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SYSTEMATIC ANALYTICAL DIFFERENCES IN THE LONGISSIMUS DORSI MUSCLE

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Although interest in, and speculation on, differences between anatomically distinct muscles is of long standing - and, indeed, cannot be ignored if controlled growth of organoleptically desirable portions of meat animals is ultimately envisaged - any variation found within a given muscle has frequently been regarded as merely fortuitous. Some observations on ultimate pH, however, suggested that such intramuscular variation might be systematic. Thus, in the semimembranosus muscle of pigs suffering from co-called "muscle degeneration disease", anatomically homogeneous locations only 1cm. apart were found to have a pH difference of 0.6 units and a very marked disparity in myoglobin content.<sup>1</sup> Less spectacular but consistent differences were observed in the ultimate pH of the longissimus dorsi muscle at the levels of the 4th, 5th and 6th lumbar, and of the 8th, 9th and 10th thoracic, vertebrae (Table 1).

Table 1. Ultimate pH of longissimus dorsi muscle at two locations

Species	Level of 8th, 9th and 10th thoracic vertebrae	Level of 4th, 5th and 6th lumbar vertebrae
Pig <sup>2</sup> (Normal)	5.54 ± .03 (21)	5.53 ± .03 (21)
Pig <sup>2</sup> (Distrophic)	5.34 ± .03 (3)	5.12 ± .01 (3)
Ox <sup>3</sup> (Normal)	5.53 ± .01 (45)	5.46 ± .01 (45)
Rabbit <sup>4</sup> (Normal)	5.78 ± .04 (10)	5.69 ± .03 (10)

Curiously enough, although "normal" oxen and rabbits showed this effect, it was not manifested in the longissimus dorsi of "normal" pigs. On the other hand, significant differences were noted in ultimate pH between lumbar and thoracic regions of the longissimus dorsi from pigs affected by the muscle degeneration condition.

It seemed desirable to investigate the composition of the longissimus dorsi at these two locations in somewhat greater detail. Samples for analysis were accordingly obtained at a standard time of 24 hr. post mortem from beef steers and bullocks of accurately known age. No significant differences were found in moisture content, ash, total soluble phosphorus or myoglobin, but with respect to some other criteria (Table 2) small, but statistically significant, differences were found.

Table 2. ~~Significantly~~ Statistically significant differences in composition of beef longissimus dorsi muscle at two locations

(Mean data from 10 animals)

Characteristic of Muscle	Level of 8th, 9th and 10th Thoracic Vertebrae	Level of 4th, 5th and 6th Lumbar Vertebrae
Ultimate pH	5.58 ± 0.03	5.51 ± 0.03
Buffering Power ( $E \times 10^{-5}/g/pH$ )	4.89 ± 0.12	4.71 ± 0.10
Total Nitrogen (%)	3.61 ± 0.02	3.52 ± 0.02
Myofibrillar Protein Nitrogen (%)	1.87 ± 0.05	1.74 ± 0.04
Sarcoplasmic Protein Nitrogen (%)	0.94 ± 0.03	0.89 ± 0.03
Intramuscular Fat (%)	1.51 ± 0.24	1.79 ± 0.31
Intramuscular Fat (Iodine Number)	55.17 ± 1.98	58.40 ± 1.61

In the first place it was confirmed that the lumbar region of the longissimus dorsi had a lower ultimate pH; and its buffering power was less. It was also clear that the contents of total nitrogen, and of nitrogen representing myofibrillar and sarcoplasmic protein, were lower in the lumbar, than in the thoracic, region of the muscle. In suggesting a lesser degree of maturity in the former these data would thus accord with the view that, anatomically, the lumbar region of the back is a later developing part.<sup>5,6</sup> On the other hand the ratio of sarcoplasmic to myofibrillar protein nitrogen is slightly greater in the region of the 4th, 5th and 6th lumbar vertebrae and, this fact, together with the lower buffering power, would suggest a greater capacity for aerobic metabolism, i.e. a greater degree of organization rather than immaturity. Again, the higher content of intramuscular fat in the lumbar region (Table 2) also indicates its relative maturity since fat deposition characterizes the last of the three phases of growth.<sup>5,6</sup> Nevertheless, the lumbar region of pig longissimus dorsi has a lower concentration of intramuscular fat than has the thoracic region.<sup>7</sup> This one would expect if the lumbar

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region were later affected by the fattening phase of growth.

