

# Contribution to knowledge of major quality parameters of traditional (domestic) kulen\*

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*S u m m a r y:* In this paper, results of the study of sensory properties, pH value and chemical composition of traditional or domestic kulen are presented. Results show certain disharmony between sensory and chemical and nutritional quality parameters, i.e. sensory quality of kulen is poorer than the chemical composition of the product. The most common quality shortages/deficits of domestic kulen is different smoking level, inadequate colour of the section/slice, presence of dry edge under casing, insufficient connection of the filling, bitter or sour taste. Most of studied samples of domestic kulen had pH value of 5.22 to 5.51, which shows that the ripening process was not finished, but also that the fermentation had been stimulated in certain way, not characteristic of domestic kulen. Change of the micro flora of domestic kulen is slow and typical for natural ripening which occurs during production of kulen in winter period. In the micro flora of kulen, bacteria which ferment sugars to lactic acid are dominant, Pseudomonadaceae and Enterobacteriaceae decrease gradually, number of Microcococaea decreases, and enterococci survive ripening. Results of the chemical analysis show that kulen contains slightly over 35% of moisture, that the protein content of meat is above 25%, that the ratio between fat and protein contents was approximately equal and that the share of collagen in meat proteins is below 10%. The amount of sodium chloride in kulen (3.4–3.8%) is adequate to the amount of added table salt. Nitrate residues were detected in kulen (10.5 to 12.1 mg/kg) which originated from spices added to product (pepper, garlic). Acid number of kulen (7.5–16.6 mg KOH/g) showed value common for fermented dry sausages. TBARS-value was in the range 0.19–0.29 mg MDA/kg, in which the oxidation of fats cannot be perceived by sensory analysis.

**Key words:** traditional or domestic kulen, quality, chemical composition, sensory properties, pH value.

## Introduction

*Kulen* is traditional fermented dry sausage which has been manufactured for centuries, during winter time, in the North Serbia (Srem, Bačka), Croatia (Slavonia, Baranja) and Hungary (Vuković et al. 1988; Incze, 2003; Vuković, 2006). Depending on the region where it is produced, *kulen* has adequate name, for instance *Sremski kulen*, *Ludoški kulen*, *Petrovački kulen*, *Kisački kulen*, *Slavonski kule* etc., but the most common and wide spread name used is *domestic kulen*. Some types of *kulen* today are produced as Products of protected designation of origin (PDO)/Products of protected geographical

indication (PGI) (*Sremski kulen*, *Slavonski kulen*, etc). Also, according to the Etymology dictionary of Croatian or Serbian language (Skok, 1971–1974), name *kulen* is derived from Greek word *kolon*, meaning large intestine. In the folk tradition, however, there are different explanations, for instance that name *kulen* is derived from the word *kula* (tower), designating a sausage that is dried for long time hung high like in a tower. According to Vuk St. Karadžiću (1851), *kulen*, *kulijen* or *kuljen* would be sausage made of stomachs and compared to some types of cooked sausages (so called *švargla*).

For all variants of basically same product, high quality meat from mature pigs containing less water,

\*Plenary paper on International 56<sup>th</sup> Meat Industry Conference held from June 12-15<sup>th</sup> 2011. on Tara mountain;

\*Plenarno predavanje na Međunarodnom 56. savetovanju industrije mesa, održanom od 12-15. juna 2011. godine na Tari.

**Note:** Results of the scientific research project TR-31032, financed by the Ministry of Science and Technological Development of Republic of Serbia, are presented in the paper.

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of more intensive red colour and firmer consistency is used as raw material. In production of *kulen* meat is used, always, which is poor in fat and connective tissue, primarily meat from the leg, shoulder and possibly some parts of neck from which fat tissue, tendons, veins and connective tissue membranes have been removed. There is still tradition, in some regions, to produce *kulen* from non-chilled meat (after slaughtering), although most of producers today use chilled meat in production of *kulen*. It can be made only from meat, but somewhere also smaller amount of firm fat tissue is used, usually pig jowl. Additives used in production of *domestic kulen* are table salt, red pepper spice and garlic. Table salt is added in the amount of 2.1 to 2.3%, red ground spice peppers from 0.9 to 1.4%, whereas the amount of garlic added varies from 0.3 even to 0.8%. Traditionally, adequate mix of sweet and hot peppers is used; sweet peppers are significant for the colour, and hot peppers for savoury taste of the *kulen*. In traditional production of *kulen* curing salt is not used (Vuković *et al.*, 1988).

