

## **The influence of energy and protein level on the carcass and lean quality in young bulls**

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### **Abstract**

On the initiative of the National Institute of Animal Science a number of experiments have been carried out in recent years in Denmark to investigate the effect of energy and protein level on the production characteristics of young bulls slaughtered at different live-weights.

These experiments have shown that the best carcass and lean quality is obtained with intensive feeding, but that it is necessary to take into account the weight at which the bulls are to be slaughtered, and whether early or late maturing breeds are being used.

Furthermore, the experiments showed that the protein level can be varied within quite wide limits without any effect on carcass and lean quality being observed.

### **Résumé**

#### *Influence du niveau des apports énergétiques et azotés sur la qualité des carcasses et des viandes de taurillons*

A l'instigation de l'Institut National des Sciences Animales plusieurs expériences ont été conduites au Danemark ces dernières années pour étudier l'influence du niveau des apports énergétiques et azotés sur les caractéristiques de la production de taurillons abattus à différents poids vifs.

Ces expériences ont montré que les carcasses et viandes de meilleures qualités ont été obtenues avec un niveau d'alimentation intensif, mais il fallait cependant tenir compte aussi du poids d'abattage et de la « précocité » des races utilisées.

En outre, ces expériences ont montré que le niveau azoté pouvait varier dans des limites assez larges, sans aucun effet notable sur les qualités de carcasse et des viandes.

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### Introduction

In Denmark nearly all bull calves are intensively fed. They are slaughtered now at a liveweight of about 400 kg, as against 230 - 250 kg liveweight previously.

The carcasses are almost exclusively sold on the Italian market, which demands a good conformation, a rather thin layer of tallow, and meat which is light in colour. To fulfil these requirements it is necessary to know how the energy and protein level influences carcass and lean quality.

Thus, a number of experiments have been carried out in recent years to establish the optimum feeding method, which also takes into account the steadily increasing requirements for carcass and meat quality.

#### 1. — The influence of energy level on carcass and lean quality

##### *Experiment 1.*

An extremely detailed experiment, known as REFSGAARD'S experiment, was carried out in Denmark in the period 1969 to 1973. The aim of this experiment was to investigate the effect of different slaughter weight and energy levels on young bulls (REFSGAARD ANDERSEN, 1974 ; KOUSGAARD, 1974 ; LIS BUCHTER, 1975). A total of 168 young bulls of the Danish Red breed were divided into 7 different slaughter weights (180, 240, 300, 360, 420, 480, and 540 kg) and 4 different energy levels (100, 85, 70 and 55 per cent). The results for carcass quality, which are probably well known, are shown in Table 1.

The following can be seen from Table 1 :

- a. The dressing percentage increases with increasing slaughter weight and increasing energy level. This was not, however, true for the lowest energy level.
- b. Conformation (the shape of the carcass) was clearly poorer with a low energy level than with a moderate or high energy level. This is related to the fact that the animals' degree of fatness falls with decreasing energy level.
- c. The percentage of meat in the cheaper cuts, the flank, flatiribs, brisket and shin, is more or less the same, irrespective of the slaughter weight or energy level. The percentage of tallow increases markedly with increasing slaughter weight for *ad libitum* feeding, while the percentage of bone falls slightly.

With intensive feeding the lean content of the shoulder, neck and forerib is about 20 per cent for all slaughter weights, while with low energy level feeding an increase is seen with the highest slaughter weight. This increase can perhaps be explained by the fact that the bulls have reached an age of 15 to 16 months and are beginning to develop a bull neck.

The percentage of meat in the pistol cut decreases with increasing slaughter weight for all energy levels. With respect to tallow and bones a greater increase and a greater decrease, respectively, is seen with the high as compared to the low energy level. The weight of the pistol cut falls with increasing slaughter weight from about 49 - 50 per cent to about 44 - 45 per cent, and this decrease is almost exclusively due to a drop in lean content.

