Physicochemical, hygienic and organoleptic characterization of Slavonian kulen

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scientific paper

Summary

Slavonian kulen (SK) is traditional dry sausage produced in the region of Slavonia in eastern Croatia. It is made from mince of pork, back fat, spices and salt filled into pork cecum. After stuffing, the sausages are cold-smoked and ripened-dried afterward for several months. Present work aimed to analyse some physicochemical and organoleptic traits of ripe SK as well as the safety of final product. The SK samples (n=12) from different small-scale manufactures were analysed. The following physicochemical attributes (mean ± s.d.) were recorded: moisture 38.2%±3.6, protein 35.0%±3.1, fat 23.7%±4.6, moisture/protein ratio 1.1±0.1, pH value 5.37±0.23 and water activity (aw) 0.82±0.02. Mean organoleptic scores, on five-point scale, were 3.7±0.6 for surface appearance, 3.4±0.6 for surface smell, 3.8±0.5 for consistency, 3.2±0.4 for inner smell, 3.0±0.7 for cross section quality, 3.3±0.5 for texture, 3.1±0.4 for taste and aroma, 3.0±0.5 for after taste and 3.2±0.4 for overall quality. Regarding the product safety, the following results (per kg) were determined: histamine 330.8 mg±126.3, tyramine 233.9 mg±124.7, nitrite 6.55 mg±3.88 and benzo(a)pyrene 0.05 µg±0.03. Salmonella spp. and L. monocytogenes have not been found in any sample while counts of S. aureus, enterobacteria and sulfite-reducing clostridia were in accordance with regulations.

Key words: *dry sausages, Slavonian kulen, physicochemical traits, safety*

Introduction

The Slavonian kulen (SK) is a traditional pork sausage from Slavonia region in eastern Croatia that is produced seasonally at many households and small-scale manufactures. It is made from a mixture of selected and minced pork and back fat, salt and spices such as paprika and garlic filled into pork blind gut (*cecum*). After stuffing, the SK is cold smoked and ripened-dried afterward for several months until the shelf-stability and typical organoleptic properties are achieved. The quality of SK can be influenced by various factors, like pig breed, rearing and feeding conditions, pre-slaughter handling and post-slaughter conditions which all affect raw pork quality. Several other factors, like selection of lean meat and fat, addition of salt and spices, hygiene and environment (i.e. temperature, humidity, air velocity) during fermentation, smoking, drying and ripening may additionally contribute to diversity of product quality. As a result, the characteristics of final product including its safety may vary, as between producers, so between the years.

The aim of the present work was to investigate some physicochemical and organoleptic attributes of traditional SK sausage, in order to characterize it better. In addition, some parameters of hygienic quality and safety of the final product were assessed.

Material and methods

Twelve ripe SK sausages aged about 6 months were sampled from different small-scale manufactures in Slavonia. All SK sausages were produced traditionally following the similar manufacturing steps and using the same type of ingredients as presented in scheme in Figure 1.

After collecting, samples were kept in cool until the analyses. The pH values were measured by TESTO 230 pH meter (TESTO®, Germany) by insertion of penetration electrode (type 13) in the core of halved sausage. Water activity (aw) was measured with the HygroPalm AW1 SET instrument (ROTRONIC®, Germany) using Aw Quick mode in samples, which were taken after coarse homogenisation of 80 g of the core of the sausage. Chemical and microbiological analyses were performed in the Croatian National Institute for Public Health, Zagreb. The determination of moisture was done by heating the samples at 105 °C until the constant weight. The nitrogen (N) content was determined by Dumas method and proximate protein content (%) was calculated using the conversion factor of 6.25 x N. Crude fat (%) was analysed by extraction using the Weibull–Stoldt method. Histamine and tyramine were analysed by thin-layer chromatography according to the procedure described by Macan et al. (2006). Nitrite content was determined according to Anonymous (2007). The microbial safety of product was assessed by the determination of the presence of *Salmonella* spp. and *Listeria monocytogenes* and the number of *Staphylococcus aureus*, enterobacteria and sulfite-reducing clostridia according to Anonymous (2003a, 1999, 2004a, 2008 and 2004b, respectively). Surface moulds were isolated according to the Anonymous (2002). In addition, the contamination by polycyclic aromatic hydrocarbons (PAH) was assessed on sub-sample (n=5) by the determination of benzo(*a*)pyrene (B*a*P) using the thin-layer chromatography and spectrophotometer.

Organoleptic evaluation of samples was carried out by four assessors (Faculty Department staff) familiar with organoleptic evaluation of kulen. Each assessor was served with one freshly cut slice of sample sausage (about 0.5cm thick) on a white plastic plate for tasting, whereas the rest of the sausage half was exposed for visual inspection and touch. They were asked to evaluate on a scale from 1 (minimum grade) to 5 (maximum grade) surface appearance, surface smell, consistency, inner smell, cross section quality, texture, taste and aroma and aftertaste. Based on mean score of the particular organoleptic characteristic and the coefficient of importance for that particular attribute, the overall quality was calculated by the following formula:

Overall quality = 1/17 x (a + b + c +3d + e + 3f + 6g + h),

where a, b, c, d, e, f, g and h are the mean scores of evaluator's assessments for: surface appearance, surface smell, consistency, inner smell, cross section quality, texture, taste and aroma, and after-taste, respectively. During the evaluation, the assessors were offered fresh water and apple slices freely.

