CHANGES IN PERIRENAL FAT FROM PIGS WITH PSE AND DFD MUSCLES

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SUMMARY

In the perirenal fat of pigs with PSE, DFD and normal muscles, stored at ± 18°C for 30 days, the following changes were observed: a more rapid increase of the acid value in the fat of PSE and DFD pigs; an increase of the higher unsaturated fatty acid content in the fat of the PSE pigs and of the free higher unsaturated fatty acids in the fat of DFD pigs; oxidation changes developed more rapidly in the fat of the PSE pigs.

INTRODUCTION

Strong selection being used in pig breeding and animal at increasing meat yield in the animal results in undesirable changes in the physiological processes, affecting negatively certain quality features of the muscle tissue /Briskey, 1964; Allen et al., 1966/.

In pigs these changes are manifested by the occurence of watery meat of pale colour, low water holding capacity and poor elasticity, which is called PSE /pale, soft, exudative/ meat /Cassens et al., 1963, Bendall and Lawrie, 1964/. Its most characteristic feature is the accelerated rate of postmortem glycolysis followed by rapid muscle acidification and increased hydrogen ion

The udesirable changes in meat quality can also result from exhaustion of glycogen in the organism ante-mortem, due a number of stress factors. The typical symptoms of these changes are: low concentraction of hydrogen ions /pH>6.3/, dark muscle colour, sticky or dry surface on muscle cross-section and firm texture of the muscle. That type of muscle tissue is called DFD /dark, firm, dry/ meat.

The quality of muscle tissue undergoes chemical and physical changes during the glycolysis post-mortem. The biochemical processes are catalysed by enzymes released from lisosomes, their activity occures at pH = 5.0 - 6.0 /Piotrowskij et al., 1975/.

In the depot fats two types of detrimental changes of complex nature are observed during storage, namely the hydrolytic and oxidative deterioration.

In the hydrolitic decomposition of fats by enzymes free fatty acids, mono- and diglycerides and glycerol are produced. That process is of both endogenic and exogenic origin.

The oxidation of fats during autolysis results in the formation of peroxides and hydroperoxides. Those compounds are of unstable nature and undergo further changes which result in the occurence of aldehydes, lower fatty acids, alcohols, lactones, ketols CO, CO_2, water and some other decompositions products /Gray, 1978; Melton, 1983; Prost, 1975/.

In this paper the hydrolytic and oxidative changes were studied during storage of perirenal fat from pigs of normal glycolytic pathway and from pigs demonstrating PSE or DFD type of meat.

MATERIALS AND METHODS

Experiments were carried out on perirenal fat from 27 pigs shoving pre-slaughter weight ± 120 kgs. Within this group of pigs there were twelve of normal muscles, eight of PSE muscles and seven of DFD muscles. Fat samples were taken 24 h after slaughter of animals and chilling the carcases to the temperature of + 2°C.

Analyses were carried out after 1, 10, 15, 20 and 30 days after slaughter. Fat samples were kept at 20°C /± 2°C/. The following analyses were conducted in fat samples; the chemical composition /Rutkowski et al.,1964/; water content from the weight difference after drying; fat content by Soxhlett method total nitrogen by Kjeldahl.

The acid value of fat was expressed in mg of KOH used to neutraliste the acid contained in 1 gram of fat, according to the Polish Standard PN-73/A-85803. The peroxide value was determined by titraction of fat sample with $Na_2S_2O_3$ solution, according to the Polish Standard PN-73/A-85803. The number of mililitres of the 0.002 $Na_2S_2O_3$ solution used in the titration of iodine separated from KJ due to the activity of peroxides contained in 1 gram of fat was expressed in $\mu g\ O_2$ per 1 gram of fat /Rutkowski et al., 1964/.

The TBA value in fat sample was determined with the 2-thiobarbituric acid reagent, using the quantitative colorimetric method at the wave length of 530 µm. The results were expressed in the extinction units $E^{1\%}_{532}$ /Bucławski and Drabent, 1972/.

