CHANGES IN THE QUALITY CHARACTERISTICS OF HORSEMEAT DURING CURING UNDER ELECTRO-MECHANICAL EFFECTS

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SUMMARY

The paper presents the results of studies into the effect of electro-mechanical treatment on the physico-chemical and structuro-mechanical characteristics of hot-cured horsemeat.

The electrical treatment was found to accelerate autolytic processes in hot horsemeat, it being indicated with an abrupt reduction of pH and WHC.

Microstructural studies revealed destructive changes in horse muscles, treated electro-mechanically during curing. Microbiological tests demonstrated the safety of the finished products prepared under intensive curing. Organoleptical and structuro-mechanical results show a marked positive effect of electrical and mechanical treatments upon horsemeat consistency and other quality characteristics.

The use of hot meat and intensive curing process allow to reduce the curing time and the processing duration on the whole, to increase the yield and to improve the quality of cured horsemeat products.

INTRODUCTION

The traditional technology of cured horsemeat products is time and labour consuming, does not allow to yield products of sufficiently high organoleptical qualities. The finished products are characterized with tough texture, low juiciness and yields (Tuleuov, 1986). On the other hand, it is due to a high content of intramuscular connective tissue in horsemeat.

To intensify and improve the technology of cured meat products, at present great attention in research work is paid to the aspects related to the application of various new physico-chemical and other effects which enable both to reduce the process time and to manufacture finished products of a higher quality and with improved yields (Stekolnikov et al., 1984).

Many scientists proved the expediency of the application of electroeffects - electro-massaging (EM) - to hot cure-injected sides to accelerate meat ageing. To redistribute brine in muscles, the energy of muscle contraction and relaxation due to electric current was used (Bolshakov & Magadayev, 1983). It was also found that cyclic mechanical treatment (MT) contributed to a more complete distribution of curing ingredients throughout meat and to enhanced flavour development, to improved yields and quality of the finished product (Bolshakov & Uzhakhova, 1984). The effect of EM and MT upon the quality of cured meats was studied.

A number of researchers combined MT with various food additives, plant proteins and vacuum-mechanical treatment to intensify horsemeat curing process (Bryanskaya et al., 1982; Bryanskaya et al., 1985; Bryanskaya et al., 1985; Anvarov et al., 1982).

Polish scientists studied the influence of electrical stimulation with direct current on the properties of horsemeat. They found that electrostimulation effected meat tenderness, colour and flavour (Dolatowski & Grochowicz, 1983; Dolatowski, 1986).

When manufacturing cured meats from hot meat cuts, it is possible to stabilize meats properties by means of brine injection, this ensuring the macrodistribution of curing ingredients. For their further re-distribution EM followed with MT can be used. Electroexcitement of muscles in sides causes the occurrence of mechanical pulses which result in filtration transfer of curing ingredients. After deboning cured cuts are subjected to additional cyclic MT. The purpose of this work was to study physico-chemical, structuro-mechanical and other characteristics of hot-cured horsemeat with the use of EM and cyclic MT.

As the object of the study served l.dorsi muscles of medium-fattened horses within 1 hour post slaughter. The muscles from the one side were used as controls, from the other side as test objects.

Both test and control hot muscles were injected with brine (18% salt, 2.5% sugar, 0.05% sodium nitrite), the injection level being 10% of the meat weight. Then, test samples were treated with pulsed electric current: 50 Hz, 220 volts, impulse duration 0.5 s, impulse intervals 0.5 s, the total EM time 5-7 min. EM was continued till the completion of muscle contraction and relaxation. Indirect electric current was supplied with two steel electrodes placed into the upper and the lower parts of the muscle. Control (no EM) and test samples were then mechanically treated for 10 hrs in a horizontal drum as follows: rotation for 1 hr, rest for 0.5 hr. The angular speed of the drum was 4.2 rad/s, the loading coefficient was 0.5.

In the course of studying the raw cured meat and the finished products the authors determined pH with a portable pH-meter 150; water-holding capacity (WHC) and plasticity - with a press-method, indentor penetration depth - with a penetrometer PP-3 with 4-needle indentor, NaCl level - with the Moore method, the shear stress - with a plunger adapter and the Kramer shear-press on a universal test machine "Instron", microbiological condition - with the standard procedure, meat microstructure - with a light microscope "Meopta", NaCl distribution - with determinations in adjacent layers (Bolshakov & Madagayev, 1983), cooking losses and yields - according to a 9-point scale. The experimental data were processed with mathematical statistical methods.

