse fat has unpleasant smell and taste. The meat is then grinded trough a grinding plate with holes of 6 mm in diameter and placed in special container with a hole for decantation overnight (min. 12 hours). Grinded horse meat is then mixed with pig back fat in the amount of 12 – 15%. Before mixing with horse meat the pig back fat is grinded trough a grinding plate with holes of 10 mm in diameter. The mixture of meat and fat is then mixed with salt in the amount of 2.2 – 2.5%, red paprika in the amount of 0.2%, hot paprika in the amount of 0.2 – 0.3%, garlic in the amount of 0.1 – 0.3%, black pepper in the amount of 0.2 – 0.3%. The mixture is then stuffed only into a horse thin intestine, collagen casings (50 cm long and 50 mm in diameter) or beef thin intestine. Thereafter, the Horse salami is smoked with dry hard wood (hornbeam, beech and its sawdust) every few day (3 - 4 hours) for four weeks. The temperature and relative humidity at this stage should be 18 to 20 °C and 70 to 90%. After the smoking, the Horse salami is left for the ripening stage. This stage is the longest and it should last for more than 2 months in a dark room with the temperature from 14 to 17 °C and relative humidity 70 to 80%. After this stage Horse salami is ready for consumption.

Table 1 **General composition of Horse salami**

Brand	Moisture (%)	Fat (%)	Protein (%)	Collagen (%)
1	$27.86^{a} \pm 0.06$	$28.66^{f} \pm 0.13$	$31.23^{c} \pm 0.08$	$3.69^{ab} \pm 0.25$
2	$25.49^{b} \pm 0.14$	$33.35^{e} \pm 0.31$	$27.55^{f} \pm 0.15$	$3.88^{a} \pm 0.12$
3	$22.5^{c} \pm 0.02$	$36.52^{d} \pm 0.12$	$32.78^{a} \pm 0.12$	$1.48^{c} \pm 0.17$
4	$20.87^{d} \pm 0.01$	$40.03^{b} \pm 0.03$	$30.42^{e} \pm 0.02$	$3.06^{bc} \pm 0.35$
5	$20.86^{d} \pm 0.03$	$41.52^{a} \pm 0.07$	$23.27^{g} \pm 0.14$	$2.88^{cd} \pm 0.18$
6	$20.81^{d} \pm 0.01$	$37.01^{c} \pm 0.13$	$32.35^{b} \pm 0.08$	$1.11^{e} \pm 0.01$
7	$18.98^{e} \pm 0.04$	$39.81^{b} \pm 0.11$	$30.70^{d} \pm 0.02$	$2.45^{d} \pm 0.54$

Values are means ±SD of triplicate. Values in the same column with different supercripts (a-f) are significantly different ($p > 0.05$)

Table 2 **a_w, pH and salt content of Horse salami**

Brand	pH	a_w	Salt (NaCl) (%)
1	$4.71^{e} \pm 0.01$	$0.82^{bc} \pm 0.01$	$3.70^{d} \pm 0.03$
2	$4.65^{f} \pm 0.01$	$0.85^{ab} \pm 0.01$	$4.25^{b} \pm 0.03$
3	$4.84^{d} \pm 0.01$	$0.85^{ab} \pm 0.01$	$3.49^{e} \pm 0.08$
4	$5.56^{c} \pm 0.02$	$0.88^{ab} \pm 0.01$	$3.93^{c} \pm 0.04$
5	$4.86^{d} \pm 0.01$	$0.85^{ab} \pm 0.07$	$3.51^{e} \pm 0.04$
6	$6.74^{a} \pm 0.02$	$0.90^{a} \pm 0.01$	$3.33^{f} \pm 0.01$
7	$5.93^{b} \pm 0.01$	$0.87^{ab} \pm 0.01$	$4.78^{a} \pm 0.05$

Values are means ±SD of triplicate. Values in the same column with different supercripts (a-f) are significantly different ($p > 0.05$)

Physico-Chemical analysis

The samples were cut into small pieces and homogenized in a knife mill Gridomix GM 200. The pH level was measured in a homogenate of the sample mixed with distilled water (1:10) with pH/Ion 510 – Bench pH/Ion/mV Meter (Eutech Instruments Pte Ltd/ Oakton Instruments, USA). Water activity (a_w) was determined using a Rotronic Hygrolab 3 (Rotronic AG, Bassersdorf, Switzerland). The FoodScan Meat Analyser was used to determine moisture, total protein, total fat and collagen according to the AOAC 2007. 04. Salt (sodium chloride (NaCl) was determined according to the ISO method nb.1841. All measurements were conducted at room temperature (20 ± 2 °C).