For variables analysed the descriptive statistics (minimum, maximum, mean, SD - standard deviation, and CV - coefficient of variation) were calculated by PROC MEANS procedure of SAS (2002).

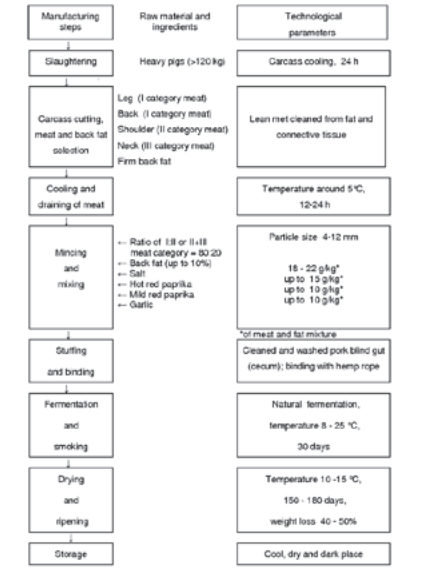

Figure 1 **Schema of traditional manufacturing processes of Slavonian kulen sausage**

Results and discussion

The results of organoleptic assessment, physicochemical and hygienic parameters, and microbiological analysis of SK are shown in Tables 1, 2 and 3, respectively.

The SK of good organoleptic quality should be well-stuffed with brownish, mildly smoked surface. The consistency should be firm but not too hard, allowing a good sliceability. When sliced, SK should have a pleasant smell after fermented meat, added spices and mild-smoke. Cross-section should have coherent texture with proper distribution of meat and fat particles. Lean parts should be more or less intense red and fat should be white to orange (from paprika). Chewing should be easy with characteristic long-lasting taste and aroma of fermented seasoned pork. In the present organoleptic evalua-

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tion of SK (Table 1), the highest variability was found for cross section quality (CV=24.7%), while grades for the other traits varied similarly with quite uniform overall quality. The highest graded traits were consistency and surface appearance, and the lowest graded were cross-section quality and after-taste.

The CV of both aw and pH values (Table 2), which are commonly used in terms of shelf life and safety of dry sausages (Incze, 2007), was very low revealing the homogeneity of SK for these parameters. This result is in agreement with those reported previously for traditional SK from different producing areas in Slavonia (Karolyi, 2005). Generally, meat products could be considered as "shelf-stable" (need no refrigeration, low susceptibility to microbial spoilage) if they have pH < 5.2 and aw < 0.95 or only pH < 5.0 or aw < 0.91 (Leistner and Rödel, 1975). Hence, the ripe SK with an average aw value of 0.82 and pH value of 5.37 can be characterized as a shelf-stable product, principally due to long period of drying/ripening and considerable dehydration occurred. European fermented sausages can be roughly classified as Mediterranean, or Southern Europe type, generally characterized by long maturing times, slow pH fall with final pH higher than 5.0 and flavour significantly affected by the use of spices; and Northern Europe type, characterized by fast acidification, final pH lower than 5.0, smoking and short maturing times (Zanardi et al., 2004). According to that, SK is similar to long matured low acid Southern Europe type of fermented sausages with the addition of smoking which is an integral part of traditional SK production technology. Similar values of final pH and aw to those observed for SK were reported for Majorcan sobrasada, which is also stuffed into pork *cecum* (Rosselló et al., 1995; Martínez et al., 2008).

Table 1 **Descriptive statistics for organoleptic traits of Slavonian kulen sausages**

Trait	Min	Max	Mean	SD	CV (%)
Surface appearance	2.3	4.5	3.7	0.6	17.4
Surface smell	2.5	4.8	3.4	0.6	17.4
Consistency	3.0	4.8	3.8	0.5	13.0
Inner smell	2.5	3.8	3.2	0.4	12.4
Cross section quality	1.5	4.0	3.0	0.7	24.7
Texture	2.5	4.0	3.3	0.5	14.7
Taste and aroma	2.5	4.0	3.1	0.4	14.0
After taste	2.0	3.8	3.0	0.5	15.5
Overall quality	2.8	3.7	3.2	0.4	10.8

SD - standard deviation, Min. - minimum, Max. - maximum, C.V. - coefficient of variability

Table 2 **Descriptive statistics for physicochemical and hygienic quality traits of Slavonian kulen sausages**

Trait	Min	Max	Mean	SD	CV (%)
pH value	5.07	5.75	5.37	0.23	4.3
aw†	0.79	0.85	0.82	0.02	2.2
Moisture (%, w/w)	31.7	42.8	38.2	3.6	9.4
Total fat (%, w/w)	16.4	31.0	23.7	4.6	19.3
Protein (%, w/w)	30.3	39.6	35.0	3.1	8.8
M/P††	1.0	1.3	1.1	0.1	9.4
Nitrite (mg/kg)	2.93	14.30	6.55	3.88	59.2
Histamine (mg/kg)	160.0	560.0	330.8	126.3	38.2
Tyramine (mg/kg)	67.0	400.0	233.9	124.7	53.3
BaP µg/kg†††	0.05	0.13	0.05	0.03	69.9

