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MEAT QUALITY IN RELATION TO AGE AND LIVE WEIGHT IN PIGS x/

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It is well known that the production of lean meat is less advantageous when heavier and older pigs are used /Clausen and Gervig, 1955; Cuthbertson and Pomeroy, 1962; Braude et al., 1963/. Nevertheless, the meat industry prefers such pigs for canned meat production, especially for canned hams.

The arguments offered by the industry experts are essentially based on the quality of meat. However, most frequently, those arguments are not well defined and without experimental background. In general, they concern such meat qualities as colour and its stability, watwer-holding capacity and related meat properties. It is, therefore, of practical importance to have one's disposal some experimental data in this matter.

Experimental procedure

The investigation was carried out on 36 Large White pigs /4 littermate barrows from 9 litters/ reared and fed uniformly. The pigs were slaughtered under standard conditions at 70, 90, 110 and 130 kg. live weight, being average 187, 212, 251 and 284 days old, respectively. Each weight group consisted of representatives of all respective litters. The gains and feed efficiency of the animals were normal for the method of fattening used.

After forty-eight hours' refrigeration as wholesale cuts, the loins were carved out and the visible aggregates of connective tissue and fat were carefully trimmed off. The segments of longiss.dorsi muscles situated against the last six thoracic vertebrae were quickly cut up and minced twice in a meat grinder, then mixed thoroughly. All operations of preparation of samples were performed in a cool dark place, upon meat which had been well refrigerated.

In the meat samples the following determinations were done: moisture content /by drying at 105°C after ethyl alcohol denaturation/, fat content /Soxhlet method/, total protein content /Kjeldahl procedure/, soluble protein /Swift and Berman, 1959/, total soluble sulfhydryl groups in meat /Benesch et al., 1955; Sarkar and Sivaraman, 1956; Bhattacharya, 1958/, thermal shrinkage /Walczak, 1959/, pH /glass electrode/, myoglobin and total pigment level /Poel, 1949/, water-holding capacity /WHC/ according to Pohja and Niinivaara /1957/. The WHC was expressed as a per cent of the bound water out of the moisture content of the meat /Wierbicki and Deatherage, 1958/.

Colour, by means of the classic method based on the spectrophotometric curves permitting the calculation of lightness, dominant wavelength and saturation /Bouma, 1951/ was determined, as well as stability of colour /Janicki et al., 1962/ and metmyoglobin concentration on the surface of sample /Dean and Ball, 1960/ after 4 hours' exposure to light.

Besides chemical and physical determinations, the sensory evaluation of fresh meat was also adopted. The center of the loin was used as a standard cut. A panel of six persons tested the meat samples using the standard method of roasting /Anon., 1942/. A five units score scale was applied, "five" meaning the best grade.

In order to obtain more adequate practical information, the ham was cut off from each pig carcass and delivered to a meat plant for preparation of canned ham in a standard manner. After 3 months of storage the cans were opened and the content analysed.

Objective determinations of jelly percentage, ham's colour /clasic spectrophotometric method/ and colour stability /Erdman and Watts, 1957/, tenderness /Tilgner, 1949/ and juiciness /Tannor et al., 1943/, wre performed. Two panels consisting of 6 meat plant experts and 6 laboratory specialists assessed the colour, aroma, tenderness, juiciness and taste of the hams subjectively.

The results obtained were statistical computed with aid of analysis of variance. In addition, the relation between the investigated parameters was also analysed by estimating the type of regression /Goulden, 1960/.

Results

Almost all fresh meat properties changed as the live weight and age of animals increased /Table 1/. Moisture content went down, fat content and protein content went up. Water-holding capacity fell, while, reversely, myoglobin content increased. Though lightness of colour was not changed, dominant wavelength and saturation showed definite shifts. Stability of colour changed as age and live weight increased.

Among the palatability properties of fresh meat, colour, juiciness and taste intensity were shown to be affected by age and live weight of the animals /Table 2/.

In canned hams, the influence of age and live weight of pigs was demonstrated for lightness of colour and juiciness when the properties were evaluated objectively /Table 3/ and for colour, intensity of aroma, tenderness and juiciness, when assessed by panel tests /Table 4/.

Discussion

The reason for the preference for heavier pigs by industry practice is based on the quality of meat. This quality is supposed to be better in older pigs. As component of this superior quality, the following are quoted most frequently: colour and its stability, water-holding capacity, drip, especially in canned meat, and so on.

There are few data concerning this question in the literature; they will be cited when discussing the particular properties.

