Dry heat treated meat product Vysočina

Alena Saláková, Josef Kameník, Zdeněk Pavlík, Iva Steinhauserová

Department of Meat Hygiene and Technology
Faculty of Veterinary Hygiene and Ecology
University of Veterinary and Pharmaceutical Sciences Brno
Brno, Czech Republic

Abstract

The Vysočina sausage belongs to the category of dry heat treated meat products. The Czech legislation lays down qualitative requirements for this product, including a minimum content of pure muscle protein and a maximum content of fat. This study presents an analysis of 20 samples of Vysočina sausage from four different producers. Five different batches from each producer were tested. No cases were found in which the maximum limit for the content of fat was exceeded. The minimum content of pure muscle protein was not observed in one sample. Six samples failed to meet the maximum water activity value for dry heated meat products. The sodium chloride content ranged from 2.3 to 3.2%. Statistically significant correlations were found between the salt content and selected sensory parameters.

Fat, instrumental analysis, pure muscle protein, sensory analysis,sodium chloride, water activity

Introduction

Vysočina sausage was first made in Hodice at the end of year 1967 (Steinhauser 2010). Over the course of the following years, this product became the most popular dry heat treated sausage in the then Czechoslovakia. The branch norm dry heat treated Vysočina sausage with the code ON 57 7271 was approved in 1977.

Vysočina sausage is a cooked product (Plate I, Fig. 1). The consumer norm (SN 43119) of the Masný Průmysl (Meat Industry) concern of that time calculated the following composition of meat for one ton of product:

- lean beef rump 400 kg
- lean pork 265 kg
- lean pork without skin 545 kg
- pork fat without skin 170 kg

The total consumption of the principal raw materials amounted to 1 380 kg as specified by the norm. After salt and seasoning were taken into account, loss by drying was less than 30%. The only seasoning used was ground black pepper (3 kg. ton^{-1} of product). The amount of curing salt was set at 2.1% per 1 kg of batter. The final product particles were mostly 1 mm in size; sporadic small soft collagen particles and small air cavities were permitted (ON 57 7271). The batter was filled into collagen casings 55 mm in diameter. The minimum drying time was set at 12 days (SN 43119).

The following laboratory test parameters were defined for Vysočina sausage:

- salt content 3.1 ± 0.6%
- minimum protein 16%
- maximum water/protein ratio 2.375

For the purpose of evaluation, a simple equation was used for protein determination: Protein = 99 – (water + fat + salt)

The norm further specified the sensory properties of the final product, and permitted the possibility of the growth of starter mould cultures on the surface (ON 57 7271).

Address for correspondence:
Ing. Alena Saláková, PhD.
Department of Meat Hygiene and Technology
Faculty of Veterinary Hygiene and Ecology
University of Veterinary and Pharmaceutical Sciences Brno
Palackého tř. 1/3, 612 42 Brno, Czech Republic

Phone: +420 541 562 749
Fax: +420 541 321 230
E-mail: salakovaa@vfu.cz
www.maso-international.cz

After 1992 when the branch norm was abolished, production of Vysočina sausages expanded and the recipes became more varied. Each producer made its own alterations to the original recipe with the aim of achieving the best possible production economics. The Ministry of Agriculture in its Decree no 326/2001 laid down rules for selected traditional meat products, including Vysočina sausage. Appendix no 4 to this regulation states that only beef and pork meat may now be used for the production of Vysočina in the Czech Republic; the addition of fibre, mechanically separated meat, plant proteins or other animal proteins is not permitted. In the area of laboratory parameters, the decree sets the minimum content of pure muscle protein (PMP) at 13%, while fat is limited to a maximum of 50%. A maximum water activity value in the category of dry heat treated meat products was set at 0.93.

The aim of this study was to assess the degree of uniformity of Vysočina sausages on the Czech retail, and to compare laboratory analysis results with the current legislation and with the original requirements of the branch norm.

Materials and Methods

Samples were taken and physico-chemical, instrumental and sensory analyses performed according to Saláková et al. (2013).