Meat intended for *kulen* is generally chopped into more coarse fragments, mixed with table salt, peppers and other spices, and only when the filling becomes sticky and well connected, it is filled into natural casings, processed pig colons. Filling is placed into casings firmly, making sure that there is no left over air. *Kulen* filling is most commonly put in appendix, but it can also be used to fill straight intestine or rectum (final straight portion of the large intestine) of pigs. Straight intestines or rectums have somewhat fuller and thicker intestine walls compared to appendix, so products in this intestine are generally without dry edge and always somewhat juicier. After filling, a mesh of rope is placed around *kulen* in appendix, and it is usually placed between natural intestine creases giving the *kulen* distinctive appearance, and also enables safer hanging of *kulen*, especially in case of larger products. *Kulen* in straight intestine/rectum is tied with rope at both ends, with one or two loops in the middle of the sausage. After brief drying, *kulen* is cold smoked using smoke obtained from beech wood and on open furnace, and it should have grey-white colour without admixture of soot. Some producers use also cherry wood, in addition to beech wood, and this smoke gives the surface colour of the product a reddish hue. *Kulen* is smoked occasionally in duration of two to three, even up to four weeks, until it acquires copper red colour. Some producers dip *kulen*, before smoking, into solution of table salt and spices, for some time, where water by osmosis passes from *kulen* into solution, and salt from the solution into sausage filling. Drying of *kulen*, including smoking, and depending

on the diameter of sausage, can last three to six months (Vuković *et al.*, 1988; Vuković, 2006).

Contrary to other products, such as *Sremska kobasica* and *zimski salami* (winter salami), *kulen* was not studied very often. It is important to say that the first scientific contribution on traditionally fermented sausages in our country was a doctoral thesis, done and defended in the fifties of the last century, at the Veterinary faculty in Belgrade, and in this thesis the ripening processes in *Sremska kobasica* were studied (Rašeta, 1958). First scientific papers analyzing major changes which occur during ripening of *kulen* were published after three and five decades (Vuković *et al.*, 1988; Vuković *et al.*, 2004). Significant contribution to study of traditional products, such as *Sremska kobasica* and *Petrovská klo-bása*, was made by Vesković-Moračanin (2007) and Ikončić *et al.* (2010).

Results of investigations so far show that there is difference between *kulen* sausage produced industrially and traditional *kulen* (Vuković *et al.*, 2004). The fact that in industrial production the hygiene conditions are significantly better, also that brining salt is used, pepper extracts, sugars, starter cultures and artificial casings, is undoubtedly of importance for safety of the product. However, this *kulen*, in its sensory and other quality indicators, differs significantly from domestic *kulen*, and could not be considered as originally traditional product. According to our knowledge, traditional production procedure of domestic *kulen* remained only in smaller producers (crafts, households). In this paper, results of the study of major quality properties of *kulen* produced by small producers in traditional manufacturing, are presented. Results presented in the paper were obtained within the scientific-research project, with aim to improve the technology of production of traditional fermented sausages with Protected designation of origin (PDO) or Protected geographical indication (PGI) and to obtain safe products of standard and distinguishing quality.

## Material and Methods

Samples of *kulen* from traditional production, obtained from small producers, were studied in the paper. By using standard assay methods the following parameters were determined: (1) pH value (apparatus WTW 340i, SRPS ISO 2917); (2)  $a_w$ -value (apparatus GBX Scientific Instruments, Fa-St/1); (3) moisture content (SRPS ISO 442); (4) protein content (SRPS ISO 937); (5) total fat content (SRPS ISO 1443); (6) ash content (SRPS ISO 936); (7) relative content of collagen in meat proteins – collagen

content was calculated by multiplying with factor 8 of the hydroxyproline content (SRPS ISO 3496); (8) chloride content (Volhard method, SRPS ISO 1841-1); (9) nitrite content (SRPS ISO 2918) and nitrate content (SRPS ISO 3091); (10) acid value (SRPS ISO 660); (11) TBARS (Thiobarbituric Acid Reactive Substances)-value (combined method according to *Tarlagdis et al.*, 1964, and *Holland*, 1971); (12) lactic acid bacteria (MRS-agar, Merck, at 32° C/72 hours anaerobic); (13) *Micrococcaceae* (Baird-Parker-agar, at 37° C/48 hours); (14) *Enterobacteriaceae* (Brilliant-Green-agar, Merck, at 37° C/48 hours); (15) *Enterococcus* spp. (Kanamycin-Esculin-Azide-agar, Merck, 37° C/24–48 hours); (16) *Salmonella*-species (ISO 6579, 2002); *Listeria monocytogenes* (ISO 11290-2, 1998, Amendment 1, 2004); (17) sensory properties, by method applied in assessment of the quality at Novi Sad Agriculture Fair.