The gas chromatographic technique was used in the determination of percentage content of the higher fatty acids /HFA/ /Baczyńska et al., 1969/ and the free higher fatty acids /FHFA/ according to Folch at al., 1957. The gas chromatograph of Willy GIEDE GCHF, made in German Democratic Republic was used in the analyses. The quantitative content of the HFA and FHFA in the fat samples was expressed in per cent, and the total surface area of all peaks was taken as 100 per cent /Straszewski, 1969/.

The measurement of pH_1 /i.e. 45 minutes post mortem/, according to Kortz /1970/ was used to distinguish between the PSE muscles and the muscles of normal N course of glycolysis, and the measurement of pH_{24} /i.e. 24h post mortem/ was used to detect the DFD muscles. The following pH values were used to categorize the muscles examinated:

$pH_1 \leq 6.0$: PSE muscles
$pH_1 \geq 6.3$: N muscles
$pH^1_{24} > 6.3$: DFD muscles

RESULTS AND DISSCUSSION

The hydrolytic changes in the perirenal fat samples taken from pig carcases demonstrating different type of meat /N, PSE and DFD/ were also of different character .

The acid value in the fat of the N pigs was increasing gradually during the 30 days of storage and reached 7.9 at the end of storage time /Fig. 2/ In the fat samples taken from the PSE pigs the rate of the hydrolytic changes was higher, and the acid

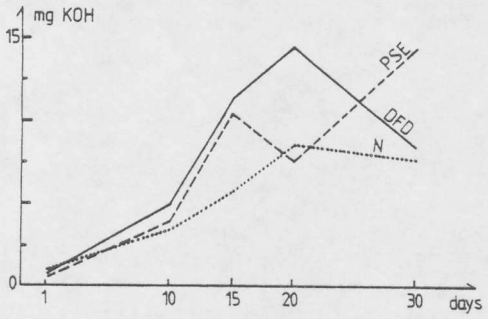

FIG.2 CHANGES OF THE ACID VALUE IN THE PERIRENAL FAT DURING STORAGE AT AROUND 18 °C

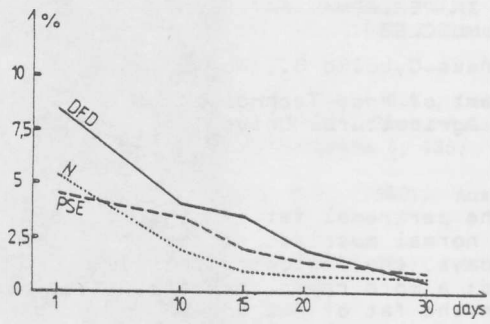

FIG.1 CHANGES OF THE WATER CONTENT IN THE PERIRENAL FAT

value was twice as high /14.7/ after 30 days of storage. However, the highest rate of the hydrolytic reaction was found in fat from the DFD pigs. After 15 days, the acid value attained 11.5 and after 20 days 14.6, thus reaching the level as it was in fat samples from PSE pigs after 30 days of storage. The hydrolysis process was also affected by water content in the fat tissue /Fig. 1/. The fat samples were kept at constant air temperature and relactive humidity.

The quantitative determination of the HFA and FHFA in the perirenal fat revealed the presence of fatty acids in the range from $C_{14:0}$ to $C_{22:0}$. The oleic acid $C_{18:1}$ was predominating and was followed by the palmitic $C_{16:0}$, stearic $C_{18:0}$ and linolic $C_{18:2}$ acids /Tabl. 1, Tabl. 2/.

The analysis of the HFA content in the fat from PSE pigs demonstrated that it contained larger amounts of unsaturated fatty acids during the whole storage period. In the fat from DFD and N pigs the saturated fatty acid predominated. The characteristic feature of the fat from DFD pigs was the decrease in the unsaturated fatty acid content during 30 days of storage. The content of the oleic, linolic and linolenic acids was decreasing continuously.

