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INVESTIGATIONS ON THE NUCLEOTIDE BREAK-DOWN AND SENSORIC AND TECHNOLOGICAL EVALUATION OF NORMAL AND PSE PIG MEAT DURING STORAGE

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SUMMARY

According to postmortem intramuscular pH_1 19 pig carcasses were divided in 3 groups: "Normal", "PSE" and "intermediate" and appropriate samples from the m. longissimus dorsi were stored for 1 and 5 days at +4°C and for 4 weeks at -18°C. Nucleotide breakdown was investigated by HPLC, the separation was achieved on a RP-18 column with a flow of 1 ml/min. of 0.01 M phosphate buffer and UV-detection at 254 nm. Further technological criteria were investigated and sensoric evaluation was performed by a 12 persons' taste panel.

At 24 hours postmortem no ATP and ADP, and only about 8 ppm AMP could still be detected, whereas IMP, inosine and hypoxanthine already augmented to 3491, 404 and 60 ppm, respectively. Further storage at 4°C showed further increasing inosine and hypoxanthine levels, (597 and 66 ppm, resp.) from an already decreasing IMP-level (2303 ppm). Normal freezing conditions (-18°C) conserved well the actual nucleotide content. No influence on the nucleotide pattern resulted from different meat qualities according to pH_1-classes, whereas in most technological criteria and sensoric evaluations PSE-meat ranked significantly lower. However, after freezing storage PSE meat showed a pronounced amelioration in the sensoric evaluation.

INTRODUCTION

Immediately after the post mortem depletion of creatine phosphate the nucleotide pattern in muscles shifts to the lower phosphorylated adenosine forms and further breaks down to IMP, inosine and hypoxanthine. Whereas the prerigor changements are rather rapid, further postrigor degradation strongly depends on the storage conditions, especially time and temperature (W. Herbel, 1985). Storage is also known to ameliorate desirable technological and sensoric properties to a certain extend, but principally also meat has a limited shelflife. In this context the original quality is of high importance for the further effects of storage.

It was the aim of this study to compare the effects of different storage condition on the nucleotide break down and further technological and sensoric properties of normal and PSE pig meat.

MATERIALS AND METHODS

From routine slaughterhouse measurements of pH at 45 min. post mortem, 19 pig carcasses were selected and accordingly grouped in 3 classes: "Normal" with a pH_1 above 6.0, "intermediate" with a pH_1 of 5.6 - 6.0, and "PSE" with a pH_1 of below 5.6.

After cooling the m. longissimus dorsi was removed and slices were sealed in PE bags for further storage: 1 day and 5 days at 4°C and 28 days at -18°C. Subsequently all samples were analyzed for nucleotide content by HPLC after extraction by 0.6 M perchloric acid (MERCK/HITACHI, RP 18, isocratic 0.01 M phosphatbuffer, UV detection at 254 nm). With some modifications this method developped by BURNS et al. was reliable and precise until near fg. All nucleotide standards were from SIGMA, St. Louis, USA, all other chemicals from MERCK, Darmstadt, FRG.
Further measurements included water binding capacity (GRAU/HAMM), tenderness by WARNER-BRATZLER-SHEAR-press, reflexion values of the fresh cut muscle surface by GOEFO, and weight losses during storage. A 12 persons' taste panel scored tenderness, juicyness, taste and overall acceptability after heating the samples to an internal temperature of 74°C. Statistical analysis including analysis of variance was performed with the SAS® program.

RESULTS AND CONCLUSIONS

According to the pH-classification differences in water binding capacity and reflexion values were significant between "PSE" and "Normal", whereas "Intermediate" did not justify being a special class (Tab. 1).
Shear values and pH_{24} values did not differ significantly. The faster postmortem glycolysis produced a lighter, already pale meat with a significantly reduced water binding capacity, typical for PSE-meat.

Table 1: pH_{24}, water binding capacity (WBC), reflexion value (GOEFO), and WARNER-BRATZLER-SHEAR values of m. longissimus according to pH_1-classification in "Normal", "Intermediate", and "PSE".

		Classification		
		Normal pH_1>6.0	Intermed. pH_1 5.6-6.0	PSE pH_1<5.6
pH_{24}	X	5.5	5.5	5.4
	SE	0.1	0.1	0.1
WBC (M:F)	X	0.42[a]	0.39	0.35[a]
	SE	0.1	0.1	0.1
Reflex.	X	57[a]	53	49[a]
	SE	3.8	5.4	5.7
WARNER BR.SH. (lbs)	X	6.5	5.7	6.9
	SE	1.3	1.6	1.3

a = means with same superscriptions are different at P<0.05

The obviously different meat qualities were not associated with differences in the postrigor nucleotide content. Analysis of variance did not show any significance at any of the storage conditions nor in the entire material. There is only a tendency of slightly smaller inosine and hypoxanthine levels in PSE-meat (Tab.2).

Storage at normal cooling temperatures at 4°C produced within 4 days a decrease of the IMP concentration of about one third, and an increase of inosine up to 40 %. AMP levels were postrigor already below 10 ppm, a small further degradation could be detected only in "Normal" and "Intermediate" quality and was not significant. Hypoxanthine was in "Normal" and "PSE" after 4 days slightly and not significantly elevated.