Textural analysis (TPA)

Texture profile analysis (TPA) tests were performed using a TA.XT2i SMS Stable Micro Systems Texture Analyzer (Stable Microsystems Ltd., Surrey, England) equipped with a cylindrical probe P/75. This involved cutting samples in 1.5 cm thick slices, which were compressed twice to 60% of their thickness. Force-time curves were recorded at across-head speed of 5 mms^{-1} and the recording speed was also 5 mms^{-1}. The following parameters were quantified (Bourne 1978): hardness (g), the maximum force required to compress the sample, springiness (mm), the ability of the sample to recover its original form after the deforming force was removed, cohesiveness the extent to which the sample could be deformed prior to rupture and chewiness (g·mm) work required to masticate the sample before swallowing, which is calculated hardness · cohesiveness · springiness.

Determination of colour

Colour measurements (L*, a*, and b* values) were taken using a Hunter-Lab Mini ScanXE (A60-1010-615 Model Colorimeter, Hunter-Lab, Reston, VA, USA). The instrument was standardized each time with a white and black ceramic plate (L*0 = 93.01, a*0 = -1.11, and b*0 = 1.30). The Hunter L*, a*, and b* values correspond to lightness, greenness (-a*) or redness (+a*), and blueness (-b*) or yellowness (+b*), respectively. The colour measurements were performed on horse salami at room temperature (20 ± 2 °C).

Table 3 **Instrumental colour measurement of Horse salami**

Brand	L^*	a^*	b^*
1	$33.29^{d} \pm 1.13$	$12.94^{a} \pm 0.86$	$11.70^{bc} \pm 0.51$
2	$34.76^{c} \pm 1.12$	$14.31^{c} \pm 0.63$	$11.91^{bc} \pm 0.54$
3	$30.69^{e} \pm 1.23$	$6.25^{f} \pm 0.63$	$8.67^{d} \pm 0.53$
4	$36.74^{b} \pm 1.06$	$17.30^{a} \pm 0.78$	$12.16^{b} \pm 0.82$
5	$39.02^{a} \pm 1.29$	$16.36^{b} \pm 0.78$	$15.65^{a} \pm 1.40$
6	$33.71^{cd} \pm 1.35$	$17.26^{a} \pm 0.93$	$11.58^{bc} \pm 1.30$
7	$35.91^{b} \pm 1.24$	$13.37^{d} \pm 0.91$	$11.87^{c} \pm 0.88$

Values are means ±SD of eight measurements. Values in the same column with different supercripts (a-f) are significantly different ($p > 0.05$)

Table 4 **Textural properties of Horse salami**

Brand	Hardness (g)	Springiness (mm)	Cohesiveness	Chewiness (g · mm)
1	$2163.92^{a} \pm 514.31$	$0.60^{d} \pm 0.06$	$0.48^{d} \pm 0.04$	$629.84^{b} \pm 172.41$
2	$2417.88^{a} \pm 391.2$	$0.62^{cd} \pm 0.11$	$0.55^{c} \pm 0.04$	$824.51^{a} \pm 182.57$
3	$1710.02^{b} \pm 205.49$	$0.65^{cd} \pm 0.04$	$0.56^{c} \pm 0.03$	$622.18^{b} \pm 107.59$
4	$1127.83^{c} \pm 532.98$	$0.65^{cd} \pm 0.06$	$0.63^{b} \pm 0.03$	$425.04^{c} \pm 179.05$
5	$689.74^{d} \pm 302.30$	$0.71^{b} \pm 0.04$	$0.72^{a} \pm 0.02$	$357.01^{c} \pm 179.23$
6	$1156.45^{c} \pm 354.51$	$0.77^{a} \pm 0.03$	$0.71^{a} \pm 0.03$	$635.12^{b} \pm 210.53$
7	$1633.18^{b} \pm 149.99$	$0.67^{bc} \pm 0.04$	$0.63^{b} \pm 0.05$	$681.14^{ab} \pm 89.25$

Values are means ±SD of eight measurements. Values in the same column with different supercripts (a-d) are significantly different ($p > 0.05$)

Data analysis

Three determinations for general composition and eight for texture and colour parameters were measured from each sample. Experimental data were analyzed by the analysis of variance (ANOVA) and Fisher's least significant difference (LSD), with significance defined at $p < 0.05$. Statistical analysis was carried out with Statistica ver. 7.0 StatSoft Inc. Tulsa, OK. USA.

