D7. THE STRESS SYNDROME AND MEAT QUALITY

pH_1 AND ULTIMATE pH VALUES IN FACTORY-KILLED PIGS

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Recent legislation in the Republic of Ireland requires that pigs are stunned before slaughter. Electrical stunning has been widely adopted by bacon factories. Previous work in Ireland has shown that low pH_1 muscle occurs more frequently among electrically stunned pigs than among pigs stunned by carbon dioxide or pigs slaughtered without stunning.

In the present survey the pH_1 was measured in 1,930 pigs in ten factories. The average pH_1 in factories using electrical stunning was 6.41 ± 0.28 and in factories not stunning before slaughter was 6.45 ± 0.33. Overall, nine percent of the carcasses had a pH_1 below 6.0.

Ultimate pH was measured in 1,575 carcasses. Five percent of the carcasses had an ultimate pH at or above 6.0; fifteen percent had an ultimate pH at or above 5.8. There was no significant difference in ultimate pH between factories using electrical stunning and factories not stunning.

INDICE DE pH_1 ET INDICE FINAL DE pH SUR DES PORCS TUES EN USINE

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Une loi récemment introduite en République d'Irlande exige que les porcs soient assommes avant d'être abattus. L'assommement électrique a été largement adopté par les usines de viande de porc. Un travail précédent en Irlande a montre qu'on trouve de muscle a, pH_1 taible plus souvent chez les porcs assommés d'une manière électrique que chez les porcs assommés à dioxide decarbone on chez les porcs abattus sans assommement.

Dans l'étude actuelle, on a mesuré le pH_1 sur 1930 porcs dans dix usines. Le pH_1 moyen dans les usines utilisant l'assommement électrique était 6.41 ± 0.28 et dans les usines abattant les porcs sans les assommer, il était 6.45 ± 0.33. Dans l'ensable, neuf pour cent des carcasses avaient un pH_1 inférieur à 6.0.

On a mesuré le pH final sur 1,575 carcasses. Cinq pour cent des carcasses avaient un pH final égal ou supérieur à 6.0; quinze pour cent avaient un pH final égal ou supérieur à 5.8. Il n'y avait pas une différence significative dans le pH_1 final entre les usines. Utilisant l'assommement électrique et les usines abattant les porcs sans les assommer.

pH_1 UND ENDGULTIGE pH WERTE IN FABRIKGESCHLACHTETEN SCHWEINEN

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Ein kurzlich in der Republik Irland erlassenes Gesetz erfordert, dass Schweine vor der Schlachtung betaubt werden mussen. Die elektrische Betaubungsmethode ist von Schinkenfabriken in umfassendem Mass angenemmen worden und es war angesichts der vorausgegangenen Arbeit notig zu veranschlagen, ob Fabriken, elektrische Betaubungsmethoden gebrauchend, einen hoheren Vorfall von niedrigerem pH_1 Kadaver und infolgedessen mehr PSE-Typ Schweinefleisch aufwiesen.

Die Resultate einer beschrankten Umfrage zeigten, dass im Durchschnitt Fabriken, die elektrische Betaubung anwandten, unbedeutend niedrigere pH_1 Werte hatten als Fabriken, ohne Betaubung schlachtend. Im Gesamten, neun Prozent der Kadaver hatten einen pH_1 Wert unter 6.0.

Messungen der letzten pH wurden an 1,575 Kadavern vorgenommen. Funf Prozent der Kadaver hatten einen Schluss pH um oder uber 6.0; funfzehn Prozent hatten einen Schluss pH um oder uber 5.8. Fabriken mit elektrischer Betaubungsmethode hatten im Durchschnitt einen kaum niedrigeren Letzt pH als Fabriken, welche ohne Betaubung schlachten.

pH_I И ПОСЛЕСУТОЧНЫЕ ВЕЛИЧИНЫ pH В СВИНЯХ, УБИТЫХ В МЯСОФАБРИКАХ

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Недавнее законодательство в Республике Ирландии требует оглушение свиней перед убоем. Электрооглушение широко применяется в фабриках для переработки бекона. Предыдущее исследование в Ирландии показало, что низкая pH в мышцах встречается чаще в электрооглушенных свинях по сравнению с свинями, оглушенными углекислотой или убитыми без оглушения.

Мы измерили pH в 1930 свинях из десяти разных фабрик. Средняя pH_I в фабриках с электрооглушением составила 6,41 ± 0,28, а в фабриках без оглушения 6,45 ± 0,33. У более чем 9% всех туш, pH_I оказалась ниже 6.0.

