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The Effect of Post Mortem pH, Rigor and Temperature Pattern on the Processing
Yield of Pork.

J.G. van Logtestijn*

* Institute of Foods of Animal Origin, Fac. of Vet. Med., Biltstraat 166,
Utrecht

THE EFFECT OF POST MORTEM pH, RIGOR AND TEMPERATURE PATTERN ON THE PROCESSING YIELD OF PORK

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1. Introduction

It is known that differences in processing yields of pork may be caused -- in a more or less degree -- by differences in the quality of the raw meat.

The work of Callow on the problem of the fatigued pigs has got international reputation.

During the last years especially the less good processing characteristics of degenerated (pale, soft and exudative) meat got much attention.

In this connection the work of Wismer-Pedersen, Borchert, Briskey and co-workers (1959, 1963), Meyer (1963), Karmas and Thompson (1964), McLean and Kidney (1965), Jacobs, Moody and Kemp (1965) must be mentioned.

We have done some additional research, in order to get more data about the processing yields of different parts of the pig carcass, and moreover to get an impression about the differences in yielding, when pigs are classified according to the method, described by van Logtestijn and Sybesma (1966).

2. Material and Methods

In a meatfactory $pH_{40} + R_{40} + T_{40}$ were measured in the M.adductor and/or the M.semimembranaceus of pigs, slaughtered under commercial conditions (as described by van Logtestijn and Sybesma, 1966).

The criteria used were as follows:

type 1 pigs (fatigued): $pH_{40} \approx 6.5$
 $R_{40} \approx 10$
 $T_{40} > 40.5^{\circ}C.$

type 3 pigs (meatdegeneration): $pH_{40} < 6.0$
 $R_{40} \approx 10$
 $T_{40} > 41.0^{\circ}C.$

type 2 pigs: the other pigs.

From pigs of these three types hams, shoulders and loins were taken and treated in different ways.

The products were followed as far as possible during the production period. During and after the production the yields were measured. The products were examined in different ways, according to their properties and our

possibilities.

We may state that in general differences in colour and aspect could always be seen — although in a less degree — in the endproducts.

There were also, in all types of investigated products, distinct differences in organoleptic properties.

However, in this paper we give only data on yields, and sometimes on the analysis of one or more muscles, from the products only from the extreme qualities (type 1 and 3). Water-, protein- and NaCl-content were determined with conventional sanddrying, resp. Kjeldahl and Volhard methods.

3. Hams and Shoulders

Hams and shoulders were injected (brine — pH 6.0 —, containing phosphates) then left in curing brine (pH 5.9) during two days and before canning matured during 4 days. The hams and shoulders were pasteurized in water at a temperature of 70°C. until a temperature of 65°C. in the center was reached.

The results of some experiments are given in tables 1, 2 and 3.

Table 1: The average weights of hams of type 1 and 3 during the curing period and the jelly percentages in canned products.

Type of pigs	1	3	1	3
number of hams	4	4	5	5
raw weight in gr.	7440	6840	6580	7470
gain of weight after brine injec.	13.0	13.2	12.4	11.2
after 2 days curing %	13.0	11.7	13.2	11.0
after 5 days maturing	12.5	11.5	12.0	9.8
% jelly in cans	7.5	13.7	9.0	13.2

Table 2: Average water-, protein- and NaCl-content in hams of types 1 and 3 and jelly percentages.

Type of pigs	1	3	1	3
number of hams	5	5	5	5
raw weight in gr.	ca.7000		7510	7370
in canned product:				
pH in muscles	6.54	6.08	6.49	6.17
water % in muscles	74.4	71.8	73.0	72.9
protein % " "	19.4	21.8	21.3	21.6
NaCl % " "	3.1	3.0	2.4	2.6
jelly %	7.3	14.0	10.5	17.1

In a preliminary experiment with two shoulders of type 1 and 3, jelly percentages of resp. 11.0 and 18.0% were found. This difference was still surprising as most of the muscles of the shoulder have comparatively high pH_{ult.}-values (van Logtestijn, 1965), and symptoms of meatdegeneration in these muscles (except in the M.pectoralis and the M.triceps brachii) in general are not distinct. Therefore we decided to continue the experiments with two sets of 4 shoulders (table 3).

Table 3: Average weight of shoulders during a curing period and the water-, protein- and NaCl-contents and jelly percentage in the canned products.