On the other hand, in the perirenal fat of the DFD pigs significantly higher quantities of the free higher unsaturated, fatty acid /FHUFA/ were found. The increase of the higher, unsaturated fatty acids /HUFA/ in the fat of PSE pigs and of the FHUFA in the fat of DFD pigs may demonstrate an accelerated rate of the hydrolisis process and an

Table 1. Content of the higher fatty acids /HFA/ in per cent of the total content of fatty acids

Fatty acids \ Days	1			10			15			20			30		
	N	PSE	DFD	N	PSE	DFD	N	PSE	DFD	N	PSE	DFD	N	PSE	DFD
14:0	1,6	1,7	1,7	2,2	2,5	1,8	1,6	1,6	1,8	2,0	2,2	1,9	2,0	2,2	2,0
16:0	29,0	27,9	30,0	27,3	26,4	30,0	26,4	25,6	31,0	28,0	25,2	32,0	23,5	24,5	31,6
16:1	2,7	3,0	1,9	2,7	2,9	1,9	3,2	3,3	1,9	2,8	2,7	1,8	2,7	3,5	1,6
18:0	20,4	17,4	17,0	16,5	15,0	18,1	18,9	19,4	19,0	16,6	15,3	19,8	17,0	16,0	20,6
18:1	39,3	42,5	41,7	40,5	44,0	41,0	40,9	40,9	40,8	41,0	45,0	39,5	43,0	43,5	38,5
18:2	6,3	6,5	6,1	9,5	8,0	5,6	7,4	7,6	4,4	7,0	7,0	4,3	7,0	7,5	4,3
18:3	1,5	1,4	1,7	1,6	2,0	1,6	1,9	1,9	1,4	1,8	3,0	1,2	1,3	1,7	1,1
Total saturated fatty acids	51,0	48,7	48,7	46,0	43,9	49,9	46,9	46,6	51,8	46,6	42,7	53,7	42,5	42,7	54,4
Total unsaturated fatty acids	49,8	53,4	51,4	54,3	56,9	50,1	53,4	53,7	48,4	52,6	57,7	46,9	54,0	56,5	45,7

Table 2. Content of free higher fatty acids /FHFA/ in per cent of the total content of fatty acids

Fatty acids \ Days	1			10			15			20			30		
	N	PSE	DFD	N	PSE	DFD	N	PSE	DFD	N	PSE	DFD	N	PSE	DFD
14:0	3,6	2,7	2,5	4,7	6,4	3,0	5,6	5,1	3,5	3,5	3,0	3,0	3,5	5,3	4,0
16:0	28,0	22,0	25,3	28,0	25,6	25,5	27,0	27,3	27,0	28,5	25,0	25,5	28,0	30,2	25,6
16:1	2,3	2,5	2,5	2,0	2,8	2,5	3,0	3,0	2,1	2,0	1,6	2,0	2,2	2,3	2,3
18:0	6,0	12,0	12,0	7,0	8,4	6,0	6,4	8,6	6,8	6,0	6,9	4,5	5,5	6,5	5,7
18:1	46,5	52,0	46,0	44,5	45,0	48,5	46,2	46,0	46,3	50,4	54,5	51,0	51,4	46,4	47,0
18:2	11,0	9,0	10,0	11,2	10,0	12,0	10,0	8,1	12,0	8,6	6,5	11,0	8,3	7,9	13,3
18:3	1,7	2,0	2,8	1,0	2,0	1,6	2,0	1,7	1,9	1,0	2,3	2,3	1,3	1,2	2,0
Total saturated fatty acids	37,6	36,7	39,8	39,7	40,4	34,5	39,0	41,0	37,3	38,0	34,9	33,0	37,0	42,0	35,3
Total unsaturated fatty acids	61,5	62,5	60,3	58,7	59,8	64,6	61,2	58,8	62,3	62,0	64,9	66,3	63,2	57,8	64,6

increased susceptibility of the fat tissue to oxidation /Tab. 1, Tab. 2/.

