THE INFLUENCE OF STUNNIG METHODS ON THE PROPERTIES AND QUALITY OF PIG MEAT

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Introduction.

Because a new slaughter-house had to be built in one of our factories it was necessary to choose the most satisfactory stunning method legally permitted in the Netherlands. Owing to difficulties to be expected in application at a large scale, captive-bolt stunning was not investigated. The experiments were concentrated on carbon dioxide and different electrical stunning methods.

As the period elapsing between stunning and bleeding and also the position of the pig during bleeding may be expected to influence meat properties these factors were varied as far as factory conditions permitted.

Materials and methods.

Groups of 15 Dutch Landrace pigs were taken at random from the factory pens after a resting time of 1 1/2 to 2 hours. They were subdued to the four stunning and bleeding procedures described below. This was repeated 10 times so that 600 animals were involved altogether. On each day all the different methods were used, distributed at random.

The experiments were carried out in February and March last year.

The procedures used were as follows:

1. Stunning by means of a CO_2-air mixture (75% CO_2) in a tunnel. Bleeding in a vertical position approximately 25 seconds

after the stunned pigs leave the tunnel. This is the normal factory procedure.

2. Electrical stunning, 70 Volts A.C., applied between the temples of the pig by a pair of tongs during 15 seconds (legally stipulated time). Bleeding in a vertical position appr. 15 seconds after that.

3. Electrical stunning as described under 2; bleeding in a horizontal position shortly (appr. 6 secs.) after stunning.

4. Electrical stunning, 300 Volts during 1 1/2 seconds (legally permitted maxima); bleeding in a horizontal position short time after that. So called electroshock method.

Immediately after bleeding pH of the blood and pH and temperature of the M.longissimus dorsi were measured. A sample of the meat was cut out and preserved in liquid nitrogen for biochemical examination.

About 35 minutes post mortem temperature, pH and rigor value were measured in the M.semi-membranaceous and again a sample of the M.longissimus dorsi preserved in liquid nitrogen.

The pH-meter used was a portable E.I.L. type 30 C fitted with a combined electrode type SDSN 33/C.

To measure the temperature a thermophyl type 9401 (Wecotherm) with a feeler type M.20 A was used.

The samples of M.longissimus dorsi were analysed on:

- lactate ; enzymatic method according to Hohorst. 1)
- glycogen ; anthrone method 2)
- ATP ; enzymatically making use of the Boehringer test combination TC-J 15979 TAAC
- creatin phosphate; diacetyl method 3)
- haemine ; isolation according to Shermin 4)

24 Hours after slaughtering the carcases were assessed as to hemorrhages in the shoulder muscles.

The loins were judged visually on general appearance (colour, texture); after that they were stitch pumped with a polyphosphate containing brine (0,5% phosphates on meat) and drained for three days.

A 600 gram piece from each loin was canned and pasteurised; centre temperature appr. 70°C. After storage under refrigeration for at least a week the cooking loss was determined. The results obtained were subdued to analysis of variance and the significance of the differences between the mean values was tested.

Results.

These are given in the table.

The underlined numbers indicate a significant difference in relation to the values found with other stunning procedures.

	CO_2 stunning long time between stunning and bleeding	Electrical stunning 70 V long time vertical bleeding	Electrical stunning 70 V short time horizontal bleeding	Electrical stunning 300 V short time horizontal bleeding
	average	average	average	average
pH blood	6.76	7.06	7.08	7.12
pH_0, M.long.dorsi	6.16	6.33	6.36	6.41
pH_1, M.semi-membr.	5.98	6.15	6.19	6.15
Temp.0, M.long.dorsi	39.0	39.4	39.3	39.1
Temp.1, M.semi-membr.	40.5	40.4	40.4	40.5
rigor value	8.0	6.5	7.1	6.9
lactate M.long.dorsi mol/g 0	36.7	34.1	33.3	31.4
1	50.1	44.2	39.9	39.9
-	13.4	10.1	6.6	7.5
glycogen M.long.d. mg/g 0	2.29	2.88	2.52	2.43
1	2.06	2.62	2.60	2.41
-	0.23	0.26	0.08	0.02
ATP M.long.dorsi mol/g 0	3.39	3.76	3.73	3.78
1	2.47	2.97	2.97	3.06
-	0.92	0.79	0.76	0.72
CP M.long.dorsi mol/g 0	6.4	7.4	8.3	7.2
1	5.8	5.7	7.2	5.7
-	0.6	1.7	1.1	1.5
haemine content M. long.dorsi mol/g	0.18	0.155	0.17	0.16
% of shoulders with haemorrhages	21	60	56	7
% of loins with unsatisfactory texture and col.	30	32	12	22
Cook.loss cured loin	12.4	12.2	10.6	11.4
% of total can content				

Discussion.