Type of pigs	1	3
number of shoulders	4	4
green weight in gr.	5250	5160
gain of weight after pickle inj.(%)	17.6	17.0
" 2 days brine	17.5	16.3
" 4 " matur.	18.7	17.5
in canned products:		
pH in muscles	6.46	6.25
water % " "	74.5	74.5
protein % " "	17.5	17.4
NaCl % " "	4.3	4.5
jelly % " "	11.6	14.2

From the work described above the following conclusions may be drawn:

1. The differences in processing yields between type 1 and 3 hams are important: about 6% on the total of 38 hams. Borchert and Briskey (1963) found the same difference between normal and P.S.E.-products. Also Kar-mas and Thompson (1963) found very marked differences in cooked products. Wismer-Pedersen (1959) did not find important differences. McLean and Kidney (1965) found differences only in small cans, but not in large canned hams.
2. In general the weights of all hams showed a gradual decrease during the curing period, however, the type 3 hams more than the type 1 hams.
3. The muscles in type 1 canned hams contained in general more water and less protein than those in type 3. There was no difference between the NaCl-contents.
4. The differences in processing yields between type 1 and 3 shoulders were smaller than in the hams.

4. Cured, smoked and cooked pork loin (Kassler Rippenspeer)

An experiment was done with 3 groups of 9 pork loins each (each group representing one type of meat).

After brine injection and curing during two days with respectively in the same brines as mentioned in 3., the pork loins were pasteurized (15 min. 90°C., 150 min. 80°C.), cooled and smoked (12 hrs at 30°C.).

The results of this experiment were given in table 6.

Table 6. Average weights of pork loins during the production of cured, cooked and smoked pork loins.

Type of pigs	1	2	3
pH ₄₀	6.72	6.84	5.79
R ₄₀	9.1	2.5	12.9
T ₄₀ in °C.	40.8	40.1	41.6
green weight in gr.	3327	3451	3560
weight after brine inj. (%)	+13.0	+12.4	+12.3
" " 2 days cure "	+12.2	+12.1	+10.3
" " cooking "	- 1.0	- 2.0	- 4.2
Analysis of 2 pork loins			
water (%)	73.6	72.1	72.2
NaCl "	3.1	3.7	3.0
pH	6.08	5.78	5.75

From these data the following conclusions may be drawn:

1. The processing yields of the type 1 were at least 3% higher than those of the type 3 loins.
2. After the curing period there was a difference of about 2% in curing gain, although it must be stated that already after the injection the type 1 loins had taken up 0.8% more brine than the type 3 loins.
5. Yield differences in fried pork loins.

Pork loin cuts, weighing about 60 grammes, from which all fat and fascia were removed, were fried.

Two or three cuts, each of a different "quality-type", were fried together under household-conditions in a frying pan. From each loin 5 or 6 cuts were taken from comparable places.

The yield differences between cuts of different quality types are given in table 7.

Table 7. Frying losses of pork loin cuts with different types of meat-qualities, fried under the same conditions (in %).

N	type 1	type 2	type 3	difference 1 - 3
5	14.1	-	23.1	9.0
6	17.4	-	27.8	10.4
6	24.3	27.2	30.4	5.9
5	20.2	22.2	24.9	4.7
5	15.4	22.6	20.4	5.0
5	18.7	28.9	35.2	16.5
2 (w. 160 grs).	17.2	20.7	32.2	15.0

From these data we may conclude that, if meat of different types is fried under household-conditions, important yield differences (up to c. 16%) may occur.

The great variation in pork quality has also direct consequences for the meat trading, not only differences in appearance and keepability but also differences in organoleptic properties and weight-losses, which are to be expected, are rather important for both, trader and consumer.

6. Country-style aged hams

Eight hams of type 1 and 8 of type 3 pigs were selected for the production of aged hams.

After 48 hours of cooling the hams were in one lot dry-cured during 11 days, then rinsed in cool water for 1 day, dried and smoked (temp. 35 - 40°C.) for 2 days, and matured during 14 or more days.

The weight-pattern during the production-period is given in table 8:

Table 8. The weight pattern in 2 series of 8 hams of type 1 resp. type 3 meatquality during aging, and some data on the composition of the muscles.

