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HEAT DEPENDABLE MYOFIBRIL SHRINKAGE AND ASSOCIATED WATER LOSSES

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SUMMARY

On cooking,losses of water are observed.They occur at temperatures about 45-60 C and 60-90 C. The former are attributed to myofibrillar and sarcoplasmic and the latter to connective tissue changes.

Samples from 15 ox L.Dorsi muscles were heated for half an hour at 50 C and 65 C.Water losses were determined as persentage of the original muscle weight. From the same muscle samples homogenates were produced in such a way that the muscle fibers were freed of connective tissue elements and split at the myofibril level.

Sarcomere length measurements were used as an indicator of muscle tissue shrinkage when it was heated.They were measured in myofibrils from the homogenates, after an identical heating treatment to the one applied in muscle samples.The measurements were applied directly on myofibrils by means of a REICHERT-JUNG "POLYVAR" microscope integrated with a MOP-VIDEOPLAN image analysis division system. Mean values for all measurements are presented in Table 1.

A statistically significant decrease ($p<0.01$) was revealed in sarcomere length,after heating at 50 C.It remained constant after heating at 65 C.Water losses after heating at 50 C amounted to about one third of the total.Although the losses did not appear to be proportional to sarcomere length decrease, the fact that the latter measurements took place in myofibrils, which were freed of connective tissue, suggests that probably losses in water,when heating at 50 C,are the result of its influence on myofibrillar and sarcoplasmic proteins.On the contrary, sarcomere length was not altered during heating from 50 C to 65 C and therefore water losses at 65 C cannot be attributed to muscle tissue. They are rather due to connective tissue shrinkage.

INTRODUCTION

Studies on cooking losses suggest that they occur at two different temperature levels at about 45-60 and 60-90°C.The former are attributed to myofibrillar and sarcoplasmic and the latter to connective tissue protein changes(Findley et al,1986,Seuss et al,1986). However it seems that so far not much direct and clear cut evidence of this have been provided.The reason seems to be the fact that most works are concerned at the same time with both (myofibrillar-sarcoplasmic and connective tissue proteins) constituents of the material under study.

It looks therefor that studies separatelly concerned with either of the above muscle constituents will contribute to claryfing the question.In the following our observations on myofibrillar and sarcoplasmic protein changes during heating in relation to water losses are presented.As an index of these changes,expressed as tissue shrinkage,sarcomere length measurements were used,before and after heating, in myofibrils striped of all connective tissue elements.

MATERIAL AND METHODS

For the study 15 ox L.Dorsi muscles,48h after slaughter,were used.Samples,weighting about 250gr, were taken from the muscles at 11-13 rib level.A portion, of about 15g each,from the sample, sealed in plastic bag,was heated for half an hour at 50°C and then at 60°C.The rate of heating was 2°C per minute. Water losses were determined,after heating at both levels, as percentage of the original muscle weight.In each sample the pH was also measured.

For the preparation of myofibrils a sample of 200±5mg was homogenised in 20ml 10% formalin using an Ultra Turax type TP 18/2(Janke and Kunkel) instrument at 9000 revolutions per minute.The result of this treatment was that muscle fibers apart from being broken were split longitudinally.Bundles of myofibrils were then produced entirely free of any connective tissue element.Sarcomere length measurements took place in these bundles.Before measuring,the homogenates were identically heated with muscle samples, as it is described above.For sarcomere length measurements a drop of the homogenate,after treated with a few drops of 1% methylene blue,was put,with the aid of a Pasteur pipette,on a microscope slide under a cover slip.

Sarcomere lengths were measured in 35 bundles from each homogenate.In each bundle the total length of 20 sarcomeres was measured and the mean was used as the sarcomere length for the particular bundle.For these measurements a Reichert-Jung "Polyvar" microscope integrated with a MOP-VIDEOPLAN image analysis division system was used.

Means,standard deviation and standard error were calculated for the measurements.Also,one way analysis of variance for the group of measurements of sarcomere length took plase.In addition correlation coefficient values (r) between water losses,pH and sarcomere length measurements were estimated.

RESULTS

In Table 1 mean values, standard deviation and standard error for water losses and sarcomere length measurements appear. Table 2 is a table for one way analysis of variance and the application of Duncan-Kramer test for sarcomere length measurements.

DISCUSSION

A statistically significant decrease ($p<0.01$) revealed in sarcomere length,after heating at 50°C. It remained constant after heating at 65°C.Water losses after heating at 50°C amount to about one third of the total.The most of the losses appear after heating

Table 1

Mean values,standard deviation and standard error for water losses and sarcomere length measurements.

	pH	Sarcom. length	Heating at 50°C		Heating at 65°C	
			% water losses	Sarcom. length	% water losses	Sarcom. length
Mean	5.52	36.40	7.42	33.15	21.94	32.81
Standard deviation	0.25	3.59	4.90	4.45	7.25	4.67
Standard error	0.06	0.93	1.26	1.15	1.87	1.21

Table 2

Table of one way analysis of variance and Duncan-Kramer test for sarcomere length measurements.

Source of variation	Degrees of freedom	Sums of squares	Means of squares	F value
Treatments	2	118.8681	59.4340	3.27
Error	42	763.5412	18.1795	
Total	44	882.4093	20.0547	P<0.01

Heated at 65°C	Heated at 50°C	Non Heated
32.82	33.15	36.42

Note:Pairs of means not underscored with common line differ from one another statisticaly significantly.

at 65°C.Althouht the losses did not appear to be proportional to sarcomere length decrease (correlation coeficient (r) values are not statistically significant) and they are pH dependable (cooking losses and pH are statistically significantly correlated), the fact that the latter measurements took place in myofibrils,which were freed of connective tissue,suggests that probably losses in water,when heating at 50°C, are the result of its influence in myofibrillar and sarcoplasmic proteins.On the contrary sarcomere length did not alter during heating from 50°C to 65°C and therefor water losses at 65°C cannot be attributed to muscle tissue.They rather due to connective tissue shrinkage.

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