INFLUENCE OF ELECTRICAL STIMULATION ON THE QUALITY OF CHILLED AND FROZEN READY-TO-EAT MEAT STEAKS

L.V. Kulikovskaya, M.A. Dibirasulayev, O.I. Rumynskaya.

The All-Union Scientific Research, Designing and Technological Institute of Refrigerating Industry (VNIKTIKholodprom), Moscow, USSR

N.N. Shishkina, I.I. Kargaltsev.

The All-Union Meat Research ai Designing Institute, Moscow, USSR.

The paper presented data on the impact of electric current after 10 min of slaughtering (voltage 220V, 36V, frequency 50 Hz) on the quality of cooled and frozen meat.

It was demonstrated that efficacy of the electrostimulation depended on the quality of raw meat and post-mortem changes.

With regard to the electrostimulation of the fresh meat it was shown that its quality could be organoleptically assessed by 1,5 grades. In comparison, fresh meat which was kept under 12°C during 16 hours was evaluated by 0,15 grades.

The author concluded, in particular, that low voltage stimulation (36V) would permit to optimize the deboning procedure of fresh meat as well as its better quality during and after of refrigeration storage.

The intensification of refrigerated treatment of ready to cook meat steaks manufactured from hot-boned beef carcasses has been dictated by technological necessity, technical feasibility and economical considerations.

It is known that low temperature air causes cold shortening of muscle fibres and results in the increase of toughness of meat and loss of meat juice during storage.

Electrical stimulation is widely used abroad to improve the quality of meat while keeping the rapidity of refrigerated treatment.

Research has been carried out by the authors to study the influence of electrical current of different parameters (voltage of one half-period current 220 V and 36 V, frequency 50 Hz, duration of the influence -120 s) on the quality of meat boneless steaks, prepared from raw materials of different stage of autolysis.

Electrical stimulation of beef carcasses was carried out at a bleeding station with the use of a pilot plant, developed in VNIKTIkholodprom. The time between stunning and beginning of electrical stimulation was 8-10 min. The carcasses with hides on after electrical stunning and cutting of the heads came on a moving conveyor to the tunnel, where the electrical stimulation plant was situated. In the tunnel the carcass with its neck part touched the lower electrode of the installation and was subjected to the effect of electrical current. The hanging rail served as a second electrode. The carcasses not subjected to the influence of electrical current were used as controls. The object of the investigations was the cattle chosen by the method of similarity (sex, breed, age, fatness, weight) from the same farm, where they were held under similar conditions of feeding and management.

The Longissimus dorsi and neck muscles without the surface fat and connective tissue were used for sampling for carrying out physical and chemical investigations.

The influence of electrical stimulation and holdng of meat on organoleptical indices was also determined in the investigations.

The experiments were carried out according to the following procedures:

1 procedure - dressing of sides in a hot condition with the excision of boneless steaks and their subsequent refrigeration in air at -3°C, air velocity 1.5 m/s during 4 hours.

2 procedure - chilling of sides at -3°C during 16 hours; dressing and boning of sides with the excision of boneless steaks.

3 procedure - precooling of sides at -15°C, air velocity 0.8 m/s during 2 hours; dressing of sides with the excision of boneless steaks and their additional cooling at -3°C, air velocity 1.5 m/s during 3 hours.

4 procedure - holding of sides at +12°C during 16 hours; dressing and boning for boneless steaks with their subsequent subfreezing at -30°C, air velocity 2.5 m/s during 10 min.

5 procedure - dressing of hot sides with the excision of boneless steaks, 10 and 40 min after slaughter with their subsequent freezing at -30°C and air velocity 1.5 m/s during 3 hours and contact thawing in water of 18°C during 1.3 hours up to the temperature of the muscle depth 0-4°C.

All the steaks were vacuum packed in plastic film and stored (except the procedure 5) at -1°C during 3 days.

The quality of stimulated and nonstimulated meat was evaluated according to the following indices:

- pH of meat - potentiometrically
- amount of drip of boneless steaks - on net weight difference
- easiness of separation of meat from bones during deboning - according to the opinion of deboners
- degree of contraction of muscle tissue - on sample length difference prior to freezing, after freezing and defrosting
- sensory evaluation of the appearance of raw and cooked meat according to a 9-score quality scale/procedure of VNIIMP/.