## Results and Discussion

Based on previous findings and studies, *traditional* or *domestic kulen* can be described as product made of high quality meat from mature pigs. Meat is coarsely ground and mixed well with table salt, ground red pepper and possibly garlic. Filling is then stuffed into natural casings, primarily pig appendix, and subsequent to smoking it is subjected to natural ripening, during which it acquires typical and distinguishing quality properties (*Vuković et al.*, 1988; *Vuković*, 2006). Same as the results of previous studies (*Vuković et al.*, 2004), results obtained in this research show that there are differences in quality of *kulen* samples taken from various producers. In Table 1, results of the sensory analysis of 9 samples of traditional *kulen* (in pig appendix), carried out by nine member expert panel/committee of the Novi Sad Agricultural Fair, are presented as well as results of determination of pH value of *kulen*, done immediately after sensory evaluation. Results show that no *kulen* samples were given the highest score (5.00); most of investigated samples were awarded silver and bronze medal, based on mean evaluation, or were unrewarded (score below 3.5), and only one sample of *kulen* received somewhat higher score, over 4.5 (gold medal). On this basis, it can be stated that *kulen* is product of average quality and not product of exceptional/superior quality, as it is rightly expected of products made from high quality raw materials.

The most common deficits of the quality of domestic *kulen* are different smoking levels, inadequate colour of cross section/slice, presence of dry

**Table 1.** Sensory assessment and pH value of traditional kulen sausage

**Tabela 1.** Senzorna ocena i pH vrednost tradicionalnog kulena

Value/Vrednost	Sensory score/ Senzorna ocena	pH value/ pH vrednost
Medium/Srednja	3,87	5,42
Highest/Najveća	4,56	6,28
Lowest/Najmanja	3,07	4,86

edge underneath the casing, insufficient connection of the filling, bitter and sour taste/aroma, more or less expressed. The fact that traditional *kulen* is stuffed into pig appendix gives distinguishing and appealing appearance to this product, but the size of the sausage - diameter requires adequate knowledge and skills. On the cross section/slice of the product there cannot be dry edge which prevents proper drying and makes the inside of the sausage soft, unconnected and enables incidence of untypical aroma, and even product spoilage. Underneath the casing, there can only be darker ring which derives from the smoke. Colour of the cross section/slice of *kulen* should be red to dark red, stable, and forming of the colour is mainly under the influence of carotenoids – natural pepper pigments, but also nitrates which are originating from peppers and garlic. Consistency of *kulen* should be firm and not disintegrating during cutting, which is not the case in sausages containing less salt, and more peppers. Taste and smell/odour of *kulen* should be mature/ripe and savoury. The hot taste of *kulen* should not be stronger than the natural taste of ripe product, and it should only come across as after taste. Sour taste is not typical for *kulen* and indicates either that the product is insufficiently ripe, or that the natural fermentation is stimulated.

If the lowest (4.86) and the highest (6.28) measured pH values are disregarded, other analyzed samples of domestic *kulen* had pH value from 5.22 to 5.51. It can be concluded that the ripening of *kulen* was not finished and that the products was not stabilized. According to results of previous studies (*Vuković et al.*, 1988), stabilization of *kulen* occurs only after 120 days of ripening, when pH value increases to 5.6. Two analyzed samples of *kulen* had pH value of approx. 4.9, and on one of them the use of starter cultures had been declared; both products had extremely sour taste which is typical for a fermented, semi-dry sausage, but not for domestic *kulen*. One sample of *kulen*, which was produced two years before the sensory analysis, according to declaration, had pH value over 6.2, but the colour and appearance of the cross section/slice, taste,

smell/odour and texture have changed greatly and product was not fit for consumption.