TABLE 1  
CARCASE QUALITY RESULTS

	180 kg liveweight			360 kg liveweight			540 kg liveweight									
	Energy level %	70	55	Energy level %	70	55	Energy level %	70	55							
Dressing percentage	54.4	53.9	52.5	52.5	52.9	52.7	57.5	57.2	56.3	52.1						
Conformation <sup>x)</sup>	6.8	6.0	5.2	4.5	7.3	6.0	4.7	4.2	7.5	7.3	5.3	3.7				
Flank flatiribs, % meat	15.8	15.2	14.6	14.5	14.5	14.6	14.5	15.1	15.2	14.6	14.8	15.7	15.1	14.9		
brisket, shin	2.9	2.9	2.8	2.7	6.7	5.5	4.5	4.3	7.9	5.9	5.2	3.6	7.9	5.9	5.2	3.6
% bone	4.5	4.7	4.5	4.7	3.9	4.1	4.4	4.2	3.7	3.7	3.9	4.5	3.7	3.7	3.9	4.5
Shoulder, neck	20.0	19.9	20.2	20.4	20.3	20.3	20.4	20.9	20.7	21.5	23.5	23.5	20.7	21.5	23.5	23.5
forerib	2.0	1.7	1.9	1.9	3.1	2.6	2.5	2.5	3.6	2.6	2.6	2.1	3.6	2.6	2.6	2.1
% bone	5.8	6.0	5.9	6.3	5.1	5.3	5.7	5.6	4.6	4.8	5.3	6.4	4.6	4.8	5.3	6.4
Pistol cut	35.0	35.4	35.3	35.0	31.4	32.4	32.6	33.2	30.4	31.8	31.5	31.6	30.4	31.8	31.5	31.6
% meat	4.0	3.7	4.0	3.8	6.7	5.9	5.4	5.4	6.8	5.9	5.1	4.1	6.8	5.9	5.1	4.1
% tallow	10.0	10.4	10.7	10.8	8.4	8.8	9.4	9.5	7.4	8.0	7.9	9.4	7.4	8.0	7.9	9.4
% bone	70.8	70.5	70.2	69.8	66.2	67.8	68.2	68.6	66.0	69.0	70.1	70.0	66.0	69.0	70.1	70.0
Half carcass	8.9	8.3	8.7	8.4	16.5	14.1	12.4	12.1	18.3	14.5	12.9	9.8	18.3	14.5	12.9	9.8
% meat	20.3	21.2	21.1	21.8	17.3	18.1	19.5	19.2	15.8	16.5	17.0	20.3	15.8	16.5	17.0	20.3
% tallow																
% bone																

x) 10 best, 1 poorest.

TABLE 2  
MEAT QUALITY RESULTS FOR *M. Long. dorsi*

	180 kg liveweight			360 kg liveweight			540 kg liveweight					
	100	85	70	55	100	85	70	55	100	85	70	55
% protein	21.3	21.4	21.3	21.1	22.0	22.1	21.8	21.9	22.2	22.9	22.2	22.2
% intramuscular fat	0.9	0.8	0.7	0.7	1.8	1.5	1.2	1.0	2.6	1.9	1.9	1.4
Colour R 535	19.4	19.0	18.6	18.8	15.7	16.3	15.2	15.4	13.5	13.5	13.5	12.6
Total pigment ppm	49	51	57	57	83	82	92	86	115	124	125	134
Volodkewich consistency	6.9	6.6	8.1	5.7	6.8	7.8	6.8	10.2	8.6	11.1	9.7	9.8

The lean quality investigations consisted of an estimation of the per cent protein, per cent intramuscular fat, reflectance value (R 535), total pigment, consistency value and the pH in the *longissimus dorsi*, *triceps brachii*, *semiten-dinosus* and *semimembranosus* muscles. The results for the *longissimus dorsi* muscle are shown in Table 2. The samples from animals with a liveweight of 180 kg were matured at 4°C to 7 days after slaughter, while the samples from animals slaughtered at 360 and 540 kg liveweight were matured to 10 days after slaughter.

The results were as follows :

- a. The protein content of the meat increases slightly with increasing slaughter weight, but is almost unaffected by energy level.
- b. The fat content increases both with increasing slaughter weight and increasing energy level, but energy level only becomes really important at the highest slaughter weight.
- c. Lean colour becomes darker with increasing slaughter weight and decreasing energy level, although the latter's effect is somewhat limited. Changes in pigment content more or less follow the changes in reflectance value.
- d. The consistency value is especially affected by increasing slaughter weight, and to a much lesser extent, by decreasing energy level. The consistency value, however, does not register the changes in connective tissue, which occur with increasing age and weight to any great extent, so a taste panel is more effective in registering increasing toughness with increasing slaughter weight, a fact that was shown by VESTERGAARD (1974) on a small number of animals.

### *Experiment II*

A crossbreeding experiment with young bulls, which is not yet finished, is being carried out in collaboration with the National Institute of Animal Science (LIBORIUSSEN *et al.*, 1978). In this experiment three different slaughter weights and three different energy levels (*ad libitum*, 85 per cent and 70 per cent) are being investigated. The results, which have not yet been published are shown in Table 3.

The differences found were highly significant and were those expected from previous experiments in that both increasing slaughter weight and increasing energy level resulted in a higher slaughter yield, a better conformation with a higher degree of tallow covering, and a higher percentage of tallow. Both lean and bone content fell with increasing slaughter weight and increasing energy level.

As the experiment involved crossbreeding, it is also interesting to see how there is a significant interaction between energy level and sire breed.

The lean quality investigations are not yet finished, but a preliminary survey which includes the results from 278 animals, shows that the tenderness of the meat deteriorates significantly, both with increasing slaughter weight and decreasing energy level.