Type of pigs	1	3
Number of hams	8	8
average pH ₂₄	6.75	5.70
av.weight: raw hams in gr.	6700	7600
after dry-curing	- 2.7%	- 4.8%
after drying/smoking	-10.3%	-12.3%
" 7 days maturing	-17.2%	-18.6%
" 17 " "	-20.8%	-21.4%
" 34	-25.6%	-26.5%

analysis of 10 muscle-samples of 2 series of 4 hams (after 34 days mat.)

pH	6.31	5.83
water	55.7%	56.1%
NaCl	12.8%	11.9%

From these data we may draw the following conclusions:

1. The weight losses in type 3 hams were in general higher than in the type 1. After drying and smoking the differences were approx. 2%. In a later period these differences decreased, according to the prolonged storage period.
Although the differences in appearance and organoleptic properties between type 1 and 3 hams were remarkable, it appears from these data that the differences in processing yield are, though worth while, not as important as expected and as reported by Jacobs et al. (1965).
2. Although the differences in pH-value in the aged hams were still rather great, the differences in moisture and sodium chloride content were rather small. Noteworthy was that the type 1 hams contained less water and more sodium chloride than the type 3 hams. This is in agreement with the results of McLean and Kidney (1965).

This and the results obtained in the canned hams and shoulders indicate

that, though it may be true that brine does not diffuse as easily into high pH pork, finally about the same NaCl-content may be reached.

7. Discussion and conclusions.

The differences in raw meat properties and processing characteristics between types of pork, classified on the basis of measurements of pH₄₀ and R₄₀ in the M. adductor and/or M. semimembranaceus were very distinct.

The differences in processing yields between type 1 and type 3 pork were in general rather important, especially in canned hams and in a less degree in canned shoulders and cured, cooked and smoked pork loins. The frying losses from type 3 loin chops were much greater than from type 1 chops.

Initial differences in colour, taste and consistency were still present in the processed meat, though especially the differences in colour were much less remarkable.

These differences in colour were much better detectable in country-style aged hams. However, in these hams the differences in weight losses during the processing period were only up to approx. 2 %.

These results are in general in agreement with data, mentioned by others. However, it must be kept in mind that most of those data are based on comparisons between degenerated and normal meat, mostly selected on the basis of visual judgment of meat 24 hours post mortem; but perhaps in our experiments more extreme qualities of pork were compared.

The results may illustrate the value of the selection criteria, described in a previous paper (VAN LOGTESTIJN and SYBESMA 1966) and underline the necessity of classification and marking slaughtered pigs on the basis of differences in organoleptic and processing characteristics of pork.

Zusammenfassung

Obwohl schon viele Daten bekannt geworden sind über die Unterschiede in den organoleptischen und technologischen Eigenschaften von Schweinefleisch, wurde versucht, mehr Einsicht zu bekommen in die Bedeutung dieser Unterschiede bei der küchenmässigen Verarbeitung dieses Fleisches und bei der Produktion von bestimmten Fleischwaren.

Weiterhin wurde versucht zu prüfen, ob die von VAN LOGTESTIJN und SYBESMA (1966) angegebenen Kriterien für die Klassifizierung von verschiedenen Typen Schweinefleisch mit wichtigen Unterschieden in den Endprodukten übereinstimmen.

Es zeigte sich, dass die grossen initiiellen Unterschiede in der Farbe des Fleisches durch Erhitzungsprozesse stark verringert wurden. Unterschiede in Konsistenz und Geschmack waren im allgemeinen in den Endprodukten noch deutlich nachweisbar.

In diesem Beitrag werden hauptsächlich Daten angegeben über auftretende Gewichtsverluste bzw -zunahmen während der Zubereitung.

Typ 3 - Schinken (degeneriertes, wässriges Fleisch) verloren während des Pökelprozesses mehr Gewicht und hatten auch einen durchschnittlich ca 6 % höheren Kochverlust als die Typ 1 - Schinken.

Diese Unterschiede waren bei Dosenschultern ebenfalls deutlich aber nicht so gross (ca 3 %).

Auch beim Kassler Rippenspeer betrug der Unterschied zwischen Typ 1 und 3 nur etwa 3 %.

Beim Braten verloren Typ 3 Koteletts bis zu 10 % mehr an Gewicht als die von Typ 1.

Geräucherte Bauernschinken zeigten wohl grosse Unterschiede in der Farbe, Konsistenz und Geschmack, jedoch betrug der Unterschied in den Gewichtsverlusten während der Herstellung nur ca 2 %.

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