At the beginning of ripening process of domestic *kulen*, pH value ranges from 5.6 to 5.8 and corresponds to pH value of cooled pig meat, and subsequently it starts to decline (Vuković *et al.*, 1988). Certainly, the sugars (fructose, glucose, sucrose) which are natural ingredients of spice peppers, have the major impact on decline of pH value of *kulen*. According to literature data (Oberdick, 1988), spice pepper contains approx 15% of sugars, whereas the content of total sugars in domestic spice peppers is higher and amounts to approx. 25% (Petrović, 2011). During ripening, bacteria ferment sugars from the peppers to lactic acid, resulting in decrease of pH value of *kulen*. In the first stage of natural ripening of domestic *kulen*, which last approx. 60 days, pH value decreases to the range of 5.2 to 5.3, and in the second stage of ripening, as a consequence of more distinguished proteolysis, pH value gradually increases to reach value of 5.6 at the end of the ripening process (Vuković *et al.*, 1988). Obviously, change of pH value of domestic *kulen* in natural ripening is moderate, but nevertheless very important for sustainability and forming of the colour, consistency and aroma of the product (Coretti, 1971). In cases when change in pH value of *kulen* is more distinct, then it is no longer case of natural ripening, but fermentation which was stimulated in some way, for instance by using sugars and starter cultures, higher

ripening temperature, or even using glucono delta-lactones; subsequently pH value of *kulen* is low, approx. 5.2 (Vuković *et al.*, 2004).

Present studies, as well as previous (Vuković *et al.*, 1988), show that during the process of natural ripening of *kulen*, microflora typical for fermented dry sausages is developed (Figure 1). In microflora of *kulen*, dominant are bacteria which ferment sugars into lactic acid. Number of *Micrococaceae* decreases, *Pseudomonadaceae* and *Enterobacteriaceae* die out, and enterococci survive the ripening process. In industrially produced *kulen*, when curing salt is used, as well as sugars and starter cultures, *Pseudomonadaceae* and *Enterobacteriaceae* die faster, and *Micrococaceae* are found very rarely (Vuković *et al.*, 2004). Figure 1 clearly shows that typical micro flora of *kulen* develops slowly, which is typical for ripening in traditional production of *kulen*, at lower temperatures and in natural conditions (Coretti, 1971). Pathogen bacteria of *Salmonella*-species and *Listeria monocytogenes* were not detected in any of the *kulen* samples.

Chemical composition and other parameters of interest for the quality of domestic *kulen* are presented in Table 2. Results show that *kulen* contains more than 35% of moisture, that the protein content and content of fats were almost equal, and that the share of collagen in meat proteins was below 10%. Higher moisture content undoubtedly indicates that the ripening process was not finished, but it is

