CHANGES OF SELECTED QUALITY PARAMETERS OF CURED,SMOKED RAW PORK-LOIN DURING STORAGE AT NEAR CRYOSCOPIC TEMPERATURE

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SUMMARY: Dynamics of selected quality features changes of raw,cured,smoked pork-loins vacuum wrapped in a laminate PA20/PE70 and stored for 12 weeks at close to cryoscopic temperature /-3°C/ was ivestigated.During long-term deep chilled storage of the experimental processed meat product the nitrosation of haeme pigments which stabilize the product colour was observed along with substantial fate of the residual nitrite and nitrate contents.The level of bacterial contamination after 12 weeks of storage was beyond sanitary reservation and protein digestibility in vitro only slightly decreases in comparison with initially determined.

INTRODUCTION: In all phases of meat and meat products trade maintenance of high quality is of paramount importance.For short-term storage appropriate wrappings and refrigeration chain is usually sufficient,while long-term storage requires freezing which applied for processed meat products results in substantial worsening of their initial quality features.Accordingly,a search for means of limiting the freezing of selected finished processed meat products seems to be fully justified.Our preliminary surwey of the subject matter and own research findings indicate that the replacement of freezing of selected assortments of processed meat products by deep chilled storage i.e. at their cryoscopic temperature effectively limits the adverse effects of freeze-storage eliminating them altogether with regard to the majority of sensory characteristics./3,5,15,16/.The aim of the study was to assess the durability of raw,cured,smoked pork-loins,wrapped in vacuum in thermoshrinkable plastic bags /Cryovac/ and stored at near cryoscopic temperature for 2,4,8 and 12 weeks.

MATERIALS and METHODS: The experimental materials were raw,cured,smoked pork-loins manufactured in industrial conditions from M.longissimus dorsi /pH$\geqslant$6.3/,wrapped under

vacuum in laminate PA20/PE70 and stored at near cryoscopic temperature i.e.-3°C ± -1°C for 2,4,8 and 12 weeks.Experiment was repeated 3 times.

Dynamics and the range of storage changes in pork-loins were assessed on the basis of the following analytical determinations:the total amount of haeme pigments,the amount of nitrosopigments and the degree of haeme pigments conversion to nitrosopigments /10/,the amount of residual nitrite and nitrate /20/,peptic digestibility in vitro /8,9/ and total plate count of bacteria in 1 g sample./1/.The stability of colour and its physical parameters i.e.dominant wavelenght /λd/,the excitation purity /pe/ and the luminance /Y/ after 3,6 and 12 hours of continuous illumination of pork-loin samples by fluorescent white light with an intensity of 250 Lx using the reflectance spectrophotometry were determined.

The data were subjected to analysis of variance and the significant differences between the means were determined at the level of $P \leqslant 0.05$, $P \leqslant 0.01$ and $P \leqslant 0.001$ significance.

RESULTS and DISCUSSION: The contents of nitrosopigments: Conversion of haeme pigments for nitrosopigments is commonly considered of being an important quality index for a cured meat products.According to the observation made the degree of haeme pigments conversion to nitrosopigments and the amount of nitrosopigments determined was the lowest in the initial material,i.e.74,7% and 45.8 ppm of hematine,respectively.Table 1. Permanent statistically significant /$P \leqslant 0.001$ and $P \leqslant 0.01$/ increase of the nitrosopigments amount and simultaneous increse of the degree of haeme pigments conversion was observed during 12 weeks of pork-loins deep chilled storage.This seems to be characteristic for raw cured meat products and reveal that the deep chilling does not arrest the nitrosation process. /11,13/.Similar observations were made by the authors in their previous experiments./4,14/.

Colour: Determination of the dominant wavelenght /λd/and the excitation purity /pe/ allow to assess,relatively precisely, the colour of cured meat products.During first 2 weeks of pork-loins deep chilled storage the changes of the colour were

practically not observed.Table 1.Statistically significant changes /$P \leq 0.05$/ of the λd in relation to the initial value and values determined after 8 weeks of storage,were noticed only after 12 weeks of deep chilled storage and resulted most probably from haeme pigments nitrosation.Irrespectivelly of the storage period applied,lenghtening of sample illumination during the test of colour stability,resulted in a shortening of the λd.Fig.1.The observed changes for unstored pork-loins and stored for 2 weeks was statistically insignificant at $P > 0.05$,while stored for 4 weeks was significant only after 12 hours of illumination in comparison with not illuminated and illuminated for 6 hours.In case of pork-loins stored for 8 weeks illumination for already 6 hours resulted in significant /$P \leq 0.01$/ the λd shortening in comparison with not illuminated samples.The dynamics of the dominant wavelenght changes during experimental periods of illumination was similar and independent of the period of deep chilled storage.Fig.1.Similar regularity was observed by other authors./4,6,14,17,18/.The excitation purity /pe/ of pork-loins colour ranged from 0.446 to 0.467.Table 1.The dynamics of this parameter changes was similar to changes of the dominant wavelenght and determined data increased significantly /$P \leq 0.05$/ in relation to the initial values only after 12 weeks of storage.This observation most probably resulted from haeme pigments nitrosation during storage influencing the colour saturation.During illumination slow decrease of colour pe values was observed.Fig.1.Unstored pork-loins in comparison with stored for 12 weeks characterized significantly greater values of the pe /$P \leq 0.05$/ which was noticed particularly during 3 and 6 and 12 hours of illumination.For pork-loins stored for 4 weeks significant decrease of the pe was observed for samples illuminated for 3 and 12 hours in comparison with un-illuminated.For 8 weeks stored significant changes at $P \leq 0.01$ in comparison with not illuminated was determined already after 6 hours of illumination. Lenghtening the time of storage resulted in increase of the values determined for the luminance of colour.Table 1.However, up to 8 weeks of storage statistically significant difference /$P > 0.05$/ in the luminance of colour values,in comparison

