

THE EFFECT OF TWO STUNNING TECHNIQUES ON THE pH_1 VALUES OF MUSCLES IN CARCASSES OF BACON PIGS

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OPSOMMING: DIE INVLOED VAN TWEE BEDWELMINGSTEGNIEKE OP DIE pH_1 -WAARDES VAN SPIERE VAN SPEKVARKKARKASSE

Tydens 'n opname van BSW (bleek, sagte en waterige) varkvlies by twee abattoirs is gevind dat pH-lesings wat op 30 en 45 minute *post mortem* in die *M. semimembranosus* geneem is, betekenisvol ($P < 0,01$) verskil, naamlik 0,07 pH-eenhede by Abattoir A wat van elektriese bedwelming gebruik maak en 0,20 pH-eenhede by Abattoir B waar die varke met die penpistool geskiet word. Spiere met 'n pH-waarde van 6,0 en laer (geneem 45 minute *post mortem*) vertoon die kenmerkende BSW-eienskappe. Die gemiddelde pH_1 -waarde (45 minute *post mortem*) was 6,41 by Abattoir A en 5,88 by Abattoir B ($P < 0,01$). By Abattoir A was 12,8% van die karkasse BSW en by Abattoir B 71,92% ($P < 0,01$). Hewige spiersametrekkings in die varke wat volg na pistoolbedwelming was verantwoordelik vir die lae pH_1 -waarde by Abattoir A.

SUMMARY

During a survey on the occurrence of pale, soft and exudative (PSE) pork at two abattoirs, pH readings taken at 30 and 45 min. *post mortem* in the *M. semimembranosus* differed significantly ($P < 0,01$). At Abattoir A (electric stunning) the difference was 0,07 pH units and Abattoir B (captive bolt stunning) the difference was 0,20 pH units. At 45 min. *post mortem* muscles with a pH value of 6,0 and lower are characterised by typical PSE symptoms. The mean pH_1 value (45 min. *post mortem*) was 6,41 at Abattoir A and 5,88 at Abattoir B ($P < 0,01$). The occurrence of PSE carcasses at Abattoir A was 12,92% and 71,92% at Abattoir B ($P < 0,01$). Violent muscle contractions resulting from stunning by captive bolt pistol were responsible for the low pH_1 values at Abattoir B.

The major cause of pale, soft and exudative (PSE) pork is the rapid rate of *post mortem* glycolysis in the muscles of pigs before the carcass has cooled off (Bendall & Lawrie, 1964; Naudé, 1972). According to the pH value of muscles in pig carcasses 45 min. *post mortem* (pH_1), carcasses can be classified as PSE, or normal. It has been found that the muscles in a carcass with a pH_1 value of 6,0 or lower and a temperature of 35°C and higher, showed PSE characteristics. The stunning method is an important cause of the occurrence of PSE pork (McLoughlin & Davidson, 1966). Differences between electrical and CO₂ stunned pigs are reported by Bendall, Cuthbertson & Gatherum (1966) but no comparative pH_1 values between electrical and pistol stunned pigs are available.

During surveys at several bacon factories and municipal abattoirs in South Africa, it was found that the occurrence of PSE pork was between 9 to 29% at centres where pigs were electrically stunned (Klingbiel & Naudé – unpublished data). The present survey was conducted to ascertain the effect of electrical in comparison to pistol stunning on the pH_1 values of the muscles in baconer pigs at two abattoirs.

Procedure

The surveys were carried out at two municipal abattoirs in controlled areas, each lasting three weeks. At Abattoir A the pigs were electrically stunned and at Abattoir B the pigs were shot with a captive bolt pistol. Due to varying conditions existing at the two abattoirs measure-

ments were taken at 30 as well as 45 min. *post mortem*. Carcasses were then already dressed completely and the pH and temperature readings were subsequently taken in the *M. semimembranosus* as this muscle became exposed during the slaughtering procedure.

In analysing the results the t-test for two means with an unequal number of observations in the two groups was used; then to test whether the percentage occurrence of PSE pork differed between the abattoirs, the Chi-square test was used (Snedecor, 1956).

Results and Discussion

PSE characteristics develop in muscles of carcasses whose pH at 45 min. *post mortem* is less than 6,0 while the temperature is still 35°C or greater (McLoughlin, 1969). At certain centres the slaughtering process was so rapid that measurements on carcasses had to be done at 30 min. *post mortem*, therefore differences between readings taken at 30 and 45 min. *post mortem* had to be considered.