†Water activity ; ††Moisture/protein ratio ; †††Benzo(*a*)pyrene
SD - standard deviation, Min. - minimum, Max. - Maximum, CV - coefficient of variability

Table 3 **Results of microbiological analysis of Slavonian kulen sausages**

Sample	SRC cfu/g	S cfu/25g	E cfu/g	LM cfu/25g	SA cfu/g	Surface moulds
1.	< 10	neg.	< 10	neg.	< 10	neg.
2.	< 10	neg.	< 10	neg.	< 10	*Aspergillus flavus*
3.	< 10	neg.	< 10	neg.	< 10	neg.
4.	< 10	neg.	< 10	neg.	< 10	*Penicillium spp.*
5.	< 10	neg.	< 10	neg.	< 10	neg.
6.	< 10	neg.	< 10	neg.	< 10	neg.
7.	< 10	neg.	< 10	neg.	< 10	*Aspergillus glaucus*
8.	< 10	neg.	< 10	neg.	< 10	neg.
9.	< 10	neg.	< 10	neg.	< 10	*Penicillium spp.*
10.	< 10	neg.	< 10	neg.	< 10	neg.
11.	< 10	neg.	< 10	neg.	< 10	neg.
12.	< 10	neg.	< 10	neg.	< 10	neg.

SRC - Sulphite-reducing clostridia; S - *Salmonella spp.*; E – *Enterobacteriaceae*; LM – *Listeria monocytogenes*; SA – *Staphylococcus aureus*.

The compositional parameters of SK were more variable (Table 2), especially in terms of total fat content (CV=19.3%). This could be attributed to the differences in the amount of added back fat and selection of more or less fatty meat cuts by certain producers. High variability for fat content was also reported in other types of traditional sausages (Ambrosiadis et al., 2004; Ferreira et al., 2007). The average value of moisture (38.2 %) found in SK was higher than those cited by Salgado et al. (2006) for different varieties of Chorizo and other Spanish traditional sausages that could be explained by large diameter of SK. Compared to the sausage of similar size and maturing period, like Majorcan sobrasada (Rosselló et al., 1995; Martínez et al., 2008), the moisture content of SK was also higher, probably due to much higher amount of fat used in Majorcan sobrasada preparation. On the other hand, the SK had less moisture than Botillo - a traditional dry fermented sausage from Galicia region in northwest Spain (Lorenzo et al., 2000; García Fontán et al., 2007), which is also stuffed into pork *cecum* but it is ripened for considerably shorter period of time than SK.

Due to prolonged drying (weight loss up to 50 %) and high lean meat share used in mince preparation, the moisture and protein content in ripe SK were at similar levels (30-40 %) indicating high nutritional value of the final product. In fact, the average protein content in SK is higher than those usually found in other traditional sausages (Ambrosiadis et al., 2004; Salgado et al., 2006; Lorenzo et al., 2000; Moretti et al., 2004; Comi et al., 2005). In relation to the fat content reported for these products, the SK with an average fat content of 23.7 % is generally less fatty.

The moisture to protein ratio (M/P), which gives the information on the extent of drying of the lean meat part (Incze, 2007) was on average 1.1 (Table 2). The M/P ratio, together with pH and aw, is used to distinguish semi-dry and dry sausages. For example, an M/P ratio of about 1.2–1.3, which equals an aw value below 0.89–0.90, is considered as a criterion for dry sausages in Europe (Incze 2007). By that, the SK could be clearly distinguished as dry sausage.

The SK is traditionally manufactured without nitrogenous salts. In meat curing, nitrite is widely used for antibacterial, colour and antioxidant purposes, often in combination with nitrate which act as a source of nitrite in long curing process. When only salt is used for the fermentation, there is a greater microbial risk. On the other hand, high intake of nitrite presents a risk to human health due to its direct toxicity, or through the endogenous formation of carcinogenic nitrosamines (Sebranek, 2009). The average value of nitrite in ripe SK was 6.55 mg/kg which is lower than residual nitrite levels reported in sausages fermented with the use of nitrite/nitrate (Comi et al., 2005).