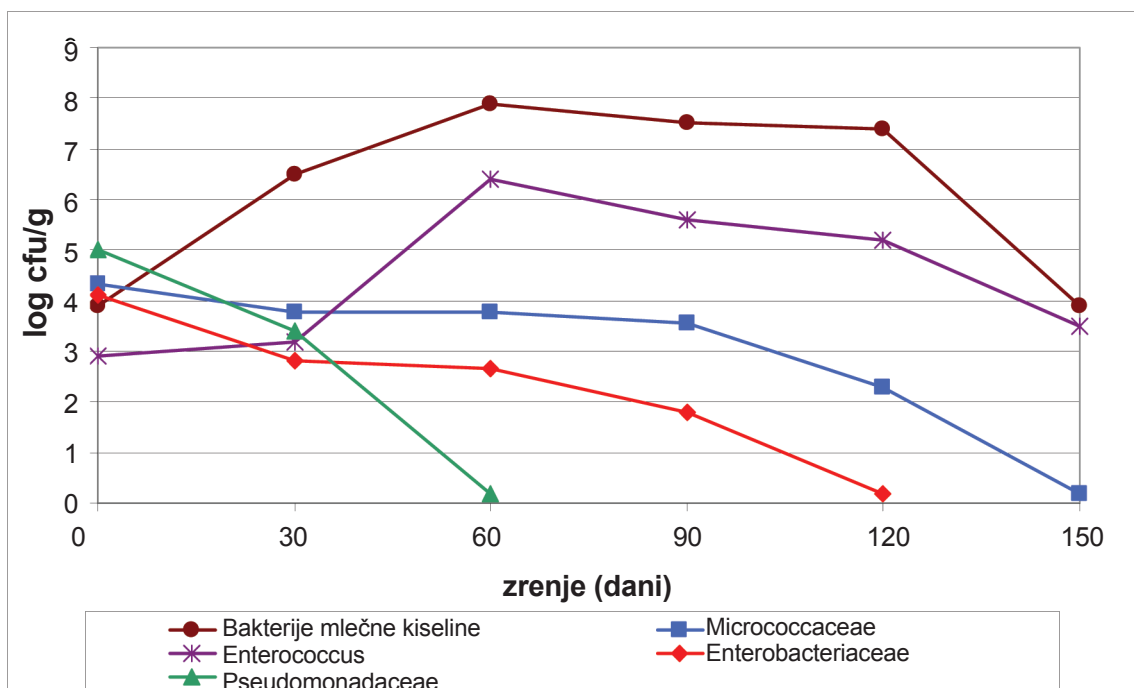


Figure 1. Changes of the microflora of domestic *kulen* sausage during natural ripening  
Slika 1. Promena mikroflora domaćeg kulena za vreme prirodnog zrenja

also consequence of lower fat content of traditional *kulen*. Our previous studies show that the content of fats in so called industrial *kulen* in average is 38.6%, which is by ten percents more than in traditional *kulen*, but, at the same time, industrial *kulen* contains less moisture, below 30% (Vuković *et al.*, 2004). Results of previous studies (Vuković *et al.*, 1988), also show that the content of fat and meat proteins in domestic *kulen* was even. All stated facts confirm that domestic *kulen*, from the standpoint of chemical quality parameters, as well as nutritional aspect, is extremely valuable product.

**Table 2.** Major chemical components and quality parameters of domestic kulen sausage

**Tabela 2.** Važniji hemijski sastojci i parametri kvaliteta domaćeg kulena

Ingredient/parameter Sastojak/parametar	Values/ Vrednosti
Moisture/Vlaga (%)	36,3 – 37,7
Meat proteins/Proteini mesa (%)	25,5 – 28,7
Share of collagens in meat proteins/ Udeo kolagena u proteinima mesa (%)	6,4 – 8,6
Fats/Masti (%)	27,9 – 28,3
Fat:protein ratio/ Odnos masti:proteini	1,0 – 1,1
Ash/Pepeo (%)	4,8 – 5,4
NaCl content/Sadržaj NaCl (%)	3,4 – 3,8
Nitrates/Nitrati (mg/kg)	10,5 – 12,1
Nitrites/Nitriti (mg/kg)	2,35 - 2,47
Acid number/Kiselinski broj (mg KOH/g)	7,5 – 16,3
TBARS-value/vrednost (mg MDA/kg)	0,19 – 0,29

The amount of sodium chloride in *kulen* (3.4–3.8%) corresponds to added amount of table salt. Traditionally, table salt is added to *kulen* in the amount of 2.1 to 2.3%, which is less than optimum. For efficient inhibition of pathogen and other harmful bacteria, it is necessary to add into fermented sausages 2.5% of table salt (Leistner, 1985). In this amount, table salt more efficiently inhibits psychrotolerance pseudomonades which have negative effect on taste (they degrade proteins resulting in bitter taste of *kulen*), and, on the other hand, salt creates more favourable conditions for development of useful/beneficial species such as reducing bacteria (*Microcococaea* and non-pathogen *Staphylococci*) and lactic acid micro flora (lactobacillus, etc.). Table

salt, also, dissolves proteins on the surface of meat pieces of the ground meat and enables first their coming together/sticking, and subsequently, when pH value decreases to 5.3, connecting of the filling (Coretti, 1971). Contrary, peppers added in excess amount can influence more difficult connecting of the filling. Therefore it happens that *kulen* containing less salt, and more peppers, although seemingly with firmer consistency, disintegrates more or less during cutting.

Even though in production of domestic *kulen* curing salt is not used, in analyzed *kulen* samples certain amount of nitrates and nitrites was determined. In our opinion, nitrate comes from spices peppers and garlic, with which it was added to *kulen*. Nitrate is not natural ingredient of peppers, but it is absorbed by peppers during growing, from the soil (fertilizers) so it appears as contaminant in peppers. According to published data (EFSA Journal, 2008), nitrate content in peppers in very wide ranges from 1 to 476 mg/kg, in average 108 mg/kg, which means that in dry peppers as nitrate content should be significantly higher. Content of nitrates in garlic doesn't vary so much, in average it is 70 mg/kg. By adding mentioned spices into *kulen*, especially peppers used in the amount of 0.9 to 1.4%, also certain amount of nitrates are added to *kulen*, and their residues were detected in the product (10 to 12 mg/kg). During ripening of *kulen*, part of these nitrates was reduced by the activity of bacteria to nitrites, which, in addition to carotenoid from peppers, have major role in forming of stable red colour of *kulen*. Acid value of *kulen* (7.5–11.2 mg KOH/g) shows value common for fermented dry sausages. TBARS-number is below the value (0.1–0.3 mg MDA/kg) above which it is possible to perceive, by sensory evaluation, oxidation of fats (Fernandez *et al.*, 1997).