Inhalation of the CO_2-air mixture by the pigs will result in severe hypoxaemia that gives rise to excess production of lactate in the animal's tissues as indicated by the experiments of Huckabee 5) 6), Lundsgaard-Hansen 7) anc Cain 8).

This may be the explanation of the high lactate content and the low pH of the M.longissimus dorsi as well as of the low pH of the blood immediately after death in CO_2-stunned pigs.

The severe state of hypoxia probably also is the explanation of the somewhat lower initial ATP content and the more rapid breakdown of this substance giving rise to a sooner onset of rigor mortis. In the end the CO_2-stunned pigs showed a high percentage of loins with PSE characteristics and high cooking losses.

The effect of the CO_2 stunning procedure on pig meat properties, as described in literature, is not uniform. Tadic and Ciric 9) found a somewhat higher glycogen content and a higher pH in the M.gracilis immediately post mortem in CO_2 stunned pigs when comared with pigs stunned by 70 V. electricity. From their experiments they conclude that CO_2-stunning is a favourable method also because correct dosing of electrical current is complicated in practice. Mc. Loughlin and Davidson 10) in their studies do not find distinct differences in pH_1 of LD muscle in pigs stunned by CO_2 or by 70 V. electricity. At the other hand Bendall c.s. 11) find a decrease in the average pH_1 of the LD muscle of 0,17 in progeny tested pigs and of 0,15 in commercial pigs when CO_2 gas is used for stunning instead of 70 V. electricity.

According to Mc Loughlin 10) this needs not to mean any conflict, because stunning procedures may well have a potential caps-

city to adversely influence meat quality, but in using small numbers of pigs in each experiment maximum care can be paid to ante mortem handling and stunning.

Our experiments were carried out under production conditions and no special attention was paid to ante mortem treatment; only the stunning procedures were controlled carefully.

Haemorrhages in organs and muscles are connected with the method of stunning and in general bleedings small in size are meant. But apart from this small haemorrhages more extensive ones may occur, in particular in the shoulder, in the CO_2 stunning apparatus in use in our factory.

In previous experiments it was established that these bigger shoulder haemorrhages, rendering the shoulder less fit or even unfit for processing, were not caused by improper handling of the pigs durint transport, unloading or during the resting period in the factory pens. They are the effect of the struggling of the pigs in the narrow passage way leading to the tunnel and in the steeply descending part oi it.

Tadic and Ciric 9), making use of a gas chamber that allow the pigs to walk in quietly, do not find any significant haemorrhages.

We therefore paid special attention to shoulder bleedings. In our experiments 21% of the shoulders from CO_2-stunned pigs showed haemorrhages. In one third of the cases they made the shoulder less fit or unfit for processing.

The pigs stunned by 70 V electricity had a higher incidence of haemorrhages but these were mainly of the pin point type; only 1,5% giving rise to reduction in quality of the shoulders.

After stunning with 300 V electrical current only in low per-

centage of the shoulders small-size haemorrhages could be found. The favourable results in this respect of 300 V. electrical stunning are in accordance with those of Giszke and Glees 12). These authors point also to the importance of the time elapsing between stunning and bleeding to reduce haemorrhages as does Mandrup 13).

This time-lapse seems also to be unfavourable to meat quality. In comparing the two 70 Volt stunning methods (2 and 3) differences in lactate formation and rate of glycogen breakdown but in particular in percentage of PSE-loins and cooking loss are found.

As it is not to be expected that the position of the carcase during bleeding plays a dominating role, the differences must be ascribed to the effect of time.

The significantly higher haemine content in the LD muscle of CO_2 stunned pigs indicates a poorer exsanguination of the carcases, despite bleeding in a vertical position.

Tadic and Ciric 9) stated a lower haemoglobin content in muscles of CO_2-stunned pigs. In our case the pigs very probably were in a more stressed condition. This together with a higher percentage of CO_2 (75 against 70) may have led to stopping of the heart-action before complete bleeding.

From the experiments described it may be concluded that carbon dioxide stunning, as applied in our experiments, gives the least satisfactory results. For the new slaughter-house to be built we therefore preferred electrical stunning. For the time being we chose 70 Volt. Whether we will apply electroshock stunning in future depends on the results of experiments as yet to be carried out.

But it may also be concluded that the carbon dioxide stunning procedure can be improved by a lay-out that causes less agitation in the pig 14) and that reduces the time between stunning and bleeding.

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