Results and Discussion

Table 1 shows the results of the physico-chemical analysis of samples of dry heat treated Vysočina sausage. It is clear that all the samples, with the exception of 1 sample from Producer B, met the limit for the minimum content of pure muscle protein of 13% stipulated by Decree no 326/2001, as amended. The mean proportion of pure muscle protein ranged from 13.72 (Producer C) to 16.99% (Producer A). A higher content of pure muscle protein was determined for Producers A and D than for Producers B and C. Válková et al. (2006) reported pure muscle protein contents ranging from 8.49 to 17.92% in Vysočina sausage. Similar results for the proportion of pure muscle protein in Vysočina sausage among various producers were also reported by Ševčík (2012). The values in his study ranged from 14.55 to 17.54%.

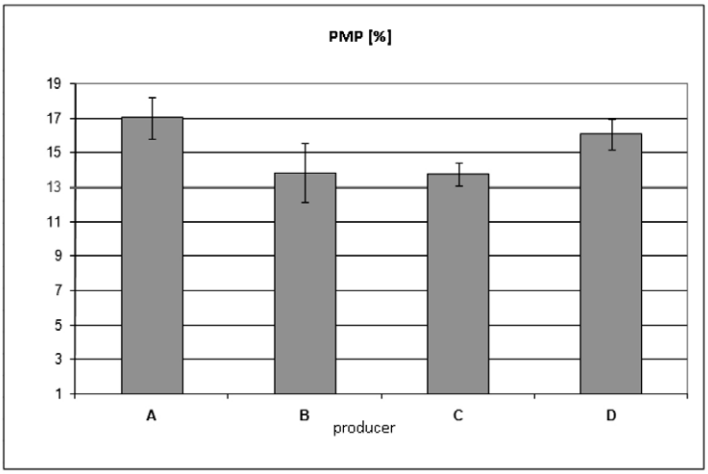

Fig. 2. Mean values for the content of pure muscle protein (PMP %) in Vysočina sausage (the minimum content of 13% is given by the valid legislation)