### *Experiment III*

In another unfinished experiment with the title "The influence of different slaughter weights and energy levels on growth rate, feed conversion, and carcass and lean quality of young bulls and steers (Danish Friesian)", the aim is to

TABLE 3  
LEAST SQUARE MEANS FOR CARCASS QUALITY RESULTS

	Number	Liveweight kg	Carcass weight kg	Dressing %	Grading		% lean	% tallow	% bone
					Conf. 1	Fatness <sup>2</sup>			
Liveweight									
320 kg	136	326	174	53.4	7.2	2.9	71.3	10.8	17.9
440 kg	147	445	242	54.4	8.0	3.1	70.1	13.2	16.7
560 kg	126	562	315	56.0	8.2	3.5	69.4	15.0	15.6
Significance <sup>3</sup>		xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx
Energy level									
70%	158	443	243	54.6	7.2	2.9	71.6	11.1	17.3
85%	161	445	241	54.0	7.4	3.1	71.1	12.0	16.9
100%	90	445	246	55.2	8.6	3.5	68.1	15.9	16.0
Significance <sup>3</sup>		NS	xxx	xxx	xxx	xxx	xxx	xxx	xxx

1) best 10 and 1 poorest

2) 1 leanest and 5 fattest

3) x = P < 0.05, xx = P < 0.01, xxx = P < 0.001

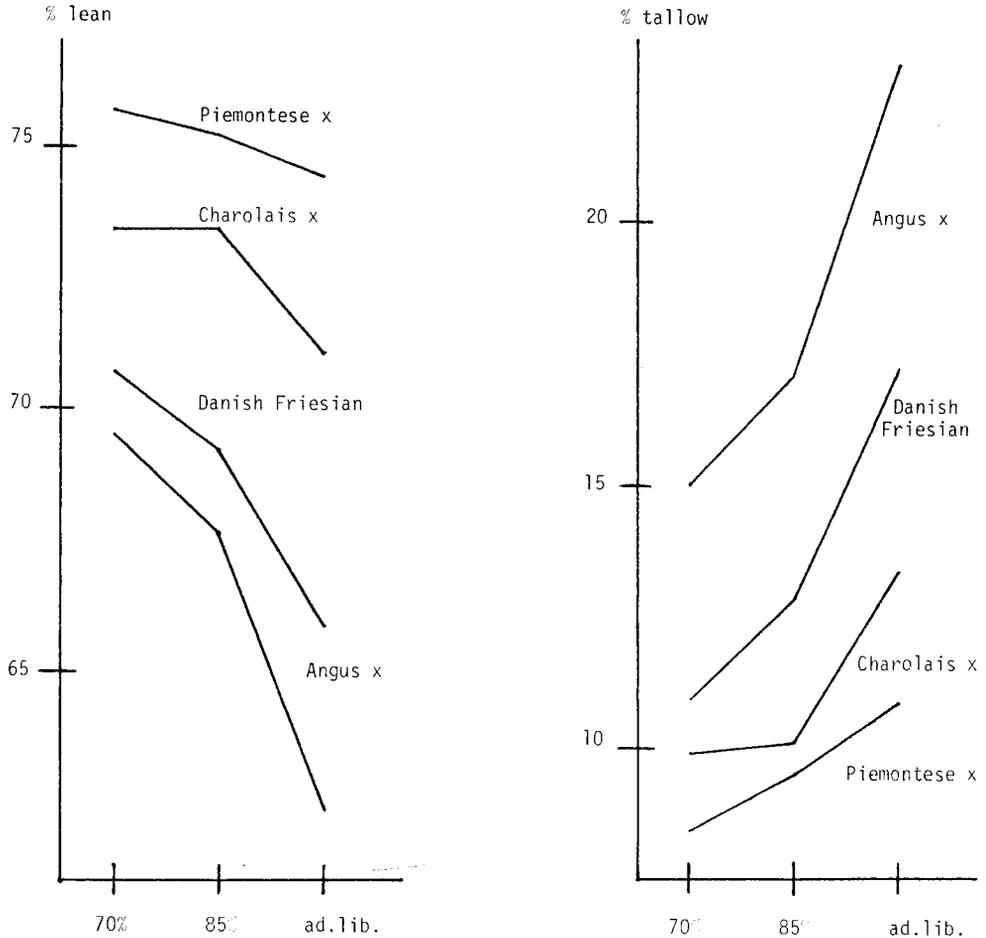


FIG. 1. — Interaction between sirebreed and feeding energy.

investigate slaughter and lean quality with *ad libitum*, 85 per cent and 70 per cent feeding, as well as to see what happens when animals fed at the 70 per cent level are fed *ad libitum* for the last 125 kg before slaughter. The young bulls and steers were slaughtered at a liveweight of 425, 550, and 675 kg, and for young bulls only, also at 800 kg. The preliminary results are shown in Table 4.

