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THERMOSTABILITY OF COLLAGEN IN HOT AND CHILLED BOVINE MUSCLE TISSUE

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Key words: old cattle meat, brining process, thermostability of collagen, fat content of meat

The influence of elevated fat content and brining process on muscle tissue from old cattle on the thermostability of collagen was the object of the study.

With the age of animals an expansion of the transversal size of the muscle fibres surrounded with the connective tissue is observed. The bonds made of areolar tissue can accumulate fat droplets which cause displacement of all other cellular elements to the periphery where the cytoplasm appears as a narrow rim.

Collagen in its initial phase of biosynthesis occurs as soluble in diluted aqueous solutions of neutral salts, acids and bases, and in buffer solutions, e.g. in a basic phosphoric buffer. The apparent symptom of changes occuring in the collagen structure with the age of animal is the gradual disappearance of soluble collagen and its transformation into aged collagen, soluble only after long-lasting treatment in strong denaturation medium.

According to Pawłowski and Palmina [4], during heating of collagen in the water medium and in the diluted water solution of neutral salts at 60°-67°C a deformation of the collagen fibres occurs manifested by a rapid heat shortening to 1/3 to 1/4 of their initial length. Particularly in the shortening of the aged collagen, greater tension is observed and the soluble collagen does not undergo dissolution during thermohydrolysis. Both phenomena — the occurence of great hydrothermal shortening tension and the slight content or even a lack of soluble collagen, in the case of the hydrothermal denaturation of the aged collagen can be explained by a relatively high degree of crosslinking of its molecules.

which makes 14.53% of the total protein content (21.03%). The amount of collagen in the muscle from animals of 3rd quality grade was 3.54% i.e. 16.6% of the total protein content (20.38%).

The thermohydrolysis resulted in diminishing the amount of collagen due to its partial solubilization resulting in gelatine formation. In the hot tissue of animals of 2nd quality grade, the amount of collagen after thermal processing decreased by 0.24% i.e. by 7.18% in the proportion of total collagen content, whilst in the muscle of animals of 3rd quality grade the latter figure was only 5.47% (Table).

The muscle tissue chilled to +4°C after slaughter demonstrated certain differences in the collagen content prior to and after thermohydrolysis of muscles of animals of both quality grades. The amount of collagen subjected to thermohydrolysis was 23.29% (group of 2nd quality grade), and 18.50% (group of 3rd quality grade). Also in this case the presence of larger amounts of fat in the muscle tissue might contribute to the acceleration of thermohydrolysis of collagen.

After 72 h refrigerated storage of control samples subjected to thermal processing (K_0 muscles of 2nd grade animals) a substantial decrease of hermostability was noted expressed in 37.60% thermohydrolysed collagen calculated in the proportion to total collagen content, whilst in the muscles of animals of 3rd quality grade this part of collagen attained only 9.73%. Such differences, as in the muscle tissue of higher fat content (2nd quality grade), were not observed in the muscles of 3rd quality grade between the first and third day of refrigerated storage.

The effect of polyphosphates on the increased swelling of muscle tissue proteins was reported in the literature [1, 5, 7] and therefore large positive changes in the thermohydrolysis of collagen, due to brining procedure were expected. However, only small part of collagen was subjected to thermohydrolysis as compared with the control samples. It can be assumed that the polyphosphates in the brine are responsible for the changes in the structure of the sarcoplasma proteins and have no appreciable effect on the transformation of scleroproteins, i.e. collagen. The experimental results have confirmed this assumption.

Certain differentiation of the thermohydrolysis was observed in the muscle tissue after 72 h treatment with brine. It was found higher (22.75%) in the non-chilled muscle (B_0) from 2nd quality grade cattle than in the chilled one (16.14%). Opposite experimental results were obtained in the thermohydrolysis of collagen in the muscles of 3rd quality grade. Only 9.98% of the total amount of collagen in the hot meat was subjected to thermohydrolysis, and the reaction of collagen to the thermal processing of chilled meat was considerably higher (20.77%).