It will be noted, however, that the iodine number of the intramuscular fat in the lumbar region is higher than those at the level of the 8th, 9th and 10th thoracic vertebrae - despite that the percentage of fat is higher at the former, and consistently so from birth, as Table 3 shows.

Table 3. Percentage of intramuscular fat and its iodine number at two locations in the longissimus dorsi muscles of steers at different ages.

Age (months)	% Intramuscular Fat			Iodine Number		
	(a) Level of 8th, 9th & 10th Thoracic Vertebrae	(b) Level of 4th, 5th & 6th Lumbar Vertebrae	(a)-(b)	(a) Level of 8th, 9th & 10th Thoracic Vertebrae	(b) Level of 4th, 5th & 6th Lumbar Vertebrae	(a)-(b)
0*	0.49	0.55	+0.06	87.02	82.41	+4.61
0.5*	0.90	0.97	+0.07	71.94	71.04	+0.90
18	1.09	1.57	+0.46	66.07	65.78	+0.29
22**	0.83	1.16	+0.33	55.29	56.25	-0.96
26	1.31	1.38	+0.07	55.10	59.73	-4.63
36	3.11	3.69	+0.58	51.92	56.50	-4.58

\* Entire males.

\*\* Implanted with 120 mg. hexoestrol.

Yet it is also clear that the iodine number falls as the percentage of intramuscular fat increases at both locations; and there is a hyperbolic type of relationship between them at both locations.<sup>8</sup> (Fig. 1) This would be expected if relatively saturated fatty acids from the diet were diluting the highly unsaturated structural phospholipids of the cell.<sup>8</sup> It must be presumed, therefore, that there is a relatively greater requirement for a deposition of more highly unsaturated fatty acids in the lumbar region. Since the ruminant has a considerable capacity for direct utilization of fatty acids,<sup>9,10</sup> the phenomenon might be regarded as representing some aspect of

functional specialization for energy production in this region. In bullocks, however, the iodine number of the intramuscular fat in the lumbar region is considerably lower than that in the thoracic region (where it is similar to the values for steers (Fig.1) No explanation for this discrepancy can be given at present. The investigations are continuing.

#### SUMMARY

1. In steers the content of intramuscular fat and its iodine number are significantly higher, and the total, myofibrillar and sarcoplasmic nitrogens, buffering power and ultimate pH are significantly lower, in the region of the 4th, 5th and 6th lumbar vertebrae than in the region of the 8th, 9th and 10th thoracic vertebrae of ox longissimus dorsi.
2. At both locations, however, fat content rises and its iodine number falls with increasing age: but whereas the iodine number in the thoracic region is higher than that at the lumbar region at birth, the reverse is true in the adult animal.
3. There is a hyperbolic type of relationship between the percentage of intramuscular fat and its iodine number at both locations in the longissimus dorsi of steers and bullocks. In the thoracic region values for both steers and bullocks are similar; but in the lumbar region the iodine numbers for steers are markedly higher than those for bullocks at a given percentage of intramuscular fat.

#### RESUMÉ

1. Dans des bouvillons, le contenu de graisse intramusculaire et l'indice d'iode sont plus élevés par un degré significatif, et l'azotes des protéines du sarcoplasme et des myofibrilles, le titre tamponage et le pH final sont moindres par un degré significatif, au région des 4ème, 5ème et 6ème vertèbres lombaires que ceux au région des 8ème, 9ème et 10ème vertèbres thoraciques des muscles l. dorsi de boeufs.
2. À tous les deux régions, néanmoins le content de graisse croît et l'indice d'iode diminue pendant que les animaux deviennent plus âgés; mais tandis que l'indice d'iode au région thoracique soit plus élevé que celui au région lombaire à la naissance, il y a une réversion quand l'animal sera adulte.