Table 1. The results of physico-chemical tests on samples of Vysočina sausage

Producer	Sample	pH [-]	a_w [-]	Dry matter [%]	Fat [%]	NaCl [%]	Collagen [%]	PMP [%]	TBARS [mg kg^{-1}]
A	1	6.04 ± 0.00	0.930 ± 0.002	64.62 ± 0.30	39.88 ± 1.42	2.79 ± 0.01	2.99 ± 0.15	17.29 ± 0.29	2.52 ± 0.33
	2	6.09 ± 0.01	0.932 ± 0.003	59.71 ± 0.31	31.24 ± 0.32	2.87 ± 0.02	3.03 ± 0.02	17.62 ± 0.35	2.42 ± 0.35
	3	6.05 ± 0.00	0.922 ± 0.000	63.96 ± 0.32	33.54 ± 0.53	2.84 ± 0.10	3.64 ± 0.12	17.00 ± 0.96	2.63 ± 0.10
	4	6.12 ± 0.04	0.918 ± 0.002	65.58 ± 0.14	40.68 ± 0.06	3.23 ± 0.04	2.96 ± 0.05	14.53 ± 0.44	2.67 ± 0.29
	5	6.04 ± 0.01	0.915 ± 0.004	64.75 ± 0.27	29.66 ± 0.68	2.74 ± 0.01	2.96 ± 0.02	20.99 ± 0.87	0.55 ± 0.08
A	mean	6.07 ± 0.04	0.923 ± 0.007	63.72 ± 2.09	35.00 ± 4.56	2.89 ± 0.18	3.11 ± 0.28	16.99 ± 2.19	2.16 ± 0.85
B	1	5.93 ± 0.01	0.949 ± 0.002	57.35 ± 0.65	35.42 ± 0.15	2.53 ± 0.12	2.22 ± 0.07	11.69 ± 0.30	2.40 ± 0.25
	2	6.03 ± 0.04	0.947 ± 0.002	61.26 ± 1.48	38.36 ± 1.11	2.31 ± 0.02	1.69 ± 0.08	13.46 ± 0.22	1.81 ± 0.29
	3	6.02 ± 0.00	0.938 ± 0.001	62.37 ± 0.30	37.14 ± 0.21	2.92 ± 0.00	2.01 ± 0.11	16.72 ± 0.36	7.29 ± 0.31
	4	5.73 ± 0.02	0.936 ± 0.002	60.44 ± 0.02	36.36 ± 0.07	2.56 ± 0.02	2.22 ± 0.15	15.80 ± 0.74	2.67 ± 0.33
	5	5.63 ± 0.01	0.927 ± 0.004	64.31 ± 0.20	42.25 ± 0.20	2.58 ± 0.01	2.37 ± 0.10	13.88 ± 0.77	2.89 ± 0.12
B	mean	5.87 ± 0.16	0.939 ± 0.008	61.14 ± 2.42	37.90 ± 2.43	2.58 ± 0.20	2.10 ± 0.26	13.82 ± 1.70	3.41 ± 1.99
C	1	5.88 ± 0.02	0.929 ± 0.002	65.57 ± 0.88	40.86 ± 0.59	2.73 ± 0.01	2.36 ± 0.15	14.09 ± 0.36	3.59 ± 0.16
	2	6.00 ± 0.01	0.944 ± 0.002	59.83 ± 0.14	35.83 ± 0.45	2.54 ± 0.04	2.07 ± 0.03	14.85 ± 0.34	2.83 ± 0.06
	3	5.79 ± 0.01	0.932 ± 0.000	62.95 ± 0.04	38.32 ± 1.96	2.66 ± 0.07	1.96 ± 0.14	14.38 ± 0.38	2.59 ± 0.14
	4	6.03 ± 0.02	0.944 ± 0.001	63.10 ± 0.15	40.60 ± 1.52	2.56 ± 0.00	3.06 ± 0.12	13.31 ± 0.45	4.35 ± 0.41
	5	5.97 ± 0.01	0.933 ± 0.003	64.09 ± 0.04	39.89 ± 0.11	2.60 ± 0.02	2.38 ± 0.05	13.05 ± 0.17	2.73 ± 0.12
C	mean	5.932 ± 0.09	0.936 ± 0.006	63.11 ± 1.93	39.10 ± 2.19	2.62 ± 0.08	2.37 ± 0.40	13.72 ± 0.67	3.22 ± 0.70
D	1	6.04 ± 0.01	0.927 ± 0.002	66.01 ± 0.47	35.67 ± 0.36	3.15 ± 0.16	2.29 ± 0.05	17.11 ± 0.34	3.90 ± 0.00
	2	5.90 ± 0.01	0.928 ± 0.001	65.93 ± 0.37	37.37 ± 0.24	2.80 ± 0.08	2.67 ± 0.05	16.72 ± 0.16	3.90 ± 0.08
	3	5.92 ± 0.01	0.913 ± 0.003	66.18 ± 0.27	34.95 ± 3.07	3.11 ± 0.01	2.33 ± 0.11	16.83 ± 0.47	1.15 ± 0.37
	4	6.10 ± 0.02	0.927 ± 0.002	66.16 ± 0.25	38.54 ± 1.01	3.03 ± 0.05	2.49 ± 0.08	15.02 ± 0.59	4.68 ± 0.00
	5	5.95 ± 0.03	0.920 ± 0.001	65.33 ± 0.23	40.42 ± 0.42	2.91 ± 0.01	2.36 ± 0.05	15.53 ± 0.61	5.75 ± 0.14
D	mean	5.98 ± 0.08	0.923 ± 0.006	65.92 ± 0.45	37.39 ± 2.46	3.00 ± 0.15	2.43 ± 0.16	16.04 ± 0.94	3.88 ± 1.53

Note: values are given as mean ± standard deviation
PMP – pure muscle protein, TBARS – malondialdehyde content (thiobarbituric reactive substances)

An overview of the mean results for the proportion of pure muscle protein in Vysočina sausages from the individual producers is given in Fig 2. Pure muscle protein values serve as an indicator of the content of lean meat in meat products. The muscle and, consequently, the lean meat of animals for slaughter, contains around 20 – 22% protein (Bauer and Honikel 2007), of which around 50% is myofibrillar protein and 30 – 35% sarcoplasmatic protein (Lonergan 2012). The remainder is made up of stromatic protein, mostly collagen. The Vysočina sausage from the four producers contained a mean of 1.7 – 3.6% collagen.

Table 2. The proportion of pure muscle protein (%) and collagen (%) in the meat protein content in Vysočina sausage

Producer	Meat protein [%]	Proportion of PMP from proteins	Proportion of collagen
A	20.10	84.5	15.5
B	15.92	86.8	13.2
C	16.09	85.3	14.7
D	18.47	86.8	13.2

If we compare the mean values in the samples from the individual producers with the content of meat protein (Table 2), we see a collagen proportion of between 13.2 and 15.5% and a percentage of pure muscle protein of around 85 – 87%, which corresponds to the proportions in fresh lean meat.