Мы измерили послесуточную pH в 1575 тушах. Из них 5% имели послесуточную pH ≥ 6.0; 15% ≥ 5.8. В фабриках с электрооглушением и без всякого оглушения никаких значительных разниц по величинам послесуточной pH не появились.

THE STRESS SYNDROME AND MEAT QUALITY

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It is generally accepted that pale, soft, exudative (PSE) pork is related to a rapid fall in pH in pig muscle after death. The pH measured at 45 min. post-mortem (pH_1) is a good indication of the rate of pH fall.

Until recently, less than half of the thirty-four bacon factories in the Republic of Ireland stunned pigs prior to slaughter. Of these, only seven factories used electrical stunning. However, the stunning of pigs before bleeding was enforced by the Slaughter of Animals Order, 1973 (S.I. No. 227 of 1973). Presently, electrical stunning has been adopted by many factories and is now the most widely used method.

Earlier work in Ireland showed that low pH_1 muscle was found more frequently among electrically stunned pigs (22% $\leq$ pH 6.0) than among pigs stunned by carbon dioxide (6% $\leq$ pH 6.0) or pigs slaughtered without stunning (3% $\leq$ pH 6.0) (McLoughlin, 1965). The purpose of this work was to estimate the amount of low pH_1 muscle in bacon factories at the present time.

The ultimate pH (pH_u; measured 24 hr. post-mortem) in pig carcasses also influences certain properties of fresh and cured pigmeat. The normal ultimate pH is in the range pH 5.4 to 5.8. Depletion of muscle glycogen by excercise or stress before slaughter raises the ultimate pH. Ten years ago it was reported that 18% of Irish pig carcasses had an ultimate pH of 6.0 or higher (McLoughlin, 1964). Cured products prepared from pigmeat of high ultimate pH (> 5.8) have been found to be more susceptible to bacterial spoilage than products prepared from meat of normal ultimate pH (Callow, 1937; Ingram 1964). However, meat of high ultimate pH has superior water-binding capacity (Hamm and Deatherage, 1960; Hatton et al., 1972; Hamm, 1974), and is preferred for the manufacture of certain comminuted meat products. As part of the present survey the ultimate pH in 1,575 factory-killed pigs was recorded.

Experimental

pH_1 measurements were recorded from the right and left sides of each carcass in the lumbar region of *M. longissimus dorsi*, at the level of the last rib. Readings were taken between 30 and 45 min post-mortem, as close to the latter time as possible. Ultimate pH was measured on the right and left sides of each carcass in a location similar to that described above for the pH_1 measurements. Ultimate pH was measured between 18 and 24 hr. post-mortem.

A radiometer 29 portable pH meter with a combined electro (Type GK 2320 C) was used to measure pH. The meter was adjust two buffers (pH 6.5 and 4.0) before each set of readings and w at intervals during use with buffer pH 6.5.

Statistical analysis showed no significant differences between and left sides of the carcasses for either pH_1 or pH_u measurements. The results presented here are the average values for right and left sides of each carcass.

Measurements of pH_1 and ultimate pH were taken at ten bacon factories located throughout the country. Six of the factories used an electrical stunning method and the other four factories slaughtered without stunning.

Results

pH_1 values. A total of 1,930 carcasses were measured in ten factories. Wide differences in pH_1 values were observed between individual factories. The average pH_1 and the percentage of pH_1 values below 6.0 for each factory are shown in Table 1.

When the pH_1 values were analysed according to the method of slaughter, there was no significant difference in carcasses from factories using electrical stunning (pH_1 = 6.41 ± 0.28) and in carcasses from factories not practising stunning (pH_1 = 6.45 ± 0.33). The percentage of pH_1 values less than 6.0 was similar in carcasses from factories using electrical stunning (8%) and those slaughtering unstunned (10%). The frequency distributions of pH_1 values from the two groups of factories are shown in Figure 1.

When the pH_1 values were analysed according to carcass grade, the better grade, leaner pigs, had slightly lower average pH_1 values than the poorer grade, fatter pigs (Table 3).

Ultimate pH. Measurements were made in 1,575 carcasses in ten factories. The frequency distribution of the ultimate pH values is shown in Figure 2. The average ultimate pH was 5.61 ± 0.19. Values at or above pH 5.8 totalled 15%; values at or above pH 6.0 totalled 5%.

The ultimate pH varied widely between the ten factories (Table 2 The average ultimate pH ranged from pH 5.47 (Factory No 3) to pH 5.7 (Factory No 6). The number of carcasses with a high ultimate pH ($\geq$ 6.0) varied from 1% (Factory No 8) to 12% (Factory No 9).

When ultimate pH values were analysed according to the method c slaughter used, no significant difference was found between factorie using electrical stunning (average ultimate pH = 5.59 ± 0.19) and factories not stunning (average ultimate pH = 5.63 ± 0.20).

