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Some effects of Hormone Implantation on Muscle Composition

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Over the last ten to fifteen years, increasing use has been made of the capacity of synthetic oestrogens (administered orally or by pellet implantation) to enhance the rate of weight gain in cattle, sheep and poultry. Whereas in poultry the increment represents fat deposition, in cattle and sheep there is, instead, a decrease in the percentage of subcutaneous, perinephritic and intermuscular fat, and an increase in the percentage of bone and of edible meat, the latter having an apparently higher moisture content. (1) (2) (3). Concomitantly, the ratio of fore to hindquarter increases and carcase grade tends to be somewhat lowered. Surprisingly little attention has been given to the more detailed composition of the lean meat from hormone-implanted animals : such analytical data as are available refer almost exclusively to joints. (1, 4, 5, 6). In the present paper a brief account is given of the effects of implantation in Friesian steers on the composition of the longissimus dorsi muscle at the level of 4th, 5th and 6th lumbar vertebrae. The data mainly refer to 12 animals paired on the basis of age and weight, one member of each pair being implanted with 120 mg. hexoestrol (when 24 to 28 months old), the other being a non-implanted control : all such steers were slaughtered when 36 to 40 months old. Data from unpaired implanted and control steers, of different ages, are also considered.

It is clear from Table I that the content of intramuscular fat is lowered in the longissimus dorsi of implanted animals, but that the dry weights and ash are identical. There is thus no evidence of reversion to a form of higher moisture content, despite that the lumbar region of the longissimus dorsi is a late developing part and hence might be expected to have a greater susceptibility to change. For unpaired samples the concentration of intramuscular fat was $2.99 \pm .35$ (14) in controls and $1.97 \pm .23$ (17) in implanted steers. It is also evident from Table 1 that the intramuscular fat of implanted steers is more unsaturated than in controls. This could be accounted for on the basis of the inverse relationship between the percentage of intramuscular fat and its iodine number, referred to by Callow (8).

The lower intramuscular fat in implanted steers alligns with the general leanness superficially observed in the carcases from treated animals. The relative absence of marbling fat will tend to make the cut surface of the longissimus dorsi muscle at the quartering point appear "darker" than usual and together with the sparse cover of subcutaneous fat (through which the

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purplish-red colour of myoglobin in the underlying musculature will be more readily observed) may account for the frequent designation of hormone-implanted beef as "dark-cutting".

The distribution of nitrogen between various fractions, as defined by the method of Helander (9), is given in Table 2.

It is clear that the nitrogen distribution in longissimus dorsi muscles from control and implanted animals is virtually identical. There is, again, no suggestion of a reversion to a less developed form, such as characterises the young animal, where a low percentage of fat and a high percentage of moisture is accompanied by a low nitrogen content, both overall and in myofibrillar and sarcoplasmic fractions (Table 3).

The mean ultimate pH, for the lumbar region of the longissimus dorsi muscle, was 5.48 $\pm$ .01 (6) and 5.51 $\pm$ .01 (6) in paired control and treated carcases respectively : in somewhat larger unpaired groups the mean values were 5.53 $\pm$ .02 (14 - control) and 5.52 $\pm$ .01 (17 implanted) respectively. The major prerequisite for the occurrence of dark-cutting beef-namely a high ultimate pH(10)- is thus absent. Moreover the mean myoglobin concentrations in control and implanted longissimus dorsi muscles (0.42 - 0.43 %) were also identical : reports of dark colour in the lean of implanted beef cannot, therefore, be substantiated on the alternative basis of there being a higher pigment concentration in the musculature of implanted animals.

As judged by the above analytical criteria, the longissimus dorsi muscle of steers implanted with hexoestrol, although showing a diminished intramuscular fat content, has no more moisture and no less nitrogen than control material. The benefits of increased growth rate and high feed conversion efficiency, which are sought, and generally effected, by the process of implantation are thus presumably not offset by an <u>intrinsic</u> deterioration in the quality of the musculature in the carcase as a whole, despite its increased quantity. Of course, the more subtle aspects of flavour and texture may be impaired ; but since 70 % of all beef cattle which are given feeding stuffs in U.S.A. are either implanted or fed oestrogens, such impairment seems unlikely to be great.

A more serious potential drawback to the use of hormones is the possibility of there being significant residues in the carcases at time of slaughter which could be consumed by human beings. Where implantation is the method of administration, this danger is remote, as the pellets are placed in the ears, which are discarded. The danger is perhaps somewhat greater when oestrogens are fed. Nevertheless, even with this method of administration, it has been reported that no oestrogenic activity could be detected in edible flesh when steers were fed up to 60 mg. stilboestrol per day for 90 - 180 days, provided administration stopped 48 hours before slaughter (11).