RESULTS AND DISCUSION

Basic chemical compositions of seven brands of Horse salami are given in Table 1. Moisture content of Horse salami varied significantly ($p < 0.05$) among brands and were similar to Spanish Chorizo and Salchichon (Gimeno et al., 2000; Rubio et al., 2008) and higher than in Slavonian homemade Sausage and Slavonian kulen (Kovačević el al., 2010; Kovačević el al., 2009), but lower than in samples of Horse salami reported by Šimić and Mioković 2008. According to the actual Croatian legislation the maximal moisture content in dry sausage is 40% (N.N. 131/2012). All samples of horse salami had moisture content below the prescribed level. Protein content of Horse salami showed high variability ($p < 0.05$) (protein contents were in range from 27.55 to 32.78 %) and it was higher than protein content in Chorizo and Salchichon (Muguerza et al., 2001; Rubio et al., 2007) and similar as in Slavonian homemade Sausage and Slavonian kulen (Kovačević el al., 2010; Kovačević el al., 2009). Fat content shoved high variability among brands ($p < 0.05$) which is in agreement with the values reported by Šimić and Mioković (2008) and can be related to different recipes used by different producers (Table 1).

a_w, pH and salt content of seven brands of Horse salami are presented in Table 2. a_w did not showed significant variation ($p < 0.05$) among brands and it was similar as a_w of Slavonian homemade Sausage and Slavonian kulen (Kovačević el al., 2010; Kovačević el al., 2009).

pH value of fermented sausages has been recognized as fermentation indicator, as well as like an indicator of ripening stage (Hagen et al., 2000; Salgado et al., 2005; Revilla et al., 2005). In this study, variations in pH values between seven different brands were significant (pH values varied between 4.97 and 5.55). The variations in pH suggest different stages of drying - ripening between the collected brands. In scientific literature, average mass fraction of salt in stuffing for dry sausages ranged from 2.0% to 2.6%, and in final product from 3,3% to 4,3% (Ockerman and Basu, 2007; Stahnke and Tjener, 2007). In this study mass fraction of salt (NaCl) in samples of horse salami was in the range from 3.33% to 4.78% and it was similar as in Slavonian homemade Sausage and Slavonian kulen (Kovačević el al., 2010; Kovačević el al., 2011).

$L^*a^*b^*$ system values are shown in Table 3. The lightness (L^*) values of all brands ranged from 30.69 to 39.02, the redness (a^*) of all brands ranged from 6.25 to 17. 30 and the yellowness (b^*) from 8.67 to 15.65 and they all varied significantly ($p < 0.05$). Especially large variation of L^* and a^* values can be related with the nature of horse meat (the meat from older horses has very dark red color) (Tateo et al., 2008; Markov et al., 2010.).

Compared to other studies on other dry fermented sausages from Spain and Croatia (Anserona et al., 1997; Fernández-Fernández et al., 1998; Gimeno et al., 2000; Muguerza et al., 2001; Muguerza et al., 2002; Kovačević el al., 2009; Kovačević el al., 2010) all *L*a*b** system values of Horse salami were lower. The lower *L** and a* values can be explained by the nature of the sample (horse meat is darker and redder than pig meat).

The lower *b** (yellowness) values of Horse salami are probably related to the lower content of yellow carotenoids (β-carotene and cryptoxanthine) coming from paprika spice, since this spice is used in smaller amounts then in Chorizo, Slavonian homemade Sausage and Slavonian kulen production (Kovačević el al., 2009; Kovačević el al., 2010).