High level of biogenic amines in foods is another issue of public health concern because of their potentially toxicological effects caused by vasoactive and/or psychoactive properties (Vidal-Carou et al., 2007). Biogenic amines are mainly produced by microbial decarboxylation of amino acids (Silla Santos, 1996) and generally could be found in various fermented and seasoned foods. The fermentation of sausages in particular offers optimal conditions for biogenic amine accumulation due to availability of free amino acids, the presence of micro-organisms and acidic environment that favours their aminogenic activity (Bover-Cid et al., 1999). The most frequent and most abundant biogenic amine usually found in fermented sausages is tyramine with average concentrations from 100 to 200 mg/kg (Vidal-Carou et al., 2009). It is known that a larger diameter of the sausage and longer ripening time may be among the contributing factors for a higher accumulation of tyramin (Bover-Cid et al., 1999; Parente et al., 2001; Miguélez-Arrizado et al., 2006; Komprda et al., 2009). This could explain the generally high levels of tyramine (Table 2) observed in large sized, long ripened SK (≥200 mg/kg in 75 % of the samples). Large diameter and prolonged ripening of SK may also be responsible, at least partly for the high accumulation of histamine observed (≥200 mg/kg in more than 90 % of the samples). However, histamine is rarely found in fermented sausages manufactured under proper hygienic conditions and the occurrence of excessive levels of this biogenic amine is rather an indicator of defective hygienic conditions of raw materials and/or manufacturing processes (Vidal-Carou et al., 2007; Vidal-Carou et al., 2009).

Traditional smoking of SK is performed by thermal combustion of hardwoods, mainly from beech (*Fagus sylvatica*), ash (*Fraxinus excelsior*) and hornbeam (*Carpinus betulus*). Both logs and sawdust have been used sometimes moistened to lower the temperature of smoke. Products are usually smoked in the same chamber where the smoke is generated. It is known, however, that direct exposing to smoke can lead to greater deposition of potentially unhealthy substances from the smoke, like polycyclic aromatic hydrocarbons (PAH) on the surface of the products (Andrés et al., 2007). Some of PAH, like benzo(*a*)pyrene (B*a*P) are classified as probable human carcinogens (Anonymous, 2004c). The B*a*P could be used as indicator of total PAH presence in smoked foods and in EU the maximum level for B*a*P of 5 µg/kg has been established for smoked meat and smoked meat products (Anonymous, 2005). In present work, the maximum B*a*P level found was far below this margin (Table 2) and lower than those reported for other traditional (Lorenzo et al., 2010) and industrial sausages (Đinović et al., 2008). Possible explanations for low B*a*P contamination observed in SK could be the generally low temperatures of combustion which generate smoke with lower amounts of PAH

(Šimko, 2009), no use of softwoods which are high in resin that increases the concentration of PAH in smoke (Stumpe-Viksna et al., 2008), and the lower surface/mass ratio of sausage which less favour the PAH adsorption (Lorenzo et al., 2010).

During fermentation and ripening of sausages various microorganisms which are not involved in fermentation are usually progressively eliminated by acidification and drying (Labadie, 2007). As a result, dry and semi-dry fermented sausages are generally considered as shelf-stable and safe products which have rarely been involved in food contamination outbreaks. This is especially true for industry where both high sanitary standards and starter cultures are used to control sausage manufacturing. On the other hand, the traditional production is often connected with considerable variability in raw materials, operation units, fermentation, and/or ripening conditions and hygiene which may result in increased ability of spoilage microorganisms and/or pathogens to survive in end product (Skandamis and Nychas, 2007). For instance, investigating the safety of traditional production of sausages in households in Croatia, Kozačinski et al. (2008) found the generally increased total bacterial count at working surfaces and equipment used in the preparation of sausages, including the finding of *S. aureus* in 4 and *Enterococcus faecalis* in 3 of twenty controlled households. The same microorganisms, together with enterobacteria and sulfite-reducing clostridia were isolated in high counts from several samples of raw sausages for cooking, and some of them like *S. aureus* and sulfite-reducing clostridia were found to be exceedingly high in 20 % and 10 % of samples of dry sausages, respectively. In another Croatian study, traditional home-made sausages also showed inferior hygienic quality of raw materials and sausage mixture, as well as slower acidification and delayed elimination of undesirable microflora but were microbiologically valid at the end of the 90-day ripening (Zdolec et al., 2007). The close relationship between microbial ecosystems of traditional processing plants (the so called "house flora") and produced sausages was also established in studies in other countries (e.g. Lebert et al., 2007). In present study (Table 3), the counts of *S. aureus*, enterobacteria and sulfite-reducing clostridia in all samples of ripe SK were in accordance with Croatian Regulation on microbiological standards for foodstuffs (Anonymous 1994, 2001, 2003b and 2004d), while *Salmonella spp*. and *L. monocytogenes* were not isolated from any of the samples. This result is in agreement with those recently reported for traditional SK (Frece et al., 2010a). Some of the mentioned meat contaminants, like enterobacteria, are known for their high ability for biogenic amine production (Vidal-Carou et al., 2007). Hence, the high accumulation of histamine in SK observed in present study could indicate the bacterial contamination of raw materials or hygienic failure during the early steps of sausage production, regardless of the absence or low levels of aminogenic micro-organisms in the final product.

Similar to other fermented products which go through the long period of ripening, the fungal colonization of the surface may also appear in SK. The natural moulding of sausages, which results from contamination by environment-contaminating mould species, mainly from genera *Penicillium* and *Aspergillus*, may be desirable as it protects against the excessive drying and lipid oxidation and contributes to the flavour development of final product (Spotti and Berni, 2007). On the other hand, many moulds have the ability to produce mycotoxins and some of species that were isolated from SK (Table 3), i.e. *Aspergillus flavus*, do have toxigenic potentiality (Bailly and Guerre, 2009). The presence of certain fungi is not always followed by toxin production as conditions (water activity in particular) which allow toxin production are more restricted than those which give way to growth (Northolt et al., 1996). However, the presence of ochratoxin A and aflatoxin B1 in both surface and deeper layers of naturally moulded SK has been recently reported by Frece et al. (2010b). The contamination of spices and/or additives used in meat processing may additionally represent a source of mycotoxins (Mandić et al., 2007; Bailly and Guerre, 2009).