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Table. Thermostability of collagen in the muscle of old beef

Mean value Standard deviation	Collagen content in the muscle tissue (%)											
	Kind of sample	quality grade	non-brined muscle						Kind of sample	quality grade	brined muscle		
			after 16 h or 24 h			after 72 h or 96 h					after 72 h or 96 h		
			A	B	C	A	B	C			A	B	C
$\bar{x}$	K_0	II	3.37	3.13	0.24	1.97	1.23	0.74	B_0	II	2.40	1.85	0.55
s			0.02	0.03	0.03	0.03	0.01	0.03			0.02	0.06	0.05
$\bar{x}$	K_{24}	II	3.19	2.44	0.75	2.46	1.92	0.54	B_{24}	II	2.59	2.16	0.42
s			0.13	0.13	0.29	0.37	0.26	0.11			0.22	0.05	0.19
$\bar{x}$	K_0	III	3.54	3.22	0.32	2.64	2.50	0.14	B_0	III	2.17	1.97	0.20
s			1.46	1.41	0.07	0.48	0.49	0.03			0.50	0.57	0.07
$\bar{x}$	K_{24}	III	2.89	2.35	0.54	2.40	1.89	0.51	B_{24}	III	2.12	1.68	0.44
s			0.03	0.04	0.01	0.02	0.01	0.01			0.05	0.01	0.05

A — prior to thermohydrolysis
B — after thermohydrolysis
C — difference

muscle tissue from animals of 2nd quality grade was more susceptible to thermohydrolysis than that of 3rd quality grade animals. The differences were apparent in the muscles examined immediately after slaughter as well as after 24 h chilling and 72 h refrigerated storage. This was found both in the brined and non-brined tissue (Fig.).