The pH values and percentage PSE carcasses at the two abattoirs as calculated for both periods are shown in Table 1. In the case of Abattoir B the readings were taken at 30 and 45 min. *post mortem* on all carcasses, while at Abattoir A pH readings at 30 and 45 min. *post-mortem* were taken on different carcasses. At Abattoir A the average pH of all carcasses at 45 minutes *post mortem* (6,41) was 0,07 pH units ($P < 0,01$) lower than at 30 minutes *post mortem* (6,48) and for the 12,87% PSE carcasses the corresponding values were 5,82 and 5,95 – a difference of 0,13 pH units. At Abattoir B the difference was 0,20

Table 1

The pH values (30 and 45 min. post mortem) in the *M. semimembranosus* of baconer carcasses at two abattoirs

| | 30 min. post mortem | | | 45 min. post mortem | | |
|------------|---------------------|--------------------------|--------------------|---------------------|--------------------------|--------------------|
| | n | \bar{x} pH | % PSE* | n | \bar{x} pH | % PSE** |
| Abattoir A | 475 | 6,48 ¹ ± 0,30 | 14,52 ⁵ | 345 | 6,41 ² ± 0,33 | 12,87 ⁶ |
| Abattoir B | 235 | 6,08 ³ ± 0,29 | 71,06 ⁷ | 235 | 5,88 ⁴ ± 0,30 | 71,92 ⁸ |

*Percentage pH values $\leq 6,1$ at Abattoir A and $\leq 6,2$ at Abattoir B.