Conclusions

By the manufacturing technique and characteristics of final product, the traditional SK is similar to long matured Southern Europe type of naturally fermented sausages with the addition of smoking. According to pH, aw and M/P values of ripe product, the SK could be characterised as low-acid dry sausages whose shelf-stability is primarily conditioned by low water activity of final product. The analysed organoleptic traits of SK were within the limits of characteristics specific to traditional production. Compared to similar products, the SK has higher protein content and less fat. All analysed samples were microbiologically valid, with low nitrite level and PAH contamination but with high biogenic amines content and, in some of the cases, with the presence of potentially toxigenic moulds. Therefore, from the hygienic and technological points of view, additional efforts should be made to improve sanitary standards and good manufacturing practice among SK producers. In addition, better characterization and control of typical microflora during the sausage processing is essential in terms of safety, acceptability and organoleptic quality of SK.

References

Ambrosiadis J., Soultos N., Abrahim A., Bloukas J.G. (2004): Physicochemical, microbiological and sensory attributes for the characterization of Greek traditional sausages. Meat Sci. 66, 279-287.

Andrés A., Barat J.M., Grau R., Fito P. (2007): Principles of drying and smoking. In: Toldrá, F. (ed) Handbook of fermented meat and poultry. Blackwell Publishing, 37-48.

Anonymous (1994): Pravilnik o mikrobiološkim standardima za namirnice, Narodne Novine broj 46.

Anonymous (1999): Microbiology of food and animal feeding stuffs - Horizontal method for the detection and enumeration of *Listeria monocytogenes*. HRN EN ISO 11290-1, Croatian Standards Institute. Zagreb.

Anonymous (2001): Pravilnik o dopuni i izmjenama Pravilnika o mikrobiološkim standardima za namirnice, Narodne Novine broj 20.

Anonymous (2002): Microbiology - General guidance for enumeration of yeast and moulds. HRN ISO 7954, Croatian Standards Institute. Zagreb.

Anonymous (2003a): Microbiology of food and animal feeding stuffs - Horizontal method for the detection of *Salmonella spp*. HRN EN ISO 6579, Croatian Standards Institute. Zagreb.

Anonymous (2003b): Pravilnik o dopuni i izmjenama Pravilnika o mikrobiološkim standardima za namirnice, Narodne Novine broj 125.

Anonymous (2004a): Microbiology of food and animal feeding stuffs - Horizontal method for the enumeration of coagulase-positive staphyloccoco (*Staphylococcus aureus* and other species). HRN EN ISO 6888-1, Croatian Standards Institute. Zagreb.

Anonymous (2004b): Microbiology of food and animal feeding stuffs – Horizontal method for the enumeration of sulfite-reducing bacteria growing under anaerobic conditions. HRN ISO 15213, Croatian Standards Institute. Zagreb.

Anonymous (2004c): IARC Monographs on the Evaluation of Carcinogenic Risks to humans, International Agency for Research on Cancer, Vol. 88.

Anonymous (2004d): Pravilnik o dopuni i izmjenama Pravilnika o mikrobiološkim standardima za namirnice, Narodne Novine broj 32.

Anonymous (2005): Commission Recommendation 2005/208/EC of 4 February 2005 amending Regulation (EC) No 466/2001 as regards polycyclic aromatic hydrocarbons. Official Journal of the European Union, L34, 3-5.

Anonymous (2007): Foodstuffs - Determination of nitrate and/or nitrite content. HRN EN 12014-3, Croatian Standards Institute, Zagreb.

Anonymous (2008): Microbiology of food and animal feeding stuffs - Horizontal methods for the detection and enumeration of *Enterobacteriaceae*. HRN ISO 21528-2, Croatian Standards Institute. Zagreb.

Bailly J-D., Guerre P. (2009): Mycotoxin analysis in poultry and processed meats. In: Nollet, L.M.T., Toldrá, F. (eds) Handbook of processed meats and poultry analysis. CRC Press, 499-543.

Bover-Cid S., Schoppen S., Izquierdo-Pulido M., Vidal-Carou M.C. (1999): Relationship between biogenic amine contents and the size of dry fermented sausages. Meat Sci. 51, 305-311.

Comi G., Urso R., Iacumin L., Rantsioi K., Cattaneo P., Cantoni C., Cocolin L. (2005): Characterisation of naturally fermented sausages produced in the North East of Italy. Meat Sci. 69, 381-392.

Đinović J., Popović A., Jira W. (2008): Polycyclic aromatic hydrocarbons (PAHs) in different types of smoked meat products from Serbia. Meat Sci. 80, 449-456.