RESULTS AND DISCUSSION

The data obtained indicated that, as a result of the action of electric current, the pH, WHC, plasticity and shear stress of test samples differed considerably from similar characteristics of the controls. In the test samples pH was markedly reduced due to a faster course of autolytic processes in muscles.

pH reduction is observed after EM completion and for the first 4 hrs of MT (Fig.1).

Lower meat WHC and plasticity after EM result from the pH shift towards the iso-electrical point of proteins, it accelerating the development of rigor mortis.

Indentor penetration depth into test samples after EM increases due to muscle fibre disintegration, which is supported with histological examination.

Short EM does not, however, ensure a complete distribution of curing ingredients in meat and, consequently, does not inhibit the ATP-ase activity of myosin. Therefore, cyclic MT of the test samples was additionally carried out. MT after EM promotes a further distribution of curing ingredients due to impact energy. Destructive changes in case of EM and MT increase muscle penetrability. Table 3 shows that during MT the concentration of NaCl grew at the distance of $2 \cdot 10^{-2}$m and $3 \cdot 10^{-2}$m from the injection points. MT results in the intensive inhibition of glycolysis with chlorine ions. Due to this, pH of the test samples was stabilized at a higher level as compared to the controls (Fig. 1).

Meat WHC and plasticity is still decreasing at earlier stages of MT, but in 4 hrs it starts to grow gradually. The WHC and plasticity of the test samples at the beginning of MT were lower as compared to those of the control samples due to lower pHs after EM and to a reduced number of hydrophylic centres in the proteins because of the formation of the actomyosin complex. Further, by the end of MT the plasticity and WHC of the test samples were stabilized at a higher level as compared to controls (Figs. 1 & 2). During MT of the control samples meat consistency becomes more compact as a result of the rigor process, it being evidenced with decreased pH and WHC. The plasticity of the controls falls from $4.11 \cdot 10^{-4}$ m^2 down to $3.4 \cdot 10^{-4}$ m^2, the penetration distance - from $21.1 \cdot 10^{-2}$ m^2 down to $18.1 \cdot 10^{-2}$ m^2 (Figs. 2 & 3). Approximately 8 hrs later no marked decrease is observed. Changes in the shear stress are demonstrated in Fig. 4.

In case of MT, pronounced disintegration of the structure of the fibres, as well as their considerable destruction and deformation are found. Histological changes in meat are greater in the surface layers than in the deep ones. Thus, EM and MT result in the breakage of muscle membrane structure, the loosening and swelling of myofibrils, the local destruction of sarcolemma, all this contributing to muscle penetrability for curing ingredients.

Table 1

Sample	Shear stress, 10^5 Pa	NaCl, %	Cooking loss, %	Yield, % of uncured weight
Operating technology	4.20	2.78	27.10	61.40
	0.14	0.11	0.70	0.41
Suggested technology	3.30	2.94	24.50	65.80
	0.17	0.04	0.42	0.63

Under production conditions experimental and control batches of cooked moulded horsemeat were processed.

The characteristics of the finished products are given in Table 1. The test product was more tender, juicier and had a better colour.

The finished products were tested microbiologically. No pathogenic and facultative pathogenic microflora were found.

The organoleptical scores of the finished product are given in Table 2.

Thus, the application of EM and MT for the curing of hot horsemeat allows to obtain a product of a high quality and with an improved yields, the processing time being considerably reduced.

The chilling and the refrigerated storage of the raw meat are eliminated, therefore the technology of meat products processing from hot meat saves energy, labour and materials.