with the initial,was not observed,while after 12 weeks of storage at -3°C significant difference /$P \leq 0.05$/ was determined.Increase of colour luminance value for pork-loins stored 2,4 and 8 weeks was observed during the test of colour stability with lenghtening of the time of sample illumination,but observed changes were statistically insignificant at $P > 0.05$.

Nitrite contents: Among other problems currently associated with nitrite and cured meat to be dealt with is potentially possible risk of N-nitrosoamines synthesis /12,14/ which requires minimalisation of the residual nitrite content in processed cured meat products.After passing of each experimental 2 weeks periods of pork-loins storage at -3°C favourable and systematic,although differenciated in intensity,fate of the residual nitrite was observed.Table 1.Their amount diminished from initially determined 205.2 ppm to 54.8 ppm after 12 weeks of storage i.e.nearly fourfold.The analysis of variance data indicates that the residual nitrite amounts decreases statistically significantly /$P \leq 0.001$/ after each of 2 weeks periods of storage passing in comparison with the initially determined.The greatest depletion of the nitrite was observed for pork-loins stored for 2 and 4 weeks after which time of storage 191.0 ppm and 61.3 ppm of nitrite was determined,respectively.Observed substantial decrease of the residual nitrite amount was most probably not only due to permanent nitrosation of haeme pigments during storage of raw,cured experimental meat products as observed by many authors /4,13,16/, but also resulted from the conversion of nitrite to nitrate /2,7,19/,whose level in experimental product significantly increases.

Nitrate contents: For curing of experimental pork-loins the nitrate was not used and despite this nitrate was determined in a ready product,which resulted most probably from conversion of nitrite to nitrate.The greatest amount of nitrate /534.2 ppm/ and statistically significant at $P \leq 0.001$ in comparison with the initial level was determined after 4 weeks of pork-loins storage at cryoscopic temperature.Further two 4 weeks sequences of storage periods characterized decrease of the nitrate amount,significant at $P \leq 0.001$ in relation to

determined after 4 weeks of storage.After 12 weeks of storage the level of the residual nitrate amounted to 73.6 ppm and was over 7-fold smaller in comparison to determined after 4 weeks of storage.The results of nitrite and nitrate determination are indicating that only after 12 weeks of storage their total amount i.e. approx.128 ppm could be considered as safe./21/.

Digestibility of protein in vitro: Implementation of a new processes and storage technics requires assessement of their influence on protein digestibility which is considered an important index of nutritional quality of food products.During 12 weeks of pork-loin storage at -3°C very slight but permanent worsening of protein digestibility in vitro was observed and was statistically significant /$P \leqslant 0.05$/ after 4 weeks of storage in comparison with the initially determined and with the tendency for further decrease after 8 and 12 weeks of storage.However,it must be stressed that approx.95% protein digestibility in vitro determined after 12 weeks of storage is a common figure for most of processed meat products and therefore it could be concluded that long-term of deep chilled storage of cured meat products such as for example raw,cured, smoked pork-loin had no serious effect on this nutritionally important index.

Total count of bacteria: The degree of bacterial contamination is considered to be the best index of freshness, stability and healthiness of processed meat products and an indicator of sanitary conditions of their processing.During experimental materials storage at -3°C permanent proliferation of bacteria was observed.After 2 weeks of storage proliferation of bacteria was still statistically insignificant /$P > 0.05$/,while after 4 weeks of storage the total count of bacteria increased significantly /$P \leqslant 0.01$/ in relation to initial contamination which amounted to 187 cells of bacteria in 1 g and further increased during next two 4 weeks sequences of experimental storage periods.The dynamics of bacterial contamination was not equal in each of the experimental periods of storage and was the greatest between 4th and 8th and 8th and 12 weeks of storage.Still after 12 weeks of storage the bacterial contamination was very small i.e. 828 cells of bacteria in

Table 1. Changes in selected quality parameters of cured smoked pork-loins stored at near cryoscopic temperature for 12 weeks.