Ferreira V., Barbosa J., Silva J., Vendeiro S., Mota A., Silva F., João Monteiro M., Hogg T., Gibbs P., Teixeira P. (2007): Chemical and microbiological characterisation of "Salpicão de Vinhais" and "Chouriça de Vinhais": Traditional dry sausages produced in the North of Portugal. Food Microbiol. 24, 618-623.

Frece J., Markov K., Čvek D., Kovačević D. (2010a): Stafilokoki kao potencijalne izvorne starter kulture iz slavonskog kulena. Meso 3, 150-155.

Frece J., Markov K., Kovačević D. (2010b): Određivanje autohtone mikrobne populacije i mikotoksina te karakterizcija potencijalnih starter kultura u slavonskom kulenu. Meso 2, 92-97.

García Fontán M.C., Lorenzo J.M., Martínez S., Franco I., Carbalo J. (2007): Microbiological characteristics of Botillo, a Spanish traditional pork sausage. LWT 40, 1610-1622.

Incze K. (2007): European products. In: Toldrá, F. (ed) *Handbook* of fermented meat and poultry. Blackwell Publishing, 307-318.

Karolyi D. (2005): Fizikalno-kemijske osobine slavonskog kulena. Meso 2, 35-37.

Komprda T., Sládková P., Dohnal V. (2009): Biogenic amine content in dry fermented sausages as influenced by a producer, spice mix, starter culture, sausage diameter and time of ripening. Meat Sci. 83, 534-542.

Kozačinski L., Hadžiosmanović M., Cvrtila Fleck Ž., Zdolec N., Filipović I., Kozačinski Z. (2008): Quality of dry and garlic sausages from individual households. Meso 1, 74-80.

Labadie J. (2007): Spoilage microorganisms: risk and control. In: Toldrá, F. (ed) Handbook of fermented meat and poultry. Blackwell Publishing, 421-426.

Lebert A., Giammarinaro P., Morot-Bizot S., Leroy S., Talon R. (2007): Microbial ecosystems of processing units and traditional products in France. *Options Mediterr. Serie A*, 76, 305-314.

Leistner L., Rödel W. (1975): The significance of water activity for microorgnisms in meats. In: Duckworth, R.B. (ed) Water relations of foods. Academic Press, 309-323.

Lorenzo J.M., Michinel M., López M., Carballo J. (2000): Biochemical characteristics of two Spanish traditional dry-cured sausage varieties: "Androlla" and "Botillo". J. Food Compos. Anal. 13, 809-817.

Lorenzo J.M., Purriños L., Fontán M.C.G., Franco D. (2010): Polycyclic aromatic hydrocarbons (PAHs) in two Spanish traditional smoked sausage varieties: "Androlla" and "Botillo". Meat Sci. 86, 660-664.

Macan J., Turk R., Vukušić J., Kipčić D. and Milković-Kraus S. (2006): Long-term follow-up of histamine levels in a stored fish meal sample. Anim. Feed Sci. Tech. 127, 169-174.

Mandić S., Grujić R., Topalić-Trivunović Lj., Đurica R., Stojković S. 2007. Izvori mikološke i mikotoksikološke kontaminacije suvomesnatih proizvoda. Tehnologija mesa 49, 157-162.

Martínez P.J., Garrido M.D., Bañón S. (2008): Stabilization by chilling of Sobrasada from Chato Murciano pigmeat manufactured without preservatives. *An. Vet. (Murcia)*, 24, 73-83.

Miguélez-Arrizado M.J., Bover-Cid S., Latorre-Moratalla M.L., and Vidal-Carou M.C. (2006): Biogenic amines in Spanish fermented sausages as a function of diameter and artisanal or industrial origin. J. Sci. Food Agr. 86, 549-557.

Moretti V.M., Madonia G., Diaferia, C., Mentasti T., Paleari M.A., Panseri S., Pirone G., Gandini, G. (2004): Chemical and microbiological parameters and sensory attributes of a typical Sicilian salami ripened in different conditions. Meat Sci. 66, 845-854.

Northolt M.D., Frisvad J.C., Samson R.A. (1996): Occurrence of food-borne fungi and factors for growth. In: Samson, R.A., Hoekstra, E.S.,

Physikalisch-chemische, hygienische und organoleptische Charakterisierung der Dauerwurst Slavonski kulen