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Table 2

Sample	Appearance	Colour	Aroma	Taste	Consistency	Juiciness	Average score
Operating	6.00	5.90	6.40	6.50	5.90	5.80	6.08
technology	0.32	0.51	0.29	0.43	0.24	0.31	0.28
Suggested	6.20	6.40	6.10	6.00	6.40	6.50	6.25
technology	0.17	0.26	0.28	0.21	0.35	0.24	0.22

Table 3

Distance from from injection point, 10^{-2} m	NaCl, %				
	Control sample		Test sample		
	after injection	after MT	after injection	after MT	after EM
0	3.01	2.81	3.1	2.64	2.81
1	2.07	2.38	2.11	2.47	2.34
2	1.41	2.12	1.38	2.21	1.63
3	0.58	1.32	0.47	1.87	0.65
$\bar{x}$	1.77	2.13	1.76	2.29	1.83

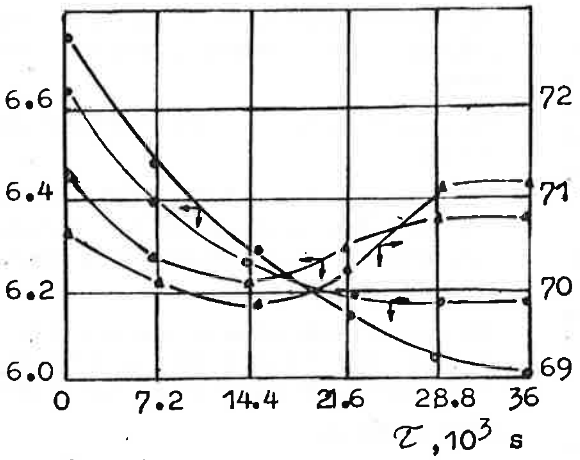

Fig.1

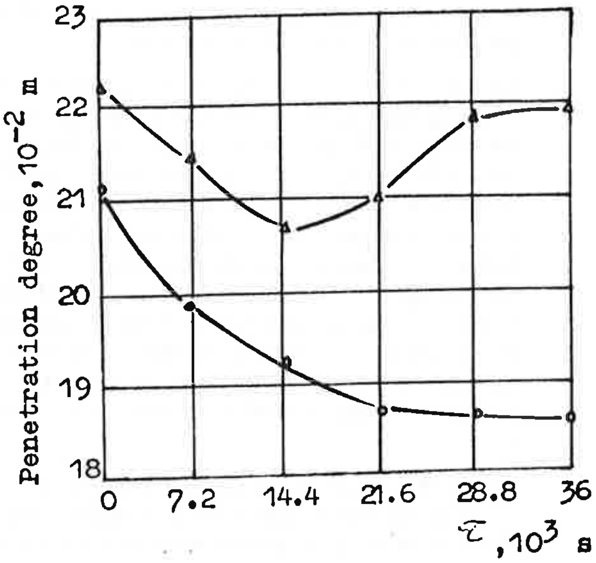

Fig. 3

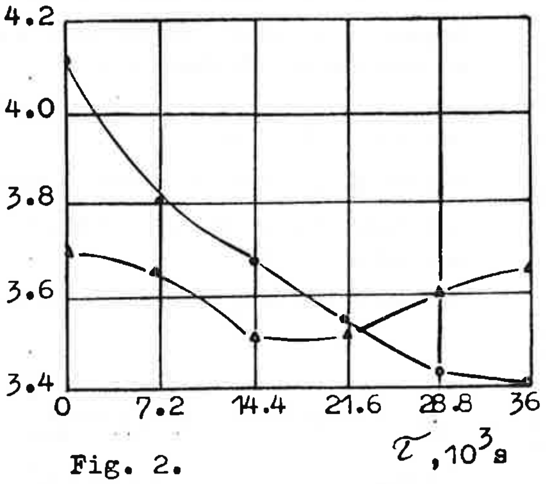

Fig. 2.

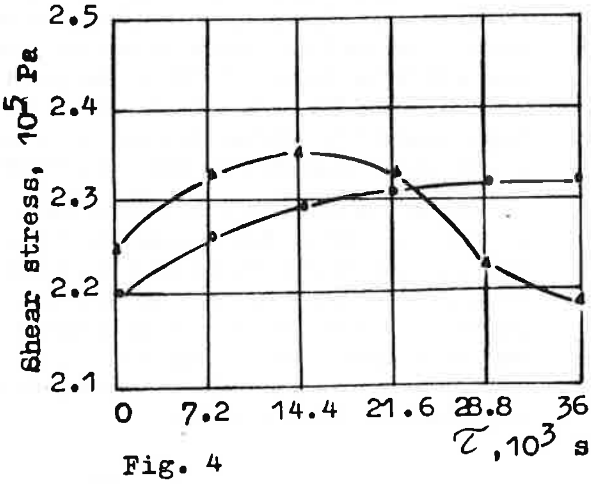

Fig. 4