Storage periods /weeks/	Traits								
	Nitroso-pigments /ppm/	Pigment conversion /%/	Colour			Residual nitrite /ppm/	Residual nitrate /ppm/	Digestability /in vitro/ of protein /%/	Number of bacteria in 1 g
			λd/nm/	pe	Y/%/				
	1	2	3	4	5	6	7	8	9
0 /n=16/ $\bar{x}$	45,8a[1]	74,7a	607,5a	0,450a	28,5a	205,2a	118,0a	97,67a	187a
s	3,8	3,3	3,4	0,019	3,3	16,9	17,1	0,80	32
2 /n=16/ $\bar{x}$	47,8b	77,3a	608,3ab	0,460ab	30,2ab	191,0b	336,1b	97,68a	240ab
s	6,4	3,4	3,6	0,022	3,6	15,9	34,1	0,84	96
4 /n=16/ $\bar{x}$	51,7b	83,6b	607,8a	0,456ab	27,8a	61,3c	534,2c	97,08b	309b
s	3,3	4,3	3,6	0,022	4,1	5,0	32,8	0,55	80
8 /n=8/ $\bar{x}$	52,6b	82,4b	607,2a	0,446a	28,1a	57,9c	292,5d	96,20c	675c
s	3,4	4,0	2,7	0,018	3,8	3,3	27,9	0,33	87
12/n=8/ $\bar{x}$	53,1b	81,9b	610,6b	0,467b	32,3b	54,8c	73,6e	95,73d	828d
s	2,0	2,8	3,0	0,018	2,6	5,1	4,1	0,44	87

1. Means with different superscripts are significantly different at $P \leq 0.05$ /columns 3,8/, $P \leq 0.01$ /columns 1,4,5,9/ and $P \leq 0,001$ /columns 2,6,7/,
S = standard deviation

1 g.This allows to conclude that storage of raw,cured,smoked meat products at cryoscopic temperature from a sanitary point of view should be considered as fulfilling the safety requirements.

CONCLUSIONS:

1.Storage of raw,cured,smoked processed meat products at cryoscopic temperature does not arrest reaction of haeme pigments nitrosation.
2.Storage of raw,cured,smoked pork-loins at $-3^{o}C \pm 1^{o}C$ results in increase of colour physical parameters i.e.the dominant wavelenght,the excitation purity and the luminance.
3.Long-term storage of pork-loins at cryoscopic temperature practically does not influence the colour stability.
4.Lenghtening of storage time results in permanent decrease of residual nitrite amount,while the amount of nitrate increases during first 4 weeks of storage and thereafter substantialy decreases to the initial level.
5.Long-term deep chilled storage of pork-loins only slightly worsen the protein digestibility in vitro of the investigated product.
6.The bacterial contamination of pork-loins stored for up to 12 weeks at cryoscopic temperature does not create any sanitary reservation.
7.Raw,cured,smoked pork-loins after 12 weeks of storage at $-3^{o}C$ are still a product of a good quality.

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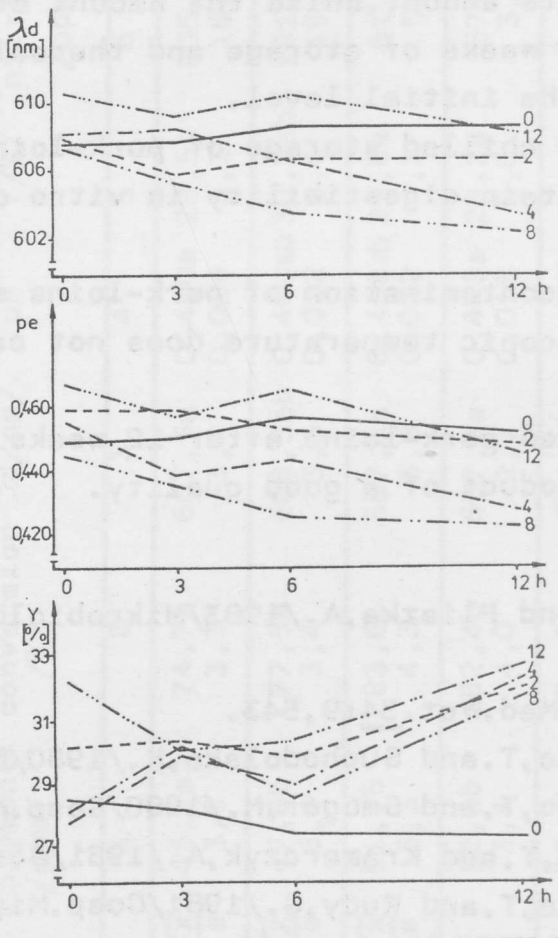

Fig.1.Influence of exposure time length on the dominant wavelength /λd/,the excitation purity /pe/ and the luminance /Y/. 0,2,4,8,12 = storage periods /weeks/.