In agreement with data in the literature /Hofmann and Ritter, 1957; Lawrie et al., 1963/ the fat content in the meat is significantly correlated with age and live weight. The relation is positive and regression linear. The moisture content shows, as normally, a negative correlation with fat content.

Protein content in meat increases with age of pigs and their live weight. This finding fits in with the results of other authors /Hofmann and Kürbs, 1956; Anon., 1961; Anon., 1962; Lawrie et al., 1963/. It is interesting to note that though total protein is higher in older pigs, the soluble protein is always lower.

No difference in ultimate pH in meat was found among weight groups of pigs.

We have been told many times by industry practitioners that the meat of young pigs bound the water poorly. Contrary to these opinions our results showed that the higher were age and slaughter weight the worse was the water-holding capacity. The differences were highly significant.

The data in the literature are not consistent in this respect. Eckart /1956/ has found no influence of age on the water-holding capacity in pigs. The same opinion has been expressed by Danish workers /Anon., 1962/. Heidtmann's /1959/ finding shows the existence of smaller drip in heifers as compared with older cows. On the other hand, according to Schön and Stosiek /1958/ water-holding capacity in lighter pigs is worse than in heavier ones. It must, however, be borned in mind, that the data in these last investigations were collected in accordance with trade grades of pigs and it is probable that this classification also included the degree of fatness of the animals. Our own results as obtained on littermate animals seem to be reliable in this respect.

No effect of age and live weight of pigs could be demonstrated on the thermal shrinkage /drip/ of meat.

The meat pigment content in pigs corresponds to age. The data for myoglobin and total pigment content show essentially the same trend. This result for myoglobin is in agreement with the findings of Lawrie /1950; 1963/, though the level of our values of myoglobin content is higher.

Literature data on the colour of meat as influenced by age and live weight of animals are very scarce. Hofmann and Ritter /1957/ have shown the greater lightness of colour in younger pigs. That is quite probable when investigating a large range of ages. However, the differences in colour lightness among groups between 70-130 kg. live wieght are not gret and it

is hardly possible to draw any final conclusion from the data of Hofmann and Ritter because of lack of statistical computations.

The dominant wavelenght and saturation of colour increase distictly with increasing age and live weight of pigs. No information on these colour attributes have been found in the literature in this respect.

Stability of fresh meat colour decreases in older pigs. This result is confirmed by quicker formation in older pigs, of metmyoglobin on the surface of meat section after exposure of sample to light. It is worthwhile to note that paralelly with colour stability, go the soluble SH-groups in muscle protein.

The sensory tests have shown that the quality of fresh pork does not depend very much on the age and live weight of pigs in the range investigated. Some tendency is observed for worse meat in pigs slaughtered at 90 kg. live weight.

The objective determinations made on canned hams revealed only few traits to be ascribed to the influence of age and live weight of pigs. The jelly content of canned hams demonstrated, in agreement with the laboratory determined drip, no significant difference among weight groups of pigs. So far, therefore, as our experiment has shown, the most important objection of industry experts to lighter pigs has no justification.

From objectively determined properties of canned meat, only colour and juiciness appeared to be governed by live weight of pigs. The hams from lighter pigs were shown to be a little paler. The relatioship between live weight and meat juiciness was nonlinear /cubic effect/. It seemed to suggest the existence of more than one factor determining the juiciness.

Palatability scores confirmed the same relationship between juiciness and live weight in the pigs investigated. Tenderness was better in lighter pigs. But older seemed to show a higher intensity of canned meat aroma.

In the light of the results obtained in this investigation we do not see any serious reason for preference given to heavier pigs, especially, when water-holding capacity, drip and colour of meat are taken into consideration. On the contrary, we may conclude that in many respects the meat of younger pigs is of superior quality to that of older ones.

SUMMARY

The experiment was carried out on 36 Large White pigs /4 littermate barrows from 9 litter/ slaughtered at 70, 90, 110 and 130 kg. live weight with the aim to study the quality of meat in relation to age and live weight of animals. The quality was assessed on fresh pork loins and on canned hams by objective and sesory methods.

The meat of younger pigs appeared to be better with respect to colour and its stability, water-holding capacity and tenderness. The juiciness represented the nonlinear relationship /cubic effect/ with age and live weight of the pigs. Only the intensity of aroma seemed to be better in heavier animals.

The authors conclude that there is no serious reason for the preference given to heavier pigs in industry practice, especially, when water-holding capacity, drip /shrinkage/ and meat colour are taken into consideration.