Discussion

The survey was confined to ten of the thirty-four Irish bacon factories. Each factory was visited on one occasion. A total of nine percent of all pH_1 values were below 6.0. This is similar to an earlier estimate of seven percent in Irish cross-bred (commercial) pigs (McLoughlin, 1965). More recently, measurements made on progeny test pigs showed that the percentages of pH_1 values below 6.0 were 19% and 11% in pure-bred Landrace and Large White pigs respectively (McGloughlin and McLoughlin, 1974). The present results suggest that the incidence of potentially pale, watery muscle among Irish pigs has remained at a relatively low level.

The results of the survey indicated that there was little overall difference in pH_1 between factories using electrical stunning and factories not stunning (Figure 1). On average, factories using electrical stunning were unlikely to produce more potentially PSE-type pigmeat than factories not stunning before slaughter.

The considerable differences observed in pH_1 values between the ten factories (Table 1) cannot be contributed to electrical stunning. The handling of pigs before slaughter may have been a contributory factor. Low pH_1 values were observed in one factory where there was congestion and fighting in the pens (Factory No 10) and in another where pigs were subjected to lengthy confinement in a pig 'race' (Factory No 3).

The incidence of high ultimate pH values reported here (5% $\geq$ pH 6.0) can be compared with the incidence of 18% at or above pH 6.0 reported by McLoughlin (1964). However, on average 15% of the carcasses were at or above pH 5.8, which is outside the range of normal ultimate pH. Certain bacon factories, for example Factory No 9 (24% $\geq$ pH 5.8), could benefit by reducing the number of carcasses in this category, either by avoiding excercising or stressing the pigs during the 48 hr period immediately before slaughter, or by feeding sugar to the pigs shortly before slaughter (Clark, 1973).

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TABLE 1

pH_1 VALUES IN FACTORY-KILLED PIGS

Factory No.	Method of Slaughter	Mean pH_1 (± standard deviation)	$pH_1 \leq 6.0$	Total
1	Electrical stunning	6.31 ± 0.24	11%	211
2	" "	6.50 ± 0.26	5%	165
3	" "	6.22 ± 0.25	19%	202
4	" "	6.40 ± 0.28	9%	232
5	" "	6.57 ± 0.24	2%	255
6	" "	6.47 ± 0.23	3%	127
7	Unstunned	6.43 ± 0.30	8%	238
8	"	6.41 ± 0.28	11%	148
9	"	6.66 ± 0.25	2%	103
10	"	6.41 ± 0.38	16%	249

TABLE 2

ULTIMATE pH VALUES IN FACTORY-KILLED PIGS

Factory No.	Method of Slaughter	Mean pH_1 (± standard deviation)	$pH_u \geq 6.0$	Total
1	Electrical stunning	5.54 ± 0.15	2%	144
2	" "	5.53 ± 0.14	2%	122
3	" "	5.47 ± 0.18	2%	208
4	" "	5.65 ± 0.16	6%	158
5	" "	5.67 ± 0.18	3%	227
6	" "	5.71 ± 0.14	5%	55
7	Unstunned	5.70 ± 0.17	7%	157
8	"	5.55 ± 0.18	1%	135
9	"	5.70 ± 0.24	12%	150
10	"	5.60 ± 0.17	5%	218

TABLE 3

MEAN pH_1 VALUES IN DIFFERENT GRADES OF CARCASSES

Grade	Mean pH_1 (± standard deviation)	Number
A Special	6.41 ± 0.29	859
A	6.44 ± 0.31	337
B	6.50 ± 0.27	252

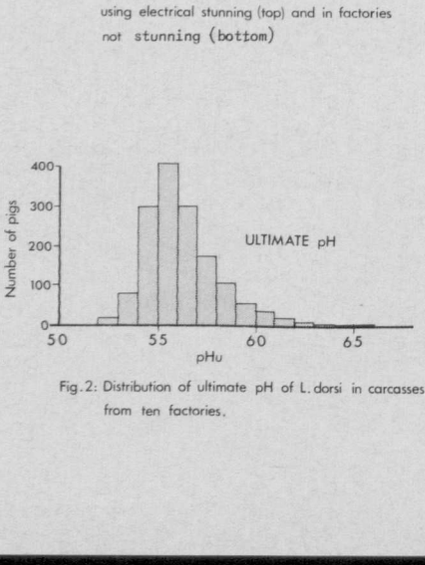

Fig. 1: Distribution of pH_1 values in L. dorsi for factories using electrical stunning (top) and in factories not stunning (bottom)

Fig. 2: Distribution of ultimate pH of L. dorsi in carcasses from ten factories.