The following can be seen from Table 4 :

- The greatest difference between young bulls and steers is found in lean and tallow content.
- With increasing slaughter weight a similar development to that found in previous experiments was observed.
- The effect of increasing energy level is also that expected, but it is interesting to see that *ad libitum* feeding the last 125 kg before slaughter gives almost the same results as feeding with 85 per cent energy level for the whole of the experimental period.

TABLE 4  
LEAST SQUARE MEANS FOR CARCASS QUALITY

	Dressing percentage	Grading Conf. 1	Fatness <sup>2</sup>	% Pistol cut	% lean	% tallow	% bone
Category <sup>3)</sup>							
Young bulls	57.8	7.5	3.1	44.1	67.8	15.5	16.7
Steers	58.1	7.1	3.1	44.3	61.1	22.6	16.3
Significance	NS	NS	-	NS	xxx	xxx	x
Carcass weight <sup>4)</sup>							
425	56.3	6.9	3.0	45.2	68.4	14.2	17.4
550	57.6	7.0	3.0	44.3	67.9	15.2	16.8
675	59.3	8.2	3.5	43.0	66.3	17.5	16.2
800	60.1	7.9	3.4	41.7	65.2	19.6	15.2
Significance	xxx	NS	-	xxx	xxx	xxx	xxx
Feeding energy <sup>3)</sup>							
<i>ad. libitum</i>	58.6	7.7	3.6	43.7	61.2	22.9	15.8
85	57.9	6.7	3.6	44.3	64.5	18.6	16.9
70	57.3	6.8	3.1	44.6	66.6	16.2	17.2
70/100	58.0	7.9	3.3	44.2	65.3	18.4	16.3
Significance	x	xx	-	xxx	xxx	xxx	xxx

1 = 10 best, 1 poorest

3 = includes 89 animals, no bulls of 800 kg

2 = 1 leanest and 5 fattest

4 = includes 47 animals, bulls only.

d. It should be noted that a significant interaction between category of animal and slaughter weight was found for per cent tallow and per cent bone, as well as between slaughter weight and energy level for per cent lean and per cent tallow.

With respect to lean quality, steers have a lower consistency value and a higher fat content in the lean compared to young bulls. Moreover, the lean becomes darker and the intramuscular fat content increases with increasing slaughter weight. *Ad libitum* feeding for the last 125 kg before slaughter seems to improve lean quality.

## 2. — The influence of protein level on carcase and lean quality

A series of experiments were carried out in Denmark in the period 1966 to 1971 to bring the protein norms used at that time up to date (ANDERSEN *et al.*, 1973 ; SORENSEN and KOUSGAARD, 1976). The experimental material consisted of 156 young bulls of the Danish Red and Danish Friesian breeds, which weighed 160 kg at the start of the experiment and 500 kg at slaughter.

The experiments showed that a ration of 110 g of digestible crude protein at the beginning of the experimental period and 70 g at the end was sufficient to ensure an acceptable daily weight gain and carcase and lean quality. The experiments showed, moreover, that the protein content of the feed could vary from 75 g to 135 g per unit, without any effect on carcase and meat quality.

The protein norms, which are recommended, are as follows :

Protein standards for fattening calves and young bulls			
Weight, kg	g digestible crude protein		
	per f.u.	per day	f.u. per day
-100	115	250	1.6
100-150	135	400	3.0
150-200	115	440	3.8
200-250	100	500	5.0
250-300	90	500	5.6
300-350	85	550	6.5
350-400	80	550	7.0
400-450	75	550	7.1
450-500	75	550	7.4

In the previously mentioned, unfinished, crossbreeding experiment two different protein levels were used for the animals on restricted feeding, i.e. 114 and 138 g digestible crude protein per feed unit. The results showed a slightly lower feed conversion, better daily gain, better conformation and a slightly lower meat and tallow content in the animals with the highest protein level. It is not possible

to give any direct explanation for this deviation from previous results, but some things point to the fact that protein quality is important, as the effect was only seen in one of the experimental years.

### Conclusions

Intensive feeding is necessary for young bulls if the best possible carcass and lean quality is to be ensured.

When slaughtering at a high liveweight, it is possible to feed restrictively in the first part of the fattening period, if the animals are fed *ad libitum* in the last part of the fattening period.

With respect to energy level, it should be noted that the optimum slaughter weight is different for the different breeds and breed combinations, and that there is an interaction between breed and energy level.

The protein level can be varied within quite wide limits without any effect on carcass and lean quality.

Steadily increasing requirements for carcass and meat quality make it necessary that the optimum feeding method be used, and this method will depend on both slaughter weight and breed.

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