ZUSAMMENFASSUNG

In einem Versuch mit 36 Large-White Schweinen /von 9 Würfen je 4 Kastratferkel/, die mit 70, 90, 110 und 130 Kg Lebendgewicht geschlachtet wurden, stellte man sich zum Ziel die Beziehungen der Fleischqualität zum Alter und Lebendgewicht der Tiere durchzuforschen. Die Qualität wurde an frischen Lendenstücken und an Konservenschinken mit Hilfe von obiektiven Methoden und sensorischen Testen begutachtet.

Das Fleisch der jüngeren Schweine scheinte eine bessere Qualität in Hinsicht auf Farbe und deren Stabilität, auf Wasserhaltungsvermögen und auf Zartheit aufzuweisen. Die Saftigkeit stand in einer nichtlinearen Beziehung zum Alter und Lebendgewicht der Schweine. Nur die Aromaintensität scheinte bei schwereren Tieren eine bessere zu sein.

Die Autoren kamen zum Schluss, dass die Bevorzugung von schwereren Schweinen durch die Fleischindustrie keine genügende Begründung hat, zumal, wenn Wasserhaltungsvermögen, Schrumpfung und Fleischfarbe in Betracht gezogen wird.

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Table 1.

Chemical and physical data for longiss. dorsi muscle

Characteristic investigated	Live weight at slaughter				Significance of differences	Effect		
	70 kg	90 kg	110 kg	130 kg		Linear	Quadratic	Cubic
Moisture, %	75.00	74.20	73.20	72.80	xx	xx	-	-
Fat, %	1.63	1.97	2.40	2.73	xx	xx	-	-
Total protein /Nx6.25/, %	22.1	23.4	23.3	23.7	xx	xx	x	x
Sol.protein, % of total protein	36.0	34.3	31.1	31.3	xx	xx	-	-
pH	5.46	5.44	5.45	5.43	-	-	-	-
WHC, %	70.7	65.5	63.1	62.6	xx	xx	-	-
Thermal shrinkage, %	31.4	32.2	33.7	32.2	-	-	-	-
Myoglobin, mg%	68.0	77.5	86.0	111.5	xx	xx	-	-
Total pigment,mg%	98.5	105.5	115.4	148.7	xx	xx	-	-
Lightness of colour,%	27.5	26.2	30.8	26.4	-	-	-	-
Dom.Wavelength, m µ	584.3	586.0	588.9	588.5	x	xx	-	-
Saturation of colour, %	14.6	21.8	24.0	25.1	xx	xx	x	-
Stability of colour	1.84	1.63	1.56	1.68	x	-	x	-
Metmyoglobin, % of myoglobin	35.7	39.8	41.0	43.1	xx	xx	-	-
Soluble SH-groups,µM/1g tissue	6.04	5.47	4.87	5.96	-	-	-	-
Soluble SH-groups,µM/1g protein	27.3	23.5	21.0	25.1	x	-	x	-

xx significant at $P < 0.01$
x significant at $P < 0.05$
- non-significant

Table 3.

Objective measurements of canned hams

Characteristic investigated	Live weight at slaughter				Siguificance of differences	Effect		
	70 kg	90 kg	110 kg	130 kg		Linear	Quadratic	Cubic
Jelly, %	12.20	10.00	11.80	9.80	-	-	-	-
Lightness of colour, %	32.64	33.62	29.04	27.08	x	xx	-	-
Dom.wavelength, m μ	606.5	604.6	609.0	617.6	-	-	-	-
Saturation of colour, %	13.97	15.04	15.53	16.12	-	-	-	-
Stability of colour	1.22	1.14	1.18	1.16	-	-	-	-
Tenderness, g	635.0	656.0	682.0	709.0	-	-	-	-
Juiciness, %	12.2	13.3	11.9	13.8	x	-	-	x

xx significant at $P < 0.01$
x significant at $P < 0.05$
- non-significant

Table 4.

Palatability scores of canned hams

Sensory characteristics	Live weight at slaughter				Significance of differences	Effect		
	70 kg	90 kg	110 kg	130 kg		Linear	Quadratic	Cubic
Colour desirability	4.7	4.6	4.5	4.3	xx	xx	-	-
Aroma intensity	3.5	3.4	3.6	3.7	xx	xx	-	-
Aroma desirability	3.8	3.8	3.9	4.0	-	-	-	-
Tenderness	3.9	3.9	3.6	3.5	xx	xx	-	-
Juiciness	3.7	3.8	3.6	3.7	x	-	-	xx
Taste intensity	3.8	3.9	3.8	3.9	-	-	-	-
Taste desirability	3.7	3.8	3.8	3.8	-	-	-	-

xx significant at $P < 0.01$
x significant at $P < 0.05$
- non-significant