3. Il y a une relation hyperbolique entre le pourcentage de graisse intramusculaire et son indice d'iode à tous les deux régions des muscles l. dorsi de bouillons et de boeufs. Au région thoracique les niveaux pour des bouillons et des boeufs sont tous deux pareils; mais au région lumbarique les indices d'iode sont plus élevés que ceux des boeufs, quoique le content de graisse intramusculaire soit même.

ZUSAMMENFASSUNG

1. In jungen Ochsen ist der Inhalt von Intramuskelfett und seiner Jodzahl bedeutend höher; und die ganze, myofibrillarische und sarkoplasmische Azote, die Pufferwert und das endguldigen pH, sind beträchtlich niedriger in der Gegend der 5. und 6. Lendenwirbel als in der Gegend der 8., 9. und 10. Brustwirbel des Rindes longissimus dorsi.
2. Mit zunehmenden Jahren jedoch erhöht sich an beiden Stellen der Fettinhalt indem die Jodzahl fällt. Aber während die Jodzahl in der Brustgegend höher ist als die der Lendengegend bei der Geburt, ist es umgekehrt im völlig erwachsenen Tier.
3. Es gibt eine übertriebene Verwandtschaft zwischen dem Gehalt an Intramuskelfett und seiner Jodzahl in beiden Gegenden im longissimus dorsi von jungen Ochsen und Stieren. In der Brustgegend sind die Werte für junge Ochsen und Stieren ähnlich, aber in der Lendengegend sind die Jodzahlen für Stieren bedeutend höher als jene für junge Ochsen, wenn der Gehalt an Intramuskelfett bestimmt worden ist.

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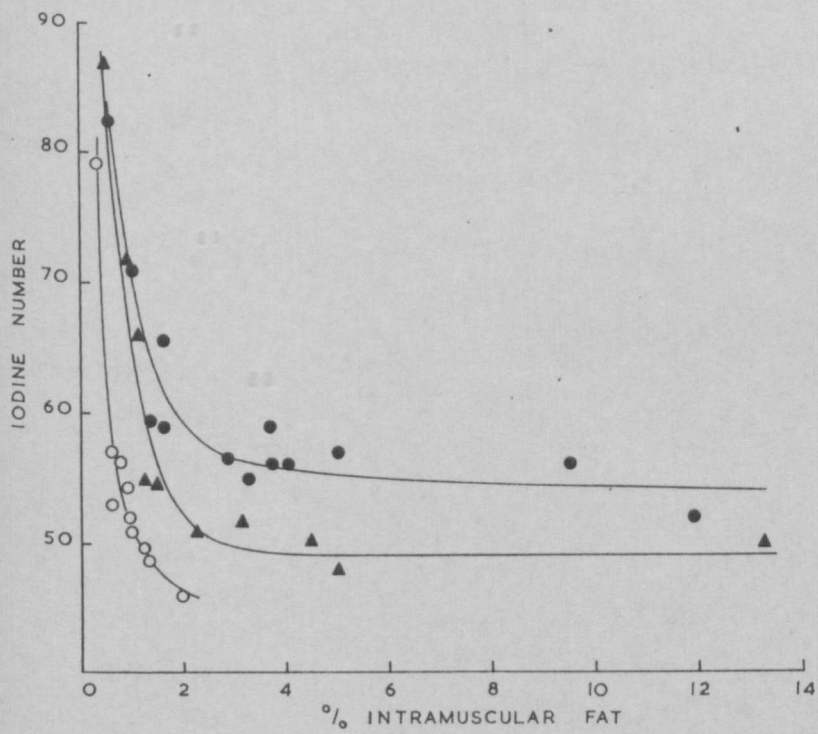


Fig.1. The relationship between the intramuscular fat content of ox longissimus dorsi muscle and its iodine number, at the level of the 4th, 5th and 6th lumbar vertebrae in steers (●) and bullocks (○); and at the level of the 8th, 9th and 10th thoracic vertebrae in steers and bullocks (▲).