Zusammenfassung

Slavonski kulen ist die traditionelle getrocknete Dauerwurst, die in Slawonien in Ostkroatien hergestellt wird. Sie wird aus der Mischung des gehackten Schweinefleisches hergestellt, u.zw. aus Rückenspeck, Gewürzen und Salz. Die Mischung wird in den Schweine-Blinddarm gefüllt. Nach der Füllung wird die Wurst kalt geräuchert und getrocknet und danach während einiger Monate gereift. In dieser Arbeit wurden einige physikalisch-chemische und organoleptische Eigenschaften der reifen Kulen-Wurst sowie die Sicherheit des fertigen Erzeugnisses analysiert. Es wurden Wurstmuster von einigen kleinen Herstellern (n=12) aus Slawonien analysiert. Folgende physikalisch-chemische Parameter wurden festgestellt: Feuchtigkeit 38,2 % ± 3,6, Protein 35,0 % ± 3,1, Fett 23,7 % ±4,6, Verhältnis Feuchtigkeit/Protein 1,1 ± 0,1, pH Wert 5,37 ± 0,23 und Wasseraktivität (aw) 0,82±0,02. Die durchschnittlichen sensorischen Resultate, auf der 5-Punkte-Skala, waren 3,7 ±0,6 für äußeres Aussehen, 3,4 ±0,6 für Oberflächengeruch, 3,8 ±0,5 für Konsistenz, 3,2 ±0,4 für Innengeruch, 3,0 ±0,7 für Qualität des Durchschnittes, 3,3 ±0,5 für Textur, 3,1 ±0,4 für Geschmack und Geruch, 3,0 ±0,5 für Aromabeständigkeit und 3,2 ±0,4 für Gesamtqualität. In Bezug auf die Sicherheit des Erzeugnisses wurden folgende Resultate (je kg) festgestellt: Histamin 330,8 mg ±126,3, 233,9 mg Tiramin ±124,7, Nitrite 6,55 mg ± 3,88 und Benz(a)pyren 0,05 g ±0,03. Bakterien Salmonella spp. und L. monocytogenes wurden in keinem Muster vorgefunden, während der Befund von S. aureus, Enterobakterien und Sulfit-reduzierenden Klostridien im Einklang mit mikrobiologischen Vorschriften war.

Schlüsselwörter: *getrocknete Dauerwürste, Slavonski kulen, physikalisch-chemische Eigenschaften, Sicherheit*

Caratterizzazione fisico-chimica, igienica ed organolettica del kulen di Slavonia

Somario

Il kulen è la tradizionale salsiccia secca che si produce in Slavonia, nella Croazia dell'est. Viene fatto da un misto di carne suina, della pancetta del dorso di maiale, i condimenti e le spezie, con il quale si riempie l'intestino cieco di maiale, dopo di che il kulen si affumica a freddo e matura durante parecchi mesi. In questo lavoro sono state analizzate alcune caratteristiche fisico-chimiche e organolettiche del maturo kulen di Slavonia, così come la sicurezza del prodotto finale. Sono stati analizzati i campioni (n=12) presi da diversi produttori minori dall'area di Slavonia. Sono stati determinati i parametri fisico-chimici come segue: umidità del 38,2% ± 3,6, proteine il 35,0% ± 3,1, grassi il 23,7% ± 4,6, percentuale umidità/proteine 1,1 ± 0,1, valore pH 5,37 ± 0,23 e attività d'acqua aw) 0,82 ± 0,02. I risultati sensorici erano in media, sulla scala di cinque punti 3,7 ± 0,6 per l'aspetto esterno, 3,4 ± 0,6 per l'odore superficiale, 3,8 ± 0,5 per la consistenza, 3,2 ± 0,4 per l'odore interno, 3,0 ± 0,7 per la qualità di sezione trasverzale, 3,3 ± 0,5 per la tessitura, 3,1 ± 0,4 per il sapore e l'odore, 3,0 ± 0,5 per la consistenza di aroma e 3,2 ± 0,4 per la qualità totale. Avendo esaminato la sicurezza del prodotto, sono stati ottenuti i seguenti risultati (per un chilogrammo): istamina 330,8 mg ± 126,3, 233,9 mg, tiramina ± 124,7, nitriti 6,55 mg ± 3,88 e il benzo(a)pirene 0,05 g ± 0,03. I batteri Salmonella spp. e L. monocytogenes non sono stati trovati in nemmeno un campione, e la presenza del tipo S. Aureus, gli enterobatteri ed i clostridie sulfid-riducenti era conforme ai criteri microbiologici.

Parole chiave: *salsicce secche, kulen di Slavonia, caratteristiche fisico-chimiche, sicurezza*

Frisvad, J.C., Filtenborg, O. (eds) Introduction to Food-Borne Fungi. Centraalbureau voor schimmelcultures, 243-251.

Parente E., Martuscelli M., Gardini F., Greco S., Crudele M.A. Suzzi G. (2001): Evolution of microbial populations and biogenic amine production in dry sausages produced in Southern Italy. J. Appl. Microbiol. 90, 882-891.

Rosselló C., Barbas J.I., Bernat A., López N. (1995): Microbial and chemical changes in "Sobrasada" during ripening. *Meat Sci.* 40, 379-385.

Salgado A., García Fontán M.C., Franco I., López M., Carballo J. (2006): Effect of the type of manufacture (homemade or industrial) on the biochemical characteristics of *Chorizo de ceballa* (a Spanish traditional sausage). Food Control 17, 213-221.

SAS, 2002. Statistical Analysis System, v.9.1, SAS Institute Inc., Cary.

Sebranek J.G. (2009): Basic curing ingredients. In: Tatré, R. (ed) Ingredients in meat products. Properties, functionality and applications. Springer, 1-23.

Silla Santos M.H. (1996): Biogenic amines: their importance in foods. Int. J. Food Microbiol. 29, 213-231.