A change in this proportion in meat products may result from the processing of meat with a high content of connective tissue or by the addition of commercial collagen-based animal protein preparations. The proportion of collagen to protein in meat products is covered by the definition of qualitative requirements in neighbouring Slovakia and Austria. Section 24 of Slovak Ministry of Agriculture and Ministry of Health Ruling 1895/2004 -100 from 2005 stipulates a minimum total protein not including collagen of 11%, and a maximum amount of collagen in total proteins of 18% in dry heat treated meat products (Decree 2005). Analysed Vysočina sausages satisfied both of these parameters. The content of meat protein, not total protein, was used for this assessment (Saláková et al. 2013). The Austrian Food Code (Österreichisches Lebensmittelbuch 2005) states a collagen value which, in practical terms, corresponds to the percentage of collagen in total proteins. A maximum value is expressed for specific products: 18% for Viennese sausage, which belongs to the "Dauerwurst" category, 15% for Wiener Spezial, and as much as 20% for Cabanossi.

Another characteristic stipulated by the Czech legislation for the observation of the Vysočina sausage standard is the fat content. The mean values discovered for Producers A – D ranged from 35.0 to 39.1%; the maximum permitted amount of 50% was not exceeded in any of the samples (Fig. 3). Ševčík (2012) found fat content between 39.7 and 42.2%. The above decree in Slovakia also states a ratio indicator for dry heat treated cooked products, i.e. the fat-to-total protein ratio, for which the maximum limit is 3.4 (Decree 2005). The values recorded for the individual producers included in the study presented here are shown in Table 3 (expressed as fat/meat protein).

Table 3. Fat-to-meat protein ratio in Vysočina sausage

Producer	Fat/meat protein ratio
A	1.7
B	2.4
C	2.4
D	2.0

In Austria, the limit for Wiener Spezial is 2.2; for other dry heat treated products (e.g. Wiener, Cabanossi) 2.4.

The criterion that determines the classification of a meat product among dry heat treated products is, according to Decree no 326/2001, as amended, a maximum water activity value of 0.93. The water activity a_w is the ratio between the pressure of water vapour above the foodstuff at a given temperature to the pressure of water vapour above distilled water at the same temperature (Feiner 2006). This value does not express the water content in the foodstuff as such, but indicates the ratio between free unbound water in the product to the total water content. Distilled water has an a_w value of 1.00, fresh meat around 0.98. Drying causes the water activity value to

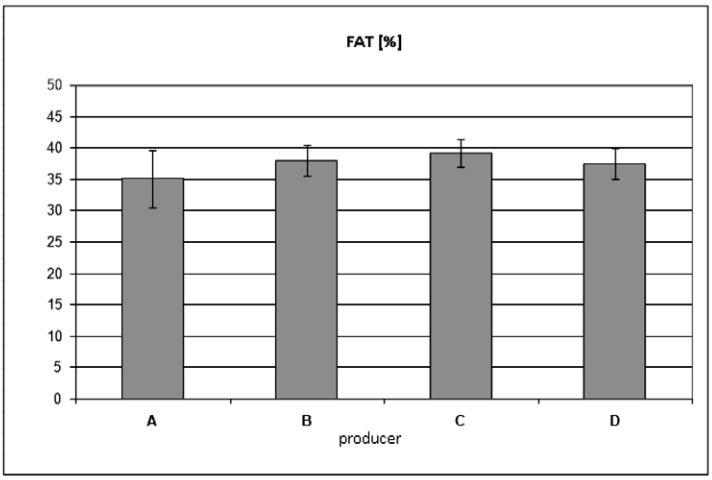

Fig. 3. Mean values for fat content (%) in Vysočina sausage
(maximum content 50% according to the valid legislation)

fall, e.g. a_w values of traditional Hungarian mould sausages are 0.83 – 0.85. After drying, which lasts 10 – 14 days on mean in production plants in this country; a_w values in dry heat treated sausages have dropped to 0.93. In view of the fact that bacteria of the family *Enterobacteriaceae* or the genus *Clostridium* require an $a_w > 0.95$ in order to grow, products with a value ≤ 0.93 can be stored at a room temperature with no risk of the proliferation of undesirable microorganisms. The mean a_w values in the samples of Vysočina sausage analysed ranged from 0.923 to 0.939 (Fig. 4). After rounding to 2 decimal places, 6 of the 20 samples tested did not comply with the maximum limit value of 0.93. The fact that there are problems relating to an unsatisfactory a_w value in Vysočina sausages in retail stores has