Storage at freezer temperatures (-18°C) conserved the original nucleotide content very efficiently, neither analysis of variance nor direct t-tests showed significance for variation for any of the nucleotides investigated.

Sensoric evaluation showed in most criteria a positive effect of prolonged storage (Table 3). With the exception of a significantly decreased taste of PSE meat after 5 days at 4°C, all other criteria were ameliorated with storage. Tenderness increased in normal quality in same amounts for both storage conditions, whereas PSE meat was relatively more tender after freezer storage. Also in overall acceptance, PSE meat showed better values for freezer storage than for normal cooling temperatures. Weight losses showed in all classes a rather similar development, being 12 % in 5 days at 4°C for PSE-meat compared to 7.6 % in normal quality; weight losses at the first day refer only to the time between removal of longissimus and further preparation (6 h).

Analysis of variance showed significant effects for all meat quality classes and storage conditions (Tab.4), but no interactions could be statistically proved.

Further calculations revealed significant correlations between sensoric estimations of tenderness and shear values. Correlations between nucleotide content and scores for taste were not significant (r=-0.28 for hypoxanthine and r=0.41 for inosine).

Table 4: Analysis of variance in sensoric parameters and weight loss for quality and storage effects in pig longissimus dorsi muscle (n=119).

	LSM $\bar{x}$	C.V. %	Effect of qual.class	storage
Juiciness	3.33	15	*	*
Tenderness	3.43	20	**	***
Taste	3.03	16	**	***
Overall accept.	2.98	18	***	**

Literature

HERBEL W. (1985):
Beitrag zur Bestimmung der in Nucleinsäuren und Nucleotiden gebundenen Purin- und Pyrimidinbasen proteinreicher Lebensmittel.
Institut für Biochemie und Lebensmittelchemie, Universität Hamburg

BURNS, B., K.E. Garth, and J. Paul (1985)
Liquid chromatographic determination of hypoxanthine content in fish tissue
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Table 2. Nucleotide content in different pig-meat-quality after storage at +4°C and -18°C (m. longissimus dorsi)

Classif.		Normal			Intermediate			PSE		
Storage		1d/4°C	5d/4°C	28d/-18°C	1d/4°C	5d/4°C	28d/-18°C	1d/4°C	5d/4°C	28d/-18°C
		n=6	n=6	n=6	n=3	n=3	n=3	n=7	n=7	n=7
AMP (ppm)	$\bar{x}$	10	6	6	8	6	7	8	8	a
	SE	1	1	1	2	2	2	1	1	1
IMP (ppm)	$\bar{x}$	a 3356	ab 2275	b 3692	c 3598	cd 2284	d 3763	e 3570	ef 2334	f 3602
	SE	145	145	145	221	221	221	135	135	135
INOSIN (ppm)	$\bar{x}$	a 424	ab 623	b 349	c 431	cd 559	d 427	e 376	ef 590	f 355
	SE	28	28	28	43	43	43	26	26	26
HYPO-XANTH. (ppm)	$\bar{x}$	64	69	50	71	62	54	53	a 65	a 45
	SE	7	7	7	11	11	11	7	7	7

a...f = means within lines with the same superscriptions are sign. different at P < 0.05

Table 3: Sensoric evaluation and weight loss of different pig meat qualities after storage at +4°C and -18°C (m.longissimus dorsi)

Classific.		N o r m a l			I n t e r m e d i a t e			P S E		
Storage		1d/4°C	5d/4°C	28d/-18°C	1d/4°C	5d/4°C	28d/-18°C	1d/4°C	5d/4°C	28d/-18°C
		n=15	n=15	n=15	n=10	n=10	n=10	n=15	n=15	n=15
Juiciness[1]	$\bar{x}$	a 3.1	3.5	a 3.6	3.4	3.3	3.6	3.0	3.1	3.3
	SE	0.14	0.14	0.14	0.15	0.15	0.15	0.13	0.13	0.13
Tenderness[1]	$\bar{x}$	ab 3.1	a 3.9	b 3.9				c 2.8	c 3.1	c 3.5
	SE	0.19	0.19	0.19	3.3 0.20	3.5 0.20	3.9 0.20	0.18	0.18	0.18
Taste[1]	$\bar{x}$	3.0	3.1	3.3	a 2.9	b 3.0	ab 3.4	c 2.9	cd 2.5	d 3.1
	SE	0.13	0.13	0.13	0.14	0.14	0.14	0.12	0.12	0.12
Overall accept.	$\bar{x}$	a 2.9	3.3	a 3.4	b 2.9	3.0	b 3.3	2.7	c 2.5	c 3.0
	SE	0.15	0.15	0.15	0.15	0.15	0.15	0.13	0.13	0.13
Weight loss % (1d=8 hours)	$\bar{x}$	a 2.8	a 7.6	a 15.5	b 3.6	b 8.1	b 16.3	c 3.8	c 12.0	c 15.3
	SE	1.60	1.41	1.41	1.60	1.47	1.47	1.60	1.31	1.31

1) 1-6 points: 1 being least, 6 being best
2) a... : means with same superscriptions are sign. different, P < 0.05