The unsaturated fatty acids are greatly subjected to oxidation. The higher fatty acids /HFA/ resulting from the hydrolytic changes in the fat tissue are more susceptible to autooxidation than triglycerides. Cerise et al. /1973/ found that the concentration of peroxides can increase due to the oxidation of the higher fatty acids. As it can be seen on Fig. 3 the increase of the peroxide value was small in the initial period of study. After 20 days of storage the peroxide value was increasing more rapidly, first of all in the fat of the PSE pigs. Laving meat in which the pH was below 6.0. It could stimulate the activity ot the lipolytic bacteria. The advanced oxidation of fat of the PSE pigs was reflected by the increase of the TBA value /Fig. 4/.

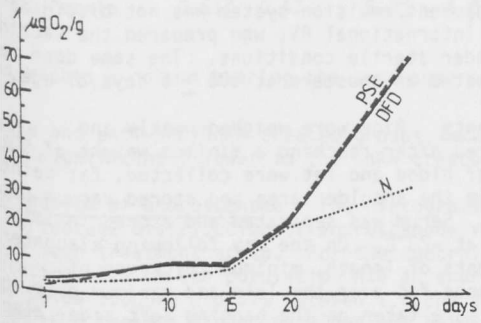

FIG.3 CHANGES OF THE PEROXIDE VALUE IN THE PERIRENAL FAT STORED AT AROUND 18°C

The experimental finding concerning the stability of the perirenal fat of the PSE and DFD pigs during storage suggest that the undesirable changes occouring in the muscle tissue of the stressed animal are followed by greater susceptibility of the fat tissue to the hydrolytic and oxidative processes.

REFERENCES

Allen, J.C., Forrest, A.B., Chapman, N.First Bray R.W., Briskey E.J. /1966/. J.Animal Sci. 23:962

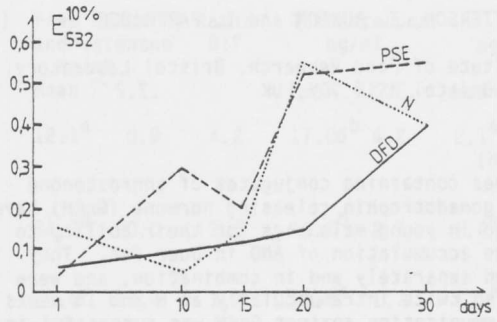

FIG.4 CHANGES OF THE TBA VALUE IN THE PERIRENAL FAT STORED AT AROUND 18°C

Baczyńska B., Krzymański I. /1969/: Tłuszcze jadalne 2:108

Bendall J.R., Lawrie R.A. /1964/: Fleischwirtschaft 16:411

Briskey E.J. /1964/: Adv. Food Res. 13:89

Budsławski J., Drabent T. /1972/: Metody analizy żywności, WNT Warszawa

Cassens R.G., Briskey E.J., Hoekstra W.G. /1963/: Nature:1919

Cerise L. /1973/: Fleischwirtschaft 53,2:202

Folch I., Lees M., Slotane Stanley G.H. /1957/: J.Biol.Chem. 226:497

Gray J.I. /1978/: J.Am.Oil Chem.Soc. 55.6: :539

Kortz J./1970/: Postępy nauk rolniczych. 103

Melton S.L. /1983/: Food Technol. 37.7:105

Pawłowskij P.E., Palmin W.W. /1975/: Biochimia mjasa. Piszczew. Promysl. Moskwa

Prost E. /1975/: Higiena mięsa, PWRiL Warszawa

Rutkowski A., Batura J. /1964/: Podstawowe analizy tłuszczów jadalnych, PWN, Łódź - Warszawa

Wyd.Norm. /1973/: PN-73 A-85803