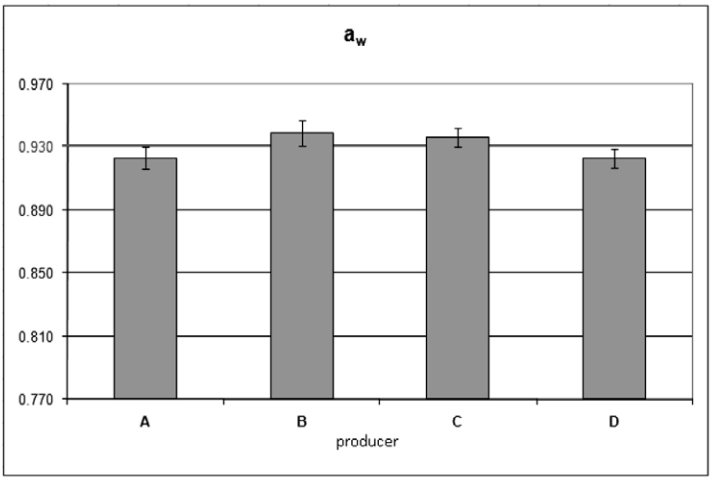

Fig. 4. Mean values of water activity (aw) in Vysočina sausage
(maximum value according to the valid legislation 0.93)

been known for a long time. Brychta et al. (2009) found that of 39 dry heat treated meat products unsatisfactory from the viewpoint of water activity, 22 were samples of Vysočina sausage. Similar findings are described by Blahová et al. (2011). The maximum a_w limit for dry heat treated products in Slovakia is 0.95 (Decree 2005).

Water activity is extremely closely linked to the content of water in the product, though it does not copy it exactly. The water content is indicated by the percentage of dry matter we determined. According to Table 1, the water content ranged from 34.1 to 38.9%. The Slovak Decree stipulates the maximum water-to-total proteins ratio of 3.2 as another qualitative characteristic for dry heat treated meat products. Table 4 shows how our Czech producers fared in respect of this parameter (the ratio is expressed by the relationship between water and meat proteins). Similarly, the Austrian Code also stipulates the water/total protein ratio indicator, e.g. 1.2 and 2.8 for Cabanossi and Wiener Spezial, respectively.

Table 4. Ratio between water and meat proteins in Vysočina sausage

Producer	Water/meat proteins ratio
A	1.8
B	2.4
C	2.3
D	1.8

The original branch norm in the meat industry also set the maximum water-to-proteins ratio at 2.375. Producer B would not have conformed to this limit, though the methodology for the calculation of the protein content used at that time was based on an extremely simple equation that took only the basic constituents of the product into consideration. It was based on the assumption that a meat product is comprised of water, protein, fat and salt. If a producer were to use fibre, for example, then the equation would count this as "protein". The proportions we would obtain using the equation given in the introduction to this article for the calculation of protein are given in Table 5. In this case, the protein content corresponds to the total protein content determined by the methodology described by Saláková et al. (2013).

Table 5. The protein content in Vysočina sausage – a comparison of the calculation according to ON 57 7271 and physico-chemical analysis

Producer	Protein content calculated by ON 57 7271 [%]	Protein content determined by analysis [%]	Difference [%]
A	24.8	20.1	4.7
B	19.7	15.9	3.8
C	20.4	16.1	4.3
D	24.5	18.5	6.0

The Table 5 shows a clear discrepancy between the proportion of protein we are now capable of determining by a physico-chemical analysis and that given by the calculation method in the original branch norm. If the equation for the protein percentage calculation is used, the water/protein in Producer B's product would be 1.98.

The NaCl content in the individual samples ranged from 2.31 to 3.23%. It is logical that the salt content in the product increases as the result of drying. Salt serves not only to intensify the taste of the meat in the product, but also has a significant effect on binding (breaking down and activating myofibrillar proteins) and shelf life. The original branch norm stipulated NaCl content in the final product of 3.1 ± 0.6%, i.e. a range from 2.5 to 3.7% was permitted. In our study, we found lower concentrations in some samples.

This does not, however, detracts from the quality of Vysočina sausage in any way. On the contrary, the current trend is for a reduced salt content in meat products.