Tables 1-3 show the results of the investigations of electrical stimulation and different methods of refrigerated treatment on physico-chemical and organoleptical quality indices of steaks.

The analysis of the investigations (Table 1) shows, that pH was 0.5 - 0.6 units lower, if electrical stimulation was carried out prior to boning, as compared to boning without electrical stimulation, which is in agreement with results of (Eikelenboom et al., 1981, Schreuder et al., 1982, Verbeke et al., 1986).

TABLE 1: Change of meat pH in dependence of electrical current voltage

pH			
Voltage 220V		Voltage 36V	
Nonstimulated meat after	Meat after electrical stimulation	Nonstimulated meat	Meat after electrical stimulation
6.67 ± 0.15	$= 6.08 \pm 0.21$	$= 8.66 \pm 0.16$	$+ 6.11 \pm 0.24$

The comparative evaluation (Table 1) of the influence of electrical stimulation on pH change at different voltages show, that the difference in the degree of decrease of active acidity of medium (pH) in experimental and control carcasses is confident ($P < 0.001$) irrespective of the voltage, while differences in pH value between experimental carcasses at different voltages are not confident ($P < 0.05$), though the carcasses muscles contraction is more evident visually at 220 V.

Taking into account the data obtained and safety factors, further investigations on the determination of influence of electrical stimulation on quality indices of meat were carried out at voltage of 36 V.

Investigations on the influence of electrical stimulation on drip losses of vacuumed packaged steaks, obtained from hot-boned meat, showed, that in experimental samples the average drip losses were 0.42% and in control ones - 0.82% while drip losses during thawing (procedure 5) were 3.35% in control samples and 1.42% - in the experimental ones. These data are in agreement with the experimental results obtained by Kotula A.B. and Berry V.V. (1981) during electrical stimulation of hot sides with the voltage 250 - 400V.

TABLE 2: Influence of electrical stimulation on degree of contraction of neck muscles, excised from the carcasses at different time after slaughter

Samples	Initial length of muscles, cm	Length of muscles after thawing, cm	Degree of muscle contraction, %
Time of excision of muscles - 10-15 min after slaughter			
Control	24.0	6.0	75.0
Control	21.0	6.0	71.4
Experiment	23.0	17.0	26.0
Experiment	19.5	13.0	31.0
Time of excision of muscles - 35-40 min after slaughter			
Control	25.0	14.0	44.7
Control	22.0	13.5	38.6
Experiment	21.3	18.5	18.1

From Table 2 it can be seen that electrical stimulation exerts a significant influence on the process of thaw-rigor during defrostation of meat, frozen in a hot condition.

Thus, the muscle contraction during thawing of control samples was 71.4 - 75%, and of the experimental ones - 26-41%. It was found that the degree of contraction of muscle tissue of control and experimental samples depends on post-mortem period and stage of autolysis.

The size of contraction of muscles isolated from the carcasses after removal of the hides (35-40 min) is 1.8-2 less than that of the muscles, isolated at the bleeding stage (10-15 min).

The difference in the degree of contraction of muscles as related to the time of isolation from the carcasses is possibly associated with the decreases of pH of the control and experimental samples, which is indicated in the paper of Currie R.V. and Wolfe F.H. (1979) having established the relationship between pH of meat and the amount of meat contraction as a percentage.

Sensory evaluation of quality of steaks, obtained according to the technological procedures 1-4 (Table 3) shows that the effect of electrical stimulation on organoleptical indices of steaks depends to a large extent on the initial state of meat and post-mortem changes.

TABLE 3: Organoleptical evaluation of steaks quality in relation to the refrigerated treatment of meat

Technological procedure	Organoleptical score	
	non-stimulated samples	stimulated samples
1	5.5	7.0
2	5.6	5.8
3	4.7	6.3
4	7.15	7.3

Thus, the difference in the scores of control and experimental samples for hot meat is 1.5, and for meat samples held during 16 hours at 12°C is only 0.15 of the score.

The comparison of quality attributes of steaks, manufactured according to procedures 2 and 3, confirms the fact of a significant influence of electrical stimulation when using rapid refrigeration of meat.