## Conclusion and recommendation

Traditional or domestic *kulen* is product made using high quality meat from mature pigs, table salt, ground spice peppers and garlic, stuffed in natural casing – pig appendix, obtained in traditional way by natural ripening, during which typical and distinguishing quality properties are formed. Protein content of meat should be higher than 25%, share of collagen in meat proteins less than 10%, contents of fat and proteins in meat should be equal, and pH value of 5.6.

Sensory properties of domestic *kulen* vary depending on the producer, and aren't always in accordance with chemical parameters of quality. In order for domestic *kulen* to be a product of

superior quality, in our opinion, there are two ways. One way is for meat industry, which disposes with necessary hygiene and other conditions, in addition to mass production of so called industrial *kulen*, to produce also domestic *kulen*, but fully respecting requirements which apply for traditional production (positive example – production of winter salami in one of the neighbouring countries).

The second way is to support the production of domestic *kulen* in small production facilities. Main pre-condition for this is adoption of necessary regulation/rulebook, which is not the case presently, enabling small production facilities and producers of traditional products to register their production, and fully respecting all requirements pertaining to

conditions and under control, produce domestic *kulen* in their households/holdings. Regional associations of small producers of domestic *kulen* would be very beneficial in regard to establishing of their own standards, defining of production and quality of *kulen* in all its segments. In this way production of traditional *kulen* of typical, distinguishing and more or less equal quality would be achieved, and it would be legally marketed in the same way as industrial products. Positive examples exist in many countries where the production of various food products, based on traditional technologies, is developed, and in some of neighbouring countries even the production of domestic *kulen*.

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## Prilog poznavanju važnijih parametara kvaliteta tradicionalnog (domaćeg) kulena

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*Rezime:* U radu su prikazani rezultati ispitivanja senzornih osobina, pH-vrednosti i hemijskog sastava tradicionalnog ili domaćeg kulena. Iz rezultata proizilazi da između senzornih i hemijskih i nutritivnih parametara kvaliteta postoji izvestan nesklad, odnosno da je senzorni kvalitet kulena slabiji od sastava proizvoda. Najčešći nedostaci kvaliteta domaćeg kulena jesu različit stepen dimljenja, neodgovarajuća boja preseka, postojanje suvog ruba ispod omotača, nedovoljna povezanost nadeva, ukus koji gorči ili kiselkasta ukus. Većina ispitivanih uzoraka domaćeg kulena imala je pH vrednost od 5,22 do 5,51, što pokazuje da proces zrenja još nije dovršen, ali i da je fermentacija stimulisana na neki način, što nije karakteristika domaćeg

*kulena. Promena mikroflore domaćeg kulena je spora i tipična je za prirodno zrenje koje se odvija za vreme proizvodnje kulena u zimskom periodu. U mikroflori kulena dominiraju bakterije koje fermentišu šećere do mlečne kiseline, Pseudomonadaceae i Enterobacteriaceae postepeno odumiru, broj Micrococaceae se smanjuje, a enterokoke preživljavaju zrenje. Rezultati hemijskog ispitivanja pokazuju da kulen sadrži nešto više od 35% vlage, da je sadržaj proteina mesa veći od 25%, da je odnos između sadržaja masti i proteina približno jednak i da je udeo kolagena u proteinima mesa manji od 10%. Količina natrijum hlorida u kulenu (3,4-3,8%) odgovara dodatnoj količini kuhinjske soli. U kulenu su utvrđeni ostaci nitrata (10,5 do 12,1 mg/kg) koji su sa začinima (paprika, beli luk) dodati u proizvod. Kiselinski broj kulena (7,5 - 16,6 mg KOH/g) ima vrednost uobičajenu za fermentisane suve kobasice. TBARS-vrednost je u oblasti (0,19–0,29 mg MDA/kg) pri kojoj oksidacija masti ne može da se percipira senzornim ispitivanjem.*

**Ključne reči:** tradicionalni ili domaći kulen, kvalitet, hemijski sastav, senzorne osobine, pH vrednost.

Paper recieved: 15.04.2011.