Sodium chloride is applied in the form of curing salt. The addition of nitrite is generally permitted by Regulation (EC) no 1333/2008 at a maximum amount of 150 $mg \cdot kg^{-1}$ at the time of production, though there are exceptions for selected types of product. Vysočina sausage is one of the exceptions given in Part E of Annex II of the above Regulation. The maximum amount of sodium nitrite permitted for this product is 180 $mg \cdot kg^{-1}$. In practice, this corresponds to the addition of 2% of curing salt with 0.9% of $NaNO_2$. Under normal conditions when curing salt with 0.6% $NaNO_2$ is used, salting to as much as 2.4% is possible. In our analysis of Vysočina sausage samples for nitrites, we found a maximum content of 9.85 $mg \cdot kg^{-1}$ in the final product. A fall in nitrite concentration occurs during the heat treating and subsequent drying of the product. Our data on nitrite concentrations in the samples corresponded to those published by Honikel (2008).

The content of malondialdehyde, a secondary product in the oxidation of fats (TBARS value), ranged from 0.55 to 7.29 $mg \cdot kg^{-1}$. Large differences may be the result of the use of raw materials (pork fat) of various ages and the associated varying degree of oxidation changes. The malondialdehyde content may continue to increase or fluctuate during the storing of products in drying chambers.

The results of colour measurements in Vysočina sausage samples using the CIEL*a*b* system and the results of texture analysis are given in Table 6. It is clear that the lowest mean lightness (the L^* value) was measured in the products from Producer A; the highest, i.e. the lightest products, from Producer B.

Instrumental texture measurements serve for the objective determination of the properties of the product perceived by the consumer when chewing the product (Xiong et al. 2006). Two texture parameters were analysed in this study – the TPA value (texture profile analysis) and W-B value (Warner-Bratzler test). The highest mean TPA value was recorded in the sausages from Producer A (118.0 N). When we compare the results for the TPA value recorded for the individual producers, we see a numerical dependence with the content of pure muscle protein and fat. The mean pure muscle protein content for Producers A–D corresponded to the mean TPA values measured – the higher the pure muscle protein content, the higher the TPA value. An inverse relationship was found between TPA and the fat content – the lower the mean fat content, the higher the TPA value. The same relationship was found for the W-B value. It is interesting to note that no relationship was found between dry matter content and TPA and W-B values. This is probably due to the fat content, which reduces the sausage toughness. It goes without saying that the composition of the fat, i.e. the proportion of individual types of fatty acids, is significant in Vysočina sausages, as it is in fermented meat products. The effect of the pure muscle protein content on texture parameters is extremely important. The development of texture in dry heat treated sausages takes place in three main steps:

1. the breakdown of myofibrillar protein caused by NaCl during comminuting and mixing;
2. the formation of protein gel during the heat treatment and subsequent cooling of the product;
3. the solidification of the protein gel during drying.

A statistically significant positive correlation ($r = 0.58$) was found between dry matter content and the a^* value during a correlation assessment between selected physico-chemical indicators and the results of the instrumental analysis (Table 7). No further statistically significant correlations were demonstrated. Válková et al. (2006) also did not find statistically significant correlations between texture as evaluated by the Warner-Bratzler test and the chemical composition of Vysočina sausages.