**Percentage pH values $\leq 6,0$ at both abattoirs

P < 0,01: 1:2, 3:4, 1:3 2:4, 5:7, 6:8

NS : 5:6, 7:8

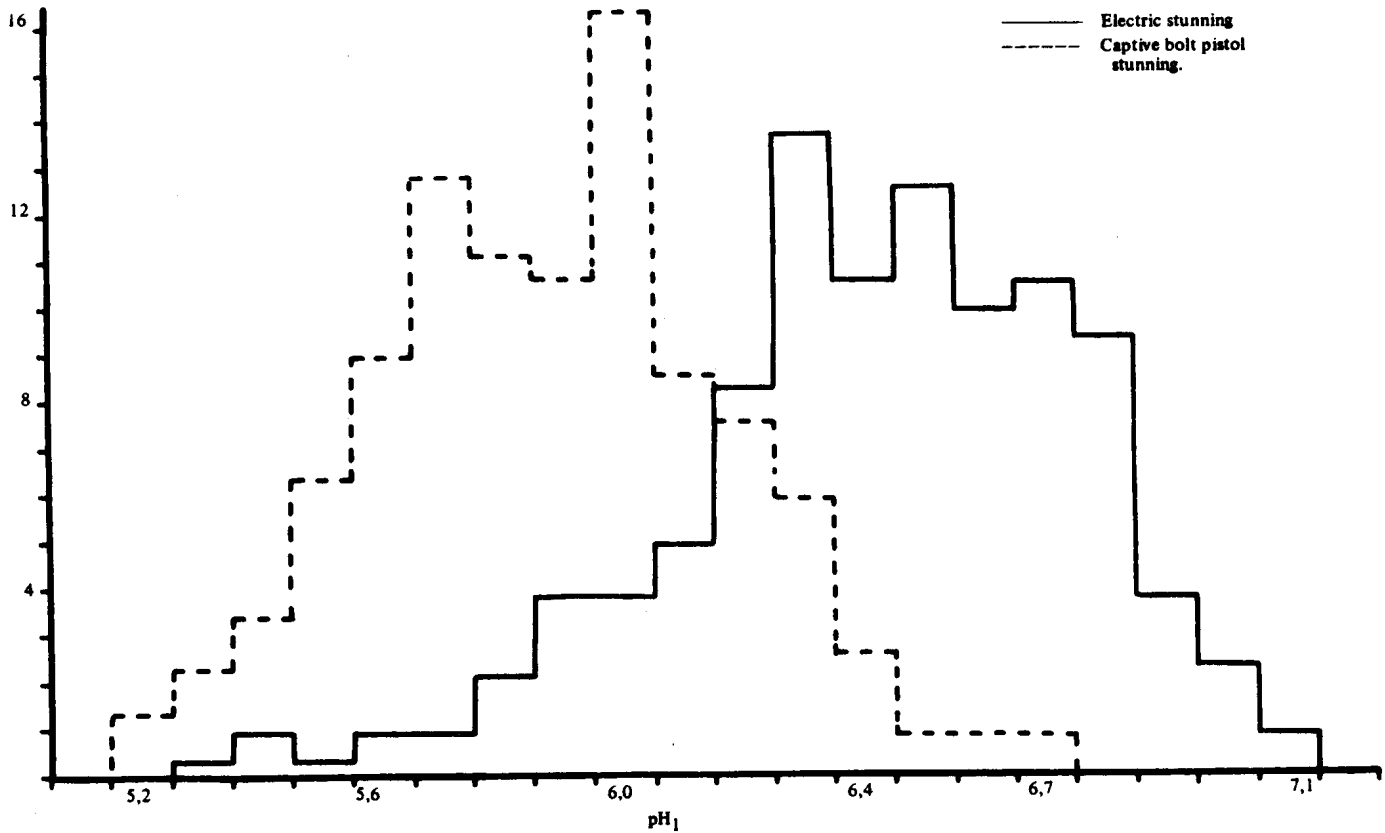


Fig. 1. — The distribution of pH₁ values in the *M. semimembranosus* of baconer carcasses at both abattoirs

pH units (5,88 cf. 6,08) (P < 0,01) for all carcasses and 0,18 pH units (5,75 cf. 5,93) for PSE carcasses. These results indicate a difference in the rate of pH fall between the two abattoirs. The muscle temperature at 30 and 45 min. post mortem was above 35°C at both abattoirs. Thus to calculate the percentage PSE carcasses at 30 min. post mortem, the number of pH values of 6,1 and lower at Abattoir A and 6,2 and lower at Abattoir B are expressed as a percentage of the total observations. (Readings were

taken to the first decimal place only.) To calculate the percentage PSE carcasses at 45 min. post mortem, the number of pH values of 6,0 and lower was calculated as a percentage of the total number of pH₁ values measured specifically in respect of each abattoir. The percentage occurrence of PSE carcasses at 30 and 45 minutes post mortem (14,52 cf 12,87 and 71,06 cf 71,92%) did not differ significantly at either abattoir. It could thus be accepted that, if the pH reduction between 30 and 45

min. *post mortem* was taken into consideration, the percentage PSE carcasses could be calculated on the basis of pH readings taken at 30 min. *post mortem*. This estimate corresponds with that taken at 45 min. *post mortem*.

Fig. 1 indicates the distribution of the pH₁ values (45 min. *post mortem*) of baconers at the two abattoirs. The distribution of pH values for pistol stunned pigs tended to be much lower than that of the electrically stunned pigs. The same tendency was obtained for readings taken at 30 min. *post mortem*.

The average pH₁ values (45 min. *post mortem*) for electrically and pistol stunned pigs were 6,41 and 5,88 respectively ($P < 0,01$). The difference in the percentage occurrence of PSE pork between Abattoir A (12,87%) and Abattoir B (71,92%) is also highly significant (Table 1).

During this survey it was observed that the reaction of electrically and pistol stunned pigs differed tremendously. With the application of the electric shock for 5 to 10 seconds there was usually contraction of the voluntary muscles; respiration ceased and the pig was stunned. The blood vessels were severed before muscle contractions resumed. When stunned with a captive bolt pistol, the pig fell to the ground and immediately struggled violently, so much so that the slaughtermen found it difficult to cut the blood vessels. This excessive struggling continued until after the blood vessels had been cut and even after bleeding had ceased. These exceptional muscle contractions caused accelerated *post mortem* glycolysis (McLoughlin & Tarrant, 1969) resulting in pale, soft and exudative pork. Bendall *et al* (1966) found that the pH₁ values of pig muscle were high when slaughter induced muscular contraction was avoided and that it was low when severe struggling occurred. After electric stunning there is much less struggling and the consequent detrimental effect on the muscle quality is also correspondingly reduced.

Conclusion

It was sometimes necessary at a bacon factory or an abattoir where a survey of this nature was conducted, to take the pH readings at 30 instead of 45 min. *post mortem*. If the muscle pH of certain carcasses could be taken at

30 and 45 min. the difference in the readings would then indicate which pH-value at 30 min. would correspond to a value of 6,0 and lower at 45 min. *post mortem*; this could then be used as a criterion for PSE muscles. The determination of this difference between pH values taken at 30 and 45 minutes *post mortem* was necessary at every centre because of the difference in the rapidity of *post mortem* glycolysis at different abattoirs.

Different stunning techniques were the most obvious differences at the two abattoirs. The use of the captive bolt pistol at Abattoir B was therefore the most important cause of the low mean pH₁. Previous studies have indicated the detrimental effect which PSE pork has on the processing procedure (Wismer-Pedersen, 1969; Briskey, 1969). It is therefore recommended that the use of the captive bolt pistol in slaughtering pigs should be replaced by an electrical stunning apparatus.

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