Results of the texture profile analysis are presented in Table 4. It is obvious that some significant differences ($p < 0.05$) can be observed between different brands of Horse salami, especially in the hardness. Only two brands of Horse salami had hardness over the 2000 g. This phenomenon can be related with different ripening stages of collected brands, the use of casings with different diameters (horse and beef small intestine and collagen casings) and different mass fraction of fat used in the recipe. During the drying-ripening process, Horse salami loses water, and other, different fermentation, proteolytic and lipolytic processes occur. This could be one of the reasons for the variability in texture profiles between the analyzed brands.

In comparison with the results of some other authors (Gimeno et al. 2000; Gimeno et al. 2001; Muguerza et al. 2001; Bruna et al. 2003; Revilla et al. 2005; Salgado et al. 2005; Rubio et al. 2008; Kovačević el al., 2010), who evaluated similar fermented sausages, such as Spanish Chorizo and Salchicon, an Croatian Slavonian Kulen, Horse salami has lower values for hardness and springiness. Values of cohesiveness springiness for Horse salami were similar to these values for the Slavonian Kulen (Kovačević el al., 2010).

CONCLUSION

There were significant differences ($p < 0.05$) in the basic composition, pH values, salt content, TPA and colour parameters of Horse salami. This shows that producers still use very different recipes in the production of Horse salami (different mass fraction of pork back fat), horse meat of different origin, different casings (different diameter) and that the analysed samples were not in the same drying - ripening stages.

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Physikalisch-chemische Eigenschaften, Textur und Farbe der Pferdewurst

Zusammenfassung

In dieser Arbeit wurden physikalisch-chemische Eigenschaften, Farbe und Texturprofil von sieben verschiedenen Mustern der Pferdewurst untersucht, die durch traditionelle Verfahren in den Haushalten von Pakrac und dessen Umgebung hergestellt worden sind. Die Analyse der phsykalisch-chemischen Eigenschaften zeigte Unterschiede hinsichtlich der pH-Werte, sowie der Massenanteile von Wasser, gesamter Eiweißstoffe und Fette, Salze und Kollagen, während die aw Werte von allen sieben Mustern der Pferdewurst angeglichen waren. Es wurden auch statistisch bedeutende Unterschiede (p<0,05) zwischen den instrumentalen Farbenparametern (L, a* und b*) und Texturprofil einzelner Muster der Pferdewurst festgestellt. Die angeführten Resultate sind die Folge von verschiedenen Rezepturen in der Herstellung von Pferdewurst (Massenanteil der zugefügten Schweinerückenspecks) bei verschiedenen Herstellern, Nutzung des Pferdefleisches unterschiedlicher Herkunft und Eigenschaften, Nutzung der Hülle unterschiedlicher Herkunft und unterschiedlichen Durchschnitts sowie unterschiedlicher Reifenstufe der analysierten Muster der Pferdewurst.*

Schlüsselwörter: Pferdewurst, traditionelle Herstellungstechnologie, physikalisch-chemische Eigenschaften, Farbe, Texturprofil

Caratteristiche fisico-chimiche, struttura e colore del salame di cavallo

Sommario

Nel presente lavoro sono individuate le caratteristiche fisico-chimiche, il colore e la grana di sette campioni di differenti salami di cavallo prodotti attraverso una tradizionale tecnica di produzione nelle tenute a conduzione familiare situate nell'area di Pakrac. L'analisi delle caratteristiche fisiche e chimiche ha mostrato differenze nei valori di pH e nella percentuale di acqua, proteine, grassi, sali e collagene totali, mentre i valori aw in tutti e sette i campioni di salame di cavallo sono risultati uniformi. Sono state, inoltre, determinate le differenze statisticamente significative (p < 0,05) tra i parametri strumentali del colore (L, a* e b*) e della grana dei singoli campioni di salame di cavallo. I suddetti risultati sono la conseguenza delle differenze nelle ricette in base alle quali i salami di cavallo sono stati prodotti (contenuto del lardo suino aggiunto), dell'uso di carne equina di varia origine e caratteristiche, dell'uso del materiale d'insacco di varia origine e diametro e dei differenti gradi di maturazione dei campioni di salame di cavallo analizzati.*

Parole chiave: salame di cavallo, tecnologia di produzione tradizionale, caratteristiche fisico-chimiche, colore, grana

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