The results of the sensory evaluation of samples of Vysočina sausage are in the

Table 6. The results of instrumental analyses of Vysočina sausage samples

Producer	Sample	L*	a*	b*	TPA [N]	W-B [N]
A	1	49.22 ± 0.24	10.54 ± 0.04	10.61 ± 0.02	101.62 ± 8.10	33.10 ± 1.32
	2	50.52 ± 1.07	12.20 ± 0.39	10.21 ± 0.31	109.32 ± 14.91	30.98 ± 2.72
	3	50.57 ± 1.77	13.74 ± 0.79	9.58 ± 0.65	132.61 ± 20.48	32.29 ± 3.46
	4	54.57 ± 2.73	10.26 ± 07.4	8.93 ± 0.76	102.61 ± 10.22	37.34 ± 1.24
	5	51.64 ± 0.65	9.93 ± 0.28	7.00 ± 0.54	143.93 ± 18.64	45.73 ± 2.45
A	mean	51.30 ± 1.81	11.33 ± 1.44	9.27 ± 1.27	118.02 ± 17.12	35.89 ± 5.36
B	1	54.99 ± 0.44	14.62 ± 0.37	8.13 ± 0.02	74.10 ± 0.66	26.31 ± 0.20
	2	53.56 ± 1.67	13.63 ± 0.89	7.48 ± 0.37	65.46 ± 6.26	27.34 ± 2.04
	3	51.35 ± 1.31	14.70 ± 1.01	7.97 ± 0.21	79.39 ± 4.84	26.58 ± 1.36
	4	56.67 ± 1.93	13.06 ± 1.00	6.15 ± 0.57	94.12 ± 7.40	33.51 ± 1.07
	5	59.79 ± 1.48	11.22 ± 0.48	6.60 ± 0.40	79.62 ± 11.86	43.37 ± 1.87
B	mean	55.27 ± 2.86	13.45 ± 1.27	7.27 ± 0.77	78.54 ± 9.33	31.42 ± 6.53
C	1	52.45 ± 0.04	13.54 ± 0.04	8.71 ± 0.01	64.93 ± 9.58	19.68 ± 1.60
	2	55.73 ± 3.18	11.93 ± 1.26	7.00 ± 0.30	53.05 ± 9.65	20.32 ± 1.84
	3	49.26 ± 2.89	14.67 ± 1.27	9.00 ± 0.55	80.83 ± 8.32	36.69 ± 1.53
	4	54.71 ± 1.85	12.03 ± 0.62	7.24 ± 0.51	62.66 ± 10.11	24.40 ± 2.45
	5	51.10 ± 0.91	14.13 ± 0.59	8.53 ± 0.32	79.19 ± 24.05	23.26 ± 2.20
C	mean	52.65 ± 2.35	13.26 ± 1.10	8.09 ± 0.81	68.13 ± 10.50	24.87 ± 6.17
D	1	53.78 ± 1.38	9.61 ± 0.81	11.25 ± 0.37	69.87 ± 12.62	25.30 ± 2.04
	2	50.24 ± 1.50	11.79 ± 0.54	11.81 ± 0.19	91.93 ± 16.08	28.40 ± 1.58
	3	50.30 ± 1.78	11.00 ± 0.44	10.43 ± 0.32	98.37 ± 12.25	42.51 ± 2.62
	4	51.68 ± 2.88	10.71 ± 0.83	9.56 ± 1.06	69.53 ± 10.87	38.03 ± 3.13
	5	54.89 ± 1.05	9.90 ± 0.50	10.28 ± 0.69	79.53 ± 6.81	23.59 ± 1.49
D	mean	52.18 ± 1.87	10.60 ± 0.78	10.67 ± 0.78	81.85 ± 11.62	31.56 ± 7.41

Note: values are given as mean ± standard deviation
L* – lightness, a* – redness, b* – yellowness, TPA – maximum force required to compress the sample during texture profile analysis, W-B – maximum force required to cut through the sample during Warner-Bratzler test

graphs in (Plate I, Fig. 5); the mean values of individual descriptors are shown in Table 8. As can be seen in Fig. 5, the products from Producer A received the worst evaluation in terms of taste and overall impression. The samples from Producer B showed considerable variability in terms of taste, overall impression and consistency. The individual samples from Producers C and D received similar evaluations.

Válková et al. (2006) determined statistically significant dependences ($P \leq 0.05$) between the pure muscle protein content and the sensory evaluation of colour, odour and taste in Vysočina sausages. Our study did not confirm the conclusions reached by Válková et al. (2006). Statistically significant correlations were found between the

Table 7. Statistical correlations between selected physico-chemical indicators and the results of instrumental analysis

	Instrumental parameters				
	L^*	a^*	b^*	TPA	W-B
pH	0.06	-0.18	0.17	0.11	0.14
Dry matter	-0.07	0.58***	-0.34	0.23	0.15
Fat	-0.32	0.33	-0.10	-0.17	0.07
Pmp	-0.18	0.10	-0.11	0.36	0.12
Collagen	-0.11	0.32	-0.32	-0.01	-0.06
Salt	0.02	0.20	-0.13	0.20	0.11

*** $P \leq 0.001$, PMP – pure muscle protein

Table 8. The results of the sensory evaluation of Vysočina sausages (mean values of 5 samples ± standard deviation)