Although public opinion will tend to support or condemn alternately the administration of hormones to stock, it seems both likely and necessary that this mode of control over the biological processes by which food is produced will be increasingly employed in the future.

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Résumé

1. Les muscles longissimus dorsi de boeufs ayant reçu des injections d'Hexoestrol montrèrent un contenu de graisses intramusculaires (avec un indice plus élevé d'iode) moindre que celui des animaux témoins . mais un contenu d'humidité et d'azote (total) similaire (calculé sur une base libre de graisse).

2. Ces résultats, accompagnés par une distribution normale d'azote entre le sarcoplasme, les myofibriles, le stroma et les portions sans protéines, indiquèrent que les injections d'Hexoestrol ne causent pas de regression vers une forme musculaire plus primitive.

3. Des indications que les boeufs injectés d'Hexoestrol donnent une viande de couleur sombre à la coupe ne furent pas confirmées par les résultats obtenus pour le pH final ou la teneur en myoglobine.

Zusammenfassungs

1. Die longissimus dorsi Muskeln von jungen Ochsen, die mit Hexoestrol eingespritzt wurden, zeigten einen niedrigeren Gehalt an Muskel-Fett (mit einem hohem Iodzahl) als die kontrollierten Tieren. Sie enthielten aber eine ähnliche Feuchtigkeit und einen ähnlichen total Gehalt an Stickstoff (auf Fett-freie Basis).

2. Von diesen Berechnungen, zusammen mit einer Normal-Verteilung von Stickstoff zwischen Sarooplasma, Myofibrils, Grundgewebe und Protein-Freie Teile, ziehen wir die Folgerung, dass Einspritzung mit Hexoestrol keinen Rückschlag auf eine mehr primitive Muskelform verursacht.

3. Berichte, dass die mit Hexoestrol eingespritzten Ochsen "dark-cutting beef" (dunkles Fleisch wenn geschitten) liefern, wurden nicht durch die Resultate über den endguldigen pH oder Myoglobine bestätigt.

Summary

1. The longissimus dorsi muscles of steers implanted with hexoestrol had a lower content of intramuscular fat (with a higher iodine number) than controls, but similar moisture and total nitrogen contents (on a fat-free basis).

2. These data, together with a normal distribution of nitrogen between sarcoplasm, myofibrils, stroma and non-protein fractions, indicated that implantation causes no reversion to a more primitive muscle form.

3. Reports that implanted steers yield "dark-cutting" beef were not substantiated by data on ultimate pH or myoglobin.

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Table 1. Fat and dry wt. content of longissimus dorsi muscles from control and implanted steers (mean data from 6 pairs of animals).

	Control	Implanted
Intramuscular fat	3.37 ± .33	2.42 ± .36
Iodine N°.	57.45 ± .70	59.31 ± .90
Dry weight (whole tissue basis)	22.51 ± .13	22.70 ± .09
Ash (whole tissue basis)	1.01 ± .04	1.02 ± .03
Dry weight (fat-free basis)	23.29 ± .04	23.26 ± .09

Table 2. Nitrogen fractions in longissimus dorsi muscles from control and implanted steers (mean data from 6 pairs of animals)

	Control	Implanted
Total nitrogen (whole tissue basis)	3.51 ± .01	3.53 ± .02
Total nitrogen (fat-free basis)	3.63 ± .01	3.63 ± .03
Non protein nitrogen (whole tissue basis)	0.43 ± . 01	0.44 ± .01
Sarcoplasm nitrogen " "	0.88 ± .02	0.89 ± .01
Myofibril nitrogen " "	1.83 ± .06	1.77 ± .05
Stroma nitrogen " "	0.36 ± .06	0.44 ± .06
Ratio myofibril/total nitrogen	0.52 ± .02	0.50 ± .01

Table 3. Comparative data on composition of beef longissimus dorsi muscle (region of 4th, 5 th & 6th lumbar vertebrae)

Criterion	Animal	
	12 day old calf	3 year old steer
Dry wt. %	21.49	22.20
Intramuscular fat %	0.55	3.69
Iodine N°	82.41	56.50
Moisture (by diff.) %	77.96	74.11
Ash %	1.17	0.96
Nitrogen		
Total	3.30	3.52
Non-protein %	0.36	0.39
Sarcoplasm %	0.62	0.87
Myofibril %	1.52	1.61
Stroma %	0.80	0.65
Myoglobin %	0.07	0.46
Ultimate pH	5.54	5.57