Skandamis P., Nychas G-J.E. (2007): Pathogens: risk and control. In: Toldrá, F. (ed) Handbook of fermented meat and poultry. Blackwell Publishing, 427-454.

Spotti E., Berni E. (2007): Sterter cultures: molds. In: Toldrá, F. (ed) Handbook of fermented meat and poultry. Blackwell Publishing, 171-176.

Stumpe-Viksna I., Bartkevičs V., Kukare A., Morozovs A. (2008): Polycyclic aromatic hydrocarbons in meat smoked with different types of wood. Food Chem. 110, 794-797.

Šimko P. (2009): Polycyclic aromatic hydrocarbons in smoked meats. In: Toldrá, F. (ed) Safety of meat and processed meat. Springer, 343-363.

Vidal-Carou M.C., Veciana-Nogués M.T., Latorre-Moratala M.L., Bover-Cid S. (2007): Biogenic amines: risks and control. In: Toldrá, F. (ed) Handbook of fermented meat and poultry. Blackwell Publishing, 455-468.

Vidal-Carou M.C., Latorre-Moratala M.L., Bover-Cid S. (2009): Biogenic amines. In: Nollet, L.M.T., Toldrá, F. (eds) Handbook of processed meats and poultry analysis. CRC Press, 665-686.

Zanardi E., Ghidini S., Battaglia A., Chizzolini R. (2004): Lipolysis and lipid oxidation in fermented sausages depending on different processing conditions and different antioxidants. Meat Sci. 66, 415-423.

Zdolec N., Hadžiosmanović M., Kozačinski L., Cvrtila Ž., Filipović I., Leskovar K., Vragović N., Budimir D. (2007): Fermentirane kobasice proizvedene u domaćinstvu – mikrobiološka kakvoća. Meso 6, 318-324.

Received: October 14, 2011
Accepted: November 11, 2011

Current state and trends in production of sheep meat in EU and Croatia

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professional paper

Summary

Production of meat as a segment of sheep production developed at the beginning of the 19th century in intensive agriculture of western Europe and in the eastern part of the USA because of the increase in population and development of industry. In sheep breeding, more than in other branches of livestock-breeding, there are significant differences in production technology within the EU, which brings to local differences in meat characteristics. Production systems may be divided to extensive and intensive ones.Extensive prevails in Mediterranean countries, where small suckling lambs of small body weight are slaughtered. Intensive system is spread in northern European countries where lambs of larger body weight are appreciated. In recent years the production and consumption of sheep meat has been in decline, mostly because of foot root disease, and because of CAP (Common Agricultural Policy) reform and large import of sheep and sheep meat from New Zealand and Australia. Production and consumption of sheep meat in Croatia have also been in decline mostly because of the Homeland war in which the number of sheep was cut by half. According to statistical data from 2009, the number of sheep from 1991 has still not been reached. As well as in other Mediterranean countries, in Croatia it is also popular to slaughter suckling lambs which are consumed in one peace or chopped in 2-4 pieces. Two best known traditional cured sheep meat are kastradina andstelja, none of which is protected.

Key words: sheep meat, production, trends

Introduction

Sheep are polygastric animals that are able to transform voluminous fodder of different backgrounds and shape into high-quality products: meat, milk, leather and wool. The quality of sheep meat depends primarily on the breed and age, and then sex, method of feeding and breeding area. The meat of young animals (lamb and mutton) is bright, with gentle muscle structures, no marbling, with a white subcutaneous and internal fat. The meat is characterized by a very fine taste and smell. Connective tissue in the meat of young animals is not developed enough and the meat is soft and delicious, with no characteristic odor. The meat of older sheep is dark red, muscle fibers are thicker, and the structure of the meat is coarser with more intense flavor and aroma (Uremović et al., 2002).One of the goals of sheep breeding is to produce the meat which will meet the high demands of consumers considering its sensory properties and quality (Cvrtila et al., 2007). The requirements of consumers of sheep meat in the EU countries, according Bernués et al. (2003), are increasing and include not only duration and origin of products, but also information concerning the system of production, traceability of animals and products, and quality control.

Historical development of sheep-breeding in Europe

Domestication of the wild progenitors of today's sheep, according to the available data, began 9000BC on the western slopes of mountain Zagros on the border of the present-day Iraq and Iran. The evolution of domesticated species is primarily the result of artificial selection, and then natural selection. Migration of the population caused the spreading of sheep across Asia into Europe and Africa (Zygoyiannis, 2006). Today, because of their high flexibility, endurance and humility, sheep are spread all over the world, except the North and South Poles. Due to their ability of better utilization of nitrogen and water, most sheep (and goats) are bred in areas with sparse vegetation and in inaccessible mountain pastures (Mioč et al., 2007).

Sheep are animals used for production of four types of products: milk, meat, leather and wool. Historically, long time ago the sheep meat was produced as a byproduct of breeds that were bred primarily for wool production, or, as in most Mediterranean countries, for milk production. Sheep that were slaughtered for human consumption were old and worn, or in dairy herds, very young, still suckling lambs eliminated from rejuvenation of herds.

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