	Producer A	Producer B	Producer C	Producer D
Cut surface appearance	85 ± 9	87 ± 4	86 ± 4	94 ± 2
Colour	72 ± 12	79 ± 10	78 ± 6	81 ± 5
Matrix	81 ± 7	74 ± 8	77 ± 5	80 ± 4
Occurrence of ring	80 ± 10	88 ± 6	86 ± 6	81 ± 7
Odour	85 ± 6	81 ± 9	85 ± 3	88 ± 4
Consistency	91 ± 3	83 ± 10	88 ± 4	88 ± 7
Texture	81 ± 8	84 ± 7	86 ± 4	87 ± 5
Taste	55 ± 7	69 ± 15	73 ± 6	76 ± 5
Overall impression	59 ± 5	69 ± 14	71 ± 4	76 ± 5

Table 9. Statistical correlations between selected physico-chemical indicators and sensory parameters

	Cut surface ppearance	Colour	Matrix	Odour	Consistency	Texture	Taste	Overall appearance
pH	-0.04	0.11	0.18	0.08	-0.19	-0.18	-0.28	-0.33
Dry matter	-0.22	-0.02	-0.07	0.14	-0.14	-0.14	-0.29	-0.31
Fat	-0.18	-0.02	0.08	-0.10	-0.19	-0.10	-0.16	-0.14
Pmp	-0.09	-0.05	-0.16	0.14	0.05	0.08	0.09	0.05
Collagen	-0.19	-0.25	-0.03	0.16	-0.23	-0.20	-0.31	-0.36
Salt	-0.18	-0.30	0.11	0.22	-0.43*	-0.53**	-0.51**	0.53**

* $P \leq 0.05$; ** $P \leq 0.01$, PMP – pure muscle protein

salt content and sensory parameters (consistency, texture, taste and overall impression of the product).

Conclusions

A total of 20 samples of Vysočina sausage (5 different batches from 4 individual producers) were analysed. The minimum pure muscle protein content was not met in one case. The maximum fat content was observed in all cases. A total of 6 samples (4 from Producer B, 2 from Producer C) did not conform to the maximum a_w value valid for dry heat treated meat products in the Czech Republic.

A comparison of the results with the physico-chemical requirements of the original

branch norm for Vysočina sausage (ON 57 7271) demonstrated conformity in all defined indicators. A statistically significant positive correlation (r = 0.58) was demonstrated between dry matter content and the a^* value. No other statistically significant correlations between selected physico-chemical indicators and instrumental analysis results were demonstrated. Statistically significant correlations were discovered between the salt content and certain sensory parameters.

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Fig 1. Dry heat treated Vysočina sausage (Ovísková V)

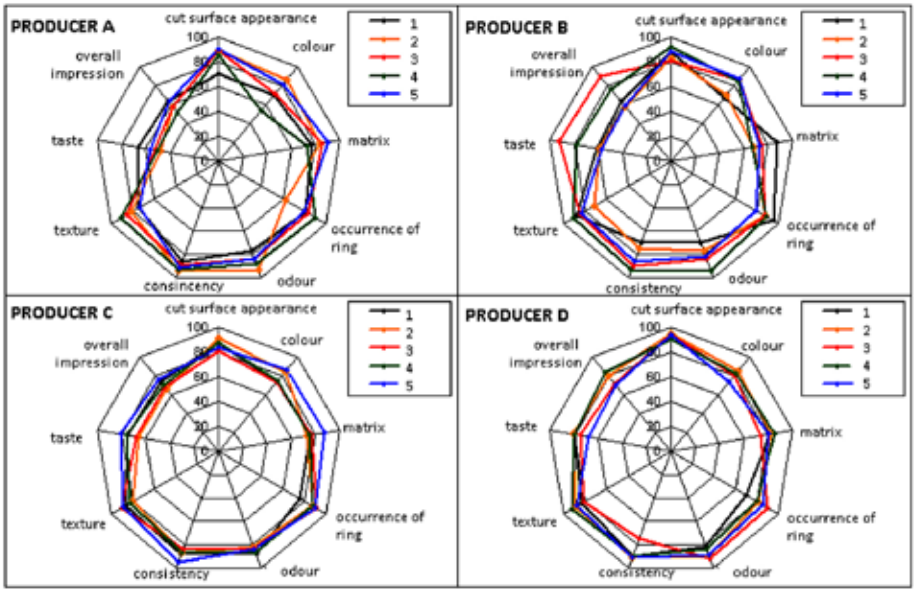

Fig. 5. The results of the sensory evaluation of Vysočina sausages