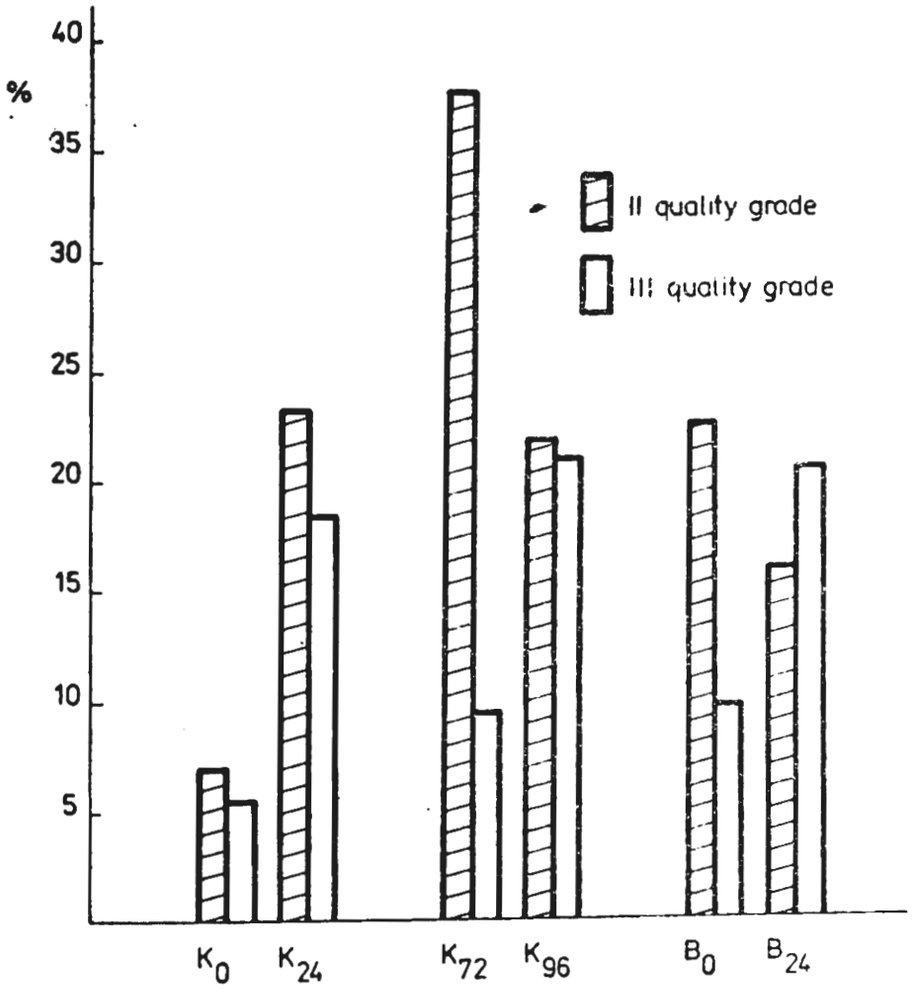

Fig. The ratio of the thermohydrolysed to the total collagen content in the muscle tissue

In the chilled muscle tissue taken from carcase of cattle of 2nd quality grade, 22.30% of collagen was thermohydrolysed and 18.46% in that from cattle of 3rd quality grade. The same relationship was observed after 72 h refrigerated storage of meat.

The effect of brine on the decrease of the thermostability of collagen was more pronounced in the muscle from cattle of 2nd quality grade than in that from 3rd quality grade, i.e. sample B_0 of 2nd grade: 22.75% and B_0 of 3rd grade: 9.98%.

The differentiated susceptibility to thermohydrolysis of collagen in the muscles of various fat content can result from the structure of the adipose tissue, which is the transformed connective tissue. It is possible that fat penetrating into the collagen fibres makes them more susceptible to thermohydrolysis. The high thermostability of the hot meat K_0 and B_0 of 3rd grade animals can result from a higher susceptibility of collagen fibres to the hydrothermal shortening of the aged collagen. Besides,

a greater shortening tension may occur in this kind of meat as compared with the muscle tissue containing more fat, which decreases this tension.

CONCLUSIONS

1. Thermostability of collagen was found greater in the muscle tissue of cattle of 3rd quality grade irrespectively of the procedure after slaughter (hot or chilled muscle tissue).

2. The thermohydrolysis of collagen measured in the non-chilled muscle tissue was lower than after 72 h of refrigerated storage, both with or without brining of meat.

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HYDROTERMICZNA OPORNOŚĆ KOLAGENU MIĘŚNI BYDLĘCYCH „CIEPŁYCH" I WYCHŁODZONYCH

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Streszczenie

Celem badań było stwierdzenie czy wzrastająca zawartość tkanki tłuszczowej w mięśniach jest związana z wielkością termohydrolizy zawartej w nich tkanki łącznej oraz czy zastosowanie soli peklujących do mięśni „ciepłych" i wychłodzonych może oddziaływać na hydrotermiczną oporność kolagenu.

Doświadczenie przeprowadzono na mięśniach karku 8-12-letnich krów, które różniły się stopniem otłuszczenia. Analizowano mięśnie „ciepłe" i wychłodzone do 4°C, po 24 h schładzania. Wpływ solanki peklującej na hydrotermiczną oporność kolagenu badano po 72 h peklowania.

Badania wykazały, że termohydroliza kolagenu jest wyższa w tkance mięśniowej zawierającej więcej śród- i okołomięśniowego tłuszczu (klasa 2) aniżeli w mięśniach zawierających więcej tkanki łącznej (klasa 3). W mięśniach klasy drugiej po 72 h przechowywania w temp. 6°C, 37,6% kolagenu ulegało termohydrolizie, podczas gdy w mięśniach klasy trzeciej tylko 9,7% czyli o 27,9% mniej.

Gdy peklowaniu poddano mięśnie ciepłe, po 72 h procesu w mięśniach klasy drugiej 22,7% kolagenu ulegało termohydrolizie a w przypadku mięśni 3 klasy — 9,8%. Przeprowadzając badania na mięśniach uprzednio wychłodzonych wielkość termohydrolizy kolagenu wynosiła: 16,1% w mięśniach klasy drugiej i 12,9% w mięśniach klasy trzeciej.

Wstępne wyniki badań prezentowane w tej pracy sugerują, że zarówno zawartość tłuszczu w tkance mięśniowej bydła oraz temperatura mięśni wpływają na